



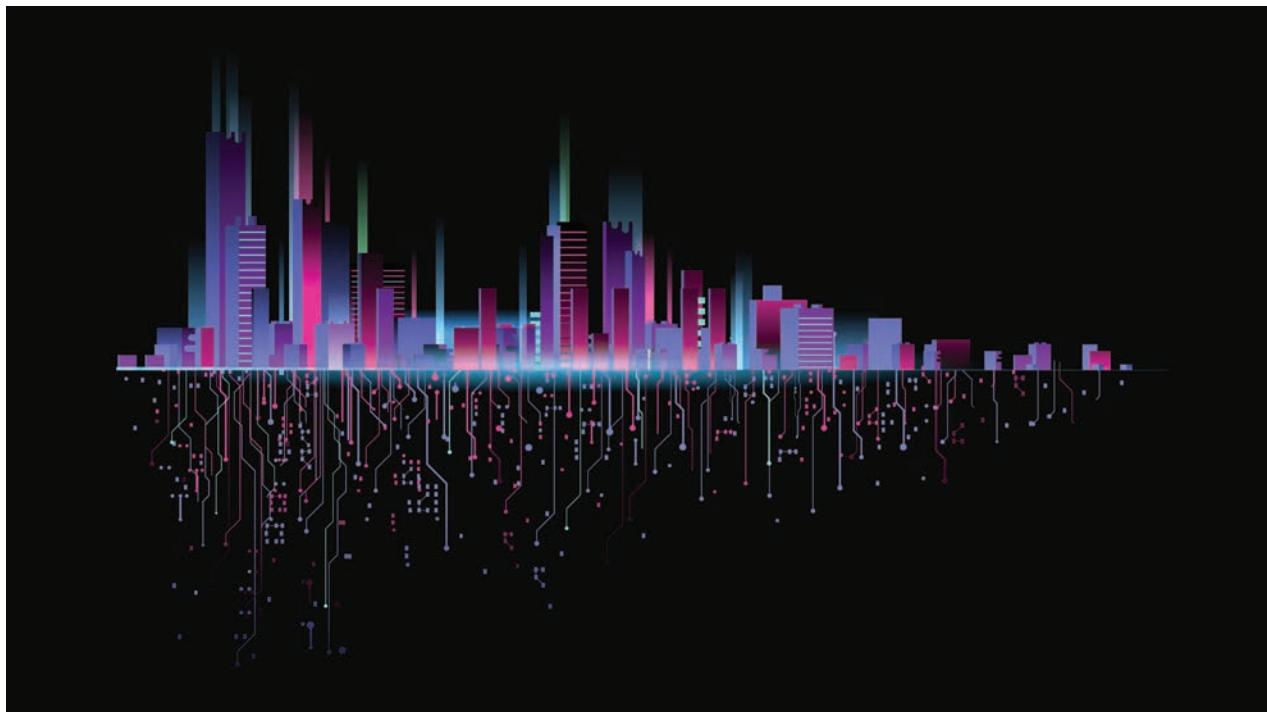
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14  
EDITION

# Principles of Information Systems

George W. Reynolds | Ralph M. Stair

Fourteenth Edition



# Principles of Information Systems

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For Lila and Leslie  
—RMS

To my grandchildren: Michael, Jacob, Jared, Fievel,  
Aubrey, Elijah, Abrielle, Sofia, Elliot, Serena, and Kendall  
—GWR



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# Preface

As organizations and entrepreneurs continue to operate in an increasingly competitive and global marketplace, workers in all business areas including accounting, customer service, distribution, finance, human resources, information systems, logistics, marketing, manufacturing, research and development, and sales must be well prepared to make the significant contributions required for success. Regardless of your future role, even if you are an entrepreneur, you need to understand what information systems can and cannot do and be able to use them to help you achieve personal and organizational goals. You will be expected to discover opportunities to use information systems and to participate in the design and implementation of solutions to business problems employing information systems. To be successful, you must be able to view information systems from the perspective of business and organizational needs. For your solutions to be accepted, you must recognize and address their impact on coworkers, customers, suppliers, and other key business partners. For these reasons, a course in information systems is essential for students in today's high-tech world.

*Principles of Information Systems, Fourteenth Edition*, continues the tradition and approach of previous editions. Our primary objective is to provide the best information systems text and accompanying materials for the first information systems course required for all business students. We want you to learn to use information systems to ensure your personal success in your current or future role and to improve the success of your organization. Through surveys, questionnaires, focus groups, and feedback that we have received from current and past adopters, as well as others who teach in the field, we have been able to develop the highest-quality set of teaching materials available to help you achieve these goals.

*Principles of Information Systems, Fourteenth Edition*, stands proudly at the beginning of the IS curriculum and remains unchallenged in its position as the only IS principles text offering basic IS concepts that every business student must learn to be successful. Instructors of the introductory course faced a dilemma. On one hand, experience in business organizations allows students to grasp the complexities underlying important IS concepts. For this reason, many schools delayed presenting these concepts until students completed a large portion of their core business requirements. On the other hand, delaying the presentation of IS concepts until students have matured within the business curriculum often forces the one or two required introductory IS courses to focus only on personal computing software tools and, at best, merely to introduce computer concepts.

This text has been written specifically for the introductory course in the IS curriculum. *Principles of Information Systems, Fourteenth Edition*, addresses the appropriate computer and IS concepts while also providing a strong managerial emphasis on meeting business and organizational needs.

## Approach of This Text

*Principles of Information Systems, Fourteenth Edition*, offers the traditional coverage of computer concepts, but places the material within the context of meeting business and organizational needs. Placing information systems concepts within this context and taking a management perspective has always set this text apart from other computer texts, thus making it appealing not only to MIS majors but also to students from other fields of study. The text is not overly technical, but rather deals with the role that information systems play in an organization and the key principles a manager or technology specialist needs to grasp to be successful. The principles of IS are brought together and presented in a way that is understandable, relevant, and interesting. In addition, the text offers an overview of the entire IS discipline, while giving students a solid foundation for further study in more advanced IS courses such as programming, systems analysis and design, project management, database management, data communications, Web site design and development, information system security, big data and analytics, e-commerce, and informatics. As such, it serves the needs of both general business managers and those who aspire to become IS professionals.

While the fundamental vision of this market-leading text remains unchanged, in the Fourteenth Edition the structure and topic coverage have been reexamined and realigned to more clearly highlight established principles and draw on new ones that have emerged as a result of business, organizational, technological, and societal changes.

### IS Principles First, Where They Belong

Exposing students to basic IS principles is an advantage even for those students who take no IS courses beyond the introductory IS course. Since most functional areas of the business rely on information systems, an understanding of IS principles helps students in their other course work. In addition, introducing students to the principles of information systems helps future business managers and entrepreneurs employ information systems successfully and avoid mishaps that often result in unfortunate consequences. Furthermore, presenting IS concepts at the introductory level creates interest among students who may later choose information systems as their field of concentration.

## Goals of This Text

Because *Principles of Information Systems, Fourteenth Edition*, is written for business majors, we believe that it is important not only to present a realistic perspective on IS in business but also to provide students with the skills they can use to be effective business leaders in their organizations. To that end, *Principles of Information Systems, Fourteenth Edition*, has three main goals:

1. To provide a set of core IS principles that prepare students to function more efficiently and effectively as workers, managers, decision makers, and organizational leaders

2. To provide insights into the challenging and changing role of the IS professional so that students can better appreciate the role of this key individual
3. To show the value of the IS discipline as an attractive field of specialization so that students can evaluate this as a potential career path

## IS Principles

*Principles of Information Systems, Fourteenth Edition*, although comprehensive, cannot cover every aspect of the rapidly changing IS discipline. The authors, having recognized this, provide students with an essential core of guiding IS principles to use as they strive to use IS systems in their academic and work environment. Think of principles as basic truths or rules that remain constant regardless of the situation. As such, they provide strong guidance for tough decision making. A set of IS principles is highlighted at the beginning of each chapter. The use of these principles to solve real-world problems is driven home from the opening examples of cutting edge applications to the dozens of real-world examples of organizations applying these principles interspersed throughout each chapter to the interesting and diverse end-of-chapter material. The ultimate goal of *Principles of Information Systems, Fourteenth Edition*, is to develop effective, thinking, action-oriented students by instilling them with principles to help guide their decision making and actions.

## Survey of the IS Discipline

*Principles of Information Systems, Fourteenth Edition*, not only offers the traditional coverage of computer concepts but also provides a broad framework to impart students with a solid grounding in the business uses of technology, the challenges of successful implementation, the necessity for gaining broad adoption of information systems, and the potential ethical and societal issues that may arise. In addition to serving general business students, this book offers an overview of the entire IS discipline and solidly prepares future IS professionals for advanced IS courses and careers in the rapidly changing IS discipline.

## Changing Role of the IS Professional

As business and the IS discipline have changed, so too has the role of the IS professional. Once considered a technical specialist, today the IS professional operates as an internal consultant to all functional areas of the organization, being knowledgeable about their needs and competent in bringing the power of information systems to bear throughout the entire organization. The IS professional must view issues through a global perspective that encompasses the entire enterprise and the broader industry and business environment in which it operates.

The scope of responsibilities of an IS professional today is not confined to just his or her organization but encompasses the entire ecosystem of employees, contractors, suppliers, customers, competitors, regulatory agencies, and other entities, no matter where they are located. This broad scope of responsibilities creates a new challenge: how to help an organization survive in our highly interconnected, highly competitive global environment. In accepting that challenge, the IS professional plays a pivotal role in shaping the business itself and ensuring its success. To survive, businesses must strive for the highest level of customer satisfaction and loyalty through innovative products and services, competitive prices, and ever-improving product and service quality. The IS professional assumes a critical role in determining the organizations approach to both overall cost and quality performance and therefore plays an

important role in the ongoing growth of the organization. This new duality in the role of the IS worker a professional who exercises a specialist's skills with a generalist's perspective is reflected throughout *Principles of Information Systems, Fourteenth Edition*.

## IS as a Field of Study

Computer science and business were ranked #1 and #4, respectively, in the 2019 Princeton Review list of top 10 college majors based on research covering job prospects, alumni salaries, and popularity. A 2019 U.S. News & World Report study placed, software developer, operations research analyst, and Web developer as three of the top 25 best jobs for 2019 based on hiring demand, median salary, employment rate, future job prospects, stress level, and work life balance. The U.S. Bureau of Labor Statistics identified information security analysts, operation research analysts, and software and applications developers as among the fastest growing occupations for the period 2018 and 2028. Clearly, the long-term job prospects for skilled and business-savvy information systems professionals is good. Employment of such workers is expected to grow faster than the average for all occupations through the year 2028. Upon graduation, IS graduates at many schools are among the highest paid of all business graduates.

A career in IS can be exciting, challenging, and rewarding! Today, perhaps more than ever before, the IS professional must be able to align IS and organizational goals and to ensure that IS investments are justified from a business perspective. The need to draw bright and interested students into the IS discipline is part of our ongoing responsibility. Throughout this text, the many challenges and opportunities available to IS professionals are highlighted and emphasized.

## Changes to the Fourteenth Edition

A number of exciting changes have been made to the text based on user feedback on how to align the text even more closely with changing IS needs and capabilities of organizations. Here is a summary of those changes:

- **Reorganized structure.** The structure and subject coverage was reexamined to ensure related content has been better aligned, and that there is a clear, logical flow of topics throughout the text. Several chapters have been reordered from the previous edition, some chapters have been combined, some topics have been separated into new chapters, and there are new chapters that focus on emerging and growing areas.
- **New chapters covering the latest IS development.** New chapters include Information Systems: People, Technology, Processes, and Structure; Networks: An Interconnected World; Cloud Computing and the Internet of Things; and Artificial Intelligence and Automation.
- **Extensive changes and updates in each chapter.** The remaining chapters in the text have all been extensively updated to provide the latest information available on a wide range of IS-related topics including hundreds of new and current examples of organizations and individuals illustrating the principles presented in the text.
- **New opening case: IS in Action.** Each chapter begins with an opening vignette to illustrate the concepts that will be covered in the chapter in the context of a real-world, business-focused example.
- **New alignment to AACSB standards.** The opening case studies, critical thinking exercises, and end-of-chapter case studies have been aligned to the latest standards from the Association to Advance Collegiate Schools

- of Business International (AACSB). Standards are indicated by a red arrow feature that appears before each activity.
- **Updated Critical Thinking Exercises.** Each exercise features a scenario followed by review and critical thinking questions. Placed at the end of each major section of each chapter, these exercises test the students' grasp of the material just read. Students must analyze a real-life scenario and synthesize the information provided to develop a recommendation of what needs to be done. The exercises can also be used to stimulate class discussion or as additional mini cases that may be assigned as individual or team exercises.
  - **Updated summary linked to objectives.** Each chapter includes a detailed summary, with each section of the summary updated as needed and tied to an associated information system principle.
  - **Updated end-of-the chapter questions and exercises.** The majority of the end-of-chapter exercises have been updated and the exercises have been realigned into the following assessment types: Review and Discussion Questions, Business-Driven Decision-Making Exercises, Teamwork and Collaboration Activities, Career Exercises, Case Study.
  - **Updated case studies.** One end-of-chapter case studies for each chapter provides a wealth of practical information for students and instructors. Each case explores a chapter concept or problem that a real-world organization has faced. The cases can be assigned as individual or team homework exercises or serve as the basis for class discussion. An additional online-only case study will be available within the online instructor resource materials.

## MindTap for Principles of Information Systems, Fourteenth Edition

MindTap for *Principles of Information Systems, Fourteenth Edition*, is a personalized, fully online, digital learning platform of content, assignments, and services that engages students and encourages them to think critically, while allowing instructors to easily set their course through simple customization options.

MindTap is designed to help students master the skills they need in today's workforce. Research shows employers need critical thinkers, troubleshooters, and creative problem-solvers to stay relevant in our fast paced, technology-driven world. MindTap helps students achieve this with assignments and activities that provide hands-on practice and real-life relevance. They are guided through assignments that help them master basic knowledge and understanding before moving on to more challenging problems.

Students can access eBook content in the MindTap Reader, which offers highlighting, note-taking, search and audio, and mobile access. Multimedia activities and assessments for this text include:

- updated Concept Clip videos
- updated lecture slides and flashcards
- new Career Connection videos
- new You Make the Decision branching exercises
- new Use It business-scenario based questions
- new IS for Life activities that focus on the latest industry trends
- an additional, online-only Case Study not featured in the text
- new SQL: Essentials for the Real World tutorial and coding lab assignments
- access to the SAM MindTap app, which includes simulated computing activities in Microsoft Office 2019

MindTap allows instructors to measure skills and outcomes with ease. Personalized teaching becomes yours through a Learning Path built with key student objectives and the ability to control what students see and when they see it. Analytics and reports provide a snapshot of class progress, time in course, engagement, and completion rates.

## Student Resources

Accessible through [cengage.com](http://cengage.com), the student companion Web site contains the following study tools (and more!) to enhance one's learning experience:

- PowerPoint Lectures that cover the key points of each chapter

## Instructor Resources

### Instructor Companion Site

As always, we are committed to providing the best teaching resource packages available in this market. All instructor materials can be found on the password-protected Web site at <http://login.cengage.com>. Here you will find the following resources:

- **Instructors Manual.** The comprehensive manual provides valuable chapter overviews; highlights key principles and critical concepts; learning objectives, and discussion topics; and features possible essay topics, further readings, cases, and solutions to the end-of-chapter questions and problems, as well as suggestions for conducting the team activities.
- **PowerPoint Lectures.** A set of impressive Microsoft PowerPoint slides is available for each chapter. These slides are included to serve as a teaching aid for classroom presentation, to make available to students on the network for chapter review, or to be printed for classroom distribution. The goal of the presentations is to help students focus on the main topics of each chapter, take better notes, and prepare for examinations. Instructors can add their own slides for additional topics they introduce to the class.
- **Additional Case Studies.** Additional, online-only case studies explore chapter concepts or problems that a real-world organization has faced.
- **Figure Files.** Figure files allow instructors to create their own presentations using figures taken directly from the text.
- **Test Bank files.** Test bank files (from Cognero) are provided for easy LMS integration.

### Test Bank and Cengage Testing Powered by Cognero

Cognero is a full-featured, online-assessment system that allows instructors to manage test bank content, quickly create multiple test versions, deliver tests in several forms including from an LMS, and create test banks anywhere with Internet access! To access Cognero, log into your Cengage—SSO account at <http://login.cengage.com>. Technical questions, guides, and tutorials are hosted on Cengage Learning Technical Support Web site <http://support.cengage.com>.

## Acknowledgments

George Reynolds was a skilled teacher, IS enthusiast, dedicated author, and family man. Over more than 20 years, Cengage has had the privilege of working with George and witnessing his commitment to writing the best information systems textbooks. In addition to *Principles of Information Systems*, George worked with Cengage as the author of *Fundamentals of Information Systems*, *Ethics in Information Technology*, and *Information Technology for Managers*. His dedication to his work never wavered and was rooted in his desire to help students excel in their current and future business careers.

In addition to his work, he was deeply devoted to his family, and often shared stories of barbeques, trips, and other adventures with his wife, children, 11 grandchildren, and his dog, Zeus. George was personable and kind, which made working with him a pleasure. We are deeply saddened by the loss of our author and friend, but take comfort in knowing that his work will continue to help students for years to come.

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# PART 1



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# Information Systems in Business and Society

## Chapter 1

### Information Systems: People, Technology, Processes, and Structure

## Chapter 2

### Secure Information Systems

## Chapter 3

### Corporate and Individual Accountability: Ethical, Legal, and Social Issues



## Principles

Managers have an essential role to play in the successful implementation and use of information systems—that role changes depending on which type of information system is being implemented.

The strategic planning process for the IS organization and the factors that influence it depend on how the organization is perceived by the rest of the organization.

The information system worker operates at the intersection of business and technology and designs, builds, and implements solutions that allow organizations to effectively leverage information systems.

## Learning Objectives

- Identify two key management responsibilities in implementing successful information systems.
  - State three reasons why organizations employ the Leavitt's Diamond model to introduce new systems into the workplace.
  - Describe four fundamental information system types based on their sphere of influence.
  - Discuss the traditional and contemporary view of the role that information systems play in an organization's value chains.
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- Identify four benefits of creating a strategic plan.
  - Identify four drivers that help set the information system organizational strategy.
  - Identify three ways the IS organization can be perceived by the rest of the organization, and how each can influence the IS strategy.
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- Identify six non-technical skills needed to be an effective information system worker.
  - Identify two benefits of obtaining a certification in an IS subject area.

# IS in Action

## mPharma Improves Prescription Availability and Affordability

### ► GLOBAL, DIVERSITY

The people of Africa are struggling to overcome severe healthcare challenges. Africa has 15 physicians per 100,000 inhabitants, less than one-tenth of most countries. Sixty-two percent of its 1.2 billion people live in rural areas where access to medical facilities is extremely difficult. The drug manufacturers and the pharmacies have limited data on which to develop an accurate forecast of the demand for specific drugs. This limited data leads to frequent out-of-stock situations of essential medicines. After seeing patients, doctors may need to make several calls to find pharmacies that can fill the necessary prescriptions. It is not uncommon for a patient to travel miles to a specific pharmacy only to find out that the needed prescription cannot be filled because it is no longer in stock.

An information system is a set of interrelated components that work together to collect, process, store, and disseminate information to support fundamental business operations, data reporting and visualization, data analysis, decision making, communications, and coordination within an organization. mPharma is a start-up company that builds information systems that connect patients, hospitals, pharmacies, and drug manufacturers via networks, software, and mobile phones. With this technology, mPharma manages the prescription drug inventory for pharmacies and pharmaceutical suppliers in four African countries. The information systems also enable mPharma to track which drugs are available at any given time and where. Knowing this information gives patients reliable access to medicines.

Once patients register in the mPharma system, their health data and prescription history can be accessed by their doctor. After registration, doctors can prescribe medication and send a prescription code to the pharmacy and the patient's mobile phone. In addition, doctors can see stock information for any of the mPharma partner pharmacies to avoid sending patients to pharmacies where drugs are unavailable. Doctors and pharmacies can also communicate directly through mPharma's messaging system. By taking over the inventory management for member pharmacies, forecasting demand of prescription drugs, and bargaining with suppliers, mPharma has been able to lower prescription costs by as much as 30 percent.

mPharma found that some participants in the program were reluctant to come on-board. For instance, hospitals were not willing to share patient/doctor data, pharmacies were not willing to allow mPharma access to their inventory data, and patients had concerns about the privacy of their data. To prove the system would work, mPharma launched a pilot program in Zambia that involved several doctors and 1,000 patients who received their prescriptions through the mPharma system. The success of this pilot helped ease many of these concerns. In addition, mPharma was able to extract an enormous amount of data to track drug usage and develop a real-time disease surveillance system.

mPharma founders had a clear goal: Make prescription drugs in emerging markets easily accessible and readily affordable. They formed partnerships with venture capitalists, major pharmaceutical manufacturers, insurance companies, financial institutions, and governments to build a new technology infrastructure. They then developed information systems on top of this infrastructure to change how prescriptions are filled and inventory is managed. These new processes changed who is responsible for forecasting the demand of prescription drugs. In addition, mPharma used key supporting system complements including physician, pharmacy, and patient education to ensure successful implementation and adoption of the system by doctors, patients, and pharmacists.

### As you read about information systems, consider the following:

- How are organizations using information systems to accomplish their objectives and meet ever-changing business needs?
- What role might you have in identifying the need for, acquisition of, or use of such systems?

## Why Learn About Information Systems?

We live in an information economy, and information systems are embedded in and control many of the products we use on a daily basis—our phone, the auto we drive, our coffee maker, the cable box that controls our TV, and so on. Information has real value. To stay competitive, organizations require a steady flow of information about their business partners, competitors, customers, employees, markets, and suppliers. When this information is in place, individuals can communicate instantaneously with one another, and consumers make purchases online using mobile devices. In addition, project members dispersed globally and across multiple organizations can collaborate effectively, and financial institutions can manage billions of dollars in assets around the world. Further, manufacturers can partner with suppliers and customers to track inventory, order supplies, and distribute goods faster than ever before.

Starbucks implemented what it calls its “digital flywheel,” which includes everything from its rewards program to its mobile order-ahead feature to eliminate congestion at stores. Target built a myCheckout app that its team members can use on their mobile devices to search Target.com for desired products, and then take guests’ payment on the spot with a credit card reader that’s attached to the handheld device. Guests walk away knowing their items are enroute to their doorstep—with free shipping, by the way! Walmart built an app that allows customers to refill and manage their prescriptions from their mobile devices and skip the line when they reach the pharmacy counter. It also recently entered the credit card processing field with its own mobile payment processing solution called Walmart Pay. Kroger is piloting a new Scan, Bag, Go handheld scanner that enables shoppers to pick items, scan them, and drop them in a grocery tote. When done shopping, consumers head to the self-checkout stand for one last scan that totals their bill and allows them to pay. They drop off the handheld scanner and head out the door.

Information systems will continue to change businesses and the way we live. Indeed, many corporate leaders are using technology to rework their products and services. To prepare to participate in and lead these innovations, you must be familiar with fundamental information system concepts. Regardless of your college major or chosen career, the ability to recognize and capitalize on information system opportunities will make you a valuable member of your organization and will advance your career. And, as you will learn in this chapter, as a manager you have an essential role in ensuring the successful implementation and adoption of your organization’s information systems.

System - Interconnected components which perform a task.  
Network - System of interconnected elements

Collect  
process  
store  
disseminate  
information

## What is an Information System

**information system:** A set of interrelated components that work together to support fundamental business operations, data reporting and visualization, data analysis, decision making, communications, and coordination within an organization.

An **information system** is a set of interrelated components that work together to collect, process, store, and disseminate information. This information supports fundamental business operations, data reporting and visualization, data analysis, decision making, communications, and coordination within an organization. A well-designed information system includes some form of feedback mechanism to monitor and control its operation. This feedback ensures that the system continues to operate in an effective and efficient manner.

Individuals and organizations use computer-based information systems every day to accomplish a wide range of both work-related tasks and everyday living activities. This includes processing the fundamental transactions required to run a business (e.g. capturing customer orders and payments) and communicating with fellow employees, customers, business partners, and other resources. Information systems are also used to analyze large amounts of

## Examples of data collection IS

- Cookies
- MyLms
- PoS - Point of Sales

data to detect underlying trends to enable accurate forecasts; track costs and schedule progress on projects, prepare presentations including slides, graphs, and tables; and monitor results and recommend appropriate actions.

## Information Systems—A Means to Achieve Competitive Advantage

A competitive advantage enables an organization to generate more sales or achieve superior profit margins compared to its rivals. The advantage can be gained in one of three ways: (1) by providing the same value as competitors but at a lower price (cost leadership), (2) by charging higher prices for providing products that are perceived by the customer as being better (differentiation), or (3) by understanding and servicing a target market better than anyone else (focus). Organizations must recognize that considerable effort may be required to sustain a competitive advantage. Organizations and their products and services must continually evolve to account for changes in customer needs, market conditions, industry conditions, and competitor actions.

Managers have a key responsibility to identify and use information systems to gain a competitive advantage. Here are a few examples of using information systems in this manner:

- mPharma, as discussed in the opening vignette, used its custom information systems to become the dominant organization in managing the prescription inventory for pharmacies and their pharmaceutical suppliers in four African countries.
- Boeing employs sophisticated information systems that enable the digital design of various aircraft-related systems. These systems allow early detection and removal of design defects and reduce development cost and time.<sup>1</sup>
- Walmart employs a vendor-managed inventory system to streamline product flow and better manage its store inventories. This system reduces the administrative costs of managing inventory, lowers inventory holding costs, and increases sales through reductions of out-of-stock situations in its stores.
- Skanska USA, a construction firm, employs an information system to track and analyze the movement and tasks of subcontractors on the job. With this system, Skanska can relocate tools and materials to more optimal locations and rearrange workflows to speed up the building process and to reduce labor costs.<sup>2</sup>
- La-Z-Boy differentiates itself from competitors by implementing a system to consolidate shipping and exception data from dozens of carriers so that consumers know when their purchase is shipping from the retailer and when they can expect to see it at their door step.

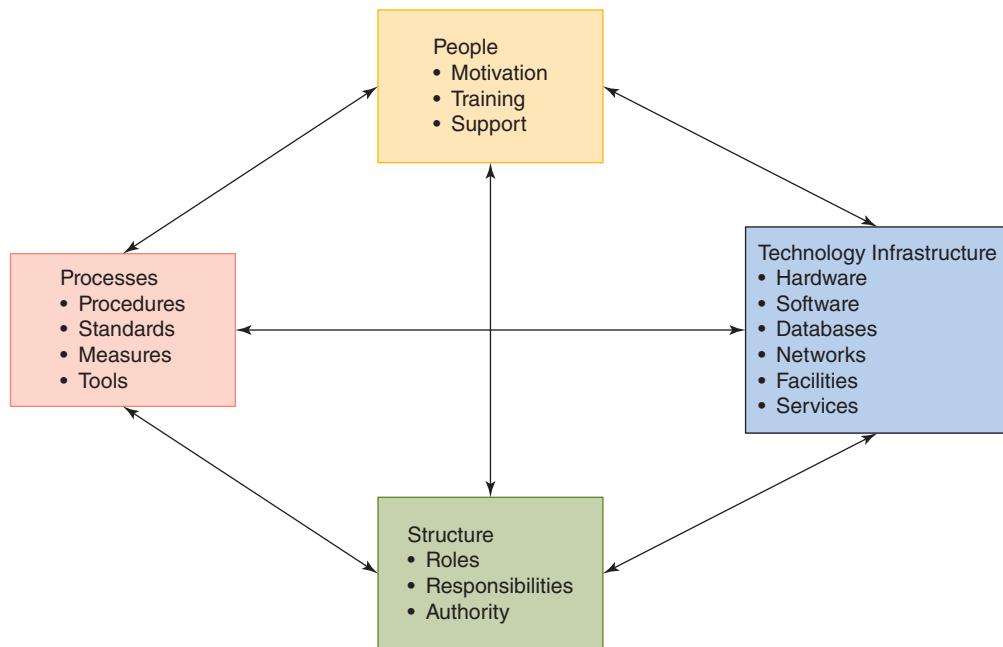
## Managers' Role in Implementing Successful Information Systems

An organization's information system operates within a context of people, technology infrastructure, structure, and processes, as shown in Figure 1.1. This model is known as **Leavitt's Diamond**, and it was defined by American psychologist and organizational scientist Harold Leavitt. Organizations use this model to introduce new systems into the workplace in a manner that lowers stress, encourages teamwork, and increases the probability of a successful implementation.

Leavitt's Diamond highlights the need for an overall implementation approach that considers all four key components. Unfortunately, company leaders often focus too narrowly on just the technology infrastructure component. When they do so, they fail to consider the people, processes, and human structure components. This

**Leavitt's Diamond:** A model that states an organization's information systems operate within a context of people, technology infrastructure, processes, and structure.

failure can create a rough system start-up, frustrated employees, and missed organizational expectations that can lead to system failure or the need to redo much of the implementation effort. Managers of the business functions most affected by the new information system have a key responsibility to ensure that the people, processes, and human structure components are fully addressed.



**FIGURE 1.1**  
**Leavitt's Diamond**

Leavitt's Diamond proposes that every organizational system operates within a context composed of people, technology infrastructure, processes, and human structure.

The various components of Leavitt's Diamond will now be discussed.

**People** People make the difference between success and failure in all organizations. Jim Collins, in his book *Good to Great*, said, “Those who build great companies understand that the ultimate throttle on growth for any great company is not markets, or technology, or competition, or products. It is one thing above all others: the ability to get and keep enough of the right people.”<sup>5</sup> Thus, it comes as no surprise that people are the most important element of information systems. Indeed, people are involved in information systems in many ways: people envision information systems and the benefits they can deliver, people design and build information systems, people support and maintain information systems, and people use information systems to achieve worthwhile results.

Good information systems can enable people to produce extraordinary results. They can also boost job satisfaction and worker productivity.<sup>6</sup> Information systems personnel include all the people who manage, run, program, and maintain the system, including the chief information officer (CIO), who leads the IS organization. End users are people who work directly with information systems to get results. They can include anyone in the organization—receptionists, financial managers, product development personnel, salespeople, human resource managers, marketing representatives, warehouse workers, executives, and manufacturing line operators.

Employees must be well trained and understand the need for the information system, what their role is in using or operating the system, and how to get the results they need from the system. They must be motivated to use the information system and have access to system support people as needed.

**technology infrastructure:** All the hardware, software, databases, networks, facilities, and services used to develop, test, deliver, control, or support the information technology applications and services an organization requires to meet the needs of its customers, suppliers, key business partners, regulatory agencies, and employees.

**Technology infrastructure** An organization's **technology infrastructure** includes all of its hardware, software, databases, networks, facilities (such as data centers and server rooms) and services provided by third parties (such as outside consultants, rented hardware, third-party software, and outside storage). An organization uses these resources to develop, test, deliver, control, or support the information technology applications and services an organization requires to meet the needs of its customers, suppliers, key business partners, regulatory agencies, and employees. The technology infrastructure forms the foundation of every computer-based information system. Worldwide information technology spending is expected to reach nearly \$3.8 trillion in 2019<sup>7</sup> as shown in Table 1.1. This is an amount rivaling the \$4.4 trillion dollar proposed U.S. federal budget for fiscal year 2019.

**TABLE 1.1** Global IT projected spending 2017–2019

Infrastructure Component	Spending in Billions		
	2017	2018	2019
Data center systems	\$178	\$179	\$179
Enterprise software	\$355	\$389	\$421
Devices	\$667	\$704	\$710
IT services	\$933	\$985	\$1,030
Communications services	\$1,393	\$1,427	\$1,443
<b>Total Spending</b>	<b>\$3,526</b>	<b>\$3,684</b>	<b>\$3,783</b>

**process:** A structured set of related activities that takes input, adds value, and creates an output for the customer of that process.

**Processes** A **process** is a structured set of related activities that takes input, adds value, and creates an output for the customer of that process. The input can be something tangible such as raw materials, data, chemical ingredients, documents, or data. The output can be finished product, information gleaned from processing the data, a completed form, or a report. The customer of the process may be an actual business customer or a worker in another organizational unit of the firm who needs the output of the process to perform his/her job or to make a decision. A salesperson taking a customer order is an example of a business process. The items in the order are pulled from inventory and shipped to the customer. The order then goes through billing, collections, and is eventually converted into cash.

A **procedure** defines the steps to follow to achieve a specific end result, such as how to enter a customer order, how to pay a supplier invoice, or how to request a current inventory report. Good procedures describe how to achieve the desired end result, who does what and when, and what to do in the event something goes wrong. When people are well trained and follow effective procedures, they can get work done faster, cut costs, make better use of resources, and more easily adapt to change. When procedures are well documented, they can greatly reduce training costs and shorten the learning curve.

Using an information system involves setting up and following many procedures, including those for the operation, maintenance, and security of the computer. For example, some procedures describe how to gain access to the system through the use of a log-on procedure and a password. Others describe who can access facts in the database or what to do if a disaster, such as a fire, earthquake, or hurricane, makes the information system unusable. Good procedures can help companies take advantage of new opportunities and avoid lengthy business disruptions in the event of natural disasters. Poorly developed and inadequately implemented procedures, however, can cause people to waste their time on useless rules or can result in inadequate responses to disasters.

**procedure:** A set of steps that need to be followed to achieve a specific end result, such as entering a customer order, paying a supplier invoice, or requesting a current inventory report.

**structure:** A definition of the relationships among the members of an organization including their roles, responsibilities, and lines of authority necessary to complete various activities.

**Structure** An organization's **structure** defines relationships among members of the organization. In addition, it defines the roles, responsibilities, and lines of authority that are necessary to complete various activities. Employees must understand and accept their roles and responsibilities, and these roles and responsibilities often change with the introduction of a new information system.

## Types of Information Systems

Organizations employ numerous information systems. When considering the role of people using information systems, it is useful to divide information systems into four types based on their sphere of influence: personal information system, workgroup information system, enterprise information system, and interorganizational information system.

**Personal information system** includes information systems that improve the productivity of individual users in performing stand-alone tasks. Examples of personal IS include word-processing, presentation, time management, and spreadsheet software.

Kroger is the largest retail grocer in the world with \$115 billion in 2016 sales from 2,792 supermarkets and multi-department stores in 35 states and the District of Columbia. Its ClickList system is an example of a personal information system that improves the efficiency of its customers. Customers use ClickList to shop for their groceries online and then pick them up at the store at a prearranged time. Once logged on, the customer can type the names of products into the search bar, browse items by department, or choose one of three other options: My Favorites, My Recent Purchases, and Sale Items for You. The price is clearly displayed under each image; the customer can either click the box beneath the image to add the item directly to the cart or the customer can click on the image itself and see alternate views of the packaging and nutrition information. After the customer order is placed, Kroger Associates choose the items, bag them, and place them in a refrigerated space in the store. Then, customers can just drive to the store at their reserved pickup time, and Kroger loads the order into their car.

In today's global work environment, success depends on our ability to communicate and collaborate with others, including colleagues, clients, and customers. A **workgroup information system** supports teamwork and enables people to work together effectively, whether team members are in the same location or dispersed around the world. These systems are also known as collaboration systems. Examples of workgroup information systems include instant messaging software, electronic conferencing software, and collaboration software used to move groups through the steps of a process toward their goals.

The Monterey Bay Aquarium in California strives to raise awareness of ocean conservation and educate and inspire the next generation of ocean stewards. Its education programs attract some 110,000 students and teachers each year. The aquarium recently set a goal to double the number of its programs and is building a new education center to meet this growth. Achieving this goal means the staff must complete many tasks while working on different teams and different projects. The team uses a group collaboration tool to help them communicate, organize, plan, schedule, track, and delegate jobs. The tool provides visibility and easy access to all ongoing projects and gives team members the opportunity to jump in and help each other out.<sup>3</sup>

An **enterprise information system** is used to meet organization-wide business needs and typically shares data with other enterprise applications used within the organization. Enterprise applications support processes in logistics, manufacturing, human resources, marketing and sales, order processing, accounting, inventory control, customer relationship management, and other essential business functions. These processes require cross-functional collaboration with employees from multiple organizational units.

### workgroup information system

**System:** Systems that support teamwork and enable people to work together effectively, whether team members are in the same location or dispersed around the world.

### enterprise information system

**System:** An information system that an organization uses to define structured interactions among its own employees and/or with external customers, suppliers, government agencies, and other business partners.

Enterprise applications are required to comply with an organization's security guidelines and may also be required to comply with standards defined by government agencies or industry groups to which the organization belongs. For example, all organizations that store, process, and transmit cardholder data strive to meet the Payment Card Industry Data Security Standard. This standard provides a framework of specifications, tools, measurements, and support resources to help organizations ensure the safe handling of cardholder information. Successful implementation of these systems often requires the radical redesign of fundamental work processes, the automation of new processes, and re-training of personnel. Target processes may include purely internal activities within the organization (such as payroll) or those that support activities with external customers and suppliers (order processing and purchasing).

Allan Bros., Inc. is a fruit growing, packing, and shipping company located in Naches, WA. It has orchards located throughout Eastern Washington. The firm developed an enterprise information system that informs workers when and how they should prune the vines and predicts the quality and volume of upcoming crops of grapes. The system can even estimate how many tons will grow per acre—key information for production planning and determining how many wineries the vineyard can serve from one harvest.<sup>4</sup>

An **interorganizational IS** enables the sharing of information across organizational boundaries. Information sharing supports collaboration between two or more organizations and provides benefits such as lower costs, reduced manual effort, and decreased time to conduct business. To achieve these benefits, the information shared between organizations must be accurate, complete, and current. Otherwise, companies using the IOS will experience inefficiencies resulting from the time spent to reconcile errors.

Many different types of IOS exist, and they vary in purpose and scope. Electronic data interchange (EDI) is an interorganizational information system that expedites purchasing, invoicing, and payment by sending orders, invoices, and payments in standardized electronic message formats from one organization's computer to another organization's computer. All companies that use EDI send their data according to rigidly defined industry standards. A number of EDI standards bodies exist in the United States and Europe, and within the United Nations. These organizations develop EDI standards for specific industries such as the automotive, grocery, and retail industries. The standard EDI messages are received and verified, and the transactions are completed with little or no human effort required. Becoming EDI capable is a relatively straight forward task as many of the purchasing and inventory management software packages available include additional software modules that enable EDI. EDI replaced the much slower and error-prone processes based on humans handling transactions over the phone and with paper documents.

Walmart employs an interorganizational information system it calls vendor-managed inventory (VMI) to streamline product flow and better manage its store inventories. Walmart suppliers who participate in the VMI program are responsible for managing the inventory of their products in Walmart's warehouses. Suppliers are authorized to access a Walmart database that contains item-level sales and inventory data for just their products and not competitors' products. The supplier can then use this data to develop product demand projections. Each supplier is aware of any unit shortfalls of any of their products and is empowered to immediately and proactively ship additional units without a Walmart-generated purchase order. Because of this system, Walmart has reduced administrative costs to manage inventory, lower inventory holding costs, and increased sales through reduction of out-of-stock situations in its stores. Supplier benefits include lower manufacturing and distribution costs and improved production scheduling. This scheduling better matches Walmart customers' demand and reduces out-of-stock situations.

**interorganizational IS:** An information system that enables sharing of information and conducting business electronically across organizational boundaries.

## Value Chain

**value chain:** A series (or chain) of activities that an organization performs to transform inputs into outputs in such a way that the value of the input is increased.

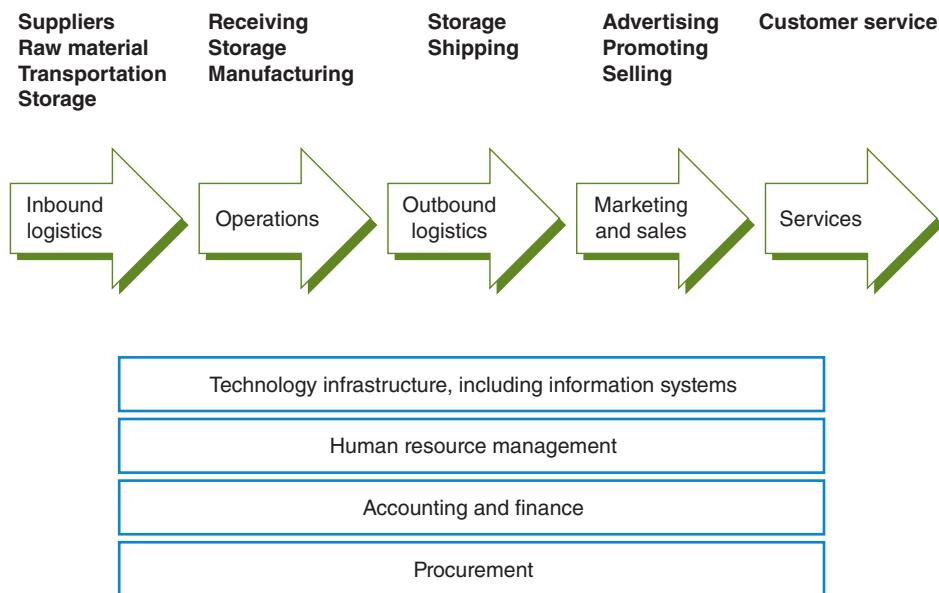
**supply chain:** A key value chain whose primary processes include inbound logistics, operations, outbound logistics, marketing and sales, and service.

The **value chain** is a series (or chain) of activities that an organization performs to transform inputs into outputs in such a way that the value of the input is increased. An organization may have many value chains, and different organizations in different industries will have different value chains. As an example of a simple value chain, consider the gift-wrapping department of an upscale retail store. It takes packages from customers, covers the packages with decorative wrapping paper, and gives the packages back to the customers, thus increasing the perceived value of the gift.

In a manufacturing organization, the **supply chain** is a key value chain whose primary processes include inbound logistics, operations, outbound logistics, marketing and sales, and service as shown in Figure 1.2. An organization's supply chain encompasses the processes required to get the right product or service into the right consumer's hands in the right quantity at the right time and at the right cost. These primary processes are directly concerned with the creation and/or delivery of the product or service. The supply chain also includes four main support processes, including technology infrastructure, human resource management, accounting and finance, and procurement.

**FIGURE 1.2**  
**Supply chain and primary and support processes**

The primary and support activities of the manufacturing supply chain are concerned with creating or delivering a product or service.



The concept of value chain is also meaningful to companies that don't manufacture products. These companies include tax preparers, restaurants, book publishers, legal firms, and other service providers. By adding a significant amount of value to their products and services, companies ensure their success.

Organizations are constantly fine-tuning and adjusting their supply chain. For example, Amazon has transformed from a small, non-profitable online bookseller to the largest Internet-based retailer in the world, as defined by total sales and market capitalization. Amazon is continually evolving its approach to supply chain management to ensure that it can deliver millions of items to customers at the right price and faster than any other retailer. Amazon offers customers Amazon Prime, an annual membership that guarantees free two-day shipping on hundreds of thousands of items. When other online retailers moved to match Amazon Prime, Amazon began offering free two-day shipping. Its next move was one-hour delivery with Amazon Prime Now. Amazon customers who live within 10 miles of an Amazon fulfillment center will soon be able to receive their eligible packages (under 5 pounds) via drones inside of 30 minutes. Amazon even introduced Dash buttons, little wireless communications devices

that allow users to simply press a button to order a household staple such as bottled water, coffee, detergent, and paper products.

What role do information systems play in supply chain management activities and other organizational activities? A traditional view of information systems holds that organizations use information systems to control and monitor processes and to ensure effectiveness and efficiency. In this view, information systems are external to the supply chain management process and serve to monitor or control it. A more contemporary view, however, holds that information systems are often so intimately involved that they are *part of* the process itself. From this perspective, the information system plays an integral role in the process, whether providing input, aiding product transformation, or producing output.



## Critical Thinking Exercise

### Zara Supply Chain System

#### ► SYSTEMS AND PROCESSES

Zara is a Spanish clothing and accessories retailer with headquarters in Arteixo, Spain. It has 2,000 stores spread across 88 countries.<sup>8</sup> Its founder, Amancio Ortega, had humble origins, but today is the third richest man in the world. Consumer clothing trends are constantly changing, creating a highly competitive environment in which companies compete not only on price but also on their ability to deliver products that are new and stimulating to their customers. To meet this challenge, Zara has developed an extremely responsive supply chain that enables it to go from design stage to sales floor in a maximum of three weeks rather than the six-month industry average.

Zara can deliver new products twice a week to its stores around the world. Mobile computers and point-of-sales systems are used to capture and review data from stores on an hourly basis to spot new trends as early as possible. This data includes sales and inventory data and anecdotal information gleaned by sales assistants as they chat with customers and as the sales assistants gather unsold items that customers tried on but left in fitting rooms. All this data is sent to Zara's headquarters where it is carefully analyzed by design teams who decide what new designs will be prototyped and produced in small quantities to see what sells. In addition, inventory optimization models help the company determine the quantities and sizes of existing items that should be delivered to each store. Zara's outstanding supply chain (which includes information systems as an integral component) has led to improved customer satisfaction, decreased risks of overstocking the wrong items, reduced total costs, and increased sales.<sup>9</sup>

#### Review Questions

1. In what sphere of influence does the Zara supply chain information system operate?
2. How has the Zara supply chain provided the firm with a competitive advantage?

#### Critical Thinking Questions

1. How can you ensure that sales assistants at each retail location will use the information system as intended? (Hint: Refer back to Figure 1.2.)
2. What issues might you encounter in using the information system at Zara? How might these issues be overcome? Whose responsibility is it to address these issues?

## Strategic Planning

**strategic planning:** A process that helps managers identify initiatives and projects that will achieve organizational objectives.

**Strategic planning** is a process that helps managers identify initiatives and projects that will achieve organizational objectives. The strategic plan must take into account that the organization and everything around it is in a state of flux. This includes consumers' likes and dislikes, changes in competitors,

and suppliers leaving and entering the marketplace. In addition, the costs and availability of raw materials and labor fluctuate, the fundamental economic environment (interest rates, growth in gross domestic product, inflation rates) changes; and the degree of industry and government regulation varies.

Strategic planning provides the following benefits:

- A framework and a clearly defined direction to guide decision making at all levels and across all organizational units
- The most effective use of the organization's resources by focusing those resources on agreed-on key priorities
- The ability of the organization to be proactive and to take advantage of opportunities and trends, rather than passively reacting to them
- Improved communication among management, employees, the board of directors, shareholders, and other interested parties

An organization develops an overall strategic plan, which sets the direction for all the other business units of the organization. Common themes in setting strategies include "increase revenue," "attract and retain new customers," "increase customer loyalty," and "reduce the time required to deliver new products to market." In choosing from alternative strategies, managers should consider the long-term impact of each strategy on revenue and profit, the degree of risk involved, the amount and types of resources that will be required, and the potential competitive reaction. Managers of the various business units also develop a strategic plan that is consistent with the overall organizational plan.

Amazon has made a strategic decision to explore the possible use of delivery drones to gain a real competitive advantage over competitors who rely on less efficient ground transportation. Because a large percentage of Amazon packages weigh less than 5 pounds, drones could become the ideal rapid-delivery vehicles. Amazon has detailed plans for this service; however, the company cannot announce if or when the program will start until regulators set out the rules regarding the commercial use of drones. Such a strategy has the potential to attract new customers and increase revenue.<sup>10</sup>

## Information System Strategic Planning

The strategic plan of an information system (IS) must identify those technologies, vendors, competencies, people, systems, and projects in which an organization will invest to support the corporate and business unit strategies. This plan is strongly influenced by new technology innovations. These innovations include increasingly more powerful mobile devices and advanced software that can analyze large amounts of structured and unstructured data. Innovative thinkers inside and outside the organization also influence the plan (see Figure 1.3).

The strategic planning process for the IS organization is also strongly influenced by how the IS organization is perceived by the rest of the organization. An IS organization can be viewed as a cost center/service provider, as a business partner/business peer, or as a game changer (see Table 1.2).

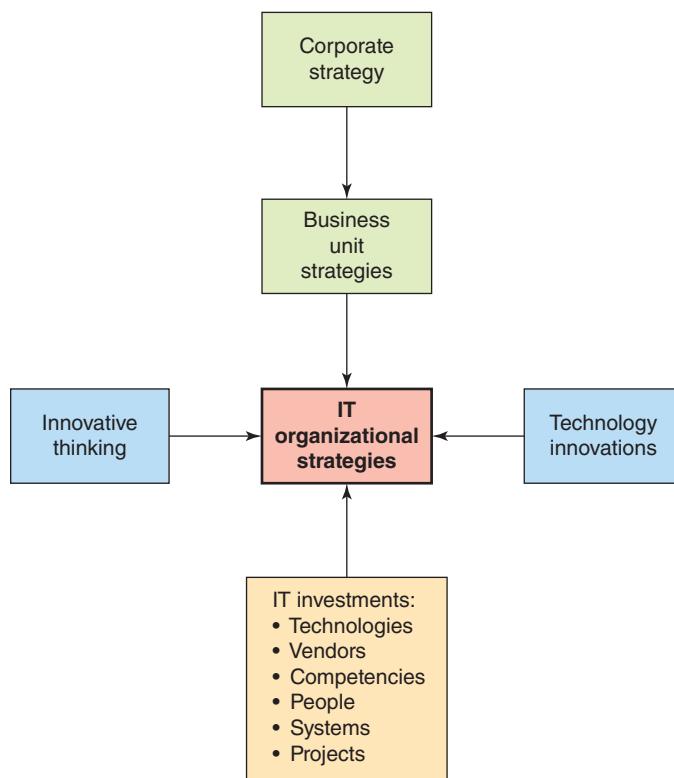
In a survey of more than 700 CIOs, 38 percent said that their IS organization is viewed as a cost center/service provider that is expected to reduce IS costs and improve IS services.<sup>11</sup> The strategic planning process for such an organization is typically directed inward and focused on determining how to do what it is currently doing but doing it cheaper, faster, and better.

The IS organization of the state of Delaware is viewed as a cost center/service provider. One of the organization's primary strategic initiatives is to consolidate IS resources and to eliminate redundant functions and resources within the various state agencies. The goal is to deliver significant improvements in customer service and to reduce costs.<sup>12</sup>

The majority of CIOs surveyed, about 52 percent, said that their IS organization is viewed as a business partner/business peer that is expected to control

**FIGURE 1.3**  
**Drivers that set IS organizational strategy and determine information system investments**

Planners must consider many factors in setting IS organizational strategy.



**TABLE 1.2** The IS strategic planning spectrum

	Cost Center/Service Provider	Business Partner/Business Peer	Game Changer
Strategic planning focus	Inward looking	Business focused	Outward looking
IS goals	Control/reduce IS costs; improve IS operations and services	Improve IS/business partnership Control IS costs; expand IS services	Drive business innovation; deliver new products and services
Strategy	React to strategic plans of business units	Execute IS projects to support plans of business	Use IS to achieve competitive advantage
Typical projects	Eliminate redundant or ineffective IS services	Implement new systems and technology infrastructure; redesign business processes	Provide new ways for customers to interact with organization

IS costs and to expand IS services in support of business initiatives.<sup>13</sup> The strategic planning process of these organizations is based on understanding the collective business plans for the next year and determining what those mean for the IS organization in terms of new technologies, vendors, competencies, people, systems, and projects.

The IS organization for the city of Seattle operates under the constraint of a decreasing budget but is continually striving to expand its services and capitalize on the latest technology developments. It employs newer technologies, such as mobile computing, to improve the interaction of city government with its constituents and to support city services on the move. The organization also seeks opportunities to access shared computer resources through cloud-based applications to gain advantages and efficiencies where it makes sense.<sup>14</sup>

Only 10 percent of surveyed CIOs stated that their IS organization is viewed by fellow employees as a game-changing organization that is asked to lead product innovation efforts and open new markets.<sup>15</sup> Their strategic planning process is outwardly focused and involves meeting with customers, suppliers, and leading IS consultants and vendors to answer questions like “What do we want to be?” and “How can we create competitive advantage?”<sup>16</sup> In such organizations, IS is not only a means for implementing business-defined objectives but also a catalyst for achieving new business objectives unreachable without IS.

GAF is a \$3 billion privately held manufacturer of commercial and residential roofing. GAF’s IS employees regularly collaborate with external customers to learn from them and to help educate potential customers about why they should do business with GAF. Using these collaboration sessions to gain a better understanding of its customers’ needs, GAF developed a mobile app that allows a contractor to take a photo of a prospect’s house and then use that photo to allow the prospect to preview different GAF shingle styles and colors on an actual image of their home. The app was a game changer for the organization as it helps GAF contractors demonstrate the beauty of GAF shingles and eliminates one of the biggest barriers to closing the sale—answering the question, “How will it look on my house?”<sup>17</sup>

No matter how an IS organization is perceived, the odds of achieving good alignment between the IS strategic plan and the rest of the business are vastly increased if IS workers have experience in the business and can talk to business managers in business terms rather than technology terms. IS workers must be able to recognize and understand business needs and develop effective solutions. The CIO especially must be able to communicate well and should be accessible to other corporate executives. However, the entire burden of achieving alignment between the business and the IS organization cannot be placed solely on the IS organization.



## Critical Thinking Exercise

### Business Liaison Role

#### ► REFLECTIVE THINKING, SYSTEMS AND PROCESSES

You have been employed as a systems analyst in the information systems organization of a medium-sized consumer goods manufacturer for three years. You are quite surprised when your manager offers you a one-year special assignment as a warehouse manager supervising workers and operations in the large distribution center used to store your company’s finished products and prepare them for shipment to retail stores around the country. Your manager explains that the company wishes to groom you to become the business liaison with the supply chain organization and wants you to become familiar with the entire order-fulfillment process. Based on its recent growth, the company is planning to open at least two new distribution centers in different regions of the country over the next two to three years. Management has chosen you to be a key player in developing a strategic plan that is consistent with corporate strategies and meets the needs of the supply chain organization.

#### Review Questions

1. What organizational benefits can be gained from the creation of this role and improved strategic planning?
2. What key drivers should govern the IS strategic plan?

#### Critical Thinking Questions

1. How would you like the IS organization to be perceived by the rest of the company? Why?
2. For you, personally, what are the pros and cons of accepting this position? Would you take this assignment? Why or why not?

## Information Systems Careers

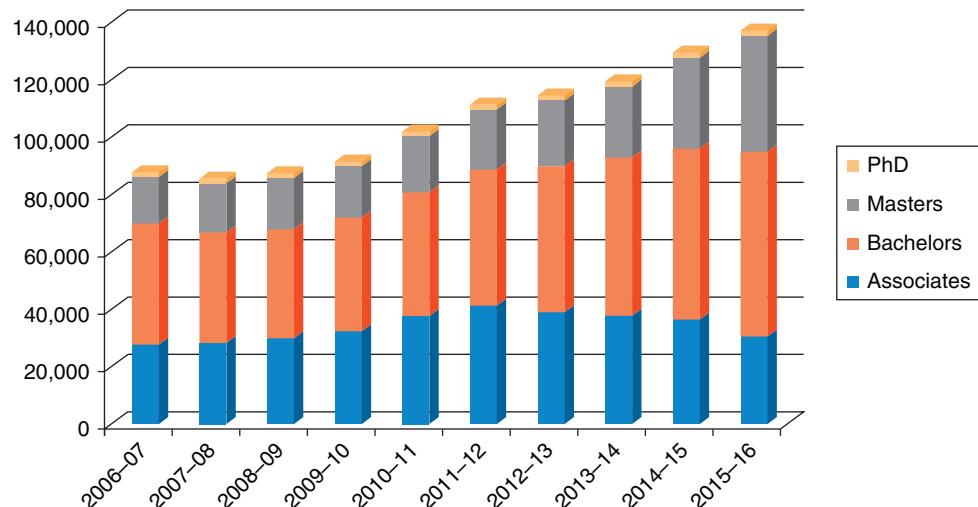
Today, most organizations cannot function or compete effectively without computer-based information systems. Indeed, organizations often attribute their productivity improvement, superior customer service, or competitive advantage in the marketplace to their information systems. The information system worker functions at the intersection of business and technology and designs and builds the solutions that allow organizations to effectively leverage information technology.

Successful information system workers must enjoy working in a fast-paced, dynamic environment where the underlying technology changes all the time. They must be comfortable with meeting deadlines and solving unexpected challenges. They need good communication skills and often serve as translators between business needs and technology-based solutions. Successful information systems workers must have solid analytical and decision-making skills and be able to translate ill-defined business problems and opportunities into effective technology-based solutions. They must develop effective team and leadership skills and be adept at implementing organizational change. Last, but not least, they need to be prepared to engage in lifelong learning in a rapidly changing field.

Specific technical skills are important for IS workers to possess. These skills—all of which are discussed in various chapters throughout this book—include the following:

- Capability to analyze large amounts of structured and unstructured data
- Ability to design and build applications for mobile devices
- Traditional programming and application development skills
- Technical support expertise
- Project management skills
- Knowledge of networking and cloud computing
- Ability to audit systems and implement necessary security measures
- Web design and development skills
- Knowledge of data center operations

Technology is one of the fastest-growing areas of the U.S. economy, and information systems professionals are in high demand. The U.S. Bureau of Labor Statistics (BLS) pegged the number of people employed in the United States in computer-related occupations in 2016 at 4.6 million. The BLS forecasts an increase of 591,000 new computing job openings in the time period 2016 to 2026 or an average of about 60,000 new jobs per year.<sup>18</sup> Figure 1.4 shows that the annual number of computer and information science degrees awarded in the United States has met or exceeded 100,000 since 2010.<sup>19</sup> Many



**FIGURE 1.4**  
**Computer and information science degrees awarded**

U.S. computer and information science degrees awarded has exceeded 100,000 since 2010–11.

computer and information science graduates take employment in related fields such as business management. They also work as mathematicians or operations research specialists; computer or electronic salespeople; or business, math, or computer science educators.

## Typical Information System Roles

IS offers many exciting and rewarding careers. Professionals with careers in information systems can work in an IS department or outside a traditional IS department as Web developers, computer programmers, systems analysts, computer operators, and in many other positions. Opportunities for IS professionals also exist in the public sector. In addition to technical skills, IS professionals need skills in written and verbal communication, an understanding of organizations and the way they operate, and the ability to work with people and in groups. The following sections provide a brief description of these roles. At the end of each chapter in this book, you will find career exercises that will help you explore careers in IS and career areas that interest you.

### Chief Information Officer

The role of the chief information officer (CIO) is to employ an IS department's equipment and personnel in a manner to best achieve the goals of the organization. CIOs must understand finance, accounting, and return on investment and be able to make wise choices on which of many projects to fund and staff. They can help companies avoid damaging ethical challenges by monitoring how their firms are complying with a large number of laws and regulations. A good CIO is typically a visionary who provides leadership and direction to the IS department to help an organization achieve its goals. CIOs need strong technical, business, and inter-personal skills. Those interested in this career path would do well to explore college-level coursework in business management, computer science, and information technology. Employers prefer applicants with at least five years of information technology experience in a management capacity.

### Software Developer

Software developers are the creative minds behind computer programs. Some develop the applications that allow people to do specific tasks on a smart phone, video game, laptop, or other computing device. Others develop the underlying operating systems that run the devices or that control networks. Software developers test and debug the software as well as maintain and upgrade software after it is released for initial use. Software developers frequently collaborate with management, clients, and others to build a software product from scratch, according to a customer's specifications, or to modify existing software to meet new business needs. Software developers usually have a bachelor's degree in computer science and strong computer programming skills.

### Information Systems Security Analyst

IS security analysts are responsible for planning, designing, implementing, and maintaining the security and integrity of their organizations' systems and data. They analyze the security measures of the organization and identify and implement changes to make improvements. Security analysts are responsible for developing and delivering training on proper security measures. They also are responsible for creating action plans in the event of a security breach. Most information security analysts work for computer companies, consulting firms, or business and financial companies. Most information security analyst positions require a bachelor's degree in a computer-related field. Employers prefer to hire analysts with experience in a related occupation.

### Systems Analyst

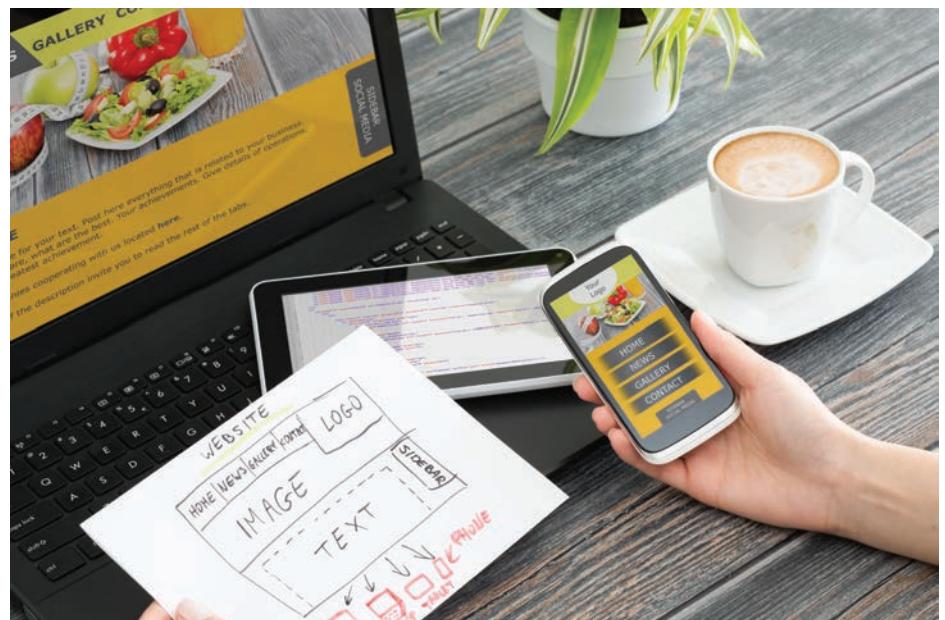
Systems analysts frequently consult with management and users to define the scope of and requirements for new information systems. They convey system requirements to software developers and network architects for implementation. They bring business and information systems together by understanding the needs and limitations of both. They also assist in choosing and configuring hardware and software, matching technology to users' needs, monitoring and testing the system in operation, and troubleshooting problems after implementation. A bachelor's degree in a computer or information science field is common, although not always a requirement. Some firms hire analysts with business or liberal arts degrees who have skills in information technology or computer programming.

### Programmer

Programmers convert a program design developed by a systems analyst or software developer into a working program written in one of many computer languages. To do this, they must write, debug, and test the program to ensure that it will operate in a way that it will meet the users' needs. Programmers usually work in offices, most commonly in the computer systems design and related services industry. Most computer programmers have a bachelor's degree; however, some employers hire workers with an associate's degree. Most programmers specialize in more than one programming language.

### Web Developer

These professionals design and maintain Web sites, including site layout and function, to meet the client's requirements. The creative side of the job includes creating a user-friendly design, ensuring easy navigation, organizing content, and integrating graphics and audio (Figure 1.5). The more technical responsibilities include monitoring Web site performance and capacity.


REDFILE/P/Shutterstock.com

### FIGURE 1.5 Web Developers

Web developers create and maintain company Web sites.

### Business Analyst

Business analysts are responsible for improving a company's competitiveness and performance across a broad spectrum of criteria. Evaluating and solving business challenges is the strong suit of these professionals. They must collect, review, and analyze information that enables them to make sound recommendations. They often specialize in a particular functional area, such as supply

chain management, marketing, finance, or product development—or in an industry like healthcare, consumer products, or transportation, among others. Business analysts may oversee teams or work independently to solve problems and address challenges. Business analysts must possess a broad set of business knowledge and skills, which can be obtained through a bachelor's degree in business administration with a specialization in management.

Table 1.3 shows the median annual salary and forecasted number of new job openings for the IS positions just discussed.

**TABLE 1.3** Median annual salary for different information system positions

Job Title	2018 Median Annual Salary	Number of Jobs, 2016	Number of New Job Openings, 2016–2026
CIO	\$202,500	N/A	N/A
Software Developer	\$115,000	1,256,300	302,400
Information Systems Security Analyst	\$115,250	100,000	28,500
Systems Analyst	\$89,500	600,500	54,400
Programmer	\$65,000	294,900	-21,300
Web Developer	\$66,100	162,900	24,400
Business Analyst	\$92,000	N/A	N/A

SOURCES: Robert Half 2018 Salary Guide for Technical Professionals and the Bureau of Labor Statistics Employment Projections, 2016–2026

### Other IS Careers

In addition to working for an IS department in an organization, IS personnel can work for large consulting firms, such as Accenture, IBM, and Hewlett-Packard. Some consulting jobs entail frequent travel because consultants are assigned to work on various projects at the client location. Such jobs require excellent project management and people skills in addition to IS technical skills. Related career opportunities include computer training, computer and computer-equipment sales, and computer equipment repair and maintenance.

Other IS career opportunities include being employed by technology companies, such as Oracle, IBM, HP, Microsoft, Google, and Dell. Such a career enables an individual to work on the cutting edge of technology, which can be challenging and exciting.

As some computer companies cut their services to customers, new companies are being formed to fill the need. With names such as Speak with a Geek and Geek Squad, these companies are helping people and organizations with computer-related problems that traditional computer vendors are no longer solving.

Some people decide to start their own IS businesses rather than continue to work for someone else. Such small business owners often prefer to be their own boss, with the freedom to think innovatively and take on new challenges. Other people become IS entrepreneurs or freelancers. They write programs, work on IS projects with larger businesses, or develop new applications for the iPhone or similar devices. Some Internet sites, such as [www.freelancer.com](http://www.freelancer.com), post projects online and offer information and advice for people working on their own. Many freelancers work for small- to medium-sized enterprises in the U.S. market. People doing freelance or consulting work must be creative in pursuing new business, while also protecting themselves financially. Freelancers and consultants must aggressively market their talents. To ensure that they are paid, they should insist that some or all of their fees for a given project are put into an escrow account. This will help ensure that they are paid for their efforts even if the client is not satisfied with the end result.

## Shadow IT

In addition to IS workers placed within the IS organization, some companies have people who take on IS-related roles outside the IS organization. For example, data scientists can be found in the marketing, sales, and supply chain management departments of large organizations. Data scientists are responsible for understanding the business analytics technology as well as the business. They use their understanding to deliver improvements in decision making.

**shadow IT:** The information systems and solutions built and deployed by departments other than the information systems department.

**Shadow IT** is a term used to describe the information systems and solutions built and deployed by departments other than the information systems department. In many cases, the information systems department may not even be aware of these efforts. Gartner studies have found that shadow IT is over 30 percent of total IT expenditures in large organizations. This statistic means that non-IT business units are responsible for 30 percent of the total information technology costs within an organization.<sup>20</sup>

At one time, shadow IT was limited to employee or departmental purchases of nonstandard computing devices and off-the-shelf software from office supply stores. However, the scope of shadow IT spending has greatly expanded, largely due to cloud computing and the availability of enterprise software, file-sharing apps, and collaboration tools as a service. For instance, cloud service providers can deliver increasing amounts of computing, network, and storage capacity on demand and without requiring any capital investment on the part of the cloud users. These cloud service providers typically offer a monthly or annual subscription service model; they may also provide training, support, and data integration services. All of this makes it easier for department managers to skirt formal procedures associated with the purchase of large capital expense items—including scrutiny by the information system department.

Shadow IT enables business managers to quickly create highly innovative solutions to real business problems and to test out these solutions. Such systems may serve as prototypes that evolve into future approved IT solutions. However, shadow IT solutions frequently employ nonapproved vendors, software, or hardware and may not meet the IS department standards for control, documentation, security, support, and reliability. This raises security risks and issues regarding compliance with essential government and industry standards, such as Basel III (international standards for the banking industry), FISMA (Federal Information Security Management Act of 2002), GAAP (Generally Accepted Accounting Principles), HIPAA (Health Insurance Portability and Accountability Act), IFRS (International Financial Reporting Standards), and Sarbanes-Oxley Act (accounting regulations for publicly traded companies).

Issues often arise when a shadow IT solution “breaks” and questions are raised about who is responsible for fixing it and supporting the end users. The IS department may not have developed the solution, or even been aware of it, but business users expect their help in “fixing” it. Table 1.4 presents a summary of the pros and cons associated with shadow IT.

The information systems department may become more comfortable with shadow IT if it sees the IS department’s role as maximizing the effective use of technology in the company rather than controlling the use of technology. Also, shadow IT provides a source of funds outside the IS department budget to tackle high-priority projects.

## Continuous Education

**certification:** A process for testing skills and knowledge.

Often, the people filling IS roles have completed some form of certification. **Certification** is a process for testing skills and knowledge; successful completion of a certification exam results in an endorsement by the certifying authority that an individual is capable of performing particular tasks or jobs. Certification frequently involves specific, vendor-provided, or vendor-endorsed coursework. Getting certified from a software, database, or network company may open

the door to new career possibilities or result in an increase in pay. According to one survey, 65 percent of employers use IT certifications to differentiate between equally qualified candidates, while 72 percent of employers require some form of IT certification for certain job roles. Table 1.5 presents some of the more in demand certifications.<sup>21</sup>

**TABLE 1.4** Pros and cons of shadow IT efforts

Pros	Cons
Enables the business to test quick solutions to business needs without delays brought on by involvement of information systems	The systems and processes developed may lack necessary levels of security required to meet compliance standards
Can create an innovative, synergistic partnership between the information systems department and other business units	Can create tension between the CIO who has responsibility for technology within the organization and business managers who want more of a role in the information system decisions
Provides the opportunity to evaluate and test many more information system initiatives	Individual departments may buy services, software, and hardware that the company could get a better deal through central purchasing
	May be wasteful and duplicate work already being done by the IS organization
	Issues can arise over responsibility to fix “non-approved” solutions

**TABLE 1.5** Certifications in high demand

Area of Certification	Topic
Application and Web Development	AJAX (Asynchronous JavaScript and XML) development (a set of Web development techniques using many Web technologies on the client side to build Web applications)
	C# development (general-purpose, object-oriented programming language)
	Java development (general-purpose, object-oriented programming language whose compiled code can run on all platforms that support Java without the need to recompile)
	.NET development (a programming framework created by Microsoft that developers can use to create applications more easily)
	PHP development (a widely-used open source general-purpose scripting language that is especially suited for Web development and can be embedded into HTML)
	Sharepoint (enables groups to set up a centralized, password-protected space for document sharing)
Database Administration	Microsoft SQL Server database
	Oracle database
Business Analytics	SAP Business Objects (platform that enables business users to discover data, perform analysis to derive insights, and create reports that visualize the insights.)
	Hadoop (an open source distributed processing framework that manages data processing and storage for big data applications)
	Python (a general-purpose programming language that can be used for Web development, data analysis, artificial intelligence, and scientific computing)
Networking/Security	Ruby on Rails (Ruby is a general-purpose programming language frequently used to develop Web applications, and Rails is a development tool that is used by Web developers)
	Cisco network administration
	LINUX/UNIX administration
	Certified Information Systems Security Professional (CISSP)
Project Management	Check Point Firewall administration
	Project Management Institute's project manager professional certification attests to your competence to fill the role of project manager leading and directing projects and teams.



## Critical Thinking Exercise

### Virtual Team Onboarding

#### ► TEAMWORK

You are a recent hire in the 100-person information systems organization of a large consumer products company with four manufacturing locations, two distribution centers, and a product research and development facility. These workplaces are spread around the United States. A virtual team consisting of three new hires and six experienced information system managers and technicians from the firm's various locations has been formed to improve the process of onboarding new information system hires and getting them up to speed as soon as possible.

#### Review Questions

1. What skills, knowledge, and experience might the new hires be lacking that could hinder them in their initial assignments?
2. How might this knowledge gap be filled? Would you consider special training courses? What about assignments tailored to capture the missing skills and knowledge?

#### Critical Thinking Questions

1. Identify some of the advantages of forming a multi-organizational, virtual team to improve the process. Do you think that the team should consider adding any non-IS members? Why or why not?
2. What are some of the logistical complications and team dynamic problems that the team can expect when working on this process?

## Summary

### Principle:

**Managers have an essential role to play in the successful implementation and use of information systems—that role changes depending on which type of information system is being implemented.**

An information system (IS) is a set of interrelated components that work together to collect, process, store, and disseminate information to support fundamental business operations, data reporting and visualization, data analysis, decision making, communications, and coordination within an organization. A well-designed information system provides a feedback mechanism to monitor and control its operation to make sure it continues to meet its goals and objectives.

A competitive advantage enables an organization to generate more sales or achieve superior profit margins compared to its rivals. It can be gained in one of three ways: (1) by providing the same value as its competitors but at a lower price (cost leadership), (2) by charging higher prices for providing products which are perceived by the customer as being better (differentiation), or (3) by understanding and servicing their target market better than anyone else (focus).

Managers have a key responsibility to identify and capitalize on opportunities to employ information systems as a tool to gain competitive advantage.

An organization's information systems operate within a context of people, technology infrastructure, processes, and structure. This framework is Leavitt's Diamond. This model is used to introduce new systems into the workplace in a manner that lowers stress, encourages teamwork, and increases the probability of a successful implementation.

Managers of the business functions most affected by the new information system have a key responsibility to ensure that the people, processes, and human structure components are fully addressed.

People make the difference between success and failure in all organizations. Good systems enable people to produce extraordinary results.

An organization's technology infrastructure includes all the hardware, software, networks, facilities, and services used to develop, test, deliver, control, or support the information technology applications and services an organization requires to meet the needs of its customers, suppliers, key business partners, regulatory agencies, and employees.

A process is a set of related activities that takes input, adds value, and creates an output for the customer of that process.

Structure has to do with the defined relationships among members of the organization and their various activities. It also includes processes that assign roles, responsibilities, and authority to complete the various activities.

When considering the role of business managers in working with information systems, it is useful to divide information systems into four types based on their sphere of influence: personal information systems, workgroup information systems, enterprise information systems, and interorganizational information systems.

Personal IS includes information systems that improve the productivity of individual users in performing stand-alone tasks.

Workgroup IS are systems designed to support teamwork and enable people to work together effectively, whether team members are in the same location or dispersed around the world.

An enterprise application IS is used to meet organization-wide business needs and typically shares data with other enterprise applications used within the organization.

An interorganizational information system (IOS) is a system that enables sharing of information and conducting business electronically across organizational boundaries.

The value chain is a series of activities that an organization performs to transform inputs into outputs in such a way that the value of the input is increased.

The supply chain is a key value chain whose primary processes include inbound logistics, operations, outbound logistics, marketing and sales, and service. Supply chain management encompasses all the processes required to get the right product into the right consumer's hands in the right quantity at the right time and at the right cost.

Information systems have transformed the nature of work and the shape of organizations themselves. A traditional view of information systems holds that organizations use them to control and monitor effectiveness and efficiency. A more contemporary view holds that information systems are often so intimately involved in the activities of the value chain that they are a part of the process itself.

### **Principle:**

**The strategic planning process for the IS organization and the factors that influence it depend on how the organization is perceived by the rest of the organization.**

Strategic planning is a process that helps managers identify desired outcomes and formulate feasible plans to achieve their objectives using available resources and capabilities.

Strategic planning provides a framework to guide decision making, ensures effective use of resources, enables an organization to be proactive and take advantage of opportunities and trends, and it improves communication.

An IS organization can be viewed as a cost center/service provider, a business partner/business peer, or a game changer.

IS strategic planning is influenced by the corporate and business unit strategic plans as well as technology innovations and innovative thinking.

The IS strategy identifies the technologies, vendors, competencies, people, systems, and projects in which the organization will invest to support the corporate and business unit strategies.

## Principle:

**The information system worker functions at the intersection of business and technology and designs, builds, and implements solutions that allow organizations to effectively leverage information technology systems.**

Successful information system workers need to have a variety of personal characteristics and skills, including the ability to work well under pressure and in a fast-paced environment constantly undergoing change, good communication skills, solid analytical and decision-making skills, effective team and leadership skills, and adeptness at implementing organizational change.

Typical information system roles include CIO, software developer, information systems security analyst, systems analyst, programmer, Web developer, and business analyst.

Technology is one of the fastest-growing areas of the U.S. economy, which has a strong demand for information system workers.

Only about 60 percent of all information technology outlays are controlled by the information systems department. Shadow IT is a term used to describe the information systems and solutions built and deployed by departments other than the information systems department. In many cases, the information systems department may not even be aware of these efforts.

Besides working for an IS department in an organization, IS personnel can work for a large consulting firm or a hardware or software manufacturer. Developing or selling products for a hardware or software vendor is another IS career opportunity.

Certification is a process for testing skills and knowledge; successful completion of a certification exam results in an endorsement by the certifying authority that an individual is capable of performing particular tasks or jobs. Certification can result in new career opportunities including promotion and a salary increase.

## Key Terms

certification

enterprise information system

workgroup information system

information system

interorganizational IS

Leavitt's Diamond

personal information system

procedure

process

shadow IT

strategic planning

structure

supply chain

technology infrastructure

value chain

workgroup information system

## Self-Assessment Test

**Managers have an essential role to play in the successful implementation and use of information systems—that role changes depending on which type of information system is being implemented.**

1. Four information system types based on their sphere of influence include interorganizational, personal, enterprise, and \_\_\_\_\_.
2. Managers of the business functions most affected by a new information system have a key responsibility to ensure that \_\_\_\_\_.  
  - a. only the most current and most advanced technology is employed
  - b. the people, processes, and human structure components are fully addressed

- c. competitors cannot use a similar information system to gain a competitive advantage
  - d. resources are deployed only against enterprise and interorganizational information systems
3. \_\_\_\_\_ is a model used to introduce new systems into the workplace in a manner that lowers stress, encourages teamwork, and increases the probability of a successful implementation.
- Strategic planning
  - Porter's Five forces model
  - Leavitt's Diamond
  - Strategic competitive advantage
4. The contemporary view of information systems is that they are often so intimately involved in an organization's value chain that they are *part of* the process itself. True or False

**The strategic planning process for the IS organization and the factors that influence it depend on how the organization is perceived by the rest of the organization.**

- Which of the following is not a benefit associated with creating a strategic plan?
  - provides a framework to guide decision making
  - ensures effective use is made of the organization's resources
  - enables the organization to be proactive
  - guarantees that only the most current technology solutions will be employed
- Four drivers that set the information strategy and determine information system investments include corporate strategy, technology innovations, innovative thinking, and \_\_\_\_\_.

- Three ways the IS organization can be perceived by the rest of the organization that influence IS strategy are \_\_\_\_\_.
  - flexible, resourceful, and forward-looking
  - cost center, business partner, and game changer
  - cost-effective, innovative, and creative
  - reliable, simple, and timely

**The information system worker functions at the intersection of business and technology and designs, builds, and implements solutions that allow organizations to effectively leverage information technology systems.**

- Which of the following are non-technical skills *not* commonly associated with an effective information system worker?
  - ability to meet deadlines and solve unexpected challenges
  - ability to work in a static, boring environment where there is little change
  - good communication skills
  - effective leadership skills
- Two potential benefits of obtaining a certification in an IS subject area are:
  - new career possibilities and a potential increase in salary
  - automatic pay increase and promotion
  - movement from a technical career ladder to a management career ladder and salary increase
  - receipt of certificate of certification which never expires and more rapid career advancement

## Self-Assessment Test Answers

- workgroup
- b
- c
- True
- d
- business unit strategy
- b
- b
- a

## Review and Discussion Questions

- Describe four fundamental information system types based on their sphere of influence.
- Identify two key management responsibilities in implementing information systems.
- The four components of Leavitt's Diamond are technology, processes, structure, and \_\_\_\_\_.
- What is the traditional role that IS plays in the supply chain? What is the contemporary role?
- Identify four key benefits of producing a strategic plan.
- Identify four drivers that help set the information systems organization strategy.
- Identify three ways the IS organization can be perceived by the rest of the organization and explain how that perception can affect the IS strategy.

8. Identify six non-technical skills needed to be an effective information system worker.
9. Identify two benefits of obtaining a certification in an IS subject area.
10. How is the IS organization at your work or university perceived by the rest of the organization? How has this influenced the IS strategy and what the organization has been able to accomplish?

## Business-Driven Decision-Making Exercises

1. You are a member of the supply chain organization of a consumer products manufacturer whose products are sold primarily through eight large retail chains. You have an idea to implement a new sales forecasting information system to replace the existing system that relies on historical sales data and marketing plans. The new system requires that the manufacturer's eight large retail customers enter their own weekly sales forecast of what they expect to order over the upcoming six weeks. The individual retailers' forecasts will then be aggregated to develop the demand forecast for each six-week period. The supply chain organization will use this aggregate demand forecast to manage its inventory and production. Retailers will receive a discount for submitting a forecast that closely matches their actual orders. What other organizations within the company must be sold on this idea? How will you deal with the natural reaction of others to resist this change? How can you sell this idea

to your company's major retail customers? How might you use Leavitt's Diamond to help sell others on your idea?

2. As discussed in this chapter, successful information system workers need to have a variety of personal characteristics and skills, including the ability to work well under pressure and in a fast-paced environment constantly undergoing change, good communication skills, solid analytical and decision-making skills, effective team and leadership skills, and adeptness at implementing organizational change. Imagine that you are applying for a position as an information system worker. Develop a brief paragraph describing how you have demonstrated each characteristic in your own personal life. If you were a job recruiter, would you consider yourself a strong candidate for an information system position? Why or why not? What might you do to improve the likelihood of being recruited for such a position?

## Teamwork and Collaboration Activities

1. With the other members of your group, create a list of software frequently used (at school and work) by each member of the team. Identify which sphere of influence each software supports. Create a matrix with a column for each member of the team and a row for each software application frequently used by any member of the team. Enter individual, group, enterprise, or interorganizational in each

intersecting cell to identify the specific software used.

2. Have the members of your team research group decision-making processes—brainstorming, affinity grouping, and multi-voting. Have your team members identify the six most important learning objectives they hope to learn from this course. If requested, share your findings with the instructor and/or class.

## Career Exercises

1. Go to the Web site for the U.S. Bureau of Labor Statistics to find information about the occupations with the greatest projected job growth in terms of the number of people who will be needed over the next 10 years. Use graphics software to illustrate the growth of the 10 fastest growing occupations. Do further research to include data about median salary and years of schooling required for each of these positions. Does this data cause you to reconsider your

college major? Prepare a brief summary of your findings including at least one graph summarizing this data.

2. Do research on the Web to learn how recruiters use social network data to help screen job applicants. Does what you learn raise any concerns about how you could be viewed when you apply for your next job? Should you remove any photos or postings you or others have made about you on any social network site?

## Case Study

### ► SYSTEMS AND PROCESSES

#### **Customer-Focused Innovation Drives CarMax**

CarMax transformed the used car buying experience back in the 1990s with its no-haggle car prices that allows the customer to focus on other features (such as fuel economy, safety features, entertainment package, and so on) of the auto. Today, CarMax is the largest used car retailer in the United States with 173 used car stores and an aggressive growth plan that calls for the opening of more than a dozen new stores each year. During the fiscal year ended February 28, 2017, total revenue was \$15.9 billion from the retail sale of just over 1 million used cars. CarMax continues to revolutionize car buying through consumer insights and customer-focused technology innovations that further distance CarMax from its competitors.

Since 90 percent of used car buyers start their search online, CarMax built a Web site search platform similar to the highly effective “Amazon product description” design with which most consumers are familiar. CarMax has a centralized vehicle inventory system with information on over 50,000 CarMax Quality Certified vehicles. Its customers can search through this inventory using their mobile devices or portable or desktop computers. Consumers may even request that CarMax transfer the car of their choice to a store near them and, indeed, nearly 30 percent of the cars it sells are transferred for this reason.

CarMax launched a new online financing app to enable customers to get prequalified for a loan prior to visiting a store. This app helps move the customer further along the sales process and provides a faster in-store shopping experience. It has been received well by customers and contributes to increased leads, which CarMax believes generates incremental sales.

When a customer arrives to sell his or her car, a CarMax associate armed with a mobile device can evaluate the vehicle in real-time without ever leaving the customer or the vehicle. The associate has access to all the information needed to provide an accurate appraisal via a mobile app. This creates a positive initial experience both for the customer and the associate. CarMax associates use their mobile devices and the same app to appraise vehicles at off-site auto auctions. This enables them to buy the best cars at the best prices so that CarMax can make them available to its customers.

CarMax customers interested in getting an appraisal value for their vehicle can also submit their vehicle information online without having to come to a store.

CarMax plans to add an app to support a loyalty program for car owners. This will help them maintain and replace auto parts and obtain roadside assistance. There will also be a wallet-like feature where customers can store their vehicle ID number and insurance information.

CarMax has a strong program for onboarding information system new hires. Once new software developers arrive at CarMax, they attend Information Technology Academy. This academy is an eight-week program designed

to jump-start their CarMax career. Here they learn about the primary technologies and tools as well as the software development process used at CarMax, thus laying a strong foundation for success in their new role. They also visit CarMax stores to observe first hand, different business processes and learn how CarMax information systems support employees and customers alike. This experience helps them to appreciate how their contributions will have a direct and significant impact on the organization’s ongoing success.

At the end of the eight-week program, each graduate is assigned to a product team matching their skill set, interests, and aptitude. CarMax fuels the innovation process by creating multi-functional product teams consisting of up to 10 people including a product manager, lead software developer, and people from quality assurance and user design. The team is challenged to go after business objectives and key results such as how many leads they generate or how many prospect-to-customer conversions they deliver. It’s up to them to determine the best solution for each customer to meet their goals. Every two weeks, the product teams conduct open houses that anyone can attend. A team member presents what the product team has accomplished against its business objectives. CarMax senior managers, including an occasional board of directors’ member, regularly attend these open houses.

#### Critical Thinking Questions

1. Would you classify the new auto appraisal system as operating in the personal, workgroup, enterprise, or interorganizational sphere of influence? Why? Identify key organizational complements CarMax needed to put in place to ensure that the new system would be successful.
2. How do you think the CarMax IS organization is perceived by the rest of the organization? Support your opinion.
3. Based on their use of multi-functional product teams, what personal traits, technical skills, and non-technical skills do you think CarMax looks for in its information systems new hires?

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## Notes

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### Principles

Computer crime is a serious and rapidly growing area of concern requiring management attention.

### Learning Objectives

- State four reasons why computer incidents have become so prevalent.
- Identify four classes of perpetrators mostly likely to initiate a cyberattack.
- Define the term attack vector.
- Identify at least three commonly used attack vectors.
- Identify five cyberthreats that pose a serious threat for organizations.
- Identify five consequences of a successful cyberattack.
- Identify five federal laws that address computer crime.

Organizations must take strong measures to ensure secure, private, and reliable computing experiences for their employees, customers, and business partners.

- Discuss how the CIA security triad can be implemented at the organizational, network, application, and end user levels to safeguard against cyberattacks.
- Conduct a security self-assessment of your own computer and usage habits.
- Identify eight steps that must be taken to perform a thorough security risk assessment.
- Describe five actions an organization must take in response to a successful cyberattack.
- Describe the role of a managed security service provider.
- Define the term computer forensics.

# IS in Action

## Organizations Mishandle Data Breaches

### ► SOCIAL AND ETHICAL ISSUES, DATA PROTECTION

What do Yahoo, Uber, and Under Armour have in common? They all suffered massive data breaches in which hackers gained access to tens of millions of customers' personal data—and then failed to disclose the breach in a timely fashion. The companies failed to disclose the breaches even though the state and federal laws require companies to alert people and government agencies when sensitive data breaches occur. In each case, the data breach resulted from a failure to apply software patches to fix known vulnerabilities, questionable allocation of information security resources, and poor management decision making. These companies are by no means the only ones to suffer large data breaches and then drag their feet in reporting it to officials and affected parties, but they are among the worst offenders and an examination of them can provide useful insights into the problem.

Yahoo disclosed in December 2016 that one billion of its users' accounts had been compromised in an August 2013 breach. In the breach, attackers accessed email addresses, passwords, birth dates, and other bits of personal information. A year later in November 2017, Yahoo provided an alarming update—the incident had exposed three billion accounts—every single Yahoo account that existed at the time! Yahoo took over four years to discover and disclose the full extent of what is currently the largest data breach in history. (During this four-year span, Yahoo suffered another data breach in late 2014 that impacted 500 million accounts. This data breach was not disclosed until September 2016—some two years after the fact.) Verizon was in the process of acquiring Yahoo during this time and uncertainty over the legal ramifications of the data breach enabled it to negotiate a \$350 million reduction in the price it would pay for Yahoo in the deal completed in June 2017. Yahoo shareholders brought a class action suit against the firm and were awarded \$80 million in 2018.

Uber, the popular ridesharing, food delivery, and transportation service company, announced in February 2015 that it had suffered a data breach in May 2014. The breach itself wasn't discovered until September 2014 and affected some 50,000 of its drivers. The New York attorney general fined Uber \$20,000 for failing to promptly disclose this data breach. Alarmingly, a second data breach occurred at Uber in October 2016 involving names, email addresses, and phone numbers of 50 million customers around the world. Company officials learned of the hack in November 2016 but failed to inform the New York attorney general and the Federal Trade Commission about this breach until November 2017. Although Uber admits it had a legal obligation to report the hack to regulators, the company instead paid the hackers to delete the data and keep the breach quiet.

Under Armour was hit with a data breach that impacted some 150 million users of its My Fitness Pal food and nutrition application. Usernames, passwords, and email addresses were compromised. The data was compromised sometime in February 2018 and users were notified several weeks later in late March. Shares of the firm dropped 4 percent on the news.

Individuals whose data is compromised in a data breach have a need to know so that they can take prompt action to avoid potential negative consequences. Somewhere between 50 and 75 percent of U.S. Internet users use just one password on most of their online accounts. These online accounts include email, social media, financial institutions, Medicare, social security, health care organizations, and so on. Hackers know this fact and take advantage of this security gap to gain access to other Web sites you frequent in order to gather additional personal data. Hackers can use this data for identify theft or blackmail purposes, to obtain a credit card or take out a loan in your name, to file a false income tax return in your name, or to execute numerous other nefarious activities related to identity theft. As a result, organizations that fail to report a data breach promptly are seen by the public as acting irresponsibly and unethically. The reputation of such an organization suffers and it may lose many customers as a result.

**As you read about secure information systems, consider the following:**

- What key trade-offs and ethical issues are associated with the safeguarding of data and information systems?
- What are the key elements of a multilayer process for managing security vulnerabilities?

## Why Learn About Secure Information Systems?

The security of data and information systems used in business is of utmost importance. Confidential business data and private customer and employee information must be safeguarded, and systems must be protected against malicious acts of theft or disruption. As we saw in the opening vignette, organizations we are familiar with have suffered serious data breaches. Other organizations that suffered serious data breaches in 2018 include retailer Saks, Lord & Taylor; the Sacramento Bee newspaper; ticketing company Ticketfly, bakery, café Panera Bread; the My Heritage genealogy platform; and marketing and data aggregation firm Exactis. Have you interacted with any of these organizations recently?

Although the need for security is obvious, it must often be balanced against other business needs. Business managers, IS professionals, and IS users all face a number of complex trade-offs regarding IS security. They might use questions such as the following to evaluate those trade-offs:

- How much effort and money should be spent to safeguard against computer crime? (In other words, how safe is safe enough?)
- What should be done if recommended computer security safeguards make conducting business more difficult for customers and employees, resulting in lost sales and increased costs?
- If a firm is a victim of a computer crime, should it pursue prosecution of the criminals at all costs, maintain a low profile to avoid the negative publicity, inform affected customers, or take some other action?

## The Threat Landscape

The number of cybercrimes being committed against individuals, organizations, and governments continues to increase, and the destructive impact of these crimes is also intensifying. Some 50 percent of small to mid-sized organizations reported suffering at least one cyberattack during 2017.<sup>1</sup> Some estimate that the global cost of cybersecurity breaches will cost some \$6 trillion by 2021, up from \$3 trillion in 2015. This monetary loss makes the financial impact of cybercrime larger than the global financial trade of illegal drugs.

The brands, reputation, and earnings of many organizations around the world have been negatively impacted by cybercrimes. To counteract cybercrime, industry experts expect spending on cybersecurity products and services to exceed \$1 trillion over the time period 2017–2022,<sup>2</sup> with the average cost of cybersecurity measures per company in 2017 pegged at \$11.7 million.<sup>3</sup>

Note the following alarming results from a recent survey of executives:<sup>4</sup>

- 89 percent of respondents say their cybersecurity function does not fully meet their needs
- 87 percent of respondents say they need up to 50 percent more cybersecurity budget
- 77 percent of respondents consider a careless member of staff as the most likely source of attack
- 75 percent of respondents rate the maturity of their vulnerability identification as very low to moderate

Clearly, we have a lot of work to do to get cyberattacks under control.

## Why Computer Incidents Are So Prevalent

Computer incidents are prevalent for a variety of reasons. These reasons include increasing computing complexity, an increase in the prevalence of bring your own device (BYOD) policies, a growing reliance on software with known vulnerabilities, and the increasing sophistication of those who would do harm. These reasons, which are discussed in the following sections, have caused a dramatic increase in the number, variety, and severity of security incidents.

### ***Increasing Complexity Increases Vulnerability***

The computing environment has become enormously complex. The Internet of Things, cloud computing, mobile devices, operating systems, applications, Web sites, switches, routers, and gateways are all interconnected and are driven by hundreds of millions of lines of code. This environment continues to increase in complexity every day and soon will include billions of communicating devices. The number of possible entry points to a network expands continually as more devices are added, further increasing the possibility of security breaches.

In addition, organizations are constantly adding new applications, modifying existing applications, and replacing older, legacy information systems. This constant change further increases the level of complexity and raises the vulnerability of the systems.

### ***Bring Your Own Device Policies***

#### ***bring your own device***

**(BYOD):** A business policy that permits, and in some cases encourages, employees to use their own mobile devices (smartphones, tablets, or laptops) to access company computing resources and applications.

**Bring your own device (BYOD)** is a business policy that permits, and in some cases encourages, employees to use their own mobile devices (smartphones, tablets, or laptops) to access company computing resources and applications. These resources and applications include email, corporate databases, the corporate intranet, and the Internet. Proponents of BYOD say the policy improves employee productivity by allowing workers to use devices with which they are already familiar—while also helping to create an image of a company as a flexible and progressive employer. However, this practice raises many potential security issues as it is highly likely that such devices are also used for non-work activity, such as browsing Web sites, blogging, shopping, and visiting social networks. This nonwork activity exposes the devices to malware much more frequently than a device that is used strictly for business purposes. (The malware may then be spread throughout the company.) In addition, BYOD makes it extremely difficult for IT organizations to adequately safeguard the wide range of portable devices with various operating systems and a myriad of applications.

### ***Use of Software with Known Vulnerabilities***

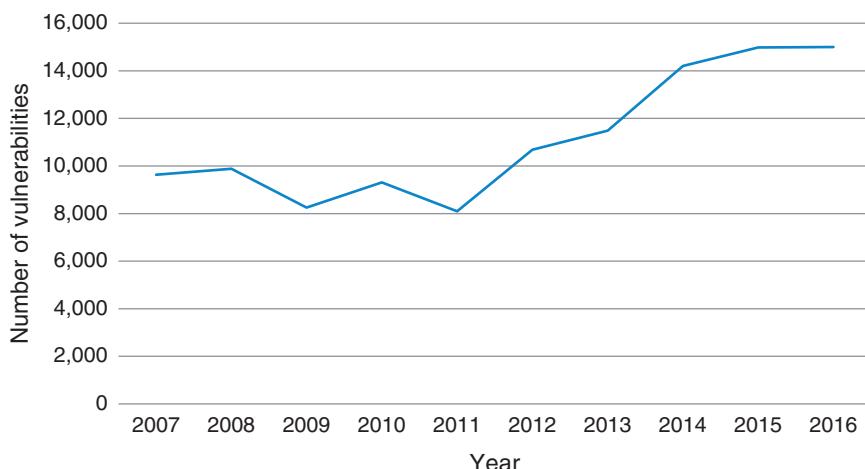
**exploit:** An attack on an information system that takes advantage of a particular system vulnerability.

In computing, an **exploit** is an attack on an information system that takes advantage of a particular system vulnerability. Often this attack is made possible due to poor system design or implementation. Once the vulnerability is discovered, software developers create and issue a “fix,” or patch, to eliminate the problem. Users of the system or application are responsible for obtaining and installing the patch, which they can usually download from the Web.

Any delay in installing a patch exposes the system to a potential security breach. The need to install a fix to prevent a hacker from taking advantage of a known system vulnerability can create a time-management dilemma for system support personnel trying to balance a busy work schedule. For instance, should support personnel install a patch that, if left uninstalled, could lead to a security breach, or should they complete assigned project work so that the anticipated project savings and benefits from the project can begin to accrue on schedule? Note that the number of new software vulnerabilities identified in 2016 was 15,000—an average of 41 per day—as shown in Figure 2.1.

**FIGURE 2.1**  
**Total number of new software vulnerabilities identified annually**

Source: Shaun Waterman, "Report: Discovery Rate of New Software Vulnerabilities Flattens," *Cyber Scoop*, February 17, 2017, <https://www.cyber-scoop.com/risk-based-security-report-number-vulnerabilities-cve-cvss>.



**zero-day attack:** An attack that takes place before the security community becomes aware of and fixes a security vulnerability.

Clearly, it can be difficult to keep up with all the required patches to fix these vulnerabilities. Of special concern is a **zero-day attack**, which is an attack that takes place before the security community becomes aware of and fixes a security vulnerability. Zero-day attacks are rare—just eight were identified in 2016 and 49 were identified in 2017. Hackers employed a zero-day attack in 2017 on the consumer credit reporting bureau Equifax. This attack led to a data breach that exposed the names, addresses, social security numbers, and driver's license numbers of over 143 individuals.<sup>5</sup>

While one would hope that the discoverer of a zero-day vulnerability would immediately inform the original software manufacturer so that a fix could be created for the problem, that is not always the case. In some cases, this knowledge is instead sold on the black market to cyberterrorists, governments, or large organizations that may then use it to launch their own cyberattacks. For example, a zero-day vulnerability that enabled hackers to gain admin rights to any Windows operating system computer from Windows 2000 to a current version of Windows 10 was offered for sale on the black market for \$90,000.<sup>6</sup>

U.S. companies increasingly rely on commercial software with known vulnerabilities. Even when vulnerabilities are exposed, many corporate IT organizations continue to use already installed software as-is rather than implement security fixes. IT organizations often make this decision because the fixes will either make the software harder to use or eliminate “nice-to-have” features that will help sell the software to end users.

### ***Increasing Sophistication of Those Who Would Do Harm***

Previously, computer troublemakers were stereotyped as introverted “geeks” who were working independently and who were motivated by the desire to gain some degree of notoriety. These individuals were armed with specialized, but limited, knowledge of computers and networks and used rudimentary tools, perhaps downloaded from the Internet, to execute exploits. While such individuals still exist, today’s computer menace is much better organized and may be part of an organized group (such as Anonymous, Chaos Computer Club, Lizard Squad, TeslaTeam) that has an agenda and that targets specific organizations and Web sites. Some of these groups have ample resources, including money and sophisticated tools, to support their efforts. Today’s computer attacker has the depth of knowledge, financial wherewithal, and expertise to get around computer and network security safeguards.

### ***Perpetrators Most Likely to Initiate a Cyberattack***

In 2017–2018, professional service firm Ernst & Young polled 1,735 global executives, information security managers, and IT leaders, and found that in descending order, careless insiders, cyber criminals, malicious employees, and

hacktivists were considered the most likely sources of a cyberattack. Currently, although the lone wolf and cyberterrorist receive a lot of publicity, they are not considered among the most serious sources of cyberattacks.

**TABLE 2.1** Classifying perpetrators of computer crime

Type of perpetrator	Description
Careless insider	An inside (employee, business partner, contractor, consultant) who does not follow the organization's security policies and enables a cyberattack to occur
Malicious employees	An insider who deliberately attempts to gain access to and/or disrupt a company's information systems and business operations
Cybercriminal	Someone who attacks a computer system or network for financial gain
Hacktivist	An individual who hacks computers or Web sites in order to promote a political ideology
Lone wolf attacker	Someone who violates computer or Internet security maliciously or for illegal personal gain
Cyberterrorist	State-sponsored individual or group who attempts to destroy the infrastructure components of governments, financial institutions, corporations, utilities, and emergency response units

IBM found that 55–60 percent of all cyberattacks are initiated through the actions of insiders. These insiders include employees, business partners, clients, contractors, and consultants who have physical or remote access to a company's assets. Careless (or untrained) insiders might not be acting with criminal intent but they might fail to follow your organization's cybersecurity policies and do something foolish such as creating a weak password or opening an email attachment containing malware.<sup>7</sup>

## Types of Attack Vectors

**attack vector:** The technique used to gain unauthorized access to a device or a network.

Perpetrators of computer crimes use an **attack vector** to gain unauthorized access to a device or a network and to initiate a cyberattack. There are numerous types of attack vectors, some of which are summarized in Table 2.2. While we usually think of cyberattacks being aimed at computers, they are also being aimed at smartphones because smartphones store an array of personal identity information, including credit card numbers and bank account numbers.

## Cyberattacks That Pose Serious Threats

Cyberattacks that pose serious threats are ransomware, distributed denial-of-service attacks, data breaches, cyberespionage, and cyberterrorism. These types of cyberattacks are serious due to either the frequency of these attacks or the potential damage they can inflict.

### Ransomware

**ransomware:** Malware that stops you from using your computer or accessing your data until you meet certain demands.

**Ransomware** is malware that stops you from using your computer or accessing the data on your computer until you meet certain demands, such as paying a ransom or, in some cases, sending compromising photos to the attacker. Payment is frequently demanded in untraceable Bitcoin. While law enforcement agencies recommend not paying the ransom, some two-thirds of victims reason that the value of the encrypted data outweighs the cost of the ransom and so they pay the ransom.<sup>8</sup>

**TABLE 2.2** Various types of cyberattacks

Attack type	Description
Advanced persistent threat	A network attack in which an intruder gains access to a network and stays there—undetected—with the intention of stealing data over a long period of time.
Blended threat	A sophisticated threat that combines the features of a virus, worm, Trojan horse, and other malicious code into a single payload.
Phishing	The act of fraudulently using email to try to get the recipient to reveal personal data.
Rootkit	A set of programs that enables its user to gain administrator-level access to a computer without the end user's consent or knowledge. Once installed, the attacker can gain full control of the system and even obscure the presence of the rootkit from legitimate system administrators.
Smishing	A variation of phishing that involves the use of texting.
Social engineering	The use of deception to trick individuals into divulging data needed to gain access to an information system or network.
Spam	The use of email systems to send unsolicited email to large numbers of people.
Trojan horse	A seemingly harmless program in which malicious code is hidden. A victim on the receiving end of a Trojan horse is usually tricked into opening it because it appears to be useful software from a legitimate source.
Virus	A piece of programming code, usually disguised as something else, that causes a computer to behave in an unexpected and usually undesirable manner.
Vishing	Similar to smishing except that the victims receive a voice mail message telling them to call a phone number or access a Web site.
Worm	A harmful program that resides in the active memory of the computer and duplicates itself. Worms differ from viruses in that they can propagate without human intervention, often sending copies of themselves to other computers by email.

From 2016 to 2017, the number of ransomware attacks on U.S. businesses tripled from one attack every two minutes to one attack every 40 seconds. Attacks against individuals doubled from 1 every 20 seconds to 1 every 10 seconds. The average ransom demand is just over \$1000. Among those who have paid ransom demands, 20% were never able to recover their files.<sup>9</sup>

A computer can become infected with ransomware when a user opens an email attachment containing the malware or is lured to a compromised Web site by a deceptive email or pop-up window. However, most ransomware attacks take advantage of vulnerabilities in widely deployed software such as Microsoft's Server Message Block (SMB). This is a network file sharing protocol, to gain remote access to victim machines and execute the ransomware directly. It is not necessary to trick users with disguised payloads to initiate a ransomware attack. Once the malware has taken over, it encrypts some or all of the victim's files. The files can then only be decrypted with a mathematical key known only to the attacker. Government agencies, medical facilities, and law firms are favorite ransomware targets as these organizations often need immediate access to their files.

Less than five percent of companies pay ransoms, electing instead to recover encrypted data from backup files. However, getting infected systems back up and running takes time and effort—nearly one-third of companies infected with ransomware suffer five days or longer without access. Each day without access runs up costs in lost business and damages due to downtime. Experts estimate that global ransomware costs due to lost business and damages exceeded \$5 billion in 2017.<sup>10</sup>

The city of Atlanta was hit with a ransomware attack in March 2018 that disabled over 40 programs of the city's mission critical apps, including those

used by the court system and police. As a result of this attack, residents could not pay their water bills or pay parking tickets, and police and other city workers had to write out their reports manually. In addition, court proceedings for people not in custody had to be cancelled until the systems were up and running again, and years of police dashcam data were lost, making it more difficult to prosecute some criminal cases.<sup>11</sup> City officials decided not to pay the \$51,000 ransom but were still working to recover from the attack three months later. It is estimated that the city will spend over \$10 million to recover from the attack.<sup>12</sup>

**distributed denial-of-service (DDoS) attack:**

A cyberattack in which a malicious hacker takes over computers via the Internet and causes them to flood a target site with demands for data and other small tasks.

**botnet:** A large group of computers controlled from one or more remote locations by hackers without the knowledge or consent of their owners.

**data breach:** The unintended release of sensitive data or the access of sensitive data by unauthorized individuals.

### Distributed Denial-of-Service Attacks

A **distributed denial-of-service (DDoS) attack** is one in which a malicious hacker takes over computers via the Internet and causes them to flood a target site with demands for data and other small tasks. A DDoS attack does not involve infiltration of the targeted system. Instead, it keeps the target so busy responding to a stream of automated requests that legitimate users cannot get in—the Internet equivalent of dialing a telephone number repeatedly so that all other callers hear a busy signal. The targeted machine essentially holds the line open while waiting for a reply that never comes; eventually, the requests exhaust all resources of the target.

The software required to initiate a DDoS is simple to use, and many DDoS tools are readily available at a variety of hacker sites. In a DDoS attack, a tiny program is downloaded surreptitiously from the attacker's computer to dozens, hundreds, or even thousands of computers all over the world. The term **botnet** is used to describe a large group of such computers, which are controlled from one or more remote locations by hackers, without the knowledge or consent of their legitimate owners. The collective processing capacity of some botnets exceeds that of the world's most powerful supercomputers. Based on a command by the attacker or at a preset time, the botnet computers (called zombies) go into action, each sending a simple request for access to the target site again and again—dozens of times per second. The target computers become so overwhelmed by requests for service that legitimate users are unable to get through to the target computer.

There were 7.5 million DDoS attacks worldwide in 2017. Victims of DDoS attacks reported a financial impact in the range of \$10,000–\$100,000 coming from damage to reputation and operational expenses.<sup>13</sup>

GitHub, a Web site where some 28 million people go to develop software, suffered perhaps the largest ever DDoS attack with over 1.35 terabytes (one million multiplied by a million bytes) of requests per second. However, the Web site was well prepared for such an attack and only experienced about 10 minutes of unavailability in February 2018.<sup>14</sup>

### Data Breach

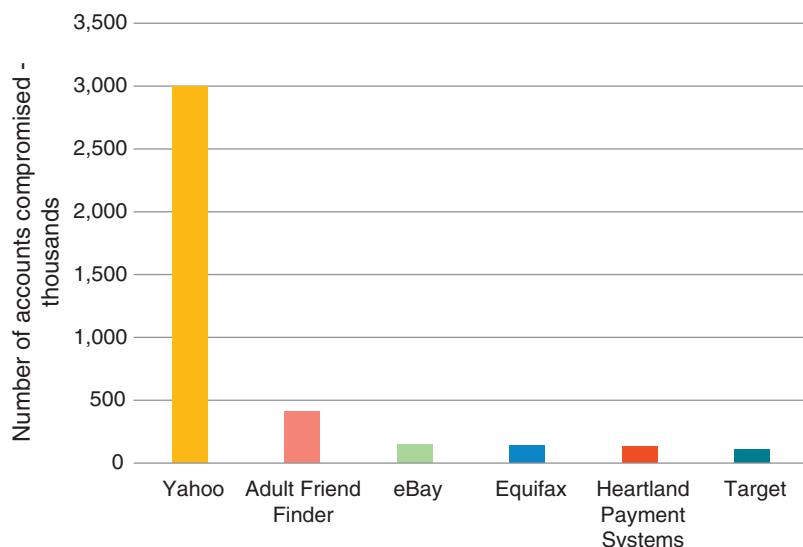
A **data breach** is the unintended release of sensitive data or the access of sensitive data by unauthorized individuals, often resulting in identify theft. Figure 2.2 illustrates the number of people who had personal identification information compromised in the six largest U.S. data breaches.

The number of U.S. data breaches in 2017 hit a record high of 1,575—a 44 percent increase over 2016.<sup>15</sup> The numbers for government and industry sectors where data breaches occurred are identified in Figure 2.3. Data breaches are considered a serious threat due to their relatively high frequency of occurrence and the large number of people affected.

Not only are the individuals whose data is compromised in a data breach put at risk of identity theft or blackmail, but also the shareholders of an organization hit with a data breach can be impacted by a decline in the valuation of the firm that follows publication of the incident. They can lose money if they need to sell the stock or if the hacked organization is being considered for

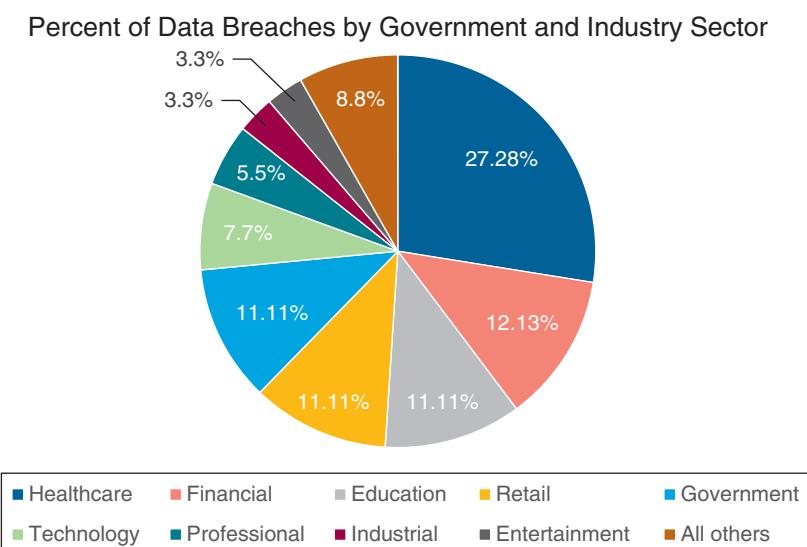
**FIGURE 2.2**  
**Six largest data breaches in the United States**

Source: Taylor Armerding, "The 17 biggest data breaches of the 21st century," *CSO Online*, January 26, 2018, <https://www.csionline.com/article/2130877/data-breach/the-biggest-data-breaches-of-the-21st-century.html>.



**FIGURE 2.3**  
**Data breaches in government and industrial sectors in 2017**

Source: "The Reality of Data Breaches," <https://breachlevelindex.com/assets/Breach-Level-Index-Infographic-2017-Gemalto-1500.jpg>, accessed July 17, 2018.



potential acquisition by another firm. Consumer credit reporting agency Equifax suffered a data breach in which over 143 million consumers personal data was compromised. Its stock price fell over 30 percent following announcement of the data breach—from a high of around \$141/share to a low of \$94/share in a period of just a week.<sup>16</sup> As stated earlier in the chapter, Verizon was able to negotiate a \$350 million reduction in the acquisition of Yahoo when it became known that it had suffered the biggest data breach in U.S. history.

### Cyberespionage

**Cyberespionage** involves the deployment of malware that secretly steals data in the computer systems of organizations. These organizations include government agencies, military contractors, political organizations, and manufacturing firms. The type of data most frequently targeted includes data that can provide an unfair competitive advantage to the perpetrator. This data is typically not public knowledge and may even be protected via patent, copyright, or trade secret. High-value data includes the following:

- Sales, marketing, and new product development plans, schedules, and budgets
- Details about product designs and innovative processes

**cyberespionage:** The deployment of malware that secretly steals data in the computer systems of organizations.

- Nonpublic information about mergers, acquisitions, and investment deals
- Employees' personal information
- Customer and client data
- Sensitive information about partners and partner agreements

Tensions have long simmered between China and the United States over alleged cyberespionage attacks. United States experts claim cyberespionage has helped China to accelerate the research and development process and cut years off the time for that country to acquire new technology in a variety of industries. Alleged targets have included aluminum and steel producers, a company that designs nuclear power plants, a solar panel manufacturer, and an aircraft manufacturer. Meanwhile, China's Foreign Ministry portrays the United States as a hypocrite that engages in cyberespionage by conducting cybertheft, wiretapping, and surveillance activities against Chinese governmental departments, companies, and universities.

After years of discussion and behind the scenes efforts, President Obama and Chinese President Xi Jinping announced in September 2015 that the two nations had agreed to initial norms of cyberactivities with the two nations pledging each will avoid conducting cybertheft of intellectual property for commercial gain.<sup>17,18</sup> Cybersecurity experts stated that Chinese cyber espionage operations aimed at stealing trade secrets, intellectual property, and other confidential business information substantially declined following this agreement. However, by May 2017, FireEye (a provider of advanced computer security services) detected a phishing campaign initiated by Chinese groups targeting at least seven global law and investment firms in an attempt to access valuable information on transactions such as mergers, acquisitions, and investment deals. The attacks were associated with a group of hackers, with some degree of sponsorship by the Chinese government.<sup>19</sup>

### Cyberterrorism

**cyberterrorism:** The intimidation of government or civilian population by using information technology to disable critical national infrastructure (e.g., energy, transportation, financial, law enforcement, emergency response) to achieve political, religious, or ideological goals.

**Cyberterrorism** is the intimidation of government or civilian population by using information technology to disable critical national infrastructure (e.g., energy, transportation, financial, law enforcement, emergency response, and healthcare systems) to achieve political, religious, or ideological goals. Cyberterrorism is an increasing concern for countries and organizations around the globe.

In September 2017, in a statement before the Senate Homeland Security and Government Affairs Committee, FBI director Christopher Wray proclaimed: "Preventing terrorist attacks remains the FBI's top priority. The terrorist threat against the United States remains persistent and acute. From a threat perspective, we are concerned with three areas in particular: (1) those who are inspired by terrorist propaganda and act out in support; (2) those who are enabled to act after gaining inspiration from extremist propaganda and communicating with members of foreign terrorist organizations who provide guidance on operational planning or targets; and (3) those who are directed by members of foreign terrorist organizations to commit specific, directed acts in support of the group's ideology or cause."<sup>20</sup> The FBI is warning private industry to be prepared for an environment where multiple attacks can come from a variety of sources, often simultaneously and always with an intent to do damage.

In February 2018, Senate Select Committee on Intelligence hearing, Daniel Coates, director of national intelligence stated: "Frankly, the United States is under attack—under attack by entities that are using cyber to penetrate virtually every major action that takes place in the United States. From U.S. businesses, to the federal government, to state and local governments, the United States is threatened by cyberattacks every day." He highlighted Russia, China, Iran, and North Korea as the greatest cyber threats, but stated that others use cyber operations to achieve strategic and malign objectives.<sup>21</sup>

**department of homeland security (DHS)**

**security (DHS):** A large federal agency with more than 240,000 employees and a budget of almost \$65 billion whose goal is to provide for a “safer, more secure America, which is resilient against terrorism and other potential threats.”<sup>25</sup>

**U.S. computer emergency readiness team (US-CERT)**

**(US-CERT):** A partnership between the Department of Homeland Security and the public and private sectors; established to provide timely handling of security incidents as well as conducting improved analysis of such incidents.

The **Department of Homeland Security (DHS)** is a large federal agency with more than 240,000 employees and a budget of almost \$65 billion whose goal is to provide for a “safer, more secure America, which is resilient against terrorism and other potential threats.” The agency was formed in 2002 when 22 different federal departments and agencies were combined into a unified, integrated cabinet agency.<sup>22</sup> The agency’s Office of Cybersecurity and Communications resides within the National Protection and Programs Directorate and is responsible for enhancing the security, resilience, and reliability of U.S. cyber and communications infrastructure. It works to prevent or minimize disruptions to critical information infrastructure in order to protect the public, the economy, and government services.<sup>23</sup>

The Department of Homeland Security Web site ([www.dhs.gov](http://www.dhs.gov)) provides a link that enables users to report cyber incidents. Incident reports go to the US-CERT Incident Reporting System, which assists analysts of the **U.S. Computer Emergency Readiness Team (US-CERT)** (a partnership between the Department of Homeland Security and the public and private sectors) in providing timely handling of security incidents as well as in conducting improved analysis of such incidents.<sup>24</sup> Established in 2003 to protect the nation’s Internet infrastructure against cyberattacks, US-CERT serves as a clearinghouse for information on new viruses, worms, and other computer security topics.

According to the Department of Homeland Security, Russia has attempted to infiltrate key U.S. infrastructure targets in the aviation, energy, manufacturing, nuclear, and water sectors since March 2016. Access was attempted by initially targeting small third-party networks that were less secure. In his book *Lights Out*, broadcast journalist Ted Koppel discusses the potential for a successful cyberterrorist attack on the United States power grid and its devastating impact—tens of millions of people without the power required for running water, sewage disposal, refrigeration, and lighting. Heating and air conditioning units, life-saving hospital equipment, cell phone towers, traffic lights—all would be without the power needed to operate for weeks or even months.

In July 2018, 12 officers within Russia’s Main Intelligence Directorate of the General Staff were indicted for allegedly hacking into various Democratic Party computers, releasing tens of thousands of stolen emails and documents, and attempting to gain control of the email accounts of people associated with the 2016 Hilary Clinton campaign. In addition, around July 2016, Russian intelligence officers hacked into the Illinois state board of elections Web site and stole information related to approximately 500,000 voters. There is no evidence that the actual vote count was tampered with.<sup>26</sup>

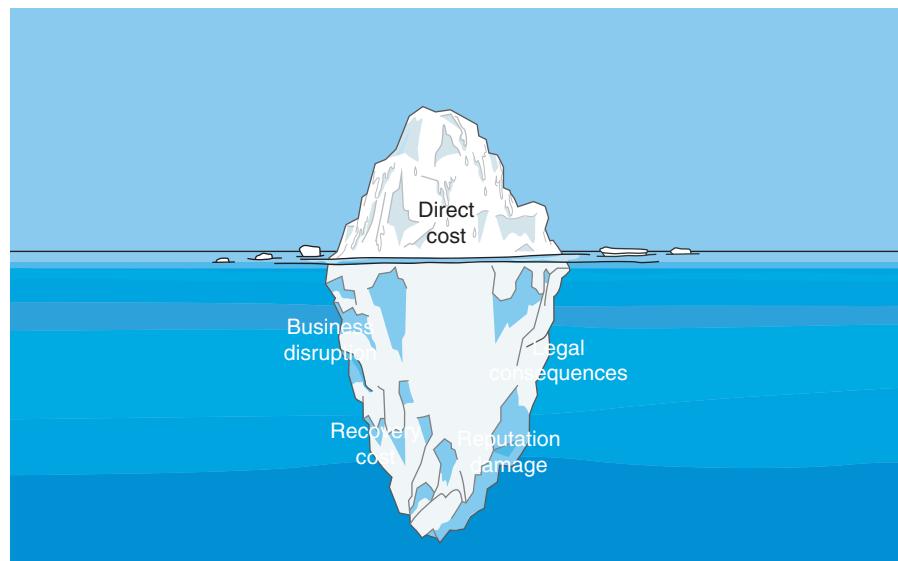
## Consequences of a Successful Cyberattack

The impact of a successful cyberattack can be serious and long lasting. There are five broad areas of impact, as illustrated in Figure 2.4 and discussed below. The image of the iceberg is appropriate for this discussion because most people only think of the direct impact of a successful cyberattack and do not consider all the other oft-hidden effects:

**Direct impact** This is the value of the assets (cash, inventory, equipment, patents, copyrights, trade secrets, data) stolen or damaged due to the cyberattack. Shareholders of the organizations will also experience a direct impact from the drop in the share price that typically follows a major cyberattack.

**Business disruption** A successful cyberattack may make it impossible for the organization to operate in an effective manner for several hours or days. This can cause a loss of existing business and customers as well as the loss of potential new business and customers. In addition, resources may be diverted from their regular duties to scramble to operate some sort of back-up procedures that enables essential business processes to continue—albeit at a lower level of efficiency.

**FIGURE 2.4**  
**Consequences of a successful cyberattack**



**Recovery cost** It may take people from the IS organization and business areas days or weeks to repair affected systems and recover lost or compromised data. Resources will need to be drawn from their normal work responsibilities to perform a post-incident analysis to identify the scope, cause, and impact of the cyberattack and to determine measures to prevent a reoccurrence.

**Legal consequences** There is the prospect of monetary penalties for businesses that fail to comply with data protection legislation. For example, the European Union General Data Protection Regulation (GDPR) has established strong guidelines for how organizations process and handle data so that the personal information of individuals is protected. Organizations that violate these guidelines can be fined 20 million euros (\$23 million U.S. dollars), or 4 percent of global annual revenue—whichever is greater. In addition, consumers are almost certain to initiate lawsuits to recover any damages incurred from the cyberattack. Many organizations that suffer a cyberattack that compromises the personal data of employees, customers, or patients provide one or two years of identity theft insurance or consumer credit monitoring for those impacted. At a cost of \$20 or so per month multiplied by the number of individuals affected, this bill can be quite expensive.

**Reputation damage** A successful cyberattack can erode the trust your organization has established with your customers, suppliers, business partners, and shareholders. This damage to your organization's reputation leads to a devaluation of the products and services of your organization resulting in a drop in stock price, loss of customers, supplier turnover, strained business partner relationships, and ultimately, a loss of sales and decrease in profits.

## Federal Laws for Prosecuting Computer Attacks

Over the years, the United States Congress has enacted multiple laws to help prosecute those responsible for computer-related crime; these laws are summarized in Table 2.3. For example, Section 814 of the USA Patriot Act defines cyberterrorism as any hacking attempts designed to gain unauthorized access to a protected computer, which, if successful, would cause a person an aggregate loss greater than \$5,000; adversely affect someone's medical examination, diagnosis, or treatment; cause a person to be injured; cause a threat to public health or safety; or cause damage to a governmental computer that is used as a tool to administer justice, national defense, or national security.<sup>27</sup> Those convicted of cyberterrorism are subject to a prison

term of 5–20 years. (The \$5,000 threshold is quite easy to exceed, and, as a result, many young people who have been involved in what they consider to be minor computer pranks have found themselves meeting the criteria to be tried as cyberterrorists.)

**TABLE 2.3** Federal laws that address computer crime

Federal Law	Subject Area
Computer Fraud and Abuse Act (U.S. Code Title 18, Section 1030)	Addresses fraud and related activities in association with computers, including the following: <ul style="list-style-type: none"> <li>• Accessing a computer without authorization or exceeding authorized access</li> <li>• Transmitting a program, code, or command that causes harm to a computer</li> <li>• Trafficking of computer passwords</li> <li>• Threatening to cause damage to a protected computer</li> </ul>
Fraud and Related Activity in Connection with Access Devices Statute (U.S. Code Title 18, Section 1029)	Covers false claims regarding unauthorized use of credit cards
Identity Theft and Assumption Deterrence Act (U.S. Code Title 18, Section 1028)	Makes identity theft a federal crime, with penalties of up to 15 years of imprisonment and a maximum fine of \$250,000
Stored Wire and Electronic Communications and Transactional Records Access Statutes (U.S. Code Title 18, Chapter 121)	Focuses on unlawful access to stored communications to obtain, alter, or prevent authorized access to a wire or electronic communication while it is in electronic storage
USA Patriot Act	Defines cyberterrorism and associated penalties



## Critical Thinking Exercise

### University Under Attack!

#### ► DECISION MAKING, DATA PROTECTION

Your university has been hit by a ransomware cyberattack. Student academic and financial records, faculty and administrative personnel information, and payroll records are all illegally encrypted and now inaccessible to legitimate users. A ransom of \$50,000 must be paid in the next two days for the university to receive the encryption key that will unlock the data. An emergency team has been called to decide what to do.

#### Review Questions

1. What are the odds that even if the university pays the ransom that it will be able to recover this data?
2. What other options does the university have to recover this data?

#### Critical Thinking Questions

1. Develop a scenario under which it would be advisable for the university to pay this ransom.
2. How would you recommend that the university respond to this request? Why?

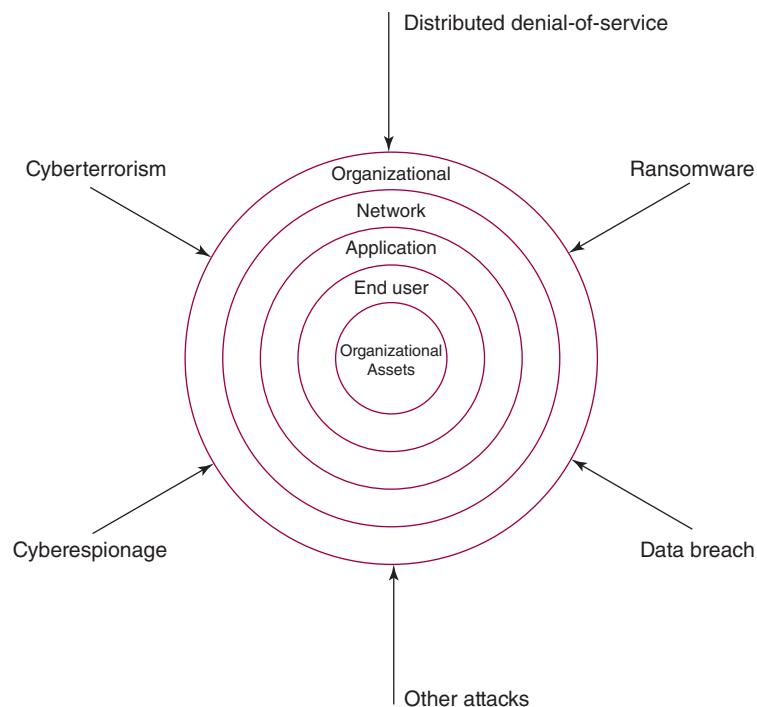
Now that we have discussed the reasons cyberattacks are increasing, the perpetrators most likely to initiate a cyberattack, the cyberattacks that pose serious threats, the consequences of a successful cyberattack, and the laws under which perpetrators can be prosecuted, we will discuss how organizations can take steps to implement a multilayer security strategy to thwart cyberattacks.

## The CIA Security Triad

The IT security teams of organizations worldwide focus on ensuring confidentiality, maintaining integrity, and guaranteeing the availability of systems and data. Confidentiality ensures that only those individuals with the proper authority can access sensitive data such as employee personal data, customer and product sales data, new product development plans, and marketing strategies. Integrity ensures that data can be changed only by authorized individuals so that the accuracy, the consistency, and the trustworthiness of the data are guaranteed. Availability ensures that the data can be accessed when and where needed, including during times of disaster recovery operations. A widely held but difficult-to-achieve standard of availability for a system or product is known as “five 9s” or 99.999 percent availability. For an operation that runs 365 days per year, 24 hours per day this translates to less than one hour of unavailability per year. Confidentiality, integrity, and availability are referred to as the **CIA security triad**.

**CIA security triad:** Confidentiality, integrity, and availability form the basis of the CIA security triad.

Although no organization can ever be completely secure from attack, a layered security solution makes cyberattacks so difficult that an attacker eventually gives up or is detected before much harm is inflicted. In a layered solution, if an attacker breaks through one layer of security, another layer must then be overcome. Security measures must be planned for, designed, implemented, tested, and maintained at the organizational, network, application, and end-user layers to achieve true CIA security (see Figure 2.5). These layers of protective measures are explained in more detail in the following sections.



**FIGURE 2.5**  
**A multi-layered security solution**

### Implementing CIA at the Organizational Level

Implementing CIA begins at the organizational level with the definition of an overall security strategy, performance of a risk assessment, laying out plans for disaster recovery, setting security policies, conducting security audits, ensuring regulatory standards compliance, and creating a security dashboard.

Completion of these tasks at the organizational level will set a sound foundation and clear direction for future CIA-related actions.

### Security Strategy

Implementing CIA security at the organizational level requires a risk-based security strategy with an active governance process to minimize the potential impact of any security incident and to ensure business continuity in the event of a cyberattack. Creating such a strategy typically begins with performing a risk assessment to identify and prioritize the threats that the organization faces. The security strategy must define a disaster recovery plan that ensures the availability of key data and information technology assets. Security policies guide employees to follow recommended processes and practices to avoid security-related problems.

Periodic security audits are needed to ensure that individuals are following established policies and to assess if the policies are still adequate even under changing conditions. In addition to complying with its internal policies, an organization may also need to comply with standards defined by external parties, including regulatory agencies. Many organizations employ a security dashboard to help track the key performance indicators of their security strategy. The various components of the security strategy are discussed in the following subsections.

### Risk Assessment

**risk assessment:** The process of assessing security-related risks to an organization's computers and networks from both internal and external threats.

**Risk assessment** is the process of assessing security-related risks to an organization's computers and networks from both internal and external threats. Such threats can prevent an organization from meeting its key business objectives. The goal of risk assessment is to identify which investments of time and resources will best protect the organization from its most likely and serious threats. In the context of an IT risk assessment, an asset is any hardware, software, information system, network, or database that is used by the organization to achieve its business objectives. A loss event is any occurrence that has a negative impact on an asset. Examples of loss events include a computer contracting a virus or a Web site undergoing a DDoS attack.

The steps in a general security risk assessment process are as follows:

- Step 1—Identify the set of IT assets about which the organization is most concerned. Priority is typically given to those assets that support the organization's mission and the meeting of its primary business goals.
- Step 2—Identify the loss events or the risks or threats that could occur, such as a DDoS attack or insider fraud.
- Step 3—Assess the frequency of events or the likelihood of each potential threat; some threats, such as insider fraud, are more likely to occur than others.
- Step 4—Determine the impact of each threat occurring. Would the threat have a minor impact on the organization, or could it keep the organization from carrying out its mission for a lengthy period of time?
- Step 5—Determine how each threat can be mitigated so that it becomes much less likely to occur or, if it does occur, has less of an impact on the organization. For example, installing virus protection on all computers makes it much less likely that a computer will contract a virus. Due to time and resource limitations, most organizations choose to focus on just those threats that have a high (relative to all other threats) probability of occurrence and a high (relative to all other threats) impact. In other words, first address those threats that are likely to occur and that would have a high negative impact on the organization.
- Step 6—Assess the feasibility of implementing the mitigation options.
- Step 7—Perform a cost-benefit analysis to ensure that your efforts will be cost effective. No amount of resources can guarantee a perfect security

**reasonable assurance:** The recognition that managers must use their judgment to ensure that the cost of control does not exceed the system's benefits or the risks involved.

system, so organizations must balance the risk of a security breach with the cost of preventing one. The concept of **reasonable assurance** in connection with IT security recognizes that managers must use their judgment to ensure that the cost of control does not exceed the system's benefits or the risks involved.

- Step 8—Make the decision on whether or not to implement a particular countermeasure. If you decide against implementing a particular countermeasure, you need to reassess if the threat is truly serious and, if so, identify a less costly countermeasure.

The general security risk assessment process—and the results of that process—will vary by organization. Table 2.4 illustrates a risk assessment for a hypothetical organization. The estimated cost includes the cost of the direct impact, the business disruption, the recovery efforts, and the legal and reputational damage.

**TABLE 2.4** Risk assessment for a hypothetical company

Adverse event	Business objective threatened	Threat (estimated frequency of event)	Vulnerability (likelihood of success of this threat)	Estimated cost of a successful attack	Risk = Threat × Vulnerability × Estimated cost	Relative priority to be mitigated
Data breach of customer account data	Provide safe, secure Web site consumers can trust	18 per year	3%	\$5,000,000	\$2,700,000	1
Distributed denial-of-service (DDoS) attack	24/7 operation of a retail Web site	3 per year	25%	\$500,000	\$375,000	2
Email attachment with harmful worm	Rapid and reliable communications among employees and suppliers	1,000 per year	0.05%	\$200,000	\$100,000	3
Harmful virus	Employees' use of personal productivity software	2,000 per year	0.04%	\$50,000	\$40,000	4
Invoice and payment fraud	Reliable cash flow	1 per year	10%	\$200,000	\$20,000	5

A completed risk assessment identifies the most dangerous threats to a company and helps focus security efforts on the areas of highest payoff.

### Disaster Recovery

Data availability requires implementing products, services, policies, and procedures that ensure that data is accessible even during disaster recovery operations. To accomplish this goal, organizations typically implement a **disaster recovery plan**. This plan is a documented process for recovering an organization's business information system assets—including hardware, software, data, networks, and facilities—in the event of a disaster such as a flood, fire, or electrical outage. A disaster recovery plan should be a component of an organization's overall **business continuity plan**, which should also include an occupant emergency evacuation plan, a continuity of operations plan, and an incident management plan.

A disaster recovery plan focuses on technology recovery and identifies the people or the teams responsible in the event of a disaster, what exactly these

#### disaster recovery plan:

A documented process for recovering an organization's business information system assets—including hardware, software, data, networks, and facilities—in the event of a disaster such as a flood, fire, or electrical outage.

#### business continuity plan:

A document that includes an organization's disaster recovery plan, occupant emergency evacuation plan, continuity of operations plan, and an incident management plan.

people will do when a disaster strikes, and the information system resources required to support critical business processes. Disasters can be natural (e.g., earthquake, fire, flood) or manmade (e.g., accident, civil unrest, terrorism). When developing a disaster recovery plan, organizations should think in terms of not being able to gain access to their normal place of business for an extended period of time, possibly up to several months.

As part of defining a business continuity plan, an organization should conduct a business impact analysis to identify critical business processes and the resources that support them. The recovery time for an information system resource should match the recovery time objective for the most critical business processes that depend on that resource. Some business processes are more essential to continued operations and goal attainment than others. These processes are called **mission-critical processes**. Quickly recovering data and operations for these mission-critical processes can make the difference between failure and survival for an organization. If your billing system doesn't work and you can't send out invoices, your company is at risk of going out of business due to cash flow issues.

Files and databases can be protected by making a copy of all files and databases changed during the last few days or the last week, a technique called incremental backup. This approach to backup uses an image log, which is a separate file that contains only changes to applications or data. Whenever an application is run, an image log is created that contains all changes made to all files. If a problem occurs with a database, an old database with the last full backup of the data, along with the image log, can be used to recreate the current database.

Organizations can also hire outside companies to help them perform disaster planning and recovery. EMC, for example, offers data backup in its RecoverPoint product.<sup>28</sup> For individuals and some applications, backup copies of important files can be placed on the Internet.

**Failover** is another approach to backup. When a server, network, or database fails or is no longer functioning, failover automatically switches applications and other programs to a redundant or replicated server, network, or database to prevent an interruption of service. SteelEye's LifeKeeper and Application Continuous Availability by NeverFail are examples of failover software.<sup>29,30</sup> Failover is especially important for applications that must be operational at all times.

It is imperative that a disaster plan be practiced, and improvements made to the plan based on the results of the test. Unfortunately, many organizations have either never tested their organization's disaster recovery solution or have no idea exactly when it was last tested. One reasonable approach to testing is to simulate a disaster for a single critical portion (e.g., order processing or customer billing) of your business during a time of low business activity. The next disaster plan test should then target a different area of the business.

## Security Policies

**security policy:** Defines an organization's security requirements, as well as the controls and sanctions needed to meet those requirements.

A **security policy** defines an organization's security requirements, as well as the controls and sanctions needed to meet those requirements. A good security policy delineates responsibilities and the behavior expected of members of the organization. A security policy outlines *what* needs to be done but not *how* to do it. The details of *how* to accomplish the goals of the policy are typically provided in separate documents and procedure guidelines.

The SANS (SysAdmin, Audit, Network, Security) Institute's Web site ([www.sans.org](http://www.sans.org)) offers several security-related policy templates that can help an organization to quickly develop effective security policies. The templates and other security policy information can be found at [www.sans.org/security-resources/policies](http://www.sans.org/security-resources/policies) and provide guidelines for creating various policies, including acceptable use policy, email policy, password protection policy, remote access policy, and software installation policy.

Experienced IT managers understand that users will often attempt to circumvent security policies or simply ignore them altogether. Because of that, automated system rules should mirror an organization's written policies

whenever possible. Automated system rules can often be put into practice using the configuration options in a software program. For example, if a written policy states that passwords be a minimum of 13 characters, include at least one number, one capital letter, and one special character, then all systems should be configured to enforce this policy automatically. Users should not be able to create weak passwords.

System administrators must also be vigilant about changing the default usernames and passwords for specific devices when they are added to an organization's network. Cybercriminals and others looking to access the networks of various organizations can easily find information online regarding the default username and password combinations for many vendors' products. A hacker was able to gain access to sensitive military documents about how to service the super classified MQ-9 Reaper drone, the deployment tactics for IEDs, and an M1 Abrams tank operations manual because the default password for several network routers was never changed.<sup>31</sup>

A growing area of concern for security experts is the use of wireless devices to access corporate email, store confidential data, and run critical applications, such as inventory management and sales force automation. Mobile devices such as smartphones can be susceptible to viruses and worms. However, the primary security threat for mobile devices continues to be loss or theft of the device. Wary companies have begun to include special security requirements for mobile devices as part of their security policies. In some cases, users of laptops and mobile devices must use a virtual private network (a method employing encryption to provide secure access to a remote computer over the Internet) to gain access to their corporate network.

### **Security Audits**

**security audit:** A process that enables the organization to identify its potential threats, establish a benchmark of where it is, determine where it needs to be, and develop a plan to meet those needs.

Another important prevention tool is a **security audit** that enables the organization to identify its potential threats, establish a benchmark of where it is, determine where it needs to be, and develop a plan to meet those needs. Management should insist on thorough annual security audits using objective, experienced resources from outside the organization. In some cases, they have no choice in conducting an external audit. Financial institutions, for example, are required to have external auditors certify compliance with regulations such as the Gramm-Leach-Bliley Act (GLBA). Potential partners or customers may insist on seeing the results of a security audit before they do business with your company and put their own assets at risk.

The audit should examine if security policies are being followed. For example, if a policy says that all users must change their passwords every 30 days, the audit must check how well that policy is being implemented. The audit should also review who has access to key systems and data and what level of authority each user has. It is not unusual for an audit to reveal that too many people have access to critical data and that many people have capabilities beyond those needed to perform their jobs. One result of a good audit is a list of items that need to be addressed to ensure that security policies are being met.

A thorough security audit should also test system safeguards to ensure that they are operating as intended. Such tests might include trying the default system passwords that are active when software is first received from the vendor. The goal of such a test is to ensure that all such known passwords have been changed.

Some organizations will also perform a penetration test of their defenses. This entails assigning individuals to try to break through the measures and identify vulnerabilities that still need to be addressed. The individuals used for this test are knowledgeable and are likely to take unique approaches in testing the security measures.

In many cases, an organization will conduct additional security audits using its own resources to ensure that the recommendation made based on previous audits have been implemented.

### **Regulatory Standards Compliance**

In addition to the requirement to comply with your own security program, your organization may also be required to comply with one or more standards defined by external parties. In that case, your organization's security program must include a definition of what those standards are and how the organization will comply. Regulatory standards that might affect your organization include those shown in Table 2.5.

**TABLE 2.5** Additional standards your organization may be required to meet

Act or standard	Who must meet this standard	Subject matter
Bank Secrecy Act (Public Law 91-507)—Amended several times, including by provisions in Title III of the USA PATRIOT Act (see 31 USC § 5311–5330 and Title 31 Code of Federal Regulations)	Financial institutions	Requires financial institutions in the United States to assist U.S. government agencies in detecting and preventing money laundering
European Union–United States Privacy Shield	Organizations that do business with companies and/or individuals in the European Union	Provides companies on both sides of the Atlantic with a mechanism to comply with EU data protection requirements when transferring personal data from the European Union to the United States in support of transatlantic commerce
Federal Information Security Management Act (44 U.S.C. § 3541, et seq.)	Every federal agency	Requires each federal agency to provide information security for the data and information systems that support the agency's operations and assets, including those provided or managed by another agency, contractor, or other source
Foreign Corrupt Practices Act (15 U.S.C. § 78dd-1, et seq.)	Any person who is a citizen, national, or resident of the United States and engages in foreign corrupt practices; also applies to any act by U.S. businesses, foreign corporations trading securities in the United States, American nationals, U.S. citizens, and U.S. residents acting in furtherance of a foreign corrupt practice whether or not they are physically present in the United States	Makes certain payments to foreign officials and other foreign persons illegal and requires companies to maintain accurate records
Gramm-Leach-Bliley Act (GLBA) (Public Law 106–102)	Companies that offer financial products or services to individuals, such as loans, insurance, or financial and investment advice	Governs the collection, disclosure, and protection of consumers' non-public personal information or personally identifiable information
Health Insurance Portability and Accountability Act (Public Law 104–191)	Health-care clearinghouses, employer-sponsored health plans, health insurers, and medical service providers	Regulates the use and disclosure of an individual's health information
Payment Card Industry Data Security Standard (PCI-DSS)	All organizations that store, process, and transmit cardholder data, most notably for debit cards and credit cards.	Provides a framework of specifications, tools, measurements, and support resources to help organizations ensure the safe handling of cardholder information
Sarbanes-Oxley Act (Public Law 107–204 116 Stat. 745)	All public corporations	Protects shareholders and the general public from accounting errors and fraudulent practices in the enterprise

### Security Dashboard

Many organizations use security dashboard software to provide a comprehensive display of all key performance indicators related to an organization's security defenses, including threats, exposures, policy compliance, and incident alerts. The purpose of a security dashboard is to reduce the effort required to monitor and identify threats in time to take action. Data that appears in a security dashboard can come from a variety of sources, including security audits, firewalls, applications, servers, and other hardware and software devices. Figure 2.6 shows an example of a security dashboard.

Organizational Security Dashboard					
#	Key performance indicator	Goal	Actual	Status	
1	Number of separation-of-duty violations	0	2	Red	
2	Number of users with weak, noncompliant passwords	<5	4	Green	
3	Percentage of critical IT assets that passed penetration tests	>96%	93%	Yellow	
4	Backlog of software security patches and updates	<3	3	Green	
5	Number of days since last internal security audit	<90	94	Yellow	
6	Number of days since last external security audit	<366	384	Red	
7	Percentage of employees and contractors who passed security exam	>95%	87%	Red	
8	Score on last disaster-recovery test	>90%	93%	Green	

Red - Immediate action required

Yellow - Caution, should be monitored

Green - OK, goal has been met

**FIGURE 2.6**  
An organizational security dashboard

Algoma Central Corporation, a leading Canadian shipping company, owns and operates the largest Canadian flag fleet of dry-bulk carriers and product tankers operating on the Great Lakes-St. Lawrence Seaway system. The firm recently implemented a security dashboard from Avaap, Inc., to improve access to security information and alleviate the complexity of managing security data for its shipping operations.<sup>32</sup>

### Implementing CIA at the Network Level

The Internet provides a wide-open and well-travelled pathway for anyone in the world to reach your organization's network. As a result, organizations are continuing to move more of their business processes to the Internet to better serve customers, suppliers, employees, investors, and business partners. However, unauthorized network access by a hacker or resentful employee can result in compromised sensitive data and severely degrade services, with a resulting negative impact on productivity and operational capability. This in turn can create a severe strain on relationships with customers, suppliers, employees, investors, and business partners, who may question the capability of the organization to protect its confidential information and offer reliable services. Organizations must carefully manage the security of their networks and implement strong measures to ensure that sensitive data is not accessible to anyone who is not authorized to see it.

### Authentication Methods

To maintain a secure network, an organization must authenticate users attempting to access the network by requiring them to enter something they know (e.g., username and password); something they possess (e.g., a smart card); or pass a biometric check. Many organizations are moving to two-factor authorization

that requires the user to provide two types of credentials before being able to access the network; the two credentials can be any of the following:

- Something you know, such as a personal identification number (PIN) or password
- Something you have, such as some form of security card or token
- Something you are, such as a biometric (e.g., a fingerprint or retina scan)

Two-factor authentication is required to withdraw money from a cash machine. You must present your bank card (something that you have) and a PIN (something that you know) to obtain cash from the machine.

**Biometric authentication** is the process of verifying your identity by using your physiological measurements (fingerprint, shape of your face, shape of your hand, vein pattern, your iris, or retina) or behavioral measurements (voice recognition, gait, gesture, or other unique behaviors). To do this, a reference model of the unique characteristics must be stored in digital form in a database or smart card. This stored data is then compared to your biometric data to authenticate you are indeed who you claim to be. Upon authentication, you may then be granted access to a room or building, computer service, app, computing or communications device.

### **Firewall**

Installation of a corporate firewall is the most common security precaution taken by businesses. A **firewall** is a system of software, hardware, or a combination of both that stands guard between an organization's internal network and the Internet, and limits network access based on the organization's access policy.

Any Internet traffic that is not explicitly permitted into the internal network is denied entry through a firewall. Similarly, most firewalls can be configured so that internal network users can be blocked from gaining access to Web sites deemed inappropriate for employees. These Web sites might include those whose content is based on sex and violence. Most firewalls can also be configured to block instant messaging, access to newsgroups, and other Internet activities.

Software vendors Agnitum, Check Point, Comodo, Kaspersky, and Total Defense provide some of the top-rated firewall software used to protect personal computers. Their software provides antivirus, firewall, antispam, parental control, and phishing protection capabilities and sell for \$30–\$80 per single user license.

A **next-generation firewall (NGFW)** is a hardware- or software-based network security system that can detect and block sophisticated attacks by filtering network traffic dependent on the packet contents. Compared to first- and second-generation firewalls, a NGFW goes deeper to inspect the content of packets and matches sequences of bytes for harmful activities, such as known vulnerabilities, exploit attacks, viruses, and malware.

### **Routers**

A router is a networking device that connects multiple networks together and forwards data packets from one network to another. Often, an Internet service provider (ISP) installs a router in a subscriber's home to connect the ISP's network to the network within the home.

Routers enable you to create a secure network by assigning it a passphrase so that only individuals who have the passphrase can connect to your network. However, a skilled and committed attacker can break the passphrase to gain access to your network. Thus, as an additional layer of security, the router provides you the capability to specify the unique media access control (MAC) address of each legitimate device connected to the network and restrict access to any other device that attempts to connect to the network. This effectively

**biometric authentication:** The process of verifying your identity using your physiological measurements (fingerprint, shape of your face, shape of your hand, vein pattern, your iris, or retina) or behavioral measurements (voice recognition, gait, gesture, or other unique behaviors).

**firewall:** A system of software, hardware, or a combination of both that stands guard between an organization's internal network and the Internet, and limits network access based on the organization's access policy.

**next-generation firewall (NGFW):** A hardware- or software-based network security system that can detect and block sophisticated attacks by filtering network traffic dependent on the packet contents.

enables the router to distinguish legitimate traffic from unsolicited traffic and reject uninvited inbound connections. Most routers also have an option to restrict access to specific Web sites thus blocking access to Web sites that are known to infect user devices with malware.

### **Encryption**

**encryption:** The process of scrambling messages or data in such a way that only authorized parties can read it.

**encryption key:** A value that is applied (using an algorithm) to a set of unencrypted text (plaintext) to produce encrypted text that appears as a series of seemingly random characters (ciphertext) that is unreadable by those without the encryption key needed to decipher it.

**Encryption** is the process of scrambling messages or data in such a way that only authorized parties can read it. Encryption is used to protect billions of online transactions each day, enabling consumers to order more than \$300 billion in merchandise online each year and enabling banks to route some \$40 trillion in financial transactions each year.<sup>33</sup> With encryption, organizations share sensitive sales data, promotion plans, new product designs, and project status data among employees, suppliers, contractors, and others with a need to know. Encryption enables physicians and patients to share sensitive healthcare data with labs, hospitals, and other health treatment facilities as well as insurance carriers. To complete such transactions, sensitive data—including names, physical addresses, email addresses, phone numbers, account numbers, health data, financial data, passwords, and personal identification numbers (PINs)—must be sent and received. Great harm could be done, and chaos could ensue if this data were to fall into the wrong hands. Encryption is one means of keeping this data secure.

An **encryption key** is a value that is applied (using an algorithm) to a set of unencrypted text (plaintext) to produce encrypted text that appears as a series of seemingly random characters (ciphertext) that is unreadable by those without the encryption key needed to decipher it. There are two types of encryption algorithms: symmetric and asymmetric. Symmetric algorithms use the same key for both encryption and decryption. Asymmetric algorithms use one key for encryption and a different key for decryption. Advanced Encryption Standard (AES) is the most widely used symmetric algorithm and is entrusted to protect classified U.S. government information. Wireless Protected Access 2 (WPA2), which is the most commonly used security protocol for wireless networks today, employs the AES encryption algorithm.

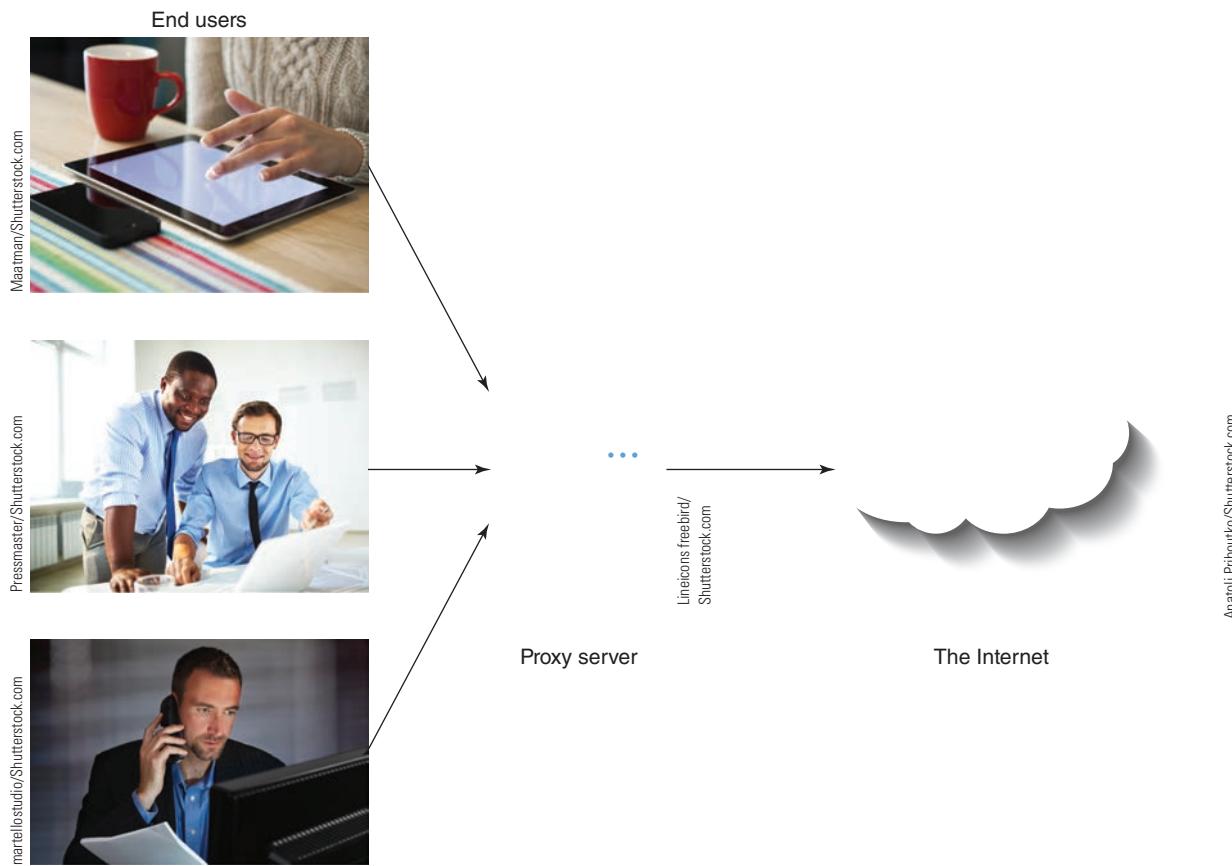
The ability to keep encrypted data secret is not determined by the encryption algorithm, which is widely known, but rather on the encryption key. The encryption key is chosen from one of a large number of possible encryption keys. In general, the longer the key, the stronger the encryption. Thus, an encryption protocol based on a 56-bit key is not as strong as one based on a 128-bit key. Of course, it is essential that the key be kept secret from possible interceptors. A hacker who obtains the key can recover the original message from the encrypted data. Encryption methods rely on the limitations of computing power for their security. If breaking a code requires too much computing power, even the most determined hacker cannot be successful.

**transport layer security (TLS):** A communications protocol or system of rules that ensures privacy between communicating applications and their users on the Internet.

Many online shoppers fear the theft of their credit card numbers and banking information. To help prevent this type of theft, the Transport Layer Security communications protocol is used to secure sensitive data. **Transport Layer Security (TLS)** is a communications protocol or system of rules that ensures privacy between communicating applications and their users on the Internet. TLS enables a client (such as a Web browser) to initiate a temporary, private conversation with a server (such as an online shopping site or bank). Before the client and server start communicating, they perform an automated process called a “handshake” during which they exchange information about who they are and which secret codes and algorithms they will use to encode their messages to each other. Then, for the duration of the conversation, all the data that passes between the client and server is encrypted so that even if somebody does listen in, they won’t be able to determine what is being communicated.

### Proxy Servers and Virtual Private Networks

A proxy server serves as an intermediary between a Web browser and another server on the Internet that makes requests to Web sites, servers, and services on the Internet for you (see Figure 2.7). When you enter the URL for a Web site, the request is forwarded to the proxy server, which relays the request to the server where the Web site is hosted. The homepage of the Web site is returned to the proxy server, which then passes it on to you. Thus, the Web site sees the proxy server as the actual visitor and not you.



**FIGURE 2.7**  
**Proxy Server**

By forcing employees to access the Internet through a proxy server, companies can prevent employees from accessing certain Web sites. A proxy server can also capture detailed records of all the Web sites each employee has visited, when, and for how long. When you access a Web site directly, the server hosting the Web site can see your IP address and store cookies on your computer, but a proxy server can hide your IP address and block cookies from being sent to your device. A proxy server relays those packets for you and strips the originating address so instead of your IP address, the Web site only sees the address of the proxy server.

Remote users working at home, from a client's office, or in a branch office often have a need to access sensitive data on a company's private servers; however, doing so from an unsecured public network, such as a coffee shop wireless hotspot, could expose that data to unauthorized users with ill intentions. A virtual private network (VPN) enables remote users to securely access an organization's collection of computing and storage devices and share data remotely. To connect to a VPN, you launch a VPN client on your computer and perform some form of authentication using your credentials. Your computer

then exchanges keys to be used for the encryption process with the VPN server. Once both computers have verified each other as authentic, all of your Internet communications are encrypted and secured from eavesdropping.

## Implementing CIA at the Application Level

Authentication methods, user roles and accounts, and data encryption are key elements of the application security layer. These elements must be in place to ensure that only authorized users have access to the organization's applications and data and that their access is limited to actions that are consistent with their defined roles and responsibilities.

### *Authentication Methods*

Users are required to be authenticated before they can access an application—ideally, two factor authentication is required. Most organizations require that their applications authenticate users by requiring them to enter something they know (e.g., username and password); something they possess (e.g., a smart card); or pass a biometric check.

### *User Roles and Accounts*

Another important safeguard at the application level is the creation of roles and user accounts so that once users are authenticated, they have the authority to perform their responsibilities and nothing more. For example, members of the finance department should have different authorizations from members of the human resources department. An accountant should not be able to review the pay and attendance records of an employee, and a member of the human resources department should not know how much was spent to modernize a piece of equipment. Even within one department, not all members should be given the same capabilities. Within the finance department, for example, some users may be able to approve invoices for payment, but others may only be able to enter them. No one user should be able to enter an invoice and approve an invoice for payment. This concept is called proper separation-of-duties. An effective system administrator will identify the similarities among users and create profiles associated with these groups.

### *Data Encryption*

Major enterprise systems such as enterprise resource planning (ERP), customer relationship management (CRM), and product lifecycle management (PLM) access sensitive data residing on data storage devices located in data centers, in the cloud, or at third-party locations. Data encryption should be used within such applications to ensure that this sensitive data is protected from unauthorized access.

## Implementing CIA at the End-User Level

Security education, authentication methods, antivirus software, and data encryption must all be in place to protect what is often the weakest link in the organization's security perimeter—the individual user. The importance of these end-user level security measures cannot be overly emphasized.

### *Security Education*

Creating and enhancing user awareness of security policies is an ongoing security priority for companies. Employees and contract workers must be educated about the importance of security so that they will be motivated to understand and follow security policies. This can often be accomplished by discussing recent security incidents that affected the organization. Users must understand that they are a key part of the security system and that they have

certain responsibilities. For example, users must help protect an organization's information systems and data by doing the following:

- Guarding their passwords to protect against unauthorized access to their accounts
- Prohibiting others from using their passwords
- Applying strict access controls (file and directory permissions) to protect data from disclosure or destruction
- Reporting all unusual activity to the organization's IT security group
- Taking care to ensure that portable computing and data storage devices are protected (hundreds of thousands of laptops are lost or stolen per year)

Table 2.6 provides a simple self-assessment security test that employees and contractors alike should be asked to complete. In each case, the preferred answer is Yes.

**TABLE 2.6** Self-assessment security test

Security assessment question	Yes	No
Do you have the most current version of your computer's operating system installed?		
Do you have the most current version of firewall, antivirus, and malware software installed?		
Do you install updates to all your software when you receive notice that a new update is available?		
Do you use different, strong passwords for each of your accounts and applications—a minimum of 12 characters, with a mix of capital and lowercase letters, numbers, and special characters?		
Are you familiar with and do you follow your organization's policies for accessing corporate Web sites and applications from your home or remote locations (e.g., access via a VPN)?		
Have you set the encryption method to WPA2 and changed the default name and password on your home wireless router?		
When using a free, public wireless network, do you avoid checking your email or accessing Web sites requiring a username and password?		
Do you refrain from clicking on a URL in an email from someone you do not know?		
Do you back up critical files to a separate device at least once a week?		
Are you familiar with and do you follow your organization's policies regarding the storage of personal or confidential data on your device?		
Does your device have a security passcode that must be entered before it accepts further input?		
Have you installed Locate My Device or similar software in case your device is lost or stolen?		
Do you make sure not to leave your device unattended in a public place where it can be easily stolen?		
Have you reviewed, and do you understand the privacy settings that control who can see or read what you do on Facebook and other social media sites?		

### Authentication Methods

End users should be required to be authenticated before their computing/communications device accepts further input. Again, several multifactor authentication schemes can be used. Many mobile devices are using the user's fingerprint as a means of authentication.

**antivirus software:** Should be installed on each user's personal computer to scan a computer's memory and disk drives regularly for viruses.

**virus signature:** Code that indicates the presence of a specific virus.

### Antivirus Software

**Antivirus software** should be installed on each user's personal computer to scan a computer's memory and disk drives regularly for viruses. Antivirus software scans for a specific sequence of bytes, known as a **virus signature**, that indicates the presence of a specific virus. If it finds a virus, the antivirus software informs the user, and it may clean, delete, or quarantine any files, directories, or disks affected by the malicious code. Good antivirus software checks vital system files when the system is booted up, monitors the system continuously for virus-like activity, scans disks, scans memory when a program is run, checks programs when they are downloaded, and scans email attachments before they are opened. Two of the most widely used antivirus software products are Norton AntiVirus from Symantec and Personal Firewall from McAfee.

According to US-CERT, most virus and worm attacks use already known malware programs. Thus, it is crucial that antivirus software be continually updated with the latest virus signatures. In most corporations, the network administrator is responsible for monitoring network security Web sites frequently and downloading updated antivirus software as needed. Many antivirus vendors recommend—and provide for—automatic and frequent updates. Unfortunately, antivirus software is not able to identify and block all viruses.

### Data Encryption

While you should already have a login password for your mobile computing device or workstation, those measures won't protect your data if someone steals your device—the thief can simply remove your storage device or hard drive and plug it into another computing device and access the data. If you have sensitive information on your computer, you need to employ full-disk encryption, which protects all your data even if your hardware falls into the wrong hands.

### Implementing Safeguards Against Attacks by Malicious Insiders

User accounts that remain active after employees leave a company are another potential security risk. To reduce the threat of attack by malicious insiders, IS staff must promptly delete the computer accounts, login IDs, and passwords of departing employees and contractors.

Organizations also need to define employee roles carefully and separate key responsibilities properly, so that a single person is not responsible for accomplishing a task that has high security implications. For example, it would not make sense to allow an employee to initiate as well as approve purchase orders. That would allow an employee to input large invoices on behalf of a dishonest vendor, approve the invoices for payment, and then disappear from the company to split the money with that vendor. In addition to separating duties, many organizations frequently rotate people in sensitive positions to prevent potential insider crimes.

Another important safeguard is to create roles and user accounts so that users have the authority to perform their responsibilities and nothing more. An effective system administrator will identify the similarities among users and create roles and user accounts associated with these groups.

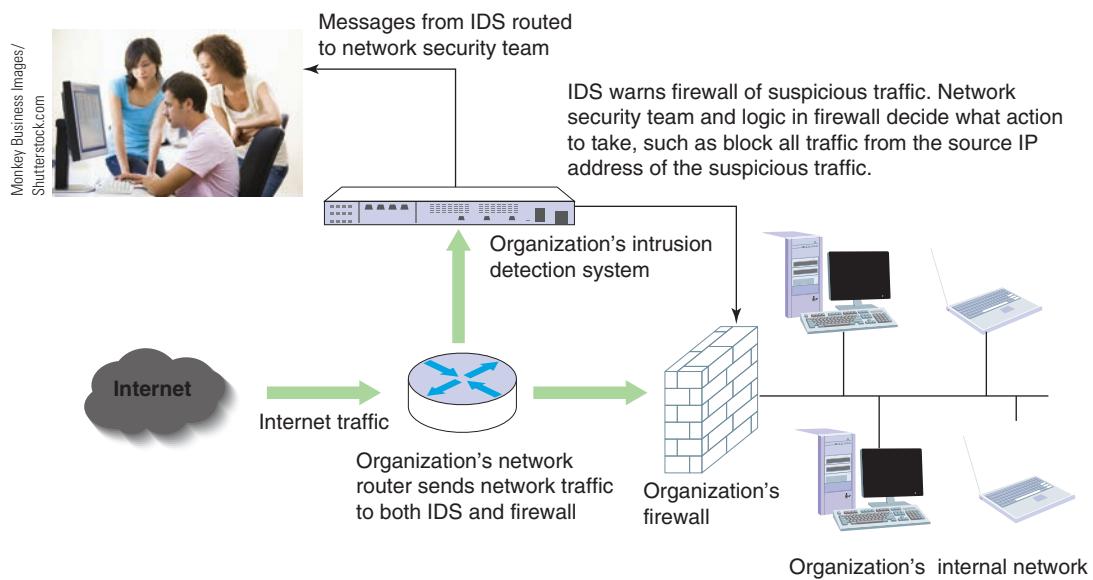
### Detection of a Cyberattack

Even when preventive measures are implemented, no organization is completely secure from a determined attack. Thus, organizations should implement detection systems to catch intruders in the act. Organizations often employ an intrusion detection system to minimize the impact of intruders.

An **intrusion detection system (IDS)** is software and/or hardware that monitors system and network resources and activities and notifies network security personnel when it detects network traffic that attempts to circumvent the security measures of a networked computer environment (see Figure 2.8).

#### intrusion detection system (IDS)

**(IDS):** Software and/or hardware that monitors system and network resources and activities and notifies network security personnel when it detects network traffic that attempts to circumvent the security measures of a networked computer environment.



**FIGURE 2.8**  
**Intrusion detection system**

An IDS notifies network security personnel when it detects network traffic that attempts to circumvent the security measures of a networked computer environment.

Such activities usually signal an attempt to breach the integrity of the system or to limit the availability of network resources.

Knowledge-based approaches and behavior-based approaches are two fundamentally different approaches to intrusion detection. Knowledge-based intrusion detection systems contain information about specific attacks and system vulnerabilities and watch for attempts to exploit these vulnerabilities, such as repeated failed login attempts or recurring attempts to download a program to a server. When such an attempt is detected, an alarm is triggered. A behavior-based intrusion detection system understands normal behavior of a system and its users because it collects reference information by various means. The intrusion detection system compares current activity to this model and generates an alarm if it finds a deviation. Examples include unusual traffic at odd hours or a user in the human resources department who accesses an accounting program that she has never before used.

## Response

An organization should be prepared for the worst—a successful attack that defeats all or some of a system's defenses and damages data and information systems. A response plan should be developed well in advance of any incident and be approved by both the organization's legal department and senior management. A well-developed response plan helps keep an incident under technical and emotional control.

In a security incident, the primary goal must be to regain control and limit damage, not to attempt to monitor or catch an intruder. Sometimes system administrators take the discovery of an intruder as a personal challenge and lose valuable time that should be used to restore data and information systems to normal.

### Incident Notification

A key element of any response plan is to define who to notify and who not to notify in the event of a computer security incident. Questions to cover include the following: Within the company, who needs to be notified, and what

information does each person need to have? Under what conditions should the company contact major customers and suppliers? How does the company inform them of a disruption in business without unnecessarily alarming them? When should local authorities or the FBI be contacted?

Most security experts recommend against giving out specific information about a compromise in public forums, such as news reports, conferences, professional meetings, and online discussion groups. All parties working on the problem must be kept informed and up-to-date without using systems connected to the compromised system. The intruder may be monitoring these systems and emails to learn what is known about the security breach.

A critical ethical decision that must be made is what to tell customers and others whose personal data may have been compromised by a computer incident. Many organizations are tempted to conceal such information for fear of bad publicity and loss of customers. Because such inaction is perceived by many to be unethical and harmful, several state and federal laws have been passed to force organizations to reveal when customer data has been breached.

### ***Protection of Evidence and Activity Logs***

An organization should document all details of a security incident as it works to resolve the incident. Documentation captures valuable evidence for a future prosecution and provides data to help during the incident eradication and follow-up phases. It is especially important to capture all system events, the specific actions taken (what, when, and who), and all external conversations (what, when, and who) in a logbook. Because this may become court evidence, an organization should establish a set of document-handling procedures using the legal department as a resource.

### ***Incident Containment***

Often, it is necessary to act quickly to contain an attack and to keep a bad situation from becoming even worse. The incident response plan should clearly define the process for deciding if an attack is dangerous enough to warrant shutting down or disconnecting critical systems from the network. How such decisions are made, how fast they are made, and who makes them are all elements of an effective response plan.

### ***Eradication***

Before the IT security group begins the eradication effort, it must collect and log all possible criminal evidence from the system and then verify that all necessary backups are current, complete, and free of any malware. Creating a forensic disk image of each compromised system on write-only media both for later study and as evidence can be very useful. After virus eradication, a new backup must be created. Throughout this process, a log should be kept of all actions taken. This will prove helpful during the incident follow-up phase and ensure that the problem does not recur. It is imperative to back up critical applications and data regularly. Many organizations, however, have implemented inadequate backup processes and found that they could not fully restore original data after a security incident. All backups should be created with enough frequency to enable a full and quick restoration of data if an attack destroys the original, and this process must be tested to confirm that it works.

### ***Incident Follow-Up***

Of course, an essential part of follow-up is to determine how the organization's security was compromised so that it does not happen again. Often the fix is as simple as getting a software patch from a product vendor. However, it is important to look deeper than the immediate fix to discover why the incident occurred. If a simple software fix could have prevented the incident, then why wasn't the fix installed before the incident occurred?

A review should be conducted after an incident to determine exactly what happened and to evaluate how the organization responded. One approach is to write a formal incident report that includes a detailed chronology of events and the impact of the incident. This report should identify any mistakes so that they are not repeated in the future. The experience from this incident should be used to update and revise the security incident response plan. The key elements of a formal incident report should include the following:

- IP address and name of host computer(s) involved
- The date and time when the incident was discovered
- The length of the incident
- How the incident was discovered
- The method used to gain access to the host computer
- A detailed discussion of vulnerabilities that were exploited
- A determination of whether or not the host was compromised as a result of the attack
- The nature of the data stored on the computer (customer, employee, financial, etc.)
- A determination of whether the accessed data is considered personal, private, or confidential
- The number of hours the system was down
- The overall impact on the business
- An estimate of total monetary damage from the incident
- A detailed chronology of all events associated with the incident

Creating a detailed chronology of all events will also document the incident for possible later prosecution. To this end, it is critical to develop an estimate of the monetary damage. Potential costs include loss of revenue, loss in productivity, and the salaries of people working to address the incident, along with the cost to replace data, software, and hardware.

Another important issue is the amount of effort that should be put into capturing the perpetrator. If a Web site was simply defaced, it is easy to fix or restore the site's HTML (Hypertext Markup Language—the code that describes to your browser how a Web page should look). However, what if the intruders inflicted more serious damage, such as erasing proprietary program source code or the contents of key corporate databases? What if they stole company trade secrets? Expert crackers can conceal their identity and tracking them down can take a long time as well as a tremendous amount of corporate resources.

The potential for negative publicity must also be considered. Discussing security attacks through public trials and the associated publicity has not only enormous potential costs in public relations but real monetary costs as well. For example, a bank or a brokerage firm might lose customers who learn of an attack and think their money or records aren't secure. Even if a company decides that the negative publicity risk is worth it and goes after the perpetrator, documents containing proprietary information that must be provided to the court could cause even greater security threats in the future. On the other hand, an organization must consider whether it has an ethical or a legal duty to inform customers or clients of a cyberattack that may have put their personal data or financial resources at risk.

## Using a Managed Security Service Provider (MSSP)

Keeping up with computer criminals—and with new laws and regulations—can be daunting for organizations. Criminal hackers are constantly poking and prodding, trying to breach the security defenses of organizations. Also,

**managed security service provider (MSSP):** A company that monitors, manages, and maintains computer and network security for other organizations.

laws such as HIPAA, Sarbanes-Oxley, and the USA Patriot Act require businesses to prove that they are securing their data. For most small and midsized organizations, the level of in-house network security expertise needed to protect their business operations can be too costly to acquire and maintain. As a result, many organizations outsource their network security operations to a **managed security service provider (MSSP)**, which is a company that monitors, manages, and maintains computer and network security for other organizations. MSSPs include such companies as AT&T, Computer Sciences Corporation, Dell SecureWorks, IBM, Symantec, and Verizon. MSSPs provide a valuable service for IS departments drowning in reams of alerts and false alarms coming from virtual private networks (VPNs); antivirus, firewall, and intrusion detection systems; and other security-monitoring systems. In addition, some MSSPs provide vulnerability scanning and Web blocking and filtering capabilities.

## Computer Forensics

**computer forensics:** A discipline that combines elements of law and computer science to identify, collect, examine, and preserve data from computer systems, networks, and storage devices in a manner that preserves the integrity of the data gathered so that it is admissible as evidence in a court of law.

**Computer forensics** is a discipline that combines elements of law and computer science to identify, collect, examine, and preserve data from computer systems, networks, and storage devices in a manner that preserves the integrity of the data gathered so that it is admissible as evidence in a court of law. A computer forensics investigation may be opened in response to a criminal investigation or civil litigation. It may also be launched for a variety of other reasons, for example, to retrace steps taken when data has been lost, assess damage following a computer incident, investigate the unauthorized disclosure of personal or corporate confidential data, or to confirm or evaluate the impact of industrial espionage.

Computer forensics investigators work as a team to investigate an incident and conduct the forensic analysis using various methodologies and tools to ensure the computer network system is secure in an organization. For example, accounting, tax, and advisory company Grant Thornton International has several IS labs around the world that employ numerous forensic experts who examine digital evidence for use in legal cases. Grant Thornton employs forensic software called Summation (a Web-based legal document, electronic data, and transcript review platform that supports litigation teams) and Forensic Toolkit (used to scan a hard drive to find a variety of information, including deleted emails and text strings, to crack encryption). The software from AccessData provides a combination of mobile forensics, computer forensics, and functions for encoding and reviewing multilingual documents.<sup>34</sup>

Proper handling of a computer forensics investigation is the key to fighting computer crime successfully in a court of law. In addition, extensive training and certification increases the stature of a computer forensics investigator in a court of law. Numerous certifications relate to computer forensics, including the CCE (Certified Computer Examiner), CISSP (Certified Information Systems Security Professional), CSFA (CyberSecurity Forensic Analyst), and GCFA (Global Information Assurance Certification Certified Forensics Analyst). The EnCE Certified Examiner program certifies professionals who have mastered computer investigation methods as well as the use of Guidance Software's EnCase computer forensic software. Numerous universities (both online and traditional) offer degrees specializing in computer forensics. Such degree programs should include training in accounting, particularly auditing, as this is very useful in the investigation of cases involving fraud.

Table 2.7 provides a list of questions that should be asked when an organization is evaluating its readiness for a security incident.

**TABLE 2.7** Questions to be considered when evaluating an organization's readiness for a security incident

Question	Yes	No
Has a risk assessment been performed to identify investments in time and resources that can protect the organization from its most likely and most serious threats?		
Have senior management and employees involved in implementing security measures been educated about the concept of reasonable assurance?		
Has a security policy been formulated and broadly shared throughout the organization?		
Have automated systems policies been implemented that mirror written policies?		
Does the security policy address the following:		
• Email with executable file attachments?		
• Wireless networks and devices?		
• Use of smartphones deployed as part of corporate rollouts as well as those purchased by end users?		
Is there an effective security education program for employees and contract workers?		
Has a layered security solution been implemented to prevent break-ins?		
Has a firewall been installed?		
Is antivirus software installed on all personal computers?		
Is the antivirus software frequently updated?		
Have precautions been taken to limit the impact of malicious insiders?		
Are the accounts, passwords, and login IDs of former employees promptly deleted?		
Are employee responsibilities adequately defined and separated?		
Are individual roles defined so that users have authority to perform their responsibilities and nothing more?		
Is it a requirement to review at least quarterly the most critical Internet security threats and implement safeguards against them?		
Has it been verified that backup processes for critical software and databases work correctly?		
Has an intrusion detection system been implemented to catch intruders in the act—both in the network and on critical computers on the network?		
Are periodic IT security audits conducted?		
Has a comprehensive incident response plan been developed?		
Has the security plan been reviewed and approved by legal and senior management?		
Does the plan address all of the following areas:		
• Incident notification?		
• Protection of evidence and activity logs?		
• Incident containment?		
• Eradication?		
• Incident follow-up?		



## Critical Thinking Exercise

### Security Self-Assessment

#### ► SOCIAL RESPONSIBILITY, DATA PROTECTION

Use Table 2.6 to conduct a security self-assessment and answer the following questions.

#### Review Questions

1. What test did you fail?
2. Which of the failed situations is most critical to address?

### Critical Thinking Questions

1. What specific actions will you take to improve your self-assessment?
2. Should individuals with insecure systems be allowed to access public networks? Should they be fined or penalized in some way if their lax security measures are found to have enabled a cyberattack?

## Summary

### Principle:

**Computer crime is a serious and rapidly growing area of concern requiring management attention.**

Increasing computing complexity, an increase in the prevalence of bring your own device (BYOD) policies, use of software with known vulnerabilities, and the increasing sophistication of those who would do harm have caused a dramatic increase in the number, variety, and severity of security incidents.

Many different types of people are responsible for cyberattacks with the four most predominant being the careless insider, the cybercriminal, malicious insider, and hacktivists.

An attack vector is the technique used to gain unauthorized access to a device or a network; it is a means used to initiate a cyberattack. Advanced persistent threats, blended threats, phishing, rootkits, smishing, social engineering, spam, Trojan horses, viruses, vishing, and worms are all examples of attack vectors.

Ransomware, distributed denial of service attacks, data breach, cyberespionage, and cyberterrorism are cyberattacks that pose serious threats.

The Department of Homeland Security (DHS) has the responsibility to provide for a “safer, more secure America, which is resilient against terrorism and other potential threats.” The agency’s Office of Cybersecurity and Communications is responsible for enhancing the security, resilience, and reliability of U.S. cyber and communications infrastructure.

The U.S. Computer Emergency Readiness Team (US-CERT) is a partnership between DHS and the public and private sectors that was established to protect the nation’s Internet infrastructure against cyberattacks by serving as a clearinghouse for information on new viruses, worms, and other computer security topics.

There are five broad areas of impact caused by a serious cyberattack: (1) the direct impact on the assets of the organization plus the likely decline in stock price, (2) the impact caused by business disruption and the inability to operate in an effective manner, (3) the recovery cost to repair affected systems and recover lost data, (4) the legal consequences of monetary penalties for failure to comply with data protection laws and lawsuits, and (5) reputation damage which causes loss of customers and future business.

Five federal laws that address computer crime are the Computer Crime and Abuse Act, the Fraud and Related Activity in Connection with Access Devices Statute, the Identity Theft and Assumption Deterrence Act, the Stored Wire and Electronic Communication and Transactional Records Access Act, and the USA Patriot Act.

### Principle:

**Organizations must take strong measures to ensure secure, private, and reliable computing experiences for their employees, customers, and business partners.**

The security practices of organizations worldwide are focused on ensuring confidentiality, maintaining integrity, and guaranteeing the availability of systems and data. This is known as the CIA security triad.

No organization can ever be completely secure from attack; however, a layered security solution makes cyberattacks so difficult that an attacker eventually gives up or is detected before much harm is inflicted. Security measures must be planned for, designed, implemented, tested, and maintained at the organization, network, application, and end-user layers to achieve true security.

Security measures at the organizational level must include implementing a security strategy, conducting a risk assessment, developing a disaster recovery plan in conjunction with a business continuity plan, defining and enforcing security policies, performing security audits, complying with regulatory standards, and monitoring all key security performance measures.

Security measures at the network level include authenticating users, installing firewalls, the judicious use of routers, encryption of messages and data, and the use of proxy servers and virtual private networks.

Security measures at the application level include authenticating users, careful definition of user roles and accounts, and data encryption.

Security measures at the end-user level include security education, end user authentication, antivirus software, and data encryption.

The concept of reasonable assurance in connection with IS security recognizes that managers must use their judgment to ensure that the cost of control does not exceed the system's benefits or the risks involved.

Eight steps that must be taken to perform a thorough security risk assessment include: (1) identify the set of IT assets that are most critical, (2) identify the loss events that could occur, (3) assess the frequency of events or likelihood of each potential threat, (4) determine the impact of each threat, (5) determine how to mitigate each threat, (6) assess the feasibility of implementing the mitigation options, (7) perform a cost-benefit analysis, and (8) make the decision on whether or not to implement a particular countermeasure.

No security system is perfect, so systems and procedures must be monitored to detect a possible intrusion. If an intrusion occurs, there must be a clear reaction plan that addresses notification, evidence protection, activity log maintenance, containment, eradication, and follow-up.

Many organizations outsource their network security operations to a managed security service provider (MSSP), which is a company that monitors, manages, and maintains computer and network security for other organizations.

Organizations must be knowledgeable of and have access to trained experts in computer forensics to identify, collect, examine, and preserve data from computer systems, networks, and storage devices in a manner that preserves the integrity of the data gathered so that it is admissible as evidence in a court of law.

## Key Terms

antivirus software  
attack vector  
biometric authentication  
botnet  
bring your own device (BYOD)  
business continuity plan  
CIA security triad  
computer forensics  
cyberespionage

cyberterrorism  
data breach  
Department of Homeland Security (DHS)  
disaster recovery plan  
distributed denial-of-service (DDoS) attack  
encryption  
encryption key  
exploit  
failover

firewall  
intrusion detection system (IDS)  
managed security service provider (MSSP)  
mission-critical processes  
next-generation firewall (NGFW)  
ransomware  
reasonable assurance

risk assessment  
security audit  
security policy  
Transport Layer Security (TLS)  
U.S. Computer Emergency Readiness Team (US-CERT)  
virus signature  
zero-day attack

## Self-Assessment Test

**Computer crime is a serious and rapidly growing area of concern requiring management attention.**

1. The growth of the Internet of Things is helping to curb the number of cyberattacks. True or False?
2. The perpetrator most likely to be the cause of a cyberattack is the \_\_\_\_\_.
  - a. cybercriminal
  - b. malicious insider
  - c. hacktivist
  - d. careless insider
3. A(n) \_\_\_\_\_ is the technique used to gain unauthorized access to a device or a network.
4. A blended threat, phishing, and virus are all examples of a(n) \_\_\_\_\_.
5. A form of cyberattack that is estimated to occur every 10 seconds against an individual in the U.S. is \_\_\_\_\_.
  - a. distributed denial-of-service attack
  - b. ransomware
  - c. data breach
  - d. social engineering
6. One of the consequences of a successful cyberattack that can lead to monetary penalties for organizations that fail to comply with data protection regulations is \_\_\_\_\_.
  - a. business disruption
  - b. expulsion from industry sponsored organizations
  - c. recovery cost
  - d. legal consequences
7. A federal law that focuses on unlawful access to stored communications to obtain, alter, or prevent authorized access to a wire or electronic communication while it is in electronic storage.
  - a. Computer Fraud and Abuse Act
  - b. Fraud and Related Activity in Connection with Access Devices Statute

- c. Identity Theft and Assumption Deterrence Act
- d. Stored Wire and Electronic Communications and Transactional Records Access Statute

**Organizations must take strong measures to ensure secure, private, and reliable computing experiences for their employees, customers, and business partners.**

8. The four levels at which the CIA security triad must be implemented include \_\_\_\_\_.
  - a. interorganizational, enterprise, workgroup, and personal
  - b. tier 1, tier 2, tier 3, and tier 4
  - c. organizational, network, application, and end user
  - d. organization, business unit, department, individual
9. Each user should conduct a security self-assessment test. True or False?
10. There are \_\_\_\_\_ steps that must be taken to perform a thorough security risk assessment.
  - a. three
  - b. five
  - c. seven
  - d. eight
11. Five actions an organization must take in the event of a successful cyberattack include incident notification, protection of evidence and activity logs, incident containment, eradication, and incident \_\_\_\_\_.
12. An organization that monitors, manages, and maintains computer and network security for other organizations is called a \_\_\_\_\_ service provider.
13. Computer forensics is a discipline that combines elements of \_\_\_\_\_ and computer science.

## Self-Assessment Test Answers

1. False
2. d
3. attack vector
4. attack vector
5. b
6. d
7. d
8. c
9. True
10. d
11. follow-up
12. managed security
13. law

## Review and Discussion Questions

1. Provide four reasons why computer incidents are so prevalent. Which of these do you think is the most significant? Why?
2. List the four perpetrators most likely to initiate a cyberattack.
3. What is the meaning of attack vector?
4. Identify three commonly used attack vectors.
5. List five cyberattacks that pose serious threats to an organization.
6. List all the likely consequences of a major data breach. Which of these are likely to be the most serious and long lasting?
7. Identify five federal laws aimed at preventing computer crime.
8. Discuss how the CIS security triad can be implemented at the organizational level to safeguard against cyberattacks.
9. Use Table 2.6 to conduct a security self-assessment. Identify specific follow-up actions you need to take.
10. You are going to perform a security risk assessment for your small company. What steps must be taken?
11. Deciding if a cyberattack is serious enough to warrant shutting down or disconnecting a critical system from the network is an action associated with which action of the response plan?
12. What actions can a managed security service provider take to improve the security of an organization?
13. Define the term computer forensics.
14. Hundreds of a bank's customers have called the customer service call center to complain that they are receiving text messages on their phone telling them to log on to a Web site and enter personal information to resolve an issue with their account. What are all the potential consequences of this attack? What actions should the bank take?

## Business-Driven Decision-Making Exercises

1. It appears that someone is using your firm's corporate directory—which includes job titles and email addresses—to contact senior managers and directors via email. The email requests that the recipient click on a URL, which leads to a Web site that looks as if it were designed by your human resources organization. Once at this phony Web site, the employees are asked to confirm the bank and account number to be used for electronic deposit of their annual bonus check. You are a member of the IS Security unit. How should you respond to this threat?
2. A successful distributed denial-of-service attack requires the downloading of software that turns unprotected computers into zombies under the control of the malicious hacker. Which perpetrators are most likely to initiate such an attack? What harm can a denial-of-service attack cause? Suppose that the federal government were proposing new legislation that would impose a fine on the owners of the zombie computers as a means of encouraging people to better safeguard their computers. Would you support this legislation? Why or why not? Can you identify other approaches to reduce the number of denial-of-service attacks?

## Teamwork and Collaboration Activities

1. You and your team have been hired to improve the computer security of the computer labs at the business college of a small local university. Identify the four classes of perpetrators most likely to initiate a cyberattack against the computer lab. Identify the cyberthreats that pose the most serious threat. How can the CIA security triad be implemented to protect the lab?
2. Have you and your team members conduct a security self-assessment of your computer and usage habits. What common issues do you find? How can you go about eliminating these issues? Do you expect that the other students in your class have these same issues? Why or why not?

## Career Exercises

1. Do research to determine typical starting salaries for someone with a four-year degree in computer forensics. What is the future demand for individuals trained in computer forensics? Do further research to find three universities that offer four-year degrees specializing in computer forensics. Compare the three programs and choose the one you think is best. Why did you choose this university?
2. You are one of the top students in your university's computer science program of 100 students, and you have agreed to meet with a recruiter

from the Department of Homeland Security. Over dinner, he talks to you about the increasing threat of cyberterrorist attacks launched on the United States by foreign countries and the need to counter those attacks. The agency has a strong need for people that can both develop and defend against zero-day exploits that could be used to plant malware in the software used by the government and military computers. At the end of the dinner, the recruiter turns to you and asks: "Would such a role be of interest to you?" How do you respond?

## Case Study

### ► GLOBAL, DATA PROTECTION

#### **Security Consultant Suffers Cyberattack**

Deloitte is one of the biggest professional services companies in the world based on both revenue (\$38.8 billion in 2017) and number of professionals (over 263,000). It provides audit, tax, management consulting, financial advisory services, and cybersecurity guidance to over 85 percent of the Fortune 500 companies and more than 6,000 private and middle market companies around the world. Its global headquarters is in New York.

In April 2017, the company discovered that its global email server had been hacked starting six months earlier. The hackers gained access to the system through an administrative account that granted them privileged, unrestricted access to all areas. Apparently, the account required just a single password and did not have two-step verification.

Deloitte offers its clients advice on how to manage the risks posed by sophisticated cyberattacks. It also operates a CyberIntelligence Center to provide clients with around-the-clock business focused operational security. In 2012, Deloitte was ranked the best cybersecurity consultant in the world. The firm earns a portion of its \$12 billion a year in consulting fees from these services. The breach was a deep embarrassment for the firm.

The use of email is interwoven into the operational fabric of the modern organization and is used to communicate

all sorts of sensitive information—new product plans, marketing strategies, merger and acquisition tactics, product designs, patent data, copyrighted material, and trade secrets. The server that was breached contained the emails of some 350 clients including the U. S. State Department, Department of Homeland Security, Department of Defense, Energy Department, and the U. S. Postal Service. Also compromised were the emails of the United Nations, National Institute of Health, and housing giants Fannie Mae and Freddie Mac, plus some of the world's biggest multinationals. In addition to emails, the hackers had potential access to usernames, passwords, and IP addresses.

Initially Deloitte kept the breach secret electing to inform only a handful of senior partners, six clients the firm knew to have been directly impacted by the attack, and lawyers at international law firm Hogan Lovells. The Washington-based firm was retained to provide legal advice and assistance about the potential fallout from the hack.

Deloitte formed a team consisting of security analysts and experts from both within and outside the firm to conduct a formal inquiry to the breach. The goals were to understand how this happened, assess the scope of the incident, determine what the attacker targeted, evaluate the potential impact to clients, and determine the appropriate cyber-security response. After six months elapsed time, the

team determined that the attacker was no longer in the email system, ascertained that there had been no business disruption to any of its clients, and recommended additional steps to enhance Deloitte's overall security. The team was unable to determine whether a lone wolf, business rivals, or state-sponsored hackers were responsible.

The attack illustrates that any organization can fall prey to a cyberattack—even those whose specialty is to stop them.

### Critical Thinking Questions

1. Identify what you believe to be the area of most severe consequences for Deloitte—direct impact, business disruption, recovery, legal, or reputation. Justify your response.
2. How would you evaluate Deloitte's response to this cyberattack? What did they do well? Where could they have done better?

3. Identify the three highest priority changes that need to be made to the Deloitte security program.

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## Principles

An ethical decision-making process and a code of ethics can guide you as you confront the many ethical dilemmas associated with information systems.

The use of technology requires balancing the needs of those who use the information that is collected against the rights of those whose information is being used.

Software developers must make trade-offs between project schedules, project costs, system reliability, and software quality.

## Learning Objectives

- Explain the difference between ethical and legal.
  - Identify five reasons for an organization to promote a work environment where employees are encouraged to act ethically.
  - Outline a five-step ethical decision-making process.
  - Define the primary intent and two key elements of an effective code of ethics.
  - Identify four benefits of following a professional code of ethics.
- 
- Summarize the differences between U.S. and EU fair information practices.
  - Identify three subject areas where measures have been taken to protect personal data.
  - Identify four measures you should take to protect your personal privacy.
  - Discuss the tradeoffs between security and privacy.
  - Discuss how three U.S. federal statutes protect citizens from government surveillance while at the same time authorize the government to collect data.
  - Discuss how the First Amendment and anonymous expression safeguard our freedom of speech.
  - Describe the impact of censorship on the operation of Internet service providers.
  - Identify measures taken to address defamation, hate speech, and pornography on the Internet.
- 
- Distinguish between a high-quality software system and safety-critical system.
  - Give three reasons why developing a safety-critical system takes longer and is more expensive.
  - Identify two ethical dilemmas that software developers face when building high-quality or safety-critical systems.

# IS in Action

## Facebook and Cambridge Analytica

### ► SOCIAL AND ETHICAL ISSUES, TECHNOLOGY IN SOCIETY

Cambridge Analytica was a British political consulting firm whose Web site claimed it used data to change audience behavior—both commercially and politically. The firm paid a Soviet-born researcher named Aleksandr Kogan and his company Global Science Research \$800,000 to collect basic profile data of Facebook users including what they chose to “Like.” This was done through an app called This Is Your Digital Life that prompted users to answer questions to develop a psychological profile.

Some 300,000 Facebook users downloaded Kogan’s app. The app’s terms of service disclosed that it would collect data on users *and* their Facebook friends if their privacy settings allowed it. The data gathering occurred during 2013 at which time Facebook allowed third-party developers to build and offer their own applications and collect information on friends of those who chose to use their apps. It was not until 2014 that Facebook modified its rules to limit a developer’s access to user data. This ensured that a third-party was no longer able to access a user’s friend’s data without gaining permission first.

In the 2016 election, Donald Trump’s team hired Cambridge Analytica who may have used the This Is Your Digital Life data to develop psychographic profiles of American voters and deliver pro-Trump material to them online based on their profile. (Psychographics is the study and classification of people according to their attitudes, aspirations, and other psychological criteria. It includes data about a person’s buying habits, hobbies, spending habits, and values.) This is a matter of contention as some executives at Cambridge Analytica have denied that any of the data was used in connection to the Trump campaign. Another point of contention is whether Cambridge Analytica’s psychographic profiles are effective as some of the firm’s clients claim they saw little value in them.

In March 2018, *The Guardian* and *The New York Times* reported that (when including friends of users) some 50 million Facebook profiles were harvested for Cambridge Analytica. This revelation and its implications ignited a firestorm that threatened to further downgrade the already frayed reputation of the embattled social media giant. Facebook shares dropped 22%, from a high of \$218 to \$171 in the two weeks following disclosure of this event. The number of Facebook users affected was later revised to as many as 87 million.

It took five days after the news broke before there was any response from Facebook. CEO Mark Zuckerberg posted a lengthy response on his personal Facebook page, apologizing for the company’s failure to protect its user’s data and announcing changes to the platform intended to do just that. The delay in Facebook communications about the incident further angered Facebook users. Two weeks after the reports were published, Zuckerberg took out full-page ads in several British and American newspapers to apologize for a “breach of trust.” “I’m sorry we didn’t do more at the time. We’re now taking steps to ensure that this doesn’t happen again,” he said in the ads.

Facebook settled previous privacy complaints with the U.S. Federal Trade Commission (FTC) by agreeing to get clear consent from users before sharing their data with others. The FTC is now investigating whether Facebook violated the terms of that 2011 consent decree. If Facebook is found to have violated this agreement, it is facing potential penalties of up to \$40,000 per user per day, which could in theory add up to billions of dollars.

The Cambridge Analytica incident is yet another example that shows that average social media users do not know how their data is being used. Their personal data can be taken away for companies, organizations, and campaigns to use in a variety of ways. A combination of improved user education, clearer privacy notices, and increased regulation is needed to avoid future such incidents at Facebook and other social media networks and services.

**As you read about corporate and individual responsibility, consider the following:**

- How can you include ethical factors in your decision-making process?
- How can you protect sensitive personal data?

## Why Learn about Corporate and Individual Accountability?

Opportunities and threats surround a wide range of nontechnical issues associated with the use of information systems and the Internet. Some of the key issues involve avoiding violations of privacy; balancing security and privacy while collecting personal data; implementing measures to safeguard freedom of speech; and making tradeoffs between cost, time, and features when developing information systems. It is essential that you have some basis to guide you in making ethical decisions in dealing with these issues and acting with integrity.

If you become a member of the human resources, information systems, or legal department within an organization, you will likely be challenged with leading your organization in dealing with these and other issues related to information systems. Also, as a user of information systems and the Internet, it is in your own self-interest to become well versed on these issues and to learn what measures you can take to protect your personal privacy. Developing a better understanding of the topics covered in this chapter will help you to manage in an ethical manner and avoid technology-related problems.

Computer-based information systems provide organizations with significant benefits including increased profits, superior goods and services, and higher quality of work life. Computers have become such valuable tools that most businesspeople today have difficulty imagining how they would accomplish their work without them. Yet, the use of information systems has brought with it concerns about the information privacy rights of individuals, censorship versus freedom of information, the safety of users, and the negative impact of information systems on the work environment.

No business organization, and hence, no information system, operates in a vacuum. All IS professionals, business managers, and users have a responsibility to see that the potential consequences of IS use are fully considered. Even entrepreneurs, especially those who use computers and the Internet, must be aware of the potential personal and social impact of computers.

## What Is Ethics?

**ethics:** The set of principles about what is right and wrong that individuals use to make choices to guide their decisions.

**Ethics** is the set of principles about what is right and wrong that individuals use to make choices to guide their decisions. Ethical behavior conforms to generally accepted norms, which may change over time to meet the evolving needs of society or a group of people who share similar laws, traditions, and values that provide structure to enable them to live in an organized manner. Ethics help members of a group understand their roles and responsibilities, so that they can work together to achieve mutual benefits such as security, access to resources, and the pursuit of life goals.

Although nearly everyone would agree that certain behaviors—such as lying and cheating—are wrong, opinions about what constitutes right and wrong behavior can vary dramatically. For example, attitudes toward software piracy—a form of copyright infringement that involves making copies of software or enabling others to access software to which they are not entitled—range from strong opposition to acceptance of the practice as a standard approach to conducting business. According to the Business Software Alliance (BSA), the global rate of software piracy stands at around 37 percent of software installed on personal computers; however, over a dozen countries have a rate exceeding 80 percent.<sup>1</sup> In many of these countries, users simply cannot afford software licenses, pirated copies are readily available at cut-rate prices, and software piracy has become an accepted business practice.

Individual views of what behavior is ethical may be impacted by a person's age, cultural group, ethnic background, religion, life experiences, education, and gender along with many other factors. Even within the same society, people can have strong disagreements over important ethical issues. In the United States, for example, issues such as abortion, stem cell research, the death

penalty, marijuana usage, and gun control are continuously debated, and people on both sides of these debates feel that their arguments are on solid moral ground. The reality is that the world has many systems of beliefs about what is right and wrong, each with many proponents.

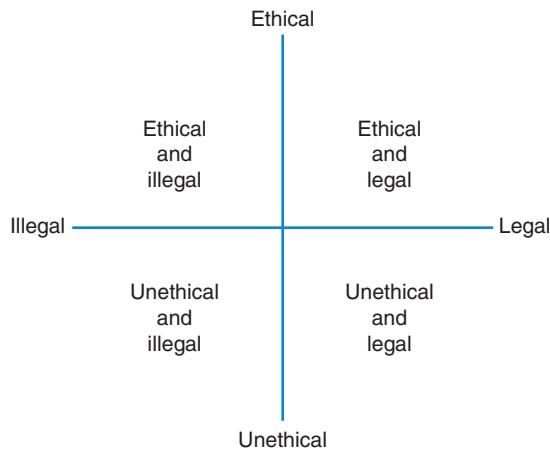
### Ethical Versus Legal

Law is a system of rules that tells us what we can and cannot do. Laws are enforced by a set of institutions (the police, courts, and law-making bodies). Violation of a law can result in censure, fines, and/or imprisonment. Laws in the United States are made by the various local, state, and federal legislatures. Sometimes the laws of these various jurisdictions are in conflict, creating confusion and uncertainty. In addition, laws are not static; new laws are constantly being introduced and existing laws repealed or modified. As a result, the precise meaning of a particular law may be different in the future from what it is today.

Legal acts conform to the law. Ethical acts conform to what an individual believes to be the right thing to do. Laws can proclaim an act as legal, although many people may consider the act unethical. Examples of this include abortion or possession of an automatic weapon. Laws may also proclaim an act as illegal, although many people may consider the act ethical. Examples of this include using marijuana to relieve stress and nausea for people undergoing chemotherapy treatment for cancer.

Laws raise important and complex issues concerning equality, fairness, and justice, but do not provide a complete guide to ethical behavior. Just because an activity is defined as legal does not mean that it is ethical (see Figure 3.1). As a result, practitioners in many professions subscribe to a code of ethics that states the principles and core values that are essential to their work and, therefore, govern their behavior. The code can become a reference point for helping an individual determine what is legal and what is ethical; however, an individual will also be guided by his/her set of morals.

**FIGURE 3.1**  
**The Difference Between Acting Ethically and Acting Legally**



### Fostering Corporate Social Responsibility and Good Business Ethics

Organizations have at least five good reasons to promote a work environment in which employees are encouraged to act ethically when making business decisions:

- Gaining the goodwill of the community
- Creating an organization that operates consistently
- Fostering good business practices
- Protecting the organization and its employees from legal action
- Avoiding unfavorable publicity

### **Gaining the Goodwill of the Community**

Although organizations exist primarily to earn profits or provide services to customers, they also have some fundamental responsibilities to society. Companies often declare these responsibilities in specific corporate social responsibility (CSR) goals.

All successful organizations, including technology firms, recognize that they must attract and maintain loyal customers. Philanthropy is one way in which an organization can demonstrate its values in action and make a positive connection with its customers, employees, suppliers, business partners, and other parties. As a result, many organizations initiate or support socially responsible activities. These activities may include making contributions to charitable organizations and nonprofit institutions, providing benefits for employees in excess of any legal requirements, and devoting organizational resources to initiatives that are more socially desirable than profitable. Here a few examples of some of the CSR activities supported by major IT organizations.

- Dell employees donated over \$1.2 million to disaster relief organizations worldwide and contributed over 23,000 hours in disaster relief efforts. In addition, the Michael and Susan Dell Foundation committed \$36 million in relief efforts to support the Hurricane Harvey relief efforts. Many of Harvey's victims were based in Dell's home state of Texas. Overall, Dell employees spent over 809,000 hours volunteering for various causes in 2017.<sup>2</sup>
- During 2017, Microsoft donated more than \$1.2 billion in software and services and an additional \$1 billion in cloud technology to non-profits and university researchers. Its employees donated \$149 million to various charities. The company is also working to bring broadband connectivity to 2 million people in rural America by 2022.<sup>3</sup>
- Oracle has a multi-pronged set of CSR initiatives aimed at advancing education, protecting the environment, and enriching community life. Its Oracle Academy and Oracle Education Foundation help students develop technical skills and build their creativity. The company is a leader in sustainability and is ranked in the top 10 percent of companies in this arena. Oracle donated millions of dollars in cash to nonprofit organizations and its employees in 45 countries donated 110,000 hours of their time to support nonprofit organizations.<sup>4</sup>

The goodwill that CSR activities generate can make it easier for corporations to conduct their business. For example, a company known for treating its employees well will find it easier to compete for the top job candidates. On the other hand, businesses that are not socially responsible run the risk of alienating their customer base. A study of more than 10,000 shoppers in ten different countries revealed that more than 90 percent are likely to switch to brands that support a socially responsible cause, given similar price and quality. In addition, 90 percent of the shoppers surveyed would boycott a company if they learned that the firm engaged in socially irresponsible business practices. Indeed, 55 percent of the respondents had already done so in the previous year.<sup>5</sup>

### **Creating an Organization That Operates Consistently**

Organizations develop and abide by values to create an organizational culture and to define a consistent approach for dealing with the needs of their stakeholders. Stakeholders include shareholders, employees, customers, suppliers, and the community. Such consistency ensures that employees know what is expected of them and can employ the organization's values to help them in their decision making. Consistency also means that shareholders, customers, suppliers, and the community know what they can expect of the organization. With consistency, the company will behave in the future much as it has in the past. It is especially important for multinational or global organizations to

present a consistent face to their shareholders, customers, and suppliers no matter where those stakeholders live or operate their business. Although each company's value system is different, many share the following values:

- Operate with honesty and integrity, staying true to organizational principles
- Operate according to standards of ethical conduct, in words and action
- Treat colleagues, customers, and consumers with respect
- Strive to be the best at what matters most to the organization
- Value diversity
- Make decisions based on facts and principles

### **Fostering Good Business Practices**

In many cases, good ethics can mean good business and improved profits. Companies that produce safe and effective products avoid costly recalls and lawsuits. (The recall of the weight loss drug Fen-Phen cost its maker, Wyeth-Ayerst Laboratories, almost \$14 billion in awards to victims, many of whom developed serious health problems due to taking the drug.<sup>6</sup>) Companies that provide excellent service retain their customers instead of losing them to competitors. Companies that develop and maintain strong employee relations enjoy lower turnover rates and better employee morale. Suppliers and other business partners often place a priority on working with companies that operate in a fair and ethical manner. All these factors tend to increase revenue and profits while decreasing expenses. As a result, ethical companies should tend to be more profitable over the long term than unethical companies.

On the other hand, bad ethics can lead to bad business results. Bad ethics can have a negative impact on employees, many of whom may develop negative attitudes if they perceive a difference between their own values and those stated or implied by an organization's actions. In such an environment, employees may suppress their tendency to act in a manner that seems ethical to them and instead act in a manner that will protect them against anticipated punishment. When such a discrepancy between employee and organizational ethics occurs, it destroys employee commitment to organizational goals and objectives, creates low morale, fosters poor performance, erodes employee involvement in organizational improvement initiatives, and builds indifference to the organization's needs.

### **Protecting the Organization and Its Employees from Legal Action**

In a 1909 ruling (*United States v. New York Central & Hudson River Railroad Co.*), the U.S. Supreme Court established that an employer can be held responsible for the acts of its employees even if the employees act in a manner contrary to corporate policy and their employer's directions.<sup>7</sup> The principle established is called *respondeat superior*, or "let the master answer."

When it was uncovered that employees of Wells Fargo Bank opened over 2 million credit card accounts not authorized by its customers, the bank was fined over \$185 million and ordered to pay customers full restitution for any fees or charges they may have incurred. The practice began at least as early as 2011 and was an attempt by thousands of bank employees to achieve their sales targets for cross-selling and be rewarded with higher sales bonuses.<sup>8</sup> Cross-selling is the practice of selling existing customers multiple products. The products included savings accounts, checking accounts, auto loans, mortgages, and credit cards. Cross-selling to existing customers is less costly than locating and selling to brand new customers. It also tends to lock existing customers into your bank.

### **Avoiding Unfavorable Publicity**

The public reputation of a company strongly influences the value of its stock, how consumers regard its products and services, the degree of oversight it receives from government agencies, and the amount of support and cooperation

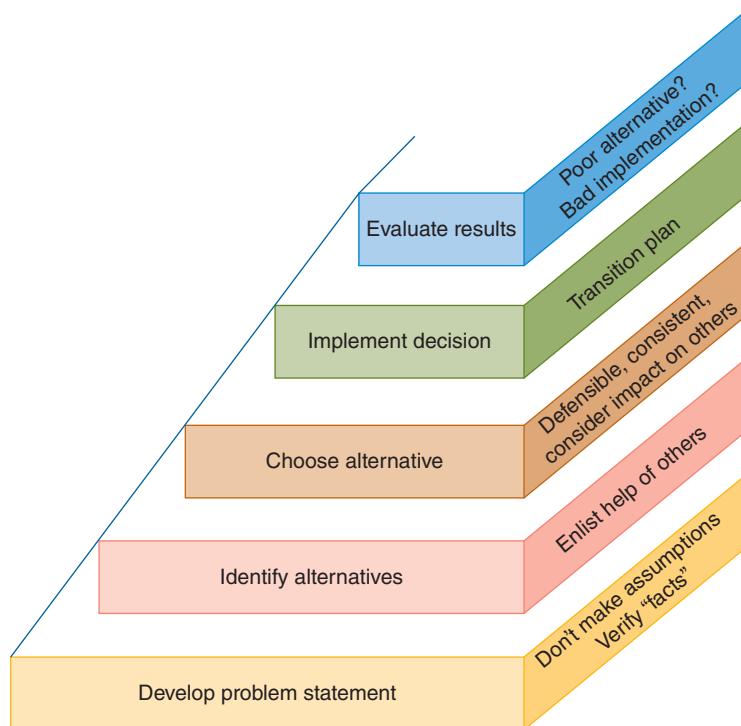
it receives from its business partners. Thus, many organizations are motivated to build a strong ethics program to avoid negative publicity. If an organization is perceived as operating ethically, customers, business partners, shareholders, consumer advocates, financial institutions, and regulatory bodies will usually regard it more favorably.

Prominent ad buyers and marketers are angry with Facebook after finding out that the world's largest online social network service greatly exaggerated the average viewing time of video ads on its platform. This is a key metric used by advertisers in deciding how much to spend on Facebook video versus other video services such as You Tube, Twitter, and TV networks. It turns out that Facebook was not including views of 3 seconds or less in calculating its average view time resulting in overestimating viewing time by 60 to 80 percent.<sup>9</sup> Some advertising industry analysts believe that the new viewing time results and bad publicity associated with the incident will impact the future placement of tens of billions of advertising dollars.

## Including Ethical Considerations in Decision Making

We are all faced with difficult decisions in our work and in our personal life. Most of us have developed a decision-making process that we execute automatically, without thinking about the steps we go through. For many of us, the process generally follows the steps outlined in Figure 3.2.

**FIGURE 3.2**  
**Five-step ethical decision-making process**



The following sections discuss this decision-making process further and point out where and how ethical considerations need to be brought into the process.

### Develop a Problem Statement

A **problem statement** is a clear, concise description of the issue that needs to be addressed. A good problem statement answers the following questions: What do people observe that causes them to think there is a problem? Who is directly affected by the problem? Is anyone else affected? How often does the problem occur? What is the impact of the problem? How serious is the problem?

Development of a good problem statement is the most critical step in the decision-making process. Without a clear statement of the problem or the

**problem statement:** A clear, concise description of the issue that needs to be addressed.

decision to be made, it is useless to proceed. If the problem is stated incorrectly, the chances of solving the real problem are greatly diminished. The following list includes one example of a good problem statement as well as two examples of poor problem statements:

- Good problem statement: Our product supply organization is continually running out of stock of finished products, creating an out-of-stock situation on over 15 percent of our customer orders, resulting in over \$300,000 in lost sales per month.
- Poor problem statement: We need to implement a new inventory control system. (This is a possible solution, not a problem statement. Pursuing this course of action will surely be expensive and time-consuming and, may or may not, solve the underlying problem.)
- Poor problem statement: We need to install cameras and monitoring equipment to put an end to theft of finished product in the warehouse. (Again, this is a possible solution, not a problem statement. And are there sufficient facts to support the hypothesis of theft in the warehouse?)

You must gather and analyze facts to develop a good problem statement. Seek information and opinions from a variety of people (include those who experience the problem first hand and those who will be affected by any changes) to broaden your frame of reference. During this process, you must be extremely careful not to make assumptions about the situation and carefully check key facts for validity. Simple situations can sometimes turn into complex controversies because no one takes the time to gather and analyze the real facts.

### ***Identify Alternatives***

During this stage of decision making, it is ideal to enlist the help of others to identify several alternative solutions to the problem. You will especially want to enlist the help of those with first-hand knowledge of the situation or those who will be affected by the decision. Brainstorming with others will increase your chances of identifying a broad range of alternatives and determining the best solution. On the other hand, there may be times when it is inappropriate to involve others in solving a problem that you are not at liberty to discuss. In providing participants information about the problem to be solved, offer just the facts, without your opinion, so that you don't influence others to accept your solution.

During any brainstorming process, try not to be critical of ideas, as any negative criticism will tend to shut down the discussion, and the flow of ideas will dry up. Simply write down the ideas as they are suggested and ask questions only to gain a clearer understanding of the proposed solution.

### ***Choose an Alternative***

Once a set of alternatives has been identified, the group must evaluate them based on numerous criteria, such as effectiveness of addressing the issue, the extent of risk associated with each alternative, cost, and time to implement. An alternative that sounds attractive but that is not feasible will not help solve the problem.

As part of the evaluation process, weigh various laws, guidelines, and principles that may apply. You certainly do not want to violate a law that can lead to a fine or imprisonment for yourself or others. Do any corporate policies or guidelines apply? Does the organizational code of ethics offer guidance? Do any of your own ethics apply?

Consider the likely consequences of each alternative from several perspectives: What is the impact on you, your organization, other stakeholders (including your suppliers and customers), and the environment? Does this alternative do less harm than other alternatives?

The alternative selected should be ethically and legally defensible to a collection of your co-workers and peers, and it must be defensible to your profession's governing body of ethics. You need to be consistent with the organization's policies and code of ethics and take into account the impact on others. Last, your alternative must provide a good solution to the problem.

### **Implement the Decision**

Once an alternative is selected, it should be implemented in an efficient, effective, and timely manner. This is often much easier said than done, because people tend to resist change. In fact, the bigger the change, the greater is the resistance to it. Communication is the key to helping people accept a change. It is imperative that someone whom the stakeholders trust and respect answer the following questions:

- Why are we doing this?
- What is wrong with the current way we do things?
- How will the change benefit us?

A transition plan must be defined to explain to people how they will move from the old way of doing things to the new way. It is essential that the transition be seen as relatively easy and pain free. It may be necessary to train the people affected, provide incentives for making the change in a successful fashion, and modify the reward system to encourage new behaviors consistent with the change.

### **Evaluate the Results**

After the solution to the problem has been implemented, monitor the results to see if the desired effect was achieved, and observe its impact on the organization and the various stakeholders. Were the success criteria fully met? Were there any unintended consequences? Was the implementation poorly executed? This evaluation may indicate that further refinements are needed. If so, return to the problem development step, refine the problem statement as necessary, and work through the process again.

## **Professional Code of Ethics**

### **professional code of ethics:**

A statement of the principles and core values that an organization wishes to develop in its leaders and members.

A **professional code of ethics** states the principles and core values that an organization wishes to develop in its leaders and members. The primary intent of a code of ethics is to define desired behavior. For example, doctors adhere to varying versions of the 2,000-year-old Hippocratic oath, which medical schools offer as an affirmation to their graduating classes. Most codes of ethics created by professional organizations have two main parts: The first outlines what the organization aspires to become, and the second typically lists rules and principles by which members of the organization are expected to abide. Many codes also include a commitment to continuing education for those who practice the profession.

Laws do not provide a complete guide to ethical behavior, and a professional code of ethics cannot be expected to provide an answer to every ethical dilemma. However, following a professional code of ethics can produce four key benefits for an individual, a profession, and society as a whole:

- *Improve ethical decision making*—Adherence to a professional code of ethics means that practitioners use a common set of core values and beliefs as a guideline for ethical decision making.
- *Set high standards of practice and ethical behavior*—Adherence to a code of ethics reminds professionals of the responsibilities and duties that they may be tempted to compromise to meet the pressures of day-to-day business. The code also defines acceptable and unacceptable behaviors to guide professionals in their interactions with others. Strong codes of

ethics have procedures for censuring professionals for serious violations, with penalties that can include the loss of the right to practice. Such codes are the exception, however, and few exist in the IT arena.

- *Engender trust and respect from the general public*—Public trust is built on the expectation that a professional will behave ethically. People must often depend on the integrity and good judgment of a professional to tell the truth, abstain from giving self-serving advice, and offer warnings about the potential negative side effects of their actions. Thus, adherence to a code of ethics enhances trust and respect for professionals and their profession.
- *Provide an evaluation benchmark*—A code of ethics provides an evaluation benchmark that a professional can use as a means of self-assessment. Peers of the professional can also use the code for recognition or censure.

No one information systems professional organization has emerged as preeminent, so there is no universal code of ethics for IS workers. However, the existence of such organizations is useful in a field that is rapidly growing and changing. To stay on top of the many new developments in their field, IS workers need to network with others, seek out new ideas, and continually build on their personal skills and expertise. Even if you are a freelance programmer or the CIO of a *Fortune* 500 company, membership in an organization of IS workers enables you to associate with others of similar work experience, develop working relationships, and exchange ideas. These organizations disseminate information through email, periodicals, Web sites, social media, meetings, and conferences. Furthermore, in recognition of the need for professional standards of competency and conduct, many of these organizations have developed codes of ethics which can be found at their Web site. Some of the most prominent IS-related professional organizations include the merged Computer Technology Industry Association (CompTIA) and Association of Information Technology Professionals (AITP), Association for Computing Machinery (ACM), Association for Women in Computing, Independent Computer Consultants Association, Institute of Electrical and Electronics Engineers Computer Society (IEEE-CS), Network Professional Association, and the SysAdmin, Audit, Network, Security (SANS) Institute.



## Critical Thinking Exercise

### An Unhappy Employee

#### ► SOCIAL AND ETHICAL ISSUES

You are the customer support manager for a small software manufacturer. The newest addition to your 10-person team is Elliot, a recent college computer science graduate. She is a little overwhelmed by the volume of calls, but is learning quickly and doing her best to keep up. Today, over lunch, one of the other members of your team informed you that she overheard a phone conversation in which it sounded like Elliot was talking with a headhunter and expressing unhappiness with her current situation. You're shocked and alarmed. You had no idea she was unhappy, and your team desperately needs her help to handle the onslaught of calls generated by the newest release of software. If you're going to lose her, you'll need to find a replacement quickly. Should you confront Elliot and demand to know her intentions? Should you avoid any confrontation and simply begin seeking her replacement? Is some other action appropriate? Follow the five-step process for ethical decision making to decide what your next steps should be.

#### Review Questions

1. What are the facts of the situation?
2. Develop a clear problem statement of this situation.

### Critical Thinking Questions

1. Identify alternatives to address this situation. Should you involve others in this?
2. Choose an alternative and defend your actions.

## Information Systems and Privacy

The use of information systems in both government and business requires balancing the needs of those who use the information that is collected against the rights and desires of the people whose information is being used. Information about people is gathered, stored, analyzed, and reported because organizations including government agencies can use it to make better decisions. Some of these decisions, including whether or not to hire a job candidate, approve a loan, or offer a scholarship, can profoundly affect people's lives.

The global marketplace and intensified competition have increased the importance of knowing consumers' purchasing habits and financial condition. Companies use this information to target marketing efforts to consumers who are most likely to buy their products and services. Organizations also need basic information about customers to serve them better. It is hard to imagine an organization having productive relationships with its customers without having data about them. Thus, organizations want systems that collect and store key data from every interaction they have with a customer. The information might include financial data, medical history, work history, and so on, as shown in Figure 3.3.

Many people object to the data collection policies of governments and businesses on the grounds that they strip individuals of the power to control their own personal information. For these people, the existing hodgepodge of privacy laws and practices fails to provide adequate protection. Instead, it causes confusion that promotes distrust and skepticism, which are further fueled by additional disclosures of threats to privacy.

**FIGURE 3.3**  
**Governments and organizations gather a variety of data about people**



A combination of approaches—new laws, technical solutions, and privacy policies—is required to balance the scales. Reasonable limits must be set on government and business access to personal information, new information and

communication technologies must be designed to protect rather than diminish privacy, and appropriate corporate policies must be developed to set baseline standards for people's privacy.

## Measures Protecting Personal Data

### **fair information practices:**

A term for a set of guidelines that govern the collection and use of personal data.

### **General Data Protection**

**Regulation (GDPR):** A set of data privacy requirements that apply across the European Union and apply as well to organizations that market to or process information of EU end users, customers, or employees.

**Fair information practices** is a term for a set of guidelines that govern the collection and use of personal data. Various organizations as well as countries have developed their own set of such guidelines and call them by different names. The overall goal of such guidelines is to stop the unlawful storage of personal data, eliminate the storage of inaccurate personal data, and prevent the abuse or unauthorized disclosure of such data. For some organizations and some countries, a key issue is the flow of personal data across national boundaries (transborder data flow). Fair information practices are important because they form the underlying basis for many national laws addressing data privacy and data protection issues. Europe has been more active in this area than the United States.

The **General Data Protection Regulation (GDPR)** is a set of data privacy requirements that apply across the European Union including non-EU organizations that market to or process information of individuals in the European Union. In general, it increases the rights of individuals and gives them more control over their information. GDPR places obligations on organizations to obtain the consent of people they collect information about and to better manage this data. This includes putting in place a data protection officer and data protection policies, performing data protection assessments, providing training for employees to ensure that they are aware of their responsibilities related to personal data, and having written documentation explaining how data is processed.

Individuals may ask an organization to provide the data they hold about them, at no charge, using a Subject Access Request which must be honored within one month. In the event of a data breach, organizations have 72 hours to notify authorities. The GDPR imposes significant fines for organizations found to be in violation. Organizations with minor violations are subject to fines of up to £10 million (\$13.1 million USD) or 2 percent of a firm's global revenue (whichever is greater). Organizations found to have major violations are subject to fines of up to £20 million (\$26.2 million USD) or 4 percent of a firm's global revenue.<sup>10</sup>

The United Kingdom's Tesco Bank was hit with a data breach that impacted some 40,000 customer accounts, with money taken from half of them. Tesco Bank refunded £2.5 million (\$3.2 million USD) to its account customers following the attack. If the GDPR had been in effect at the time of the breach, Tesco Bank's parent company could have been facing a fine of nearly £2 billion (\$2.5 billion USD).

The situation in regards to fair information practices in the United States is much different. Although numerous laws have been implemented over time, no single, overarching national data privacy policy has been developed in the United States. Nor is there an established advisory agency that recommends acceptable privacy practices to businesses. Instead, there are laws that address potential abuses by the government, with little restrictions for private industry. Legislation that protects people from data privacy abuses by corporations is almost nonexistent. The various major federal laws that govern data privacy can be divided into the following topics: financial data, health information, and children's personal data.

### **Financial Data**

Individuals must reveal much of their personal financial data to take advantage of the wide range of financial products and services available, including credit cards, checking and savings accounts, loans, payroll direct deposit, and

brokerage accounts. To access many of these financial products and services, individuals must use a personal logon name, password, account number, or PIN. The inadvertent loss or disclosure of this personal financial data carries a high risk of loss of privacy and potential financial loss. Individuals should be concerned about how this personal data is protected by businesses and other organizations and whether it is shared with other people or companies.

#### **Fair Credit Reporting Act (15 U.S.C. § 1681)**

The **Fair Credit Reporting Act** regulates the operations of credit-reporting bureaus, including how they collect, store, and use credit information. The act, enforced by the U.S. Federal Trade Commission, is designed to ensure the accuracy, fairness, and privacy of information gathered by the credit-reporting companies and to provide guidelines for organizations whose systems that gather and sell information about people. The act outlines who may access your credit information, how you can find out what is in your file, how to dispute inaccurate data, and how long data is retained. It also prohibits a credit-reporting bureau from giving out information about you to your employer or potential employer without your written consent.

Consumer credit reporting agency TransUnion was fined \$60 million for violation of three FCRA provisions: (1) failure to follow “reasonable procedures to ensure maximum possible accuracy of the information” contained in the plaintiffs’ consumer reports, (2) failure to clearly and accurately disclose all the information in the plaintiffs’ consumer reports upon their request, and (3) failure to provide plaintiffs with a summary of their rights under the FCRA. TransUnion had mistakenly identified individuals as drug lords and terrorists because their names were similar to names found on a list kept by the Treasury Department.<sup>11</sup> Many companies both large and small are targets for FCRA lawsuits and need to ensure that they are in compliance with FCRA and state regulations.

#### **Right to Financial Privacy Act (12 U.S.C. § 3401)**

The **Right to Financial Privacy Act** protects the records of financial institutions’ customers from unauthorized scrutiny by the federal government. Under this act, a customer must receive written notice that a federal agency intends to obtain their financial records, along with an explanation of the purpose for which the records are sought. Customers must also be given written procedures to follow if they do not wish the records to be made available. The financial institution cannot release a customer’s financial records until the government authority seeking the records certifies in writing that it has complied with the applicable provisions of the act. The act only governs disclosures to the federal government; it does not cover disclosures to private businesses or state and local governments. The act allows for civil penalties, liability, and disciplinary action for agencies or departments of the United States or financial institutions for noncompliance.

#### **Fair and Accurate Credit Transactions Act (Public Law 108-159)**

The **Fair and Accurate Credit Transactions Act** was passed in 2003 as an amendment to the Fair Credit Reporting Act, and it allows consumers to request and obtain a free credit report once each year from each of the three primary consumer credit reporting companies (Equifax, Experian, and TransUnion). The act also helped establish the National Fraud Alert system to help prevent identity theft. Under this system, consumers who suspect that they have been or may become a victim of identity theft can place an alert on their credit files. The alert places potential creditors on notice that they must proceed with caution when granting credit.

#### **Health Information**

The use of electronic medical records and the subsequent interlinking and transferring of this electronic information among different organizations has become widespread. Individuals are rightly concerned about the erosion of

#### **Fair Credit Reporting Act:**

Regulates the operations of credit-reporting bureaus, including how they collect, store, and use credit information.

#### **Right to Financial Privacy Act:**

Protects the records of financial institutions’ customers from unauthorized scrutiny by the federal government.

#### **Fair and Accurate Credit Transactions Act:**

Allows consumers to request and obtain a free credit report once each year from each of the three primary consumer credit reporting companies (Equifax, Experian, and TransUnion).

privacy of data concerning their health. They fear intrusions into their health data by employers, schools, insurance firms, law enforcement agencies, and even marketing firms looking to promote their products and services.

### ***Health Insurance Portability and Accountability Act (HIPAA) (Public Law 104-191)***

#### **Health Insurance Portability and Accountability Act (HIPAA) (Public Law 104-191):**

Requires health care organizations to employ standardized electronic transactions, codes, and identifiers to enable them to fully digitize medical records, thus making it possible to exchange medical data over the Internet.

The **Health Insurance Portability and Accountability Act (HIPAA)** requires health care organizations to employ standardized electronic transactions, codes, and identifiers to enable them to fully digitize medical records, thus making it possible to exchange medical data over the Internet. Under the HIPAA provisions, health care providers must obtain written consent from patients prior to disclosing any information in their medical records. Thus, patients need to sign a HIPAA disclosure form each time they are treated at a hospital, and such a form must be kept on file with their primary care physician. In addition, health care providers are required to keep track of everyone who receives information from a patient's medical file.

The penalties for noncompliance are based on the level of negligence, and violations can also carry criminal charges that can result in jail time. The University of Texas MD Cancer Center was fined \$4.3 million for theft of unencrypted patient data from an employee's laptop and two USB thumb drives.<sup>12</sup>

HIPPA assigns responsibility to health care organizations for certifying that their business partners (billing agents, insurers, debt collectors, research firms, government agencies, and charitable organizations) also comply with HIPAA security and privacy rules. This provision of HIPAA is a major concern for many health care executives, as they do not have direct control over the systems and procedures that their partners implement.

### ***American Recovery and Reinvestment Act (Public Law 111-5) Title XIII***

#### **American Recovery and Reinvestment Act Title XIII:**

Includes strong privacy provisions for electronic health records (EHRs), including banning the sale of health information, promoting the use of audit trails and encryption, providing rights of access for patients, and mandating that each individual whose health information has been exposed be notified within 60 days after discovery of a data breach.

The **American Recovery and Reinvestment Act Title XIII**, also known as the Health Information Technology for Economic and Clinical Health Act (HITECH), included strong privacy provisions for electronic health records (EHRs). These provisions included banning the sale of health information, promoting the use of audit trails and encryption, providing rights of access for patients, and mandating that each individual whose health information has been exposed be notified within 60 days after discovery of a data breach. It also provided funding and incentives to accelerate the adoption of standard and interoperable health information systems by awarding payments to health care organizations that could demonstrate meaningful use of such systems.

An electronic health record (EHR) is a comprehensive view of a patient's complete medical history designed to be shared with authorized providers and staff across multiple health care organizations. It is a digital history of the patient's medical history, diagnoses, and treatments. EHRs enable health care providers to track changes in patient health care data over time; identify patients due for vaccinations, screenings, or check-ups; and monitor key patient parameters such as blood glucose levels, blood pressure, and weight. Electronic health records vendors must certify that their software satisfies criteria based on a thorough evaluation by an accredited testing body.

A lawsuit was filed against 62 Indiana hospitals claiming that the hospitals systematically falsified records and defrauded taxpayers of more than \$300 million. The lawsuit claimed the hospitals falsified records to meet the requirements required to show meaningful use of electronic systems and receive incentive payments.<sup>13</sup>

### ***Children's Personal Data***

Many people feel that there is a need to protect children from being exposed to inappropriate material and online predators; becoming the target of harassment; divulging personal data; and becoming involved in gambling or other inappropriate behavior. To date, only a few laws have been implemented to

protect children online, and several of these have been ruled unconstitutional under the First Amendment and its protection of freedom of expression.

### ***Family Educational Rights and Privacy Act (FERPA) (20 U.S.C. § 1232g)***

**Family Educational Rights and Privacy Act (FERPA):** Assigns certain rights to parents regarding their children's educational records.

**Family Educational Rights and Privacy Act (FERPA)** is a federal law that assigns certain rights to parents regarding their children's educational records. These rights transfer to the student once the student reaches the age of 18, or earlier, if the student attends a school beyond the high school level. These rights include the right to demand that educational records be disclosed only with student consent; the right to amend educational records; and the right to file complaints against a school for disclosing educational records in violation of FERPA.

### ***Children's Online Privacy Protection Act (COPPA) (15 U.S.C. §§ 6501–6506),***

**Children's Online Privacy Protection Act (COPPA):** States that any Web site that caters to children must offer comprehensive privacy policies, notify parents or guardians about its data collection practices, and receive parental consent before collecting any personal information from children under 13 years of age.

According to **Children's Online Privacy Protection Act (COPPA)**, any Web site that caters to children must offer comprehensive privacy policies, notify parents or guardians about its data collection practices, and receive parental consent before collecting any personal information from children under 13 years of age. COPPA was implemented in 1998 to give parents more control over the collection, use, and disclosure of their children's personal information; it does not cover the dissemination of information to children. The law has had a major impact and has required many companies to spend hundreds of thousands of dollars to make their Web sites compliant; other companies eliminated preteens as a target audience.

A class-action lawsuit was filed against Walt Disney Company by a group of parents for privacy violations involving children by allowing Twitter, comScore, Upsight, Unity Technology, and Kochava to embed code that tracked young children using 42 Disney apps including the popular "Where's My Water?", "Princess Palace Pets," and "Moana Island Life." The lawsuit alleges that Disney allowed the software companies to embed trackers in these apps that could extract information from the smart device for advertising and other purposes.<sup>14</sup>

## **Web Site Privacy Policy**

Most organizations feel a strong need to create a privacy policy that describes how it gathers, stores, shares, and sells data about its visitors. They recognize that many countries around the world have laws requiring privacy policies if their organization operates in their jurisdiction, or if it collects information from their citizens. In addition, if your organization has any interactions or relationships with third-party apps or services (e.g. Google AdSense, Google Analytics, Facebook Lead Ads, Amazon Affiliates), a privacy policy will be required for you to use the service.

The Better Business Bureau recommends that a privacy notice should be based on the following five elements:<sup>15</sup>

- Notice (what personal information is being collected on the site)
- Choice (what options the customer has about how/whether personal data is collected and used)
- Access (how a customer can see what data has been collected and change/correct it if necessary)
- Security (state how any data that is collected is stored/protected)
- Redress (what customer can do if privacy policy is not met)

There are numerous privacy policy generators available online, however, be sure to customize the standard template to accommodate the laws in the legal jurisdiction in which your organization operates and the type of business in which you are engaged.

## Individual Efforts to Protect Privacy

Although numerous state and federal laws deal with privacy, the laws do not completely protect individual privacy. In addition, not all companies have privacy policies. As a result, many people are taking steps to increase their own privacy protection. Steps that you can take to protect your personal privacy include the following:

- **Find out what is stored about you in existing databases.** Call the major credit bureaus to get a copy of your credit report. You are entitled to a free credit report every 12 months from each of the three major consumer reporting agencies (Equifax, Experian, and TransUnion). You can also obtain a free report if you have been denied credit in the last 60 days. Note that the only Web site authorized by federal law to provide the free credit reports is AnnualCreditReport.com. Other Web sites claim to offer free credit reports but actually charge consumers, sometimes on an ongoing basis, for access to their credit report.<sup>16</sup> The major companies are Equifax ([www.equifax.com](http://www.equifax.com)), TransUnion ([www.transunion.com](http://www.transunion.com)), and Experian ([www.experian.com](http://www.experian.com)). You can also submit a Freedom of Information Act request to a federal agency that you suspect might have information stored on you.
- **Be careful when you share information about yourself.** Don't share information unless it is absolutely necessary. Every time you give information about yourself through an 800, 888, or 900 call, your privacy is at risk. Be vigilant in insisting that your doctor, bank, or financial institution not share information about you with others without your written consent. Don't do online shopping or banking over public Wi-Fi networks as your communications can be easily intercepted. Keep personal information such as your birth date, place of birth, home address, and phone number off social networks.
- **Be proactive in protecting your privacy.** You can get an unlisted phone number and ask the phone company to block caller ID systems from reading your phone number. If you change your address, don't fill out a change-of-address form with the U.S. Postal Service; you can notify the people and companies that you want to have your new address. Destroy copies of your charge card bills and shred monthly statements before disposing of them in the garbage. Be careful about sending personal email messages over a corporate email system. You can also cut down on the junk mail and telemarketing calls you receive by visiting the Direct Marketing Association Web site ([www.tbedma.org](http://www.tbedma.org)). Go to the site and look under Consumer Help-Remove Name from Lists.
- **Take extra care when purchasing anything from a Web site.** Make sure that you safeguard your credit card numbers, passwords, and personal information. Do not do business with a site unless you know that it handles credit card information securely. (Look for a seal of approval from organizations such as the Better Business Bureau Online or TRUSTe. When you open the Web page where you enter credit card information or other personal data, make sure that the Web address begins with *https* and check to see if a locked padlock icon appears in the Address bar or status bar.) Do not provide personal information without reviewing the site's data privacy policy. Many credit card companies will issue single-use credit card numbers on request. Charges appear on your usual bill, but the number is destroyed after a single use, eliminating the risk of stolen credit card numbers.



## Critical Thinking Exercise

### HIPAA Regulations Raise Concern

#### ► SOCIAL AND ETHICAL ISSUES

HIPAA requires that health care organizations, as the originators of individual medical data, certify that their business partners (billing agents, insurers, debt collectors, research firms, government agencies, and charitable organizations) also comply with HIPAA security and privacy rules. This provision of HIPAA is particularly worrisome to executives of health care organizations since they do not have direct control over the systems and procedures that their partners implement.

#### Review Questions

1. Which HIPAA provisions do you think cause the most concern for health care executives in regards to the systems and procedures that their partners implement?
2. Which business partners of a health care organization do you think are most likely to run afoul of HIPAA provisions? Why?

#### Critical Thinking Questions

1. What measures might a health care organization take to ensure that its business partners are compliant with key HIPAA provisions?
2. What actions should a health care organization take if it discovers that one of its business partners is non-compliant with HIPAA provisions?

## Information Systems and Government Surveillance

It is important to gain a historical perspective on the right to privacy from government surveillance. During the debates on the adoption of the U.S. Constitution, some of the drafters expressed concern that a powerful federal government would intrude on the privacy of individual citizens. After the Constitution went into effect in 1789, several amendments were proposed that would spell out additional rights of individuals. Ten of these proposed amendments were ultimately ratified and became known as the Bill of Rights. So, although the Constitution does not contain the word privacy, the U.S. Supreme Court has ruled that the concept of privacy is protected by the Bill of Rights. For example, the Supreme Court has stated that American citizens are protected by the Fourth Amendment when there is a “reasonable expectation of privacy.”

The Fourth Amendment reads as follows:

The right of the people to be secure in their persons, houses, papers, and effects, against unreasonable searches and seizures, shall not be violated, and no Warrants shall issue, but upon probable cause, supported by Oath or affirmation, and particularly describing the place to be searched, and the persons or things to be seized.

It is important to note that the courts have ruled that without a reasonable expectation of privacy, there is no privacy right.

In recent years, new laws addressing government electronic surveillance have been added and old laws amended in reaction to the development of new communication technologies and a heightened awareness of potential terrorist threats. The net result is that the scope of government surveillance has greatly expanded—going from collecting data on as few people as necessary to collecting as much data as possible on as many people as possible.

Many of the resulting surveillance activities are viewed by some as an unconstitutional violation of the **Fourth Amendment**, which protects us from illegal searches and seizures. As a result, there are frequent court challenges to these government actions, as well as an ongoing public debate about whether such activities make Americans safer or simply erode our rights to privacy.

**Fourth Amendment:** Protects us from illegal searches and seizures.

Some people also feel that our basic rights of freedom of expression and association are violated when the U.S. government conducts widespread electronic surveillance on U.S. citizens. For instance, some people who belong to particular ethnic, religious, and social groups (including political activists on both ends of the political spectrum) are concerned that private data collected by the government could at some point be used to identify and target them and their associates. There is also concern that our past communications may be used in the future to implicate us in crimes that were once private and innocent acts. Many individuals are also concerned about the potential for a data breach in which personal data stored by the government falls into the hands of criminals.

On the other hand, many Americans feel that the U.S. government is obligated to do all that it can do to provide for the security of its citizens, even if it means violating some of the rights designed to protect our privacy. After all, they argue, if you are not doing anything “wrong” you should have no concerns. Listed below are the 21 government agencies authorized to conduct surveillance activities while Table 3.1 summarizes some of the many government surveillance systems in place today

**TABLE 3.1** Government surveillance systems

System/ Program	Used by	How Used
Automatic license plate readers (ALPR)	Law enforcement agencies, including the U.S. Drug Enforcement Administration and the U.S. Customs and Border Protection agency	ALPRs snap photos and document the location of vehicles; some systems can also photograph drivers and passengers. ALPRs are used to snag red-light runners and to identify motorists with outstanding arrest warrants, overdue parking tickets, and delinquent tax bills.
Backscatter imaging scanners	Law enforcement agencies, including the U.S. Customs and Border Protection agency, maritime police, general aviation security, and event security	Backscatter scanners can scan vehicles as well as individuals and crowds at public events to search for currency, drugs, and explosives.
Drones	Law enforcement agencies, including the U.S. Customs and Border Protection agency	Drones are unmanned aerial vehicles used to support operations that require aerial surveillance.
MYSTIC	National Security Agency (NSA)	MYSTIC is used by the NSA to intercept and record all telephone conversations in certain countries, including Afghanistan, the Bahamas, Mexico, Kenya, and the Philippines. Because there is no practical way to exclude them, the conversations captured by MYSTIC include those of Americans who make calls to or from the targeted countries. <sup>17,18</sup>
Downstream (formerly PRISM)	National Security Agency (NSA)	PRISM is an NSA surveillance program that collects Internet data, such as search histories; photos sent and received; and the contents of email, file transfers, and voice and video chats from the servers of AOL, Apple, Facebook, Google, Microsoft, Paltalk, Skype, Yahoo, and YouTube.
Secure Flight Program	Transportation Security Agency (TSA)	Secure Flight is an airline passenger prescreening program that checks travelers' personal information against the TSA's passenger watch list.
Stingray	Law enforcement agencies	Stingray is a type of hardware device used to impersonate a cell tower, forcing all mobile phones within range to connect to it. The device can then capture information that can be used to identify and locate users and the phone numbers they call or text.
Surveillance cameras	Law enforcement agencies, National Security Agency, others.	Tens of millions of surveillance cameras are installed in the United States and over 250 million worldwide. The average U.S. urban dweller is captured on camera over 50 times/day. The images are used for intelligence gathering, the prevention and investigation of crime, and the protection of individuals or objects.
Upstream	National Security Agency (NSA)	Collects communications as they travel over the Internet high capacity backbone links.

Central Intelligence Agency  
National Reconnaissance Office  
Federal Bureau of Investigation  
Office of Intelligence and Analysis  
Drug Enforcement Agency  
Department of Energy  
Defense Intelligence Agency  
National Geospatial-Intelligence Agency  
Bureau of Intelligence and Research  
Department of Treasury  
Department of Homeland Security  
Office of the Director of National Intelligence  
National Security Agency  
Intelligence and Counterintelligence of the Army,  
Intelligence and Counterintelligence of the Navy  
Intelligence and Counterintelligence of the Air Force  
Intelligence and Counterintelligence of the Marine Corps  
Intelligence and Counterintelligence of the Coast Guard  
Department of State  
Office of National Security Intelligence  
Office of Intelligence and Counterintelligence

## Federal Statutes That Protect Citizens from Government Surveillance

There are many federal statutes that protect citizens from government surveillance. Summaries of the more significant statutes are included in the following sections of this chapter.

### **Foreign Intelligence Surveillance Act (FISA) (50 U.S.C.)**

FISA, passed by Congress in 1978, describes procedures for the electronic surveillance and collection of foreign intelligence information in communications (e.g., phone calls, emails) between foreign powers and the agents of foreign powers. Foreign intelligence is information relating to the capabilities, intentions, or activities of foreign governments or agents of foreign governments or foreign organizations. The act allows surveillance, without court order, *within the United States* for up to a year unless the “surveillance will acquire the contents of any communication to which a U.S. person is a party.” If a U.S. citizen is involved, judicial authorization is required within 72 hours after surveillance begins. The act also specifies that the U.S. attorney general may request a specific communications common carrier (a company that provides communications transmission services to the public) to furnish information, facilities, or technical assistance to accomplish the electronic surveillance.

FISA requires the government to obtain an individualized court order before it can intentionally target a U.S. person anywhere in the world to collect the content of his/her communications. The FISA court must be satisfied, based on a probable cause standard, that the U.S. person is an agent of a foreign power or an officer or employee of a foreign power. The FISA act also created the Foreign Intelligence Surveillance Act (FISA) court, which meets in secret to hear applications for orders approving electronic surveillance anywhere within the United States. Each application for a surveillance warrant is made before an individual judge of the court. Such applications are rarely turned down.

Section 702 of FISA was added in 2008 and allows intelligence agencies to gather foreign intelligence from non-Americans located *outside the United States*. However, if a U.S. citizen is communicating with a non-U.S. citizen outside the United States, their conversations can be monitored and recorded. This incidental collection is a major point of contention among privacy advocates.

While many argue that this represents a violation of the Fourth Amendment's guarantee against unreasonable searches and seizures, a six-year extension of this controversial amendment was approved in January 2018.

### ***USA PATRIOT Act (Uniting and Strengthening America by Providing Appropriate Tools Required to Intercept and Obstruct Terrorism) (Public Law 107-56)***

This act was passed just 5 weeks after the terrorist attacks of September 11, 2001. It gave sweeping new powers both to domestic law enforcement and U.S. international intelligence agencies. It increased the ability of law enforcement agencies to search telephone, email, medical, financial, and other records.

Title II of the Patriot Act amended FISA and greatly expanded the scope of surveillance permitted under U.S. law. Foreign intelligence could now be gathered from both U.S. citizens and foreigners, government agencies no longer needed to prove that a target is an agent of a foreign power, and the maximum duration of surveillance and investigations was lengthened. In addition, law enforcement agencies were authorized to break into and enter premises without the owner's consent and stealthily search the premises using so-called sneak and peak warrants. Roving wiretaps were allowed so that anyone who comes into contact with a suspected terrorist can be wiretapped.

Critics have argued that the law removed many checks and balances that previously gave courts the opportunity to ensure that law enforcement agencies did not abuse their powers. Critics also argue that many of its provisions have nothing to do with fighting terrorism.

### ***USA Freedom Act***

This act was passed in 2015 following startling revelations by Edward Snowden. He was a former government contractor who copied and leaked classified information from the National Security Agency in 2013. The information was about secret NSA surveillance programs. Here is a partial list of those revelations:

- U.S. phone companies had been providing the NSA with *all* their customers records, not just metadata. This metadata from the U.S. phone companies included phone numbers called and called from, the time contact was made, how long the call was, and the number of characters exchanged in text messages.
- The NSA had been spying on over 120 world leaders, including German Chancellor Angela Merkel, a U.S. ally.
- The NSA has developed a variety of tools to circumvent widely used Internet data encryption methods.
- An NSA team of expert hackers called the Tailored Access Operations hack into computers worldwide to infect them with malware.
- The Foreign Intelligence Surveillance Court reprimanded the NSA for frequently providing misleading information about its surveillance practices.

The USA Freedom Act terminated the bulk collection of telephone records and Internet metadata by the NSA. Instead, telecommunications providers are now required to hold the data and respond to NSA queries on the data. The bill authorizes the government to collect from the phone companies up to "two hops" of call records related to a target—provided the government can prove it has reasonable suspicion that the target is linked to a terrorist organization.

During 2017, the NSA obtained orders as required by this Act to target 40 individuals. These authorizations enabled the agency to gather over 500 million call records from telecom providers as the requests allow the NSA to access metadata from every single person a target has been in contact with.<sup>19</sup> The 2017 call records total is far less than the estimated billions of records collected per day under the NSA's old bulk surveillance system.



## Critical Thinking Exercise

### Voice Your Opinion on Government Surveillance

#### ► SOCIAL AND ETHICAL ISSUES

You have a meeting with your U.S. Senator to voice your opinion on government surveillance programs and to share the changes you wish to see made to the FISA, Patriot, and Freedom Acts.

#### Review Questions

1. Are there specific measures of these Acts which you support? If so, what are they?
2. Are there specific measures of these Acts which you do not support? If so, what are they?

#### Critical Thinking Questions

1. What changes would you recommend to these three Acts and the government surveillance program in general?
2. Would you recommend additional federal statutes related to government surveillance? If so, please summarize the key features you wish to see implemented.

## Information Systems and Freedom of Expression

The Internet enables a worldwide exchange of news, ideas, opinions, rumors, and information. Its broad accessibility, open discussions, and anonymity make the Internet a remarkable communications medium. It provides an easy and inexpensive way for a speaker to send a message to a large audience—potentially thousands or millions of people worldwide. In addition, given the right email addresses, a speaker can aim a message with laser accuracy at a select subset of powerful and influential people.

People must often make ethical decisions about how to use such incredible freedom and power. Organizations and governments have attempted to establish policies and laws to help guide people, as well as to protect their own interests. Businesses have sought to conserve corporate network capacity, avoid legal liability, and improve worker productivity by limiting the nonbusiness use of IT resources.

### Measures Protecting Freedom of Speech

Information technology has provided amazing new ways for people to communicate with others around the world. This section discusses measures that have been taken to help safeguard our ability to communicate freely.

#### First Amendment

The right to freedom of expression is one of the most important rights for free people. The First Amendment to the U.S. Constitution was adopted to guarantee this right and others. Over the years, many federal, state, and local laws have been found unconstitutional because they violated one of the tenets of this amendment. The First Amendment reads as follows:

“Congress shall make no law respecting an establishment of religion, or prohibiting the free exercise thereof; or abridging the freedom of speech, or of the press; or the right of the people peaceably to assemble, and to petition the government for a redress of grievances.”

In other words, the **First Amendment** protects Americans' rights to freedom of religion, freedom of expression, and freedom to assemble peaceably. This amendment has been interpreted by the Supreme Court as applying to the entire federal government, even though it only expressly refers to Congress.

**First Amendment:** Protects Americans' rights to freedom of religion, freedom of expression, and freedom to assemble peaceably.

Numerous court decisions have broadened the definition of speech to include nonverbal, visual, and symbolic forms of expression, such as flag burning, dance movements, and hand gestures. Sometimes the speech at issue is unpopular or highly offensive to most people; however, the Bill of Rights provides protection for minority views. The Supreme Court has also ruled that the First Amendment protects the right to speak anonymously as part of the guarantee of free speech.

The Supreme Court has held that the following types of speech are not protected by the First Amendment and may be forbidden by the government: perjury, fraud, defamation, obscene speech, incitement of panic, incitement to crime, “fighting words,” and sedition (incitement of discontent or rebellion against a government).

### **Anonymity on the Internet**

**anonymous expression:** The expression of opinions by people who do not reveal their identity.

**Anonymous expression** is the expression of opinions by people who do not reveal their identity. The freedom to express an opinion without fear of reprisal is an important right of a democratic society. Anonymity is even more important in countries that don’t allow free speech. However, in the wrong hands, anonymous communication can be used as a tool to commit illegal or unethical activities.

Anonymous political expression played an important role in the early formation of the United States. Before and during the American Revolution, patriots who dissented against British rule often used anonymous pamphlets and leaflets to express their opinions. England had a variety of laws designed to restrict anonymous political commentary, and people found guilty of breaking these laws were subject to harsh punishment—from whippings to hangings. A famous case in 1735 involved a printer named John Zenger, who was prosecuted for seditious libel because he wouldn’t reveal the names of anonymous authors whose writings he published. The authors were critical of the governor of New York. The British were outraged when the jurors refused to convict Zenger, in what is considered a defining moment in the history of freedom of the press in the United States.

Other democracy supporters often authored their writings anonymously or under pseudonyms. For example, Thomas Paine was an influential writer, philosopher, and statesman of the Revolutionary War era. He published a pamphlet called *Common Sense*, in which he criticized the British monarchy and urged the colonies to become independent by establishing a republican government of their own. Published anonymously in 1776, the pamphlet sold more than 500,000 copies, at a time when the population of the colonies was estimated to have been less than 4 million; it provided a stimulus to produce the Declaration of Independence six months later.

Despite the importance of anonymity in early America, it took nearly 200 years for the Supreme Court to render rulings that addressed anonymity as an aspect of the Bill of Rights. One of the first rulings was in the 1958 case of *National Association for the Advancement of Colored People (NAACP) v. Alabama*, in which the court ruled that the NAACP did not have to turn over its membership list to the state of Alabama. The court believed that members could be subjected to threats and retaliation if the list were disclosed and that disclosure would restrict a member’s right to freely associate, in violation of the First Amendment.

Maintaining anonymity on the Internet is important to some computer users. They might be seeking help in an online support group, reporting defects about a manufacturer’s goods or services, taking part in frank discussions of sensitive topics, expressing a minority or antigovernment opinion in a hostile political environment, or participating in chat rooms. Other Internet users, however, would prefer to ban Web anonymity because they think its use increases the risks of defamation, fraud, and libel, as well as the exploitation of children.

When an email is sent, the email software (e.g., Outlook) automatically inserts information called a header on each packet of the message that identifies where the email originated from and who sent it. In addition, IP addresses are attached to the email and captured as the message transfers through various routers and relay servers. Internet users who want to remain anonymous can send email to an anonymous remailer service, which uses a computer program to strip the originating header and/or IP number from the message. It then forwards the message to its intended recipient—an individual, a chat room, or a newsgroup—with either no IP address or a fake one, ensuring that the header information cannot be used to identify the author. Some remailers route messages through multiple remailers to provide a virtually untraceable level of anonymity. Anonymous remailers do not keep any list of users and corresponding anonymizing labels used for them; thus, a remailer can ensure its users that no internal information has been left behind that can later be used to break identity confidentiality. Even if law-enforcement agencies serve a court order to release information, there is nothing to turn over.

The use of a remailer keeps communications anonymous; what is communicated, and whether it is ethical or legal, is up to the sender. The use of remailers by people committing unethical or even illegal acts in some states or countries has spurred controversy. Remailers are frequently used to send pornography, to illegally post copyrighted material to Usenet newsgroups, and to send unsolicited advertising to broad audiences (spamming). An organization's IT department can set up a firewall to prohibit employees from accessing remailers or to send a warning message each time an employee communicates with a remailer.

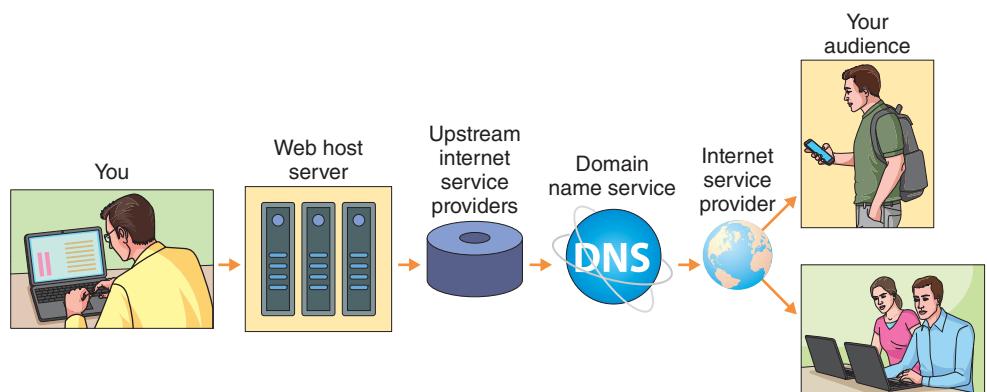
As part of an antiterrorist operation in late 2014, police in Spain raided 14 houses and social centers. Seven people arrested that day were held in a Madrid prison on suspicion of terrorism. The judge in the case cited three reasons for jailing the seven people—possession of certain books, including *Against Democracy* (a book that challenges the belief that the version of democracy practiced today is good and moral), the production of publications and forms of communication, and their use on an anonymous remailer to send emails. Many privacy experts believe that citing the use of secure email as a potential indicator of involvement in terrorist activities is an exceedingly dangerous precedent. As one blogger commented and many observers agree “Security is not a crime.”<sup>20</sup>

## Internet Censorship

**internet censorship:** The control or suppression of the publishing or accessing of information on the Internet.

**Internet censorship** is the control or suppression of the publishing or accessing of information on the Internet. Speech on the Internet requires a series of intermediaries to reach its audience (see Figure 3.4) with each intermediary vulnerable to some degree to pressure from those who want to silence the speaker. Web hosting services are often the recipients of defamation or copyright infringement claims by government authorities or copyright holders, demanding the immediate takedown of hosted material that is deemed inappropriate or illegal. Government entities may pressure “upstream” Internet service providers to limit access to certain Web sites, allow access to only some content or modified content at certain Web sites, reject the use of certain keywords in search engine searches, and track and monitor the Internet activities of individuals.

Several countries have enacted so called three strikes laws that require ISPs to terminate a user's Internet connection once that user has received a number of notifications of posting of content deemed inappropriate or illegal. Censorship efforts may also focus on Domain Name System (DNS) servers, which



**FIGURE 3.4**  
**Internet Censorship**

convert human-readable host and domain names into the machine-readable, numeric Internet Protocol (IP) addresses that are used to point computers and other devices toward the correct servers on the Internet. This configuration is shown in Figure 3.4. Where authorities have control over DNS servers, officials can “deregister” a domain that hosts content that is deemed inappropriate or illegal so that the Web site is effectively invisible to users seeking access to the site.

China has the largest online population in the world, with over 772 million Internet users (see Table 3.2, which depicts the top 12 countries in terms of number of Internet users). Note, however, that Internet censorship in China is perhaps the most rigorous in the world. The Chinese government blocks access to Web sites that discuss any of a long list of topics that are considered objectionable—including the Buddhist leader the Dalai Lama, anything to do

**TABLE 3.2** The top twelve countries with the highest number of internet users (2018)

Rank	Country	Internet users (Millions)	Population (Millions)	Internet Penetration (% of population)
1	China	772	1,415	54%
2	India	462	1,354	34%
3	United States	312	327	95%
4	Brazil	149	211	71%
5	Indonesia	143	267	54%
6	Japan	119	127	94%
7	Russia	110	144	76%
8	Nigeria	98	196	50%
9	Mexico	85	131	65%
10	Bangladesh	81	166	49%
11	Germany	79	82	96%
12	Philippines	67	107	63%

SOURCES: “Internet Users by Country (2018)”, Internet Live Stats, <https://www.internetworldstats.com/top20.htm>.

with the government crackdown on the 1989 Tiananmen Square protests, and the banned spiritual movement Falun Gong. Chinese Web sites also employ censors who monitor and delete objectionable content. The government hires workers to post comments favorable to the government.<sup>21</sup>

Surprisingly, Brazilian government demands have closed more Google Gmail accounts and more blogger sites than in any other country. In Brazil, filing a lawsuit to demand that Internet content be taken down is relatively easy and inexpensive. The ability of litigants to challenge content and demand that anonymous sources be revealed stifles Brazilian journalists and Internet bloggers.<sup>22</sup>

Although there are clear and convincing arguments to support freedom of speech online, the issue is complicated by the ease with which children can access the Internet. Even some advocates of free speech acknowledge the need to restrict children's Internet access, but it is difficult to restrict their access without also restricting adults' access. In attempts to address this issue, the U.S. government has passed laws and software manufacturers have invented special software to block access to objectionable material. The following sections summarize these and other approaches to blocking access to content.

### **Communications Decency Act (CDA)**

The Telecommunications Act became law in 1996. Its primary purpose was to allow free competition among phone, cable, and TV companies. The act was broken into seven major sections or titles. Title V of the Telecommunications Act was the Communications Decency Act (CDA), aimed at protecting children from pornography. The CDA imposed \$250,000 fines and prison terms of up to two years for the transmission of "indecent" material over the Internet.

In February 1996, the American Civil Liberties Union (ACLU) and 18 other organizations filed a lawsuit challenging the criminalization of so-called indecency on the Web under the CDA. The problem with the CDA was its broad language and vague definition of *indecency*, a standard that was left to individual communities to determine. In June 1997, the Supreme Court ruled the law unconstitutional and declared that the Internet must be afforded the highest protection available under the First Amendment.<sup>23</sup> The Supreme Court said in its ruling that "the interest in encouraging freedom of expression in a democratic society outweighs any theoretical but unproven benefit of censorship."<sup>24</sup> The ruling applied essentially the same free-speech protections to communication over the Internet as exist for print communication.

If the CDA had been judged constitutional, it would have opened all aspects of online content to legal scrutiny. Many current Web sites would probably either not exist or would look much different today had the law not been overturned. Web sites that might have been deemed indecent under the CDA would be operating under an extreme risk of liability.

**Section 230 of the CDA**, which was not ruled unconstitutional, provides immunity to an Internet service provider (ISP) that publishes user-generated content, provided its actions do not rise to the level of a content provider. It states that "No provider or user of an interactive computer service shall be treated as the publisher or speaker of any information provided by another information content provider" (47 U.S.C. § 230). In general, the closer an ISP is to a pure service provider than to a content provider, the more likely that the Section 230 immunity will apply.<sup>25</sup> This portion of the CDA protects social networking companies such as Facebook and Twitter from defamation suits in connection with user postings that appear on their sites. Because of Section 230, Web site owners and server hosts aren't constantly dragged into endless lawsuits because someone said something inflammatory on one of their sites.

Facebook presents a constantly updated list of stories, called the News Feed, in the middle of each Facebook user's home page. Using an algorithm

**Section 230 of the CDA:** Provides immunity to an Internet service provider (ISP) that publishes user-generated content, provided its actions do not rise to the level of a content provider.

based on each user's Facebook activity and connections, the social networking site attempts to choose the "best" content out of several thousand potential stories, placing those near the top of the News Feed. The number of comments and likes a post receives as well as what type of story it is (e.g., photo, video, news article, or status update) influence whether and how prominently a story will appear in a user's News Feed. Facebook also conducts surveys and focus groups to get input on what stories people think should appear. The more engaging the content, the more time users will spend on Facebook and the more often they will likely return to the site. This enables Facebook to earn more revenue from ads shown in News Feed content.<sup>26</sup>

Because one of the traditional roles of a publisher is to select which stories to show its readers, Facebook's efforts to shape the news that its users see could result in it being viewed as an information content provider by the courts, resulting in a loss of protection under Section 230 of the CDA. If that were to happen, Facebook could become liable for defamation based on the postings of its subscribers.

### ***Internet Filtering***

**internet filter:** Software that can be used to block access to certain websites that contain material deemed inappropriate or offensive.

An **Internet filter** is software that can be used to block access to certain Web sites that contain material deemed inappropriate or offensive. The best Internet filters use a combination of URL, keyword, and dynamic content filtering. With URL filtering, a particular URL or domain name is identified as belonging to an objectionable site, and the user is not allowed access to it. Keyword filtering uses keywords or phrases—such as *sex*, *Satan*, and *gambling*—to block Web sites. With dynamic content filtering, each Web site's content is evaluated immediately before it is displayed, using techniques such as object analysis and image recognition.

The negative side of Internet filters is that they can block too much content, keeping users from accessing useful information about civil rights, health, sex, and politics as well as online databases and online book catalogs.

Some organizations choose to install filters on their employees' computers to prevent them from viewing sites that contain pornography or other objectionable material. Employees unwillingly exposed to such material would have a strong case for sexual harassment. The use of filters can also ensure that employees do not waste their time viewing nonbusiness-related Web sites. According to TopTenREVIEWS, the top-rated Internet filters for home users for 2018 include Net Nanny, Spy Agent, and Qustodio.<sup>27</sup> Internet software filters have also been developed to run on mobile devices such as Android and iPhone smartphones.

### ***Children's Internet Protection Act (CIPA)***

In another attempt to protect children from accessing pornography and other explicit material online, Congress passed the Children's Internet Protection Act (CIPA) in 2000. The act required federally financed schools and libraries to use some form of technological protection (such as an Internet filter) to block computer access to obscene material, pornography, and anything else considered harmful to minors. Congress did not specifically define what content or Web sites should be forbidden or what measures should be used—these decisions were left to individual school districts and library systems. Any school or library that failed to comply with the law would no longer be eligible to receive federal money through the E-Rate program, which provides funding to help pay for the cost of Internet connections.

Opponents of the law were concerned that it transferred power over education to private software companies who develop the Internet filters and define what sites to block. Furthermore, opponents felt that the motives of these companies were unclear—for example, some filtering companies track students' online activities and sell the data to market research firms. Opponents

also pointed out that some versions of these filters were ineffective, blocking access to legitimate sites and allowing access to objectionable ones. Yet another objection was that penalties associated with the act could cause schools and libraries to lose federal funds from the E-Rate program, which is intended to help bridge the digital divide between rich and poor, urban and rural. Loss of federal funds would lead to a less capable version of the Internet for students at poorer schools, which have the fewest alternatives to federal aid.

CIPA's proponents contended that shielding children from drugs, hate speech, pornography, and other topics was a sufficient reason to justify filters. They argued that Internet filters are highly flexible and customizable and that critics exaggerated the limitations. Proponents pointed out that schools and libraries could elect not to implement a children's Internet protection program; they just wouldn't receive federal money for Internet access.

Many school districts implemented programs consistent with CIPA. Acceptance of an Internet filtering system is more meaningful if the system and its rationale are first discussed with parents, students, teachers, and administrators. Then the program can be refined using everyone's feedback. An essential element of a successful program is to require that students, parents, and employees sign an agreement outlining the school district's acceptable-use policies for accessing the Internet. Controlling Internet access via a central district-wide network rather than having each school set up its own filtering system reduces administrative effort and ensures consistency. Procedures must be defined to block new objectionable sites as well as remove blocks from Web sites that should be accessible.

Implementing CIPA in libraries is much more difficult because a library's services are open to people of all ages, including adults who have First Amendment rights to access a broader range of online materials than are allowed under CIPA. In *United States, et al v. American Library Association, Inc., et al*, the American Library Association challenged CIPA. Ultimately in that case, the Supreme Court made it clear that the constitutionality of government-mandated filtering schemes depends on adult patrons' ability to request and receive unrestricted access to protected speech.<sup>28</sup> A possible compromise for public libraries with multiple computers would be to allow unrestricted Internet use for adults but to provide computers with only limited access for children.

### Defamation Lawsuits

The right to freedom of expression is restricted when the expressions, whether spoken or written, are untrue and cause harm to another person. Making either an oral or a written statement of alleged fact that is false and that harms another person is **defamation**. The harm is often of a financial nature, in that it reduces a person's ability to earn a living, work in a profession, or run for an elected office, for example. An oral defamatory statement is slander, and a written defamatory statement is libel. Defamation lawsuits are filed frequently and are a form of censorship because they are seeking to stop unwanted speech or writings and to impose financial penalties for those speech instances or writings.

Because defamation is defined as an untrue statement of fact, truth is an absolute defense against a charge of defamation. Although people have the right to express opinions, they must exercise care in their online communications to avoid possible charges of defamation. Organizations must also be on their guard and prepared to act in the event of libelous attacks against them.

In recent years, a woman was hit with a \$1 million defamation lawsuit after posting a poor review of a gynecologist on Yelp, Health Grades, and ZocDoc. She claimed she was billed over \$1,300 for a new patient visit and ultrasound services that she received and for additional services that she did not receive. So far she has spent over \$20,000 defending herself.<sup>29</sup>

**defamation:** The making of either an oral or a written statement of alleged fact that is false and that harms another person.

**hate speech:** Persistent or malicious harassment aimed at a specific person.

### Hate Speech Censoring

In the United States, speech that is merely annoying, critical, demeaning, or offensive enjoys protection under the First Amendment. Legal recourse is possible only when hate speech turns into clear threats and intimidation against *specific* citizens. Persistent or malicious harassment aimed at a specific person is **hate speech**, which can be prosecuted under the law, but general, broad statements expressing hatred of an ethnic, racial, or religious group cannot. For instance, a threatening private message sent over the Internet to a person, a public message displayed on a Web site describing intent to commit acts of hate-motivated violence against specific individuals, and libel directed at a specific person are all actions that can be prosecuted.

Although ISPs and social networking sites do not have the resources to prescreen content (and they do not assume any responsibility for content provided by others), many ISPs and social networking sites do reserve the right to remove content that, in their judgment, does not meet their standards. The speed at which content may be removed depends on how quickly such content is called to the attention of the ISP or social networking site, how egregious the content is, and the general availability of the company's resources to handle such issues.

To post videos on YouTube, you must first create a YouTube or a Google account (Google is the owner of YouTube) and agree to abide by the site's published guidelines.<sup>30</sup> The YouTube guidelines prohibit the posting of videos showing such things as pornography, animal abuse, graphic violence, predatory behavior, and drug use. The guidelines also prohibit the posting of copyrighted material—such as music, television programs, or movies—that is owned by a third party. YouTube staff members review user-posted videos on a regular basis to find any that violate the site's community guidelines. Those that violate the guidelines are removed. Certain other videos are age-restricted because of their content. Users are penalized for serious or repeated violations of the guidelines and can have their account terminated.<sup>31</sup>

Because such prohibitions are included in the service contracts between ISPs and social networking sites and their subscribers and members—and do not involve the federal government—they do not violate anyone's First Amendment rights. Of course, people who lose an ISP or social networking account for violating the provider's regulations may resume their hate speech by simply opening a new account, either under a different name or with some other, more permissive site or ISP.

Social media networks are increasingly coming under pressure to remove hate speech. Germany passed a law known as NetzDG or the Network Enforcement Act to crack down on offensive posts. The law requires that Facebook, Google, Instagram, Snapchat, Twitter, and YouTube to delete hate speech postings within 24 hours or face a fine of up €50 million (\$57 million USD) for noncompliance. Critics are concerned that the social networks will err on the side of safety and delete content which does not really qualify as hate speech.<sup>32</sup>

### Internet Pornography Censoring

Many people, including some free-speech advocates, believe that there is nothing illegal or wrong about viewing adult pornographic material made by and for consenting adults. They argue that the First Amendment protects such material. On the other hand, most parents, educators, and other child advocates are concerned that children might be exposed to online pornography. They are deeply troubled by its potential impact on children and fear that increasingly easy access to pornography encourages pedophiles and sexual predators.

Clearly, the Internet has been a boon to the pornography industry by providing fast, cheap, and convenient access to many millions of porn Web sites worldwide.<sup>33</sup> Access via the Internet enables pornography consumers to avoid offending others or being embarrassed by others observing their purchases.

There is no question that online adult pornography is big business (revenue estimates vary widely between \$1 billion and \$97 billion). PornHub, one of the most popular and largest hardcore porn Web sites, had 28.5 billion visits during 2017—almost 1000 per second.<sup>34</sup>

If what someone distributes or exhibits is judged obscene, they are subject to prosecution under the obscenity laws. The precedent-setting *Miller v. California* ruling on obscenity predates the Internet. The judges in that case ruled that contemporary community standards should be used to judge what is obscene. The judges allowed that different communities could have different norms.

The key question in deciding what Internet material is obscene is: “Whose community standards are used?” Because Internet content publishers cannot easily direct their content into or away from a particular geographic area, one answer to this question is that the Internet content publisher must conform to the norms of the most restrictive community. However, this line of reasoning was challenged by the Third Circuit Court of Appeals in the *Ashcroft v. American Civil Liberties Union* case, which involved a challenge to the 1998 Child Online Protection Act (COPA). The Supreme Court reversed the circuit court’s ruling in this case—but with five different opinions and no clear consensus on the use of local or national community standards.<sup>35</sup> In *United States v. Kilbride*, the Ninth Circuit Court of Appeals ruled that “a national community standard must be applied in regulating obscene speech on the Internet, including obscenity disseminated via email.”<sup>36</sup> In *United States v. Little*, the Eleventh Circuit Court of Appeals rejected the national community standard and adopted the older, local community standard. Currently there is no clear agreement within the courts on whether local or national community standards are to be used to judge obscenity.

U.S. organizations must be very careful when dealing with issues relating to pornography in the workplace. By providing computers, Internet access, and training in how to use those computers and the Internet, companies could be seen by the law as purveyors of pornography because they have enabled employees to store pornographic material and retrieve it on demand. A survey published in the Archives of Sexual Behavior found that 21 percent of men watched porn at work.<sup>37</sup> If an employee sees a coworker viewing porn on a workplace computer, that employee may be able to claim that the company has created a hostile work environment. Such a claim opens the organization to a sexual harassment lawsuit that can cost hundreds of thousands of dollars and tie up managers and executives in endless depositions and court appearances.

Many companies believe that they have a duty to stop the viewing of pornography in the workplace. As long as they can show that they took reasonable steps and determined actions to prevent it, they have a valid defense if they become the subject of a sexual harassment lawsuit. If it can be shown that a company made only a half-hearted attempt to stop the viewing of pornography in the workplace, then the company could have trouble defending itself in court. Reasonable steps include establishing and communicating an acceptable use policy that prohibits access to pornography sites, identifying those who violate the policy, and taking disciplinary action against those who violate the policy, up to and including termination.

A few companies take the opposite viewpoint—that they cannot be held liable if they don’t know employees are viewing, downloading, and distributing pornography. Therefore, they believe the best approach is to ignore the problem by never investigating it, thereby ensuring that they can claim that they never knew it was happening. Many people would consider such an approach unethical and would view management as shirking an important responsibility to provide a work environment free of sexual harassment. Employees unwillingly exposed to pornography would have a strong case for sexual harassment because they could claim that pornographic material was available in the workplace and that the company took inadequate measures to control the situation.

Numerous federal laws address issues relate to child pornography—including laws concerning the possession, production, distribution, or sale of pornographic images or videos that exploit or display children. Possession of child pornography is a federal offense punishable by up to five years in prison. The production and distribution of such materials carry harsher penalties; decades or even life in prison is not an unusual sentence. In addition to these federal statutes, all states have enacted laws against the production and distribution of child pornography, and all but a few states have outlawed the possession of child pornography. At least seven states have passed laws that require computer technicians who discover child pornography on clients' computers to report it to law enforcement officials.

Sexting—sending sexual messages, nude or seminude photos, or sexually explicit videos over a cell phone—is a fast-growing trend among teens and young adults. Some states have adopted laws that prescribe penalties—a form of censorship—aimed specifically at teenagers engaged in sexting. Increasingly, people who take part in sexting are suffering the consequences of this fad. Once an image or video is sent, there is no taking it back and no telling to whom it might be forwarded. And it is not just teenagers who participate in sexting. Numerous educators, political figures, and celebrities have been discovered in embarrassing sexting situations. Sexters can also face prosecution for child pornography leading to possible years in jail and decades of registration as a sex offender.

### **Fake News as a Form of Censorship**

**fake news:** A false story that is presented as being factually accurate and appears to be news.

**Fake news** is a false story that is presented as being factually accurate and appears to be news. Fake news may be spread by the news media, over the Internet, via social media, or by other means. It is usually created to advance a certain political view or agenda. There are several strategies used to create fake news<sup>38</sup>:

- Simply make a claim that is patently false.
- Exclude a key piece of information critical to proper understanding the situation.
- Deliberately not provide critical information until the end of the story by which time many readers will have lost interest and stopped reading.
- Provide an incomplete accounting of the facts by not presenting facts unfavorable to the position of the writer.
- Make a claim which is false, and then correct the original statement in manner that few people will see (post the initial story on the front page of the newspaper and then post the correction on the weekend buried in the back section of the newspaper).

The proliferation of online sources of information and opinion means that the Internet is full of “news” accounts that are, in fact, highly opinionated, fictionalized, or satirical accounts of current events presented in journalistic style. Critics of such sites argue that real journalists adhere to certain standards, such as fact checking, identifying and verifying sources, presenting opinions on both sides of an issue, and avoiding libelous statements.

Journalism, including the ways in which people get their news, is going through a period of rapid change. The sale of traditional paper newspapers and magazines continues to fall while online consumption of news is growing. Nearly twice as many adults (38 percent) report that they often get news online rather than from print media (20 percent).<sup>39</sup> Much online news continues to come from traditional news sources, such as ABC, CBS, CNN, Fox, and NBC news, the *Chicago Tribune*, *The New York Times*, *Newsweek*, *The Wall Street Journal*, and *U.S. News & World Report*. However, readers looking for news and information online will also find a wide range of nontraditional sources—some

of which offer more objective, verifiable news reporting than others—including the following types:

- Blogs—On some blogs, writers discuss news and editorial content produced by other journalists and encourage reader participation. Bloggers often report on things about which they are very passionate. As a result, they may be less likely to remain unbiased, instead stating their opinion and supporting facts without presenting the other side of an argument. Indeed, many bloggers pride themselves on their lack of objectivity, instead viewing themselves as an activist for a particular cause or point of view.
- Fake news sites—These sites display salacious headlines on a legitimate Web site (e.g., Ivanka Trump moving out of the White House) designed to attract your attention. If the Web site visitor clicks on the headline (really an ad), the visitor is taken to a fake news site masquerading as a legitimate news site complete with imitation logo and page design. The fake news story begins with a headline and a large photo of the personality who is the subject of the headline. However, after just a few sentences, the story transitions into an ad for some product. Fake news publishers have been able to use the automated ad placement systems of Facebook, Google, and Twitter to place their ads on the legitimate Web sites of Snopes and PolitiFact, two fact-checking Web sites that rate the accuracy of claims made by elected officials and others. For the casual reader who perhaps just skims the headlines, all this can spread false, divisive, and inflammatory messages. This whole process is called tabloid cloaking.<sup>40</sup>
- Social media sites—Ordinary citizens are increasingly involved in the collection, reporting, analysis, and dissemination of news, opinions, and photos, which are then posted to various social media sites. Often, citizen journalists are “on the spot” and able to report on breaking news stories before traditional news reporters. While such timeliness of reporting can be a good thing, it does not always promote accuracy, clarity, and objectivity. Because reports, images, opinions, and videos shared via social media often spread like wildfire, they can sometimes cause confusion, misunderstanding, and controversy, rather than bringing clarity to a situation.



## Critical Thinking Exercise

### Defining Hate Speech

#### ► WRITTEN AND ORAL COMMUNICATION

Many ISPs and social networking sites reserve the right to remove content that, in their judgment, does not meet their community standards. You have been asked by the system administrator of your social networking site to draft a definition of hate speech to be included in your site’s community standards. Content that is judged to be hate speech will be removed. Members who continue to violate this standard will lose their membership.

#### Review Questions

1. How is removal of hate speech from a social networking Web site not a violation of a member’s First Amendment rights?
2. How can you distinguish between speech that is directly harmful versus speech that is simply distasteful?

#### Critical Thinking Questions

1. Develop a clear and concise definition of hate speech to become part of the definition of your site’s community standards and that is suitable for use by monitors who will review content posted to your social network.
2. Develop a statement to justify the monitoring of the postings to your site.

## Ethical Issues in Developing Quality Software

### high-quality software systems:

Systems that are easy to learn and use because they perform quickly and efficiently; they meet their users' needs; and they operate safely and reliably so that system downtime is kept to a minimum.

**software defect:** Any error that, if not removed, could cause a software system to fail to meet its users' needs or open a door for a cyberattacker.

**High-quality software systems** are systems that are easy to learn and use because they perform quickly and efficiently; they meet their users' needs; and they operate safely and reliably so that system downtime is kept to a minimum. Computers and software are integral parts of almost every business, and the demand for high-quality software in a variety of industries is increasing. End users cannot afford system crashes, lost work, or lower productivity. Nor can they tolerate security holes through which intruders can spread viruses, steal data, or shut down Web sites. Software manufacturers face economic, ethical, and organizational challenges associated with improving the quality of their software.

A **software defect** is any error that, if not removed, could cause a software system to fail to meet its users' needs or provide an open door for a cyberattacker. The impact of a defect can range from the trivial to the serious. Tricentis, a software testing company, examined 606 software failures from 314 companies to better understand the business and financial impact of software defects. It found that these 606 software failures affected 3.6 billion people, caused \$1.7 trillion in financial losses, and a cumulative total of 268 years of business downtime.<sup>41</sup> Here are a few recent examples of software defects:<sup>42</sup>

- Fiat Chrysler recalled over a million trucks due to a software defect related to at least one fatality. The issue was caused by faulty code that temporarily disabled airbags and seat belt functionality.
- A major software defect affecting five Australian hospitals was introduced during the application of faulty software corrections designed to counter potential future cyber-attacks. It took over two weeks for the hospitals to recover their electronic medical record systems.
- Each year multiple airlines are affected by software defects in their ticketing and/or reservation systems, resulting in massive cancellations of local flights and significant delays in international flights, further upsetting travelers and resulting in loss of revenue.

Software developers constantly face ethical questions of how much money, time, and effort they should invest to ensure the development of high-quality software. A manager who takes a short-term, profit-oriented view may feel that any additional time and money spent on quality assurance will only delay a new software product's release, resulting in a delay in new sales revenue and lowering of profits. However, a different manager may consider it unethical not to fix all known problems before putting a product on the market and charging customers for it.

## Safety-Critical Systems

Although defects in any software system can cause serious problems, the consequences of software defects in certain systems can be deadly. In these kinds of systems, the stakes involved in creating quality software are raised to the highest possible level. The ethical decisions involving a trade-off—if one must be considered—between quality and such factors as cost, ease of use, reliability, and time to market require extremely serious examination.

A **safety-critical system** is one whose failure may cause human injury or death. The safe operation of many safety-critical systems relies on the performance of software. Such systems control an ever-increasing array of products and applications, including antilock brakes, adaptive cruise control functionality, and a myriad of other safety-related features found in automobiles; nuclear power plant reactors; aircraft flight control; military weapons; and a wide range of medical devices.

Failure to take the strongest measures to ensure the safety of a safety-critical system “is at best unprofessional and at worst leads to disastrous consequences.”<sup>43</sup>

**safety-critical system:** A system whose failure may cause human injury or death.

However, even with these types of precautions, the software associated with safety-critical systems is still vulnerable to errors that can lead to injury or death. The following are some examples of safety-critical system failures:

- Problems with uncontrollable acceleration and a faulty antilock braking system resulted in lost lives and required Toyota to issue three separate recalls costing it nearly \$3 billion.<sup>44</sup>
- Neonatal ventilators manufactured by Covidien were recalled because a software problem caused the amount of air being delivered to the patient to be less than the amount specified by the physician or nurse. The problem could lead to serious injury or death.<sup>45</sup>
- As many as 4.3 million General Motors cars and trucks have potentially defective airbags that may fail to deploy in an accident due to flawed embedded software in the vehicles.<sup>46</sup>

The process of building software for safety critical systems takes much longer and is much more expensive than for high-quality systems for the following reasons:

- Software developers working on a safety-critical system must be highly trained and experienced professionals who recognize that the software is only one component of the system; other components typically include system users or operators, hardware, and other equipment. Software developers need to work closely with safety and systems engineers to ensure that the entire system, not just the software, operates in a safe manner.
- Extreme measures must be taken to identify and remove software defects from safety-critical systems starting at the very earliest stages of software development—requirements definition and all the way through final testing. All tasks—including requirements definition, systems analysis, design, coding, fault analysis, testing, implementation, and change control—require additional steps, more thorough documentation, and vigilant checking and rechecking. As a result, safety-critical software takes much longer to complete and is much more expensive to develop.
- A great deal of effort must be put into identifying what can go wrong, the likelihood and consequences of such occurrences, and how these risks can be averted, mitigated, or detected so the users can be warned.

The increased time and expense of completing safety-critical software can draw developers into ethical dilemmas. They must carefully weigh cost and ease of use issues in developing a system that is safe and that also appeals to customers. For example, the use of hardware mechanisms or redundant software to back up or verify critical software functions can help ensure safe operation. However, such hardware or redundancy may make the final product more expensive to manufacture or harder for the user to operate—potentially making the product less attractive than a competitor's.

Another key issue is deciding when sufficient software testing has been performed. How much testing is enough when you are building a product whose failure could cause loss of human life? At some point, software developers must determine that they have completed sufficient testing and then sign off to indicate their approval to release the product. Determining how much testing is sufficient demands careful decision making.



## Critical Thinking Exercise

### Problems with EHR Systems

#### ► SOCIAL AND ETHICAL ISSUES

It is estimated that some 250,000 to 440,000 people in the United States die every year from medical errors. This makes medical errors the third-leading cause of death after heart disease and cancer.<sup>47</sup> Electronic health records (EHRs) and other

technologies are intended to reduce errors and improve the delivery of care. However, some industry experts believe use of these tools is simply swapping one set of mistakes for another. For instance, EHR users are highly prone to forgetting to enter orders for patient tests and erroneously entering medication orders. Such errors can result in harm to patients.<sup>48</sup>

In some cases, the rush by doctors and hospitals to earn cash incentives under the HITECH Act has led to the adoption of complex and error-prone EHR systems. Implementation of poor EHR systems coupled with inadequate user training can leave patients just as vulnerable to medication errors as they were when health care providers used paper charts. “Patient safety is not improved by merely implementing health IT. The technology is part of a larger sociotechnical system, which relies not only on hardware and software functionality but also people, workflow, and processes.”<sup>49</sup>

And there have been cases of EHR software vendors exaggerating the quality of their systems. For example, The Department of Justice contends that software vendor eClinicalWorks falsely obtained certification of its EHR product. Charges include allegedly cheating the “meaningful use” certification test, failing to make critical updates and bug fixes, and not ensuring data portability to enable doctors to transfer patient data to other vendor’s EHR systems.<sup>50</sup>

### Review Questions

1. Do you believe the EHR systems should be classified as safety-critical systems? Why or why not?
2. Does your personal physician employ an EHR system during your office visits? Do you feel that this system improves the quality of your interaction with the physician? Why or why not?

### Critical Thinking Questions

1. Explain how measures could be implemented in the software to reduce the likelihood of forgetting to enter patient tests. What software logic could be introduced to reduce the potential that the wrong medications are prescribed for the patient?
2. What measures should be taken to ensure a more rigorous EHR software certification process?

## Summary

### Principle:

**An ethical decision-making process and a code of ethics can guide you as you confront the many ethical dilemmas associated with information systems.**

Ethics is the set of principles about what is right and wrong that individuals use to make choices to guide their decisions.

Ethical behavior conforms to generally accepted norms, which may change over time to meet the evolving needs of society or a group of people who share similar laws, traditions, and values that provide structure to enable them to live in an organized manner.

Legal acts are acts that conform to the law. Ethical acts conform to what an individual believes to be the right thing to do. Laws can proclaim an act as legal, although many people may consider the act unethical.

Practitioners in many professions subscribe to a code of ethics that states the principles and core values that are essential to their work and, therefore, govern their behavior.

Organizations have five good reasons to promote a work environment in which employees are encouraged to act ethically: to gain the goodwill of the community, to create an organization that operates consistently, to foster good business practices, to protect the organization and its employees from legal action, and to avoid unfavorable publicity.

An effective decision-making process that includes ethical consideration consists of these five steps: develop a problem statement based on facts, identify several alternatives enlisting help from those who have first-hand knowledge of the situation, choose an alternative based on a number of criteria, implement the decision with clear communications to those who will be affected, and evaluate the results to see if the desired results were achieved.

A professional code of ethics states the principles and core values that are essential to the work of a particular occupational group.

Following a code of ethics can produce four key benefits for the individual, the profession, and society: improve ethical decision-making, provide high standards of practice and ethical behavior, engender trust and respect from the general public, and provide an evaluation benchmark the professional can use as a means of self-assessment.

### **Principle:**

**The use of technology requires balancing the needs of those who use the information that is collected against the rights of those whose information is being used.**

Organizations want systems to collect and store basic information about customers to serve them better. However, many people object to the data collection policies on the grounds they strip individuals of the power to control their own personal information. A combination of new laws, technical solutions, and privacy policies is needed to balance the scales.

Fair information practices is a term for a set of guidelines that govern the collection and use of data. Nor is there an established advisory agency that recommends acceptable privacy practices to businesses.

The General Data Protection Regulation (GDPR) is a set of privacy requirements that apply across the European Union including non-EU organizations that market to or process information of individuals in the European Union.

The United States has no single, overarching national data privacy policy.

Three subject areas where federal statutes have been implemented to protect the personal data of U.S. citizens are financial data, health information, and children's personal data.

The Fair Credit Reporting Act, Right to Financial Privacy Act, and Fair and Accurate Credit Transactions Act are three U.S. federal statutes aimed at protecting individuals' financial data.

The Health Insurance Portability and Accountability Act and American Recovery and Reinvestment Act are two U.S. federal statutes aimed at protecting individuals' health care data.

The Family Educational Rights and Privacy Act and the Children's Online Privacy Protection Act are two U.S. federal statutes aimed at protecting children's data.

Four steps individuals can take to protect their personal privacy include: (1) find out what is stored about you in existing databases, (2) be careful when you share information about yourself, (3) be proactive in protecting your privacy, and (4) take extra care when purchasing anything from a Web site.

U.S. federal statutes protect citizens from government surveillance while at the same time authorize the government to collect data.

The scope of government surveillance has expanded from collecting data on as few people as possible to collecting as much data on as many people as possible.

The federal government has implemented many laws addressing personal privacy; however, data-collection programs have raised concerns and debate between those who favor data collection as a means to increased security and those who view such programs as a violation of their rights.

Information technology has provided amazing new ways for people to communicate with others around the world, but with these new methods come new responsibilities and new ethical dilemmas related to freedom of expression, control of access to information on the Internet, anonymity, hate speech, pornography, and fake news.

The First Amendment and anonymous expression safeguard our freedom of speech.

The First Amendment protects Americans' rights to freedom of religion, freedom of expression, and freedom to assemble peaceably.

Anonymous expression is the expression of opinions by people who do not reveal their identity. The freedom to express an opinion without fear of reprisal is an important right of a democratic society.

Section 230 of the Communications Decency Act and the Children's Online Privacy Protection Act have a major impact on the operation of Internet service providers.

Section 230 of the Communications Decency Act provides immunity to an Internet service provider that publishes user-generated content, provided its actions do not rise to the level of a content provider.

The Children's Online Privacy Protection Act requires that any Web site that caters to children must offer comprehensive privacy policies, notify parents or guardians about its data collection practices, and receive parental consent before collecting any personal information from children under 13 years of age.

To help parents control what their children see on the Internet, some companies provide filtering software to help screen Internet content.

Schools and libraries that fail to comply with the Children's Internet Protection Act would no longer be eligible to receive federal money through the E-Rate program, which provides funding to help pay for the cost of Internet connections.

Internet censorship is the control or suppression of the publishing or accessing of information on the Internet. Speech on the Internet requires a series of intermediaries to reach its audience with each intermediary vulnerable to some degree to pressure from those who want to silence the speaker. Internet censorship in China is perhaps the most rigorous in the world.

The freedom to express an opinion without fear of reprisal is an important right of a democratic society. The use of anonymous remailers helps keep communication anonymous; whether what is communicated, whether it is ethical or legal, is up to the sender.

The right to freedom of expression is restricted when the expressions are untrue and cause harm to another person such as with defamation or hate speech.

A business should develop a clear and thorough policy about privacy rights for customers, including database access. That policy should also address the rights of employees, including electronic monitoring systems and email.

**Software developers must make trade-offs between project schedules, project costs, system reliability, and software quality.**

High-quality systems are easy to learn and use because they perform quickly and efficiently; they meet their users' needs; and they operate safely and reliably so that system downtime is kept to a minimum.

A software defect is any error that, if not removed, could cause a software system to fail to meet its users' needs or provide an open door for a cyberattack.

A safety-critical system is one whose failure may cause human injury or death.

There are three reasons why the process of building software for safety critical systems takes much longer and is much more expensive than for high quality systems: (1) it requires highly trained and experienced professionals who work closely with safety and systems engineers to ensure that the entire system operates in a safe manner; (2) extreme measures must be taken to identify and remove software defects starting at the earliest stages of software development; and (3) a great deal of effort must be spent identifying what can go wrong, the likelihood and consequences of such occurrences, and identifying how these risks can be averted, mitigated, or detected so users can be warned.

Two key issues software developers face when developing safety-critical systems are (1) how to weigh cost and ease of use issues versus safety and product appeal and (2) how to decide when sufficient software testing has been done.

## Key Terms

American Recovery and Reinvestment Act Title XIII  
anonymous expression  
Children's Online Privacy Protection Act (COPPA)  
Defamation  
ethics  
Fair and Accurate Credit Transactions Act  
Fair Credit Reporting Act  
fair information practices  
fake news  
Family Educational Rights and Privacy Act (FERPA)  
First Amendment  
Fourth Amendment  
General Data Protection Regulation (GDPR)

hate speech  
Health Insurance Portability and Accountability Act (HIPAA)  
high-quality software systems  
Internet censorship  
Internet filter  
problem statement  
professional code of ethics  
Right to Financial Privacy Act  
safety-critical system  
Section 230 of the CDA  
software defect

## Self-Assessment Test

An ethical decision-making process and a code of ethics can guide you as you confront the many ethical dilemmas associated with information systems.

1. Acting in an ethical manner and acting in a legal manner will always lead to the same actions.  
True or False?
2. \_\_\_\_\_ is not a benefit of promoting a work environment in which employees are encouraged to act ethically.
  - a. The organization will find it easier to recruit and retain top job candidates.
  - b. Employees will act in a consistent manner so that stakeholders can know what to expect of the organization.

- c. The employees' tendency to act in a manner that seems ethical to them will be suppressed and instead they will act in a manner that will protect them from punishment.
- d. The value of its stock and how consumers regard its products and services will be improved.
3. The \_\_\_\_\_ step in the ethical decision-making process is considered the most critical.
  - a. develop a problem statement
  - b. identify alternatives
  - c. choose alternative
  - d. implement the decision
4. The primary intent of a code of ethics is to define desired behavior. True or False?

5. The fact that \_\_\_\_\_ is not a benefit that can be expected from following a professional code of ethics.
- peers of a professional can use the code for recognition or censure
  - adherence to a code of ethics enhances trust and respect for professionals and their profession
  - a code can provide an answer to every ethical dilemma
  - a code of ethics provides an evaluation benchmark that a professional can use as a means of self-assessment

**The use of technology requires balancing the needs of those who use the information that is collected against the rights of those whose information is being used.**

- A key difference between the U.S. and EU fair information practices is that \_\_\_\_\_.
- although numerous laws have been implemented over time, no single overarching national data privacy policy has been developed in the United States
- U.S. federal statutes impose substantial monetary fines for data abuses by corporations
- the GDPR does not place obligations on organizations to obtain the consent of people they collect information about and to better manage this data
- in the United States, organizations found to be in violation of fair data practices are subject to fines of up to 2 percent of their global revenue
- Three subject areas where federal statutes have been implemented to protect the personal data of U.S. citizens include financial data, children's personal data, and \_\_\_\_\_ information.
- One means of ensuring that you are interacting with a secure Web site is to look for a Web address beginning with https. True or False?
- There is a concern by some people who belong to a particular ethnic, religious, or social group that surveillance data collected by the government could be used to identify and target them and their associates. True or False?
- The NSA is required to obtain permission from the Foreign Intelligence Surveillance Court (FISC) to access the telephone metadata records of U.S. citizens, which are now held by telecommunication companies rather than by the government. True or False?
- The right to freedom of expression is one of the most important rights for free people in the

United States. The \_\_\_\_\_ was adopted to guarantee this right and others.

- Bill of Rights
  - First Amendment
  - Fourth Amendment
  - Constitution
12. Which of the following statements about any website that caters to children is not true? \_\_\_\_\_
- It must offer comprehensive privacy policies.
  - It must notify parents or guardians about its data collection practices.
  - It must receive parental consent before collecting any personal information from children under 13 years of age.
  - It must request birth date and a confirming social security number.

13. \_\_\_\_\_ Act was written to protect children from pornography on the Internet but was ruled unconstitutional.
- The Telecommunications
  - Section 230 of the Communications Decency
  - Much of the Communications Decency
  - The Children's Internet Protection

**Software developers must make trade-offs between project schedules, project costs, system reliability, and software quality.**

- Safety-critical systems are easy to learn and use because they perform quickly and efficiently, they meet their users' needs, and they operate safely and reliably. True or False?
- The process of building software for safety-critical systems takes much longer and is much more expensive because \_\_\_\_\_.
- they are usually being built for the government and there is much red tape and delays
- they usually involve either aircraft or automobiles and must meet additional imposed by the National Transportation and Safety Board
- extreme measures must be taken to identify and remove defects starting at the very earliest stages of software development
- the software must be written in machine or assembly programming languages which are extremely tedious and time consuming to use
- The builders of safety-critical systems must determine when they have completed sufficient testing and sign off their approval to release the product. This is typically an easy and straight-forward decision. True or False?

## Self-Assessment Answers

1. False
2. c
3. a
4. True
5. c
6. a
7. health
8. True
9. True
10. True
11. b
12. d
13. d
14. False
15. c
16. False

## Review and Discussion Questions

1. Explain the difference between ethical and legal.
2. Fostering good business practices and protecting the organization and its employees from legal action are two reasons for an organization to promote a work environment in which employees are encouraged to act ethically. True or False.
3. List the steps within the ethical decision-making process.
4. What are the two key elements of an organization's code of ethics?
5. Following a professional code of ethics can improve ethical decision making. True or False?
6. Summarize the differences between U.S. and EU fair information practices.
7. Identify three subject areas where federal statutes have been implemented to protect the personal data of U.S. citizens.
8. What are four steps you can take to protect your personal privacy?
9. Discuss the tradeoffs between information security and privacy.
10. Discuss why it is said that U.S. federal statutes protect citizens from government surveillance but at the same time authorize the government to collect such data.
11. What are the key points of the First Amendment in terms of protecting our freedom of speech?
12. Describe how Section 230 of the Communications Decency Act protects social media networks.
13. What measures are social media networks taking to address defamation, hate speech, and pornography on the Internet?
14. What are the differences between a high-quality software system and a safety-critical system?
15. Identify three measures taken during the development of a safety-critical system that cause such systems to cost more and take longer to complete.
16. Identify two ethical dilemmas that software developers face when building high-quality or safety-critical systems.

## Business-Driven Decision-Making Exercises

1. You are a member of the HR organization of a large consumer goods manufacturing company. Over lunch one day, a friend of yours who works in the warehouse mentions that video surveillance cameras have been installed in an attempt to cut down on rampant theft of finished products. You are surprised when your friend tells you that the warehouse workers are unaware and uninformed that cameras were installed. Does this constitute a potential violation of the employees' Fourth Amendment rights? What action should you take?
2. You are a new hire at a large software firm and have been working overtime for the last two

months trying to complete the final testing of a new software release for the firm's flagship product, which is used by thousands of organizations worldwide. Unfortunately, the software has many bugs and testing has taken weeks longer than expected. This afternoon your boss stopped by and asked you to "sign off" on the completion of your portion of the testing. He explains that the project has gone over budget and is in danger of missing the committed release date for customers. When you object because you feel the software is still buggy, he says not to worry and that whatever bugs remain will be fixed in the next release of the software. What do you do?

## Teamwork and Collaboration Activities

- Organizational network analysis is a method for studying communication among individuals. Read the article: Making the Invisible Visible: SNA of the NSA by Joseph A.E. Shaheen at <https://www.josephshaheen.com/nsa-sna-xkeyscore/370>. The NSA uses the techniques described there to analyze communications among individuals. Use graphics software to create an organizational network analysis that depicts the email and text communications of the members of your team for a week. If someone were to study this network analysis, what conclusions might they draw about the members of your team?
- You and your team members are setting up a Web site that offers coloring books and art supplies to young children in the 4–13 age range. Develop a list of actions needed to ensure that your Web site does not violate the Children’s Online Privacy Protection Act. Your Web site will process orders placed using PayPal and major credit cards. Draft an appropriate Web site privacy policy using one of the online templates.

## Career Exercises

- It is the year 2026 and you are one of five Gotham City council members. Violent crime has been a serious problem in your city for decades with more than 650 homicides/year. The city is considering spending \$45 million to implement a new Domain Awareness surveillance system to cover the three community areas with the highest homicide rate—all with over 125 homicides per 100,000 residents.

The Domain Awareness surveillance system includes 1,000 state-of-the-art surveillance cameras equipped with gunshot detection devices that can detect where a gun was fired to within 50 feet, license plate readers, and advanced analytic software designed to recognize suspicious activity or crimes in process. The surveillance cameras are designed to hand off to each other so that a suspect's trail can be followed from one camera to the next.

Although Gotham City's annual budget exceeds \$3 billion, the city has been running a deficit of over \$200 million/year and a financial

crisis is looming over a shortfall of some \$300 million in the city employee's retirement fund. City council meets in two weeks to consider a proposal to implement the Domain Awareness system.

- What steps would you take to become more informed about the capabilities, strengths, and limitations of this system? What potential technical and non-technical issues are associated with this system? How might the citizens of Gotham City react to installation of such a system?
- You are a member of the human resources group of an IT consulting firm with some three dozen consultants. You are considering initiating a program to encourage more of the consultants to join IT-professional organizations and to earn more IT-related certifications. Identify three business benefits of doing this. What incentives might you offer to the consultants to encourage them to join professional organizations and gain more certifications? What resistance might you expect from some of the staff?

## Case Study

### ► SOCIAL AND ETHICAL ISSUES, TECHNOLOGY IN SOCIETY

#### **Government Employs Backdoor Searches**

The Central Intelligence Agency (CIA) conducts foreign covert operations, counterintelligence operations, and collects and analyzes foreign intelligence for the president and his staff to aid in national security decisions. The National Security Agency (NSA) is responsible for global monitoring, collection, and processing of information for foreign intelligence and counterintelligence purposes. The Federal Bureau of Investigation (FBI) conducts domestic counterintelligence and counterterrorism operations in addition to its role as the lead law enforcement agency in the country.

These three agencies have implemented sophisticated programs to capture, store, and analyze electronic communications. The Downstream program (formerly called PRISM) extracts data from the servers of nine major American Internet companies including AOL, Apple, Facebook, Google, Microsoft, Paltalk, Skype, Yahoo, and YouTube to obtain direct access to audio, video, photographs, emails, documents, and connection logs for each of these systems. The Upstream program taps into the infrastructure of the Internet to capture the online communications of foreigners outside the United States while

their communications are in transit. The leaders of the intelligence agencies argue that these programs are essential to fighting terrorism. The agencies can also provide a dozen or more examples of how use of the data gathered by these programs has thwarted the efforts of terrorists around the world.

The programs are authorized by Section 702 of the FISA Amendments Act which authorizes surveillance of any foreigner overseas, provided the purpose is to obtain “foreign intelligence.” The Act loosely defines “foreign intelligence” to mean any information that “relates to” the conduct of foreign affairs. This broad definition means that the target being surveilled need not be a terrorist. The target needs only to be thought to have information that is relevant to the government’s foreign intelligence objective—whatever that may be.

The process of gathering foreign electronic communications necessarily means the incidental capture of many conversations involving an American (who may be here in the United States) and a foreign target. They may well be having a totally innocent communication with a foreign friend, relative, or business partner who is not suspected of any wrongdoing whatsoever. The total number of Americans’ communications “incidentally” collected since the inception of Section 702 is well into the millions.

Section 702 also allows the government to pool all the messages it intercepts into a giant database and then search the database, including conversations involving Americans—without a warrant. Warrantless surveillance of communications between Americans and foreigners is known as a “backdoor search” because it effectively evades other provisions of United States law that require an individualized warrant or court order for access to such data. The agencies are authorized to conduct unlimited warrantless backdoor searches of those communications for information about Americans or individuals located in the United States during any investigation. The agencies are only required to obtain a warrant to view American’s data if the investigation is not related to national security.

There is a rigorous process that law enforcement agents must go through to wiretap a phone with three key requirements that clearly distinguishes this method of gathering data from Downstream and Upstream. First, *before beginning the wiretap*, agents must prove to a judge that they have probable cause to believe that tapping a specific phone will help them solve serious federal crimes such as terrorism, money laundering, or drug trafficking. Second, a time limit must be defined for the wiretapping to start and end; it cannot go on forever. Third, the wiretapping is limited only to those conversations that are likely to yield evidence against the suspect.

There are also major differences between the way Downstream and Upstream programs collect data and the way data is gathered under an ordinary search warrant. Downstream and Upstream gather all the data there is to be collected and create a source of data that can be queried to find evidence of a crime. If a police department obtains a search warrant to search a house for illegal drugs, agents can lawfully enter the house and search every room. But after finding (or failing to find) the drugs, they cannot then go rummaging through file cabinets for evidence of sex-trafficking and then seize computers to search for evidence of tax evasion, even though the officers are lawfully present in the house. They must get a separate warrant to conduct each search in advance of any search.

### Critical Thinking Questions:

1. Many people believe that the lack of evidence that an American is engaged in wrongdoing is hardly a compelling justification for a warrantless search of his or her communications. To the contrary: if the intelligence agencies do not have probable cause to suspect criminal activity, they have no business reading Americans’ emails and listening to their phone calls. Imagine that you agree with this position, what changes do you feel are needed to FISA Section 702?
2. Others believe that our intelligence agencies should capture all the data possible to protect us from terrorists and if, while doing this, a source of data is created that can be used in criminal cases, so much the better. Imagine that you agree with this position, what changes do you feel are needed to FISA Section 702?
3. Do you believe that the Downstream and Upstream programs are examples of tipping the scales of justice in favor of security over privacy? Justify your answer.

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# PART 2

# Technology Infrastructure

**Chapter 4**  
**Hardware and Software**

**Chapter 5**  
**Database Systems and Management**

**Chapter 6**  
**Business Intelligence: Big Data and Analytics**

**Chapter 7**  
**Networks: An Interconnected World**

**Chapter 8**  
**Cloud Computing and the Internet of Things**



## Principles

The computer hardware industry is rapidly changing and highly competitive, creating an environment ripe for technological breakthroughs.

Computer hardware must be carefully selected to meet the evolving needs of the organization and its supporting information systems.

The computer hardware industry and users are implementing green computing designs and products.

Software is valuable in helping individuals, workgroups, and entire enterprises achieve their goals.

Organizations typically use off-the-shelf application software to meet common business needs and proprietary application software to meet unique business needs and provide a competitive advantage.

## Learning Objectives

- Describe the functions of the four fundamental hardware components of every computer.
- Explain the difference between multiprocessing, parallel processing, and grid computing.

- Describe how each of the three primary classes of computers is used within an organization.
- Identify the three or four subclasses associated with each primary class of computer.

- Identify three primary features that distinguish tier 1, 2, 3, and 4 data centers.
- State the three primary goals of the “green computing” program.

- List the two basic kinds of software and their associated subclasses.
- Describe the role of the operating system.
- State three cost savings benefits associated with server virtualization.
- Describe how the service-oriented architecture approach is used to build software and microservices.

- Identify three advantages of off-the-shelf versus proprietary software.
- State four key advantages of the software as a service model.
- Give an example of how application software is used in the personal, workgroup, and enterprise sphere of influence.
- Identify five tasks for which programming languages are commonly used.
- Identify the three primary types of end-user license agreements.
- Compare open-source software to licensed software in terms of how each is used and supported.

# IS in Action

## Pixar Streamlines Key Business Process

### ► SYSTEMS AND PROCESSES

Pixar is a computer animation film studio that began in 1979 as the Graphics Group. Now, it is part of the Lucasfilm computer division. Initially Pixar was a hardware computer firm developing high-end image processing devices. After he was ousted from Apple in 1985, Apple co-founder Steve Jobs purchased Pixar and began producing animated short features to demonstrate the power of its hardware. However, the hardware company was not profitable and so Pixar began doing more animated projects. Pixar made a deal with Disney to produce the first feature film entirely in computer-generated imagery (CGI)—Toy Story. Based on the success of this film, Jobs was able to take Pixar public. Disney eventually purchased Pixar in 2006 in a stock deal valued at \$7.4 billion.

A typical Pixar animation takes four to five years to complete. Pixar employees collaborate on their films as a team in a design process that involves the routine ongoing exchange of digital design products between designers and animators. They employ RenderMan, Pixar's own image-rendering application programming interface, to generate high-quality images.

Pixar's proprietary animation software is used to create three-dimensional computer models of characters, props, and sets. These initial models have no surface color or texture—just the lines and outlines of the individual cubes, blocks, and spheres that have been used to construct it. These initial models are called the wireframe. The models are then given avars or hinges which the animator uses to make the object or character move. (Woody from Toy Story has 100 avars in his face alone.) Next, shadows, lighting, animation, colors, and textures must be added in order to create life-like images on a screen. Finally, powerful computers are used to assemble all the digital information that the animators have created into a single frame of film. Pixar's RenderMan software draws the finished image by computing every pixel of the image from the model, shadows, lighting, animation, colors, and texture data stored in various files to create life-like images. If the director decides a set of frames does not produce the desired visual effects, Pixar team members repeat some of these steps.

The time it takes to render one frame depends on the complexity of the scene and the speed of the computer doing the rendering. Monster's University is a 110-minute movie released in 2013. Pixar-animated films are produced at a frame rate of 24 frames per second, so this film required the rendering of over 150,000 individual frames. With the technology available at the time, it took over two years of processing time to complete the rendering process.

Pixar built what it calls a render farm—a large data-processing center filled with over 2,000 multicore processors and a data storage capacity exceeding 100 terabytes—in order to reduce the rendering bottleneck. This enables Pixar to turn out films faster, thus accelerating cash flow—Pixar full length films generate an average of over \$600 million in worldwide revenue. Another factor to consider is the value of the artist's time—skilled artists can cost studios \$2,500 a day. Creative directors must assure that these expensive resources are kept creating art forms for 3D animation movies, commercials, and special effects and are not sitting around idle while waiting around for their images to finish rendering.

The information systems operations group must understand the creative process as well as the technology that powers the rendering. This understanding is needed so they can predict demand for the render farm and maintain a high throughput of render jobs to meet production deadlines as well as stay within the information systems budget. They must be constantly upgrading the computer hardware and adjusting capacity to meet demand. The faster the computer, the more energy it consumes and the more heat it generates so the operations group must seek out the most powerful and energy efficient computers available and employ green computing guidelines to govern its choices.

### As you read about hardware and software, consider the following:

- What major competitive advantages can organizations gain from the effective use of computer hardware and software?
- What impact do the increasing capabilities and decreasing costs of hardware over time have on how organizations are using information system hardware?

## Why Learn About Hardware and Software?

Organizations invest in computer hardware and software to improve worker productivity, increase revenue, reduce costs, provide better customer service, speed up time to market, and facilitate collaboration among employees. Organizations that don't make wise hardware and software investments are often stuck with outdated equipment that is unreliable and that cannot take advantage of the latest software advances. Such obsolete hardware and software can serve as an anchor to progress and can place an organization at a competitive disadvantage. On the other hand, state-of-the-art hardware and software enable enhanced network and data security, increase productivity, improve employee morale, lower costs, and enable the organization to remain competitive.

McDonald's is spending \$6 billion to upgrade its U.S. stores with much of that going toward enhancing the customer experience with digital self-order kiosks that make ordering and paying for a meal easier. Home Depot is adding 1,000 tech professionals as part of an \$11 billion, three-year plan to build some of the most advanced software anywhere to help customers shop whenever, wherever, and however they want. Auto manufacturers are competing to put the most advanced navigation, entertainment, and self-driving software packages in their new models.

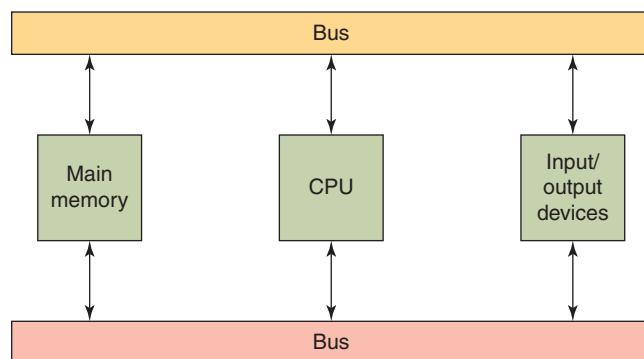
Managers, no matter what their career field and educational background, are expected to help define the business needs that hardware and software must support. In addition, managers must be able to ask relevant questions and evaluate options when considering hardware and software investments for their areas of the business. This need is especially true in small organizations, which might not employ information system specialists. Managers in marketing, sales, and human resources often help IS specialists assess opportunities to apply computer hardware and software. They help evaluate the options and features specified for the software. Managers in finance and accounting must keep an eye on the bottom line—guarding against overspending—yet be willing to invest in computer hardware and software when and where business conditions warrant it.

## Anatomy of a Computer

The four fundamental computer system hardware components include the processor (also known as the CPU), memory, buses, and input/output devices as shown in Figure 4.1. Each component has a key role to play.

**FIGURE 4.1**  
**Basic anatomy of a computer**

Computer hardware components include the central processing unit or cpu, memory, bus, and input/output devices.



**core:** Receives instructions and performs calculations, or actions, based on those instructions.

**memory:** A component of the computer that provides the processor with a working storage area to hold program instructions and data.

**bus:** A set of electronic circuits used to route data and instructions to and from the various components of a computer.

**input/output devices:** A computer component that provides data and instructions to the computer and receives results from it.

The **core** of a computer receives instructions and performs calculations, or actions, based on those instructions. The processor known as the central processing unit or CPU is capable of executing millions of instructions per second.

**Memory** provides the processor with a working storage area to hold program instructions and data. It rapidly provides data and instructions to the processor. Memory storage is frequently measured in units of gigabytes or billions of bytes of data. Each byte is capable of representing one character of data.

Data and instructions are routed to and from the various components over the **bus**, a set of electronic circuits. The bus speed determines the speed at which data is transferred between all the hardware components in the computer. If the computer has a slow bus, the processor has to wait to receive instructions, which makes the computer run slower.

**Input/output devices** provide data and instructions to the computer and receive results from it.

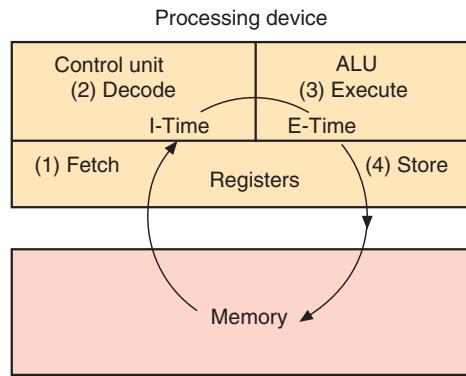
The components of the computer work together to complete the instructions (e.g., multiply, divide, add, subtract, compare) of a computer program to accomplish the goals of the user (e.g., send/receive email, develop a profit forecast, pay an invoice). Completing an instruction involves two phases (instruction or I-Time, and execution or E-Time), which are broken down into the following four steps (see Figure 4.2):

#### Instruction phase:

- **Fetch instruction.** The computer reads the next program instruction to be executed—along with any necessary data—into the processor. The instruction and data are typically held in a storage register.
- **Decode instruction.** The instruction is decoded and passed to the appropriate processor execution unit.

#### Execution phase:

- **Execute instruction.** The computer executes the instruction by making an arithmetic computation, logical comparison, bit shift, or vector operation.
- **Store results.** The results are stored in temporary storage locations called registers or in memory.



**FIGURE 4.2**  
**Execution of an instruction**

(1) In the instruction phase, a program's instructions and any necessary data are read into the processor. (2) The instruction is then decoded by the control unit of the CPU so that the central processor can understand what to do. (3) In the execution phase, the arithmetic and logic unit (alu) component of the CPU does what it is instructed to do, making either an arithmetic computation or a logical comparison. (4) The results are then stored in the registers or in memory. The instruction and execution phases together make up one machine cycle.

## Processor

**multicore processor:** A processor that has two or more independent processing units, called cores, that are capable of sequencing and executing instructions.

**clock speed:** A series of electronic pulses produced at a predetermined rate that affects machine cycle time.

**gigahertz (GHz):** A unit of frequency that is equal to one billion cycles per second; a measure of clock speed.

A **multicore processor** has two or more independent processing units, called cores, that are capable of sequencing and executing instructions. A processor with two cores is called a dual-core processor and one with four cores is called a quad-core processor. Personal computer processors are available with two, four, six, and eight cores. The more cores a processor has, the more sets of instructions the processor can receive and process at the same time enabling it to complete more work per unit of time.

Each processor produces a series of electronic pulses at a predetermined rate, called the **clock speed**, which governs the speed at which these steps are completed. Clock speed is measured in **gigahertz (GHz)**, which is a unit of frequency that is equal to one billion cycles per second. Most of today's personal computers operate in the 1–4 GHz range. The higher the clock speed, the shorter the interval between pulses and the faster instructions can be completed.

Unfortunately, the faster the clock speed of the processor, the more heat the processor generates. This heat must be dissipated to avoid corrupting the data and instructions the computer is trying to process. Thus, processors that run at higher temperatures need bigger heat sinks (a device or substance for absorbing excessive heat), fans, and other components to eliminate the excess heat. This increases the size and weight of the computing device.

## Manufacturing Processors

**integrated circuit (IC):** A set of electronic circuits on one small piece of semiconductor material, normally silicon.

**semiconductor fabrication plant:** A factory where integrated circuits are manufactured; also called a fab or a foundry.

An **integrated circuit (IC)**—or chip—is a set of electronic circuits on one small piece of semiconductor material, normally silicon. ICs can be made extremely small with up to several billion electronic components packed into an area the size of a fingernail. Processors and memory chips are examples of integrated circuits.

A **semiconductor fabrication plant** (also called a fab or foundry) is a factory where integrated circuits are manufactured. Extreme ultraviolet lithography (EUVL) is a highly complex process used in manufacturing computer chips with feature sizes that are extremely small—measured in nanometers (nm) or billionths of a meter. EUVL involves directing a laser beam at xenon gas to heat it up and eject electrons to etch the tiny components of the chip. The entire process must occur in a vacuum. Intel is able to create chips with features that measure as small as 10 nm across. AMD is expected to achieve 7 nm lithography, a form of printing, by 2020. For perspective, a molecule of water is about 0.5 nm across.

Intel, Samsung, and STMicroelectronics design and manufacture their chips in their own fab plants. Some organizations operate a semiconductor fab for the purpose of fabricating the designs of other companies. Such organizations are known as foundry companies. Apple, Qualcomm, Nvidia, and AMD are examples of fabless manufacturers; they outsource their manufacturing to foundry companies who fabricate the design.

Fabs are extremely expensive to set up and require many expensive devices to function. Intel plans to complete the Intel Fab 42 semiconductor factory in Chandler, Arizona at a cost of more than \$7 billion by 2021. When fully operational, the factory will employ about 3,000 process engineers, equipment technicians, and facilities-support engineers and technicians. The fab will produce advanced 7 nanometer chips.<sup>1</sup>

## Multiprocessing

**multiprocessing:** The simultaneous execution of two or more instructions at the same time.

**coprocessor:** The part of the computer that speeds processing by executing specific types of instructions while the CPU works on another processing activity.

**parallel processing:** The simultaneous execution of the same task on multiple processors to obtain results faster.

**massively parallel processing systems:** A system that speeds processing by linking hundreds or thousands of processors to operate at the same time, or in parallel, with each processor having its own bus, memory, disks, copy of the operating system, and applications.

**grid computing:** The use of a collection of computers, often owned by multiple individuals or organizations, that work in a coordinated manner to solve a common problem.

**Multiprocessing** involves the simultaneous execution of two or more instructions at the same time. One form of multiprocessing uses coprocessors. A **coprocessor** speeds processing by executing specific types of instructions while the CPU works on another processing activity. Coprocessors can be internal or external to the CPU and can have different clock speeds than the CPU. Each type of coprocessor performs a specific function. For example, a math coprocessor chip speeds mathematical calculations, while a graphics coprocessor chip decreases the time it takes to manipulate graphics.

The first computer processor was the Intel 4004 with a single 740 kHz processor capable of processing roughly 92,000 instructions per second. Today's processors are multicore GHz processors capable of processing over 100 billion instructions per second. All computers are multicore processors these days; even the iPhone 4s has two cores.

## Parallel Processing

**Parallel processing** is the simultaneous execution of the same task on multiple processors to obtain results more quickly. Systems with thousands of such processors are known as **massively parallel processing systems**, a form of multiprocessing that speeds processing by linking hundreds or even thousands of processors to operate at the same time, or in parallel, with each processor having its own bus, memory, disks, copy of the operating system, and applications. The processors might communicate with one another to coordinate when executing a computer program, or they might run independently of one another under the direction of another processor that distributes the work to the various processors and collects their results.

The most frequent uses for parallel processing include modelling, simulation, and analyzing large amounts of data. For example, parallel processing is used in medicine to develop new imaging systems that complete ultrasound scans in less time and with greater accuracy, enabling doctors to provide better, more timely diagnoses to patients. Instead of building physical models of new products, engineers can create virtual models and use parallel computing to test how the products work and then change design elements and materials as needed.

Over the past quarter century, scientists have made rapid progress in using DNA, the molecule of life, to perform computer-like computations within living cells. DNA molecules can take on an astronomical number of potential sequences providing the opportunity to perform many computational operations at the same time. In the future, DNA computing may be capable of working inside living cells and combining with their existing biochemistry to provide new methods of disease detection and treatment possible.

**Grid computing** is the use of a collection of computers, often owned by multiple individuals or organizations, that work in a coordinated manner to solve a common problem. Grid computing is a low-cost approach to parallel processing. The grid can include dozens, hundreds, or even thousands of computers that run collectively to solve extremely large processing problems. Key to the success of grid computing is a central server that acts as the grid leader and traffic monitor. This controlling server divides the computing task into subtasks and assigns the work to computers on the grid that have (at least temporarily) surplus processing power. The central server also monitors the processing, and if a member of the grid fails to complete a subtask, the

server restarts or reassigns the task. When all the subtasks are completed, the controlling server combines the results and advances to the next task until the whole job is completed.

Some 650,000 individuals and 460 organizations have donated their computing device's unused capacity to the World Community Grid to support over two dozen research projects related to health, poverty, and sustainability. These include such projects as identifying new drug candidates to combat the childhood cancer neuroblastoma, discovering innovative ways to provide clean water to millions, and finding novel materials for capturing solar power more efficiently. Donors choose a research area of interest to them, download and install a toolkit called BOINC, and join the thousands of volunteers allowing their device to perform research calculations when it would otherwise be idle, thus helping scientists get results in months instead of decades.<sup>2</sup>

## Main Memory

**main memory:** The component of a computer that provides the CPU with a working storage area for program instructions and data.

**byte (B):** Eight bits that together represent a single character of data.

**Main memory** provides the CPU with a working storage area for program instructions and data. The chief function of memory is to rapidly provide data and instructions to the CPU. In order for their systems to run efficiently, organizations must invest in a sufficient amount of main memory. Organizations also need large amounts of secondary storage to hold the huge quantities of data that cannot fit within the limits of main memory.

Like the CPU, memory devices contain thousands of circuits imprinted on silicon chips. Each circuit is either conducting electrical current (on) or not conducting current (off). Data is stored in memory as a combination of on or off circuit states. Usually, 8 bits are used to represent a character, such as the letter A. Eight bits together form a **byte (B)**. In most cases, storage capacity is measured in bytes, with 1 byte equivalent to one character of data. The contents of the Library of Congress, with over 126 million items and 530 miles of bookshelves, would require about 20 petabytes of digital storage. Table 4.1 lists units for measuring computer storage.

**TABLE 4.1** Computer storage units

Name	Abbreviation	Number of Bytes
Byte	B	1
Kilobyte	KB	1,000
Megabyte	MB	1,000 <sup>2</sup>
Gigabyte	GB	1,000 <sup>3</sup>
Terabyte	TB	1,000 <sup>4</sup>
Petabyte	PB	1,000 <sup>5</sup>
Exabyte	EB	1,000 <sup>6</sup>
Zettabyte	ZB	1,000 <sup>7</sup>
Yottabyte	YB	1,000 <sup>8</sup>

## RAM and Cache

**random access memory (RAM):** A form of memory in which instructions or data can be temporarily stored.

Computer memory can take several forms. Instructions or data can be temporarily stored in and read from **random access memory (RAM)**. As currently designed, RAM chips are volatile storage devices, meaning they lose their contents if the current is turned off or disrupted, which can be caused by a

power surge, a brownout, or electrical noise generated by lightning or nearby machines. RAM chips are mounted directly on the computer's main circuit board or in other chips mounted on peripheral cards that plug into the main circuit board. These RAM chips consist of millions of switches that are sensitive to changes in electric current.

RAM comes in many varieties: Static random access memory (SRAM) is byte-addressable storage used for high-speed registers and caches; dynamic random access memory (DRAM) is byte-addressable storage used for the main memory in a computer; and double data rate synchronous dynamic random access memory (DDR SDRAM) is an improved form of DRAM that effectively doubles the rate at which data can be moved in and out of main memory. DDR has been superseded by second-, third-, and fourth-generation DDR called DDR2, DDR3, and DDR4, respectively. DDR3 requires 1.5 volts of electrical power to operate, while DDR4 needs just 1.2 volts. DDR4 also supports a deep power-down mode, which allows the host device to go into standby without needing to refresh its memory—reducing standby power consumption by up to 50 percent. Thus, DDR4 reduces the energy required to run portable devices and servers. This means longer battery life for portable computer users and lower electric bills for organizations that operate server farms.<sup>3</sup>

Although microprocessor speed has roughly doubled every 24 months over the past several decades, memory performance has not kept pace. In effect, memory has become the principal bottleneck to system performance. **Cache memory** is a type of high-speed memory that a processor can access more rapidly than main memory to help ease this bottleneck. Frequently used data is stored in easily accessible cache memory instead of slower memory, such as RAM. Because cache memory holds less data, the CPU can access the desired data and instructions more quickly than when selecting from the larger set in primary storage. Thus, the CPU can execute instructions faster, improving the overall performance of the computer system. Cache memory is available in three forms. The level 1 (L1) cache is on the CPU chip. The level 2 (L2) cache memory can be accessed by the CPU over a high-speed dedicated interface. The latest processors go a step further, placing the L2 cache directly on the CPU chip itself and providing high-speed support for a tertiary level 3 (L3) external cache.

**cache memory:** A type of high-speed memory that a processor can access more rapidly than main memory.

**read-only memory (ROM):** A nonvolatile form of memory.

**Read-only memory (ROM)**, another type of memory, is nonvolatile, meaning that its contents are not lost if the power is turned off or interrupted. ROM provides permanent storage for data and instructions that do not change, such as programs and data from the computer manufacturer, including the instructions that tell the computer how to start up when power is turned on. ROM memory also comes in a couple varieties. Programmable read-only memory (PROM) is used to hold data and instructions that can never be changed. Electrically erasable programmable read-only memory (EEPROM) is user-modifiable read-only memory that can be erased and reprogrammed repeatedly through the application of higher-than-normal electrical voltage.

## Secondary Storage

Storing data safely and effectively is critical to an organization's success. Driven by many factors—such as needing to retain more data longer to meet government regulatory concerns, storing new forms of digital data such as audio and video, and keeping systems running under the onslaught of increasing volumes of email—the world's information is more than doubling every two years. Nearly 6 zettabytes ( $6 \times 10^{21}$  bytes) of information was created and stored in 2013 alone.<sup>4</sup> It is mainly unstructured digital content such as video, audio, and image objects that is fueling this growth.

**secondary storage:** A device that stores large amounts of data, instructions, and information more permanently than allowed with main memory.

For most organizations, the best overall data storage solution is likely a combination of different **secondary storage** options that can store large amounts of data, instructions, and information more permanently than allowed with main memory. Compared with memory, secondary storage offers the advantages of nonvolatility, greater capacity, and greater economy. On a cost-per-megabyte basis, secondary storage is considerably less expensive than primary memory. The selection of secondary storage media and devices requires understanding their primary characteristics: access method, capacity, and portability.

As with other computer system components, the access methods, storage capacities, and portability required of secondary storage media are determined by the business requirements that must be met. An objective of a credit card company might be to rapidly retrieve stored customer data to approve consumer purchases. In this case, a fast access method is critical. In other cases, such as equipping the Coca-Cola field salesforce with smartphones, portability and ruggedness might be major considerations in selecting and using secondary storage media and devices.

In addition to cost, capacity, portability, and ruggedness, organizations must address security issues so that only authorized people are allowed access to sensitive data and critical programs. Because the data and programs kept on secondary storage devices are so critical to most organizations, all of these issues merit careful consideration.

Secondary data storage is not directly accessible by the CPU. Instead, computers usually use input/output channels to access secondary storage and then transfer the desired data using intermediate areas in primary storage. The most common forms of secondary storage devices are magnetic, optical, and solid state.

### Secondary Storage Devices

**magnetic tape:** A type of sequential secondary storage medium, now used primarily for storing backups of critical organizational data in the event of a disaster.

Magnetic storage uses tape or disk devices covered with a thin magnetic coating that enables data to be stored as magnetic particles. **Magnetic tape** is a type of secondary storage medium, which is frequently used for storing backups of critical organizational data in the event of a disaster. Examples of tape storage devices include cassettes and cartridges measuring a few millimeters in diameter, requiring very little storage space. Magnetic tape has been used as storage media since the time of the earliest computers, such as the 1951 Univac computer.<sup>5</sup> Continuing advancements have kept magnetic tape as a viable storage medium. The High-End Computing Capability (HECC) Project at NASA offers scientists and engineers access to supercomputing systems services that are backed up by a 132-petabyte tape storage system.<sup>6</sup> Many such supercomputers, including those deployed at the National Center for Atmospheric Research, use robotic tape backup systems. See Figure 4.3.

**hard disk drive (HDD):** A direct access storage device used to store and retrieve data from rapidly rotating disks coated with magnetic material.

A **hard disk drive (HDD)** is a direct access storage device used to store and retrieve data from rapidly rotating disks coated with magnetic material. A hard disk represents bits of data with small magnetized areas and uses a read/write head to go directly to the desired piece of data. Because direct access allows fast data retrieval, this type of storage is used by organizations that need to respond quickly to customer requests, such as airlines and credit card firms. For example, information on the credit history of a customer or the seat availability on a particular flight would likely be stored on a direct access hard disk drive so that a customer service representative or manager could obtain that data in seconds. Hard disk drives vary widely in capacity and portability.

Putting an organization's data online involves a serious business risk—the loss of critical data can put a corporation out of business. The concern is that the most critical mechanical components inside a HDD storage device—the disk drives, the fans, and read/write heads—can fail. Thus, organizations now require that their data storage devices be fault tolerant, that is, they can

**FIGURE 4.3****Robotic tape backup system**

The national center for atmospheric research uses a robotic tape backup system to back up a fleet of supercomputers that solve the world's most computationally intensive climate-modeling problems.



U.S. Department of Energy

continue with little or no loss of performance if one or more key components fail. In response, disk manufacturers are continually developing new technologies that will improve the performance and reliability of their hard disk drives.

A **redundant array of independent/inexpensive disks (RAID)** is a method of storing data that generates extra bits of data from existing data, allowing the system to create a “reconstruction map” so that if a hard drive fails, it can rebuild lost data. With this approach, data can be split and stored on different physical disk drives, using a technique called striping that evenly distributes the data. RAID technology has been applied to storage systems to improve system performance and reliability.

RAID can be implemented in several ways. RAID 1 subsystems duplicate data on the hard drives. This process, called “disk mirroring,” provides an exact copy that protects users fully in the event of data loss. However, to keep complete duplicates of current backups, organizations need to double the amount of their storage capacity. Other RAID methods are less expensive because they duplicate only part of the data, allowing storage managers to minimize the amount of extra disk space they must purchase to protect data.

**Virtual tape** is a storage technology suitable for less frequently needed data. With virtual tape systems, data appears to be stored entirely on tape cartridges, although some parts might actually be located on faster hard disks. The software associated with a virtual tape system is sometimes called a virtual tape server. Virtual tape can be used with a sophisticated storage-management system that moves data to slower but less costly forms of storage media as people use the data less often. Virtual tape technology can decrease data access time, lower the total cost of ownership, and reduce the amount of floor space consumed by tape operations.

### Solid State Secondary Storage Devices

A **solid state storage device (SSD)** stores data in memory chips rather than on hard disk drives or optical media. These memory chips require less power and provide much faster data access than magnetic data storage devices. In addition, SSDs have no moving parts, so they are less fragile than hard disk drives. All these factors make the SSD a preferred choice over hard disk drives for portable computers.

**virtual tape:** A storage device for less frequently needed data. With virtual tape systems, data appears to be stored entirely on tape cartridges, although some parts of it might actually be located on faster hard disks.

**solid state storage device (SSD):** A storage device that stores data in memory chips rather than on hard disk drives or optical media.

A universal serial bus (USB) flash drive is one example of a commonly used SSD. USB flash drives are external to the computer and are removable and rewritable. Most weigh less than an ounce and can provide a wide range of storage capacity.

## Input/Output Devices

Input and output devices are the gateways to the computer system—you use them to provide data and instructions to the computer and receive results from it. Input and output devices are part of a computer's user interface, which includes other hardware devices and software that allow you to interact with a computer system.

In general, businesses want input devices that let them accurately and rapidly enter data into a computer system, and they want output devices that let them produce timely results. Some organizations have very specific needs for input and output, requiring devices that perform specific functions. The more specialized the application, the more specialized the associated system input and output devices.

Getting data into a computer—input—often requires transferring human-readable data, such as a sales order, into a computer system. “Human-readable data” means data that people can read and understand. The temperature registered on a thermometer is an example of human-readable data. An example of machine-readable data is the universal bar code on many grocery and retail items that indicates the stock-keeping identification number for that item. To the human eye, the universal bar code is unintelligible and looks like a series of vertical bars of varying thicknesses. Some data, such as magnetic ink on bank checks, can be read by people and machines. Usually, people begin the input process by organizing human-readable data and transforming it into machine-readable data. Every keystroke on a keyboard, for example, turns a letter symbol of a human language into a digital code that the machine can manipulate.

Data entry and input devices come in many forms. They range from special-purpose devices that capture specific types of data to more general-purpose input devices. Some of the special-purpose data entry and input devices are discussed later in this chapter. First, we focus on devices used to enter and input general types of data, including text, audio, images, and video for personal computers.

### Common Personal Computer Input Devices

A keyboard and a computer mouse are common devices used for entry and input of data, such as characters, text, and basic commands. Some companies manufacture keyboards that are more comfortable, more easily adjusted, and faster to use than standard keyboards. These ergonomic keyboards, such as the split keyboard, are designed to help users avoid wrist and hand injuries caused by hours of typing. Other keyboards include touch pads, which let you enter sketches on the touch pad while still using keys to enter text. See Figure 4.4. A mouse is used to point to and click symbols, icons, menus, and commands on the screen. The computer takes a number of actions in response, such as entering data into the computer system. Many mice and keyboards are now wireless, helping to keep a physical desktop free from clutter.

### Optical Data Readers

Individuals and organizations can also use a special scanning device called an optical data reader to scan documents. The two categories of optical data readers are optical mark recognition (OMR) and optical character recognition (OCR). OMR readers are used for tasks such as grading tests and scanning forms. With this technology, pencils are used to fill in bubbles or check boxes

**FIGURE 4.4**  
**Drawing pad and integrated keyboard**

A drawing pad and integrated keyboard can replace a traditional keyboard and mouse for input.



Slobodan Vasic/E+/Getty Images

on OMR paper, which is also called a “mark sense form.” OMR systems are used in standardized tests, including the SAT and GMAT tests, and to record votes in elections.

In contrast, most OCR readers use reflected light to recognize and scan various machine-generated characters. With special software, OCR readers can also convert handwritten or typed documents into digital data. After data is entered, it can be shared, modified, and distributed over computer networks to hundreds or thousands of people. Previously, the use of OCR technology required a special scanner device that creates an image of the characters to be converted. Expensive OCR software was then required to convert that image into text. However, it is now possible to complete this process using the camera in an Android smartphone or tablet. Once the image is stored on the camera or tablet, you use the Google Drive app for Android to copy the image to Google Drive, where Google’s software and servers will do the OCR conversion at no cost.

### Bar-Code Scanners

A bar-code scanner employs a laser scanner to read a bar-coded label and pass the data to a computer. The bar-code reader may be stationary or handheld to support a wide variety of uses. This form of input is used widely in-store checkouts and warehouse inventory control. Bar codes are also used in hospitals, where a nurse scans a patient’s wristband and then a bar code on the medication about to be administered to prevent medication errors.

Several companies have created applications that convert a cell phone camera into a bar-code reader. You can scan a bar code from a print ad, packaging, or label to launch Web sites and buy items with a few clicks.

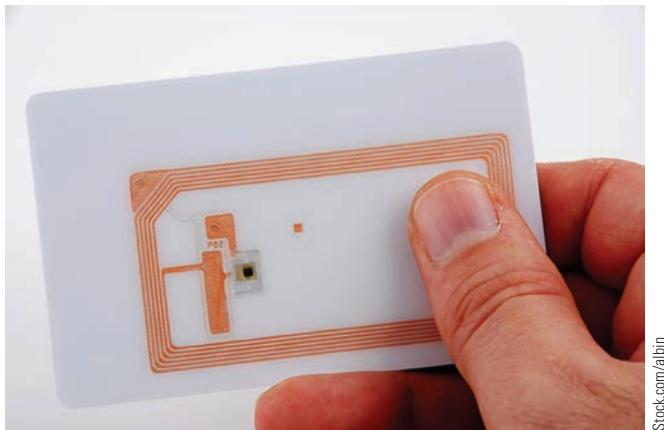
### Radio Frequency Identification (RFID) Devices

**radio frequency identification (RFID):** A technology that employs a microchip with an antenna to broadcast its unique identifier and location to receivers.

**Radio frequency identification (RFID)** is a technology that employs a microchip with an antenna to broadcast its unique identifier and location to receivers. The purpose of an RFID system is to transmit data by a mobile device, called a tag (see Figure 4.5), which is read by an RFID reader and processed according to the needs of a computer program. One popular application of RFID is to place microchips on retail items and install in-store readers that track the inventory on the shelves to determine when shelves should be restocked. The RFID tag chip includes a special form of EPROM memory that holds data about the item to which the tag is attached. A radio frequency signal can update this memory as the status of the item changes. The data transmitted by the tag might provide identification, location information, or details about the product tagged, such as date of manufacture, retail price, color, or date of purchase.

**FIGURE 4.5****RFID tag**

An rfid tag is small compared with current bar-code labels used to identify items.



iStock.com/albin

***Pen Input Devices***

By touching the screen with a pen input device, you can activate a command or cause the computer to perform a task, enter handwritten notes, and draw objects and figures. Pen input requires special software and hardware. Handwriting-recognition software, for example, converts onscreen handwriting into text. Many tablet computers can transform handwriting into typed text and store the “digital ink” just the way a person writes it. People can use a pen to write and send email, add comments to documents, mark up presentations, and even hand draw charts in a document. The data can then be moved, highlighted, searched, and converted into text. If perfected, this interface is likely to become widely used. Pen input is especially attractive to people who are uncomfortable using a keyboard. The success of pen input depends on how accurately and at what cost handwriting can be read and translated into digital form.

***Touch Screens***

Advances in screen technology allow display screens to function as input as well as output devices. By touching certain parts of a touch-sensitive screen, you can start a program or trigger other types of action. Touch screens can remove the need for a keyboard, which conserves space and increases portability. Touch screens are frequently used at gas stations to allow customers to select grades of gas and request a receipt; on photocopy machines for selecting options; at fast-food restaurants for entering customer choices; at information centers for finding facts about local eating and drinking establishments; and at amusement parks to provide directions to patrons. They also are used in kiosks at airports and department stores. Touch screens are also being used for gathering votes in elections.

As touch screens get smaller, the user’s fingers begin to block the information on the display. Nanotouch technology is being explored as a means of overcoming this problem. With this technology, users control the touch screen from its backside so that fingers do not block the display. As the user’s finger moves on the back of the display, a tiny graphical finger is projected onto the touch screen. Such displays are useful for mobile audio players that are about the size of a coin.

Application developers are busy trying to find ways to take advantage of Apple’s 3D Touch feature, which the company introduced in the fall of 2015 with its iPhone 6s smartphone. 3D Touch uses a pressure-sensitive touch screen that measures how forcefully you press down on the screen. The new feature adds “peek” and “pop” gestures to the tap, swipe, and pinch gestures with which most smartphone users are familiar. 3D Touch is designed to bring a new dimension of functionality to the iPhone, allowing users to both see and feel what a press can do. OpenTable, an online restaurant-reservation

and review service, has included 3D Touch features in the latest version of its iPhone apps. Users can 3D Touch the app's icon to quickly view favorite restaurants and upcoming reservations. Within the app, users can "peek" at a restaurant's details by pressing lightly on the name of the restaurant in a list of search results. Swiping up offers the ability to instantly see available reservation times, and pressing harder on a restaurant name "pops" a user to the restaurant's full profile.<sup>7</sup>

## Output Devices

Computer systems provide output to decision makers at all levels of an organization so they can solve a business problem or capitalize on a competitive opportunity. In addition, output from one computer system can provide input into another computer system. The desired form of this output might be visual, audio, or even digital. Whatever the output's content or form, output devices are designed to provide the right information to the right person in the right format at the right time.

### Display Screens

The display screen is a device used to show the output from the computer. Today a variety of flat-panel display screens are far lighter and thinner than the early cathode-ray tubes (CRTs) associated with early computers. Table 4.2 compares types of flat-panel display screens.

**TABLE 4.2** Various types of flat-panel displays

Type	Description	Noteworthy Feature
Liquid crystal display (LCD)	Uses several layers of charged liquid crystals placed between clear plates that are lit from behind by a fluorescent light to create light and images	The viewing angle tends to be worse than that of plasma displays
Light-emitting diode (LED)	An LCD display that uses light-emitting diodes (LEDs) as backlight on the screen rather than a fluorescent lamp	Provides better contrast and lower energy consumption than LCDs
Organic light-emitting diode (OLED)	Functions by exciting organic compounds with electric current to produce bright, sharp images	Does not employ a backlight, which enables improved contrast and lower power consumption than LCD and LED LCD displays
Plasma	Uses electricity to excite gas atoms to light up appropriate phosphors on the screen to emit light and color	Performs well in dark conditions but not as well in well-lit rooms

With today's wide selection of display screens, price and overall quality can vary tremendously. The quality of a screen image is largely determined by the number of horizontal and vertical pixels used to create it. The images shown on your display device are composed of a million or more pixels. Resolution is the total number of pixels contained in the display; the more pixels, the clearer and sharper the image. A common resolution is 2,040 horizontal pixels  $\times$  1,536 vertical pixels. The size of the display monitor also affects the quality of the viewing. The same pixel resolution on a small screen is sharper than on a larger screen, where the same number of pixels is spread out over a larger area.

The **computer graphics card** takes binary data from the CPU and translates it into an image you see on your display device. It is the computer graphics card that controls the quality of the image and determines how many

**computer graphics card:** A component of a computer that takes binary data from the CPU and translates it into an image you see on your display device.

**graphics processing unit (GPU)**

**(GPU):** A powerful processing chip that renders images on the screen display.

display devices can be attached to the computer. The computer graphics card holds the **graphics processing unit (GPU)**, a powerful processing chip that renders images on the display screen. After the computer graphics card takes binary data from the CPU, the GPU decides what to do with each pixel on the screen to create the image. As the GPU creates images, it uses RAM on the graphics card (called video RAM or VRAM) to store data about each pixel, including its color and location on the screen. One measure of a video card's performance is how many complete images the card can display per second, which is called the frame rate. The human eye can process roughly 25 frames per second; however, many video games require a frame rate of at least 60 frames per second to provide a good user experience.

Because many users leave their computers on for hours at a time, power usage is an important factor when deciding which type of display to purchase. Although power usage varies from model to model, OLED displays are the most energy efficient, with LCD monitors generally consuming between 35 and 50 percent less power than plasma screens.

Aspect ratio and screen size describe the size of the display screen. Aspect ratio is the ratio of the width of the display to its height. The aspect ratio of width to height of 4:3 or 5:4 is good for people who use their computer to view or create Web pages or documents. Widescreen displays typically have an aspect ratio of 16:10 or 16:9 to allow improved viewing of movies and video games.

### Printers and Plotters

One of the most useful and common forms of output is called hard copy, which is simply paper output from a printer. The two main types of printers are laser printers and inkjet printers, and they are available with different speeds, features, and capabilities. Some can be set up to accommodate paper forms, such as blank check forms and invoice forms. Newer printers allow businesses to create full-color, customized, and individualized printed output using standard paper and data input. Ticket-receipt printers, such as those used in restaurants, ATMs, and point-of-sale systems are in wide-scale use.

The speed of a printer is typically measured by the number of pages printed per minute (ppm). Similar to a display screen, the quality, or resolution, of a printer's output depends on the number of dots printed per inch (dpi). A 600-dpi printer prints more clearly than a 300-dpi printer. A recurring cost of using a printer is the inkjet or laser cartridge that must be replaced periodically—every few thousand pages for laser printers and every 500–900 pages for inkjet printers.

Inkjet printers that can print 10–40 ppm for black and white output and 5–20 ppm for color output are available for less than \$175. With an initial cost much less than color laser printers, inkjet printers can print vivid hues and can produce high-quality banners, graphics, greeting cards, letters, text, and photo prints.

Laser printers are generally faster than inkjet printers and can handle a heavier print load volume. A monochrome laser printer can print 25–45 ppm and cost anywhere from \$150 to \$700. Color laser printers can print color pages at a rate of 10–35 ppm and are available in a wide range of prices—from \$300 to more than \$3,500 for a high-quality color laser printer.

A number of manufacturers offer multiple-function printers that can copy, print (in color or black and white), fax, and scan. Such multifunctional devices are often used when people need to do a relatively low volume of copying, printing, faxing, and scanning. Typical prices for multifunction printers range from \$100 to \$500, depending on features and capabilities. Because these devices take the place of more than one piece of equipment, they are less expensive to acquire and maintain than a stand-alone fax plus a stand-alone printer, copier, and so on. Also, eliminating equipment that was once located

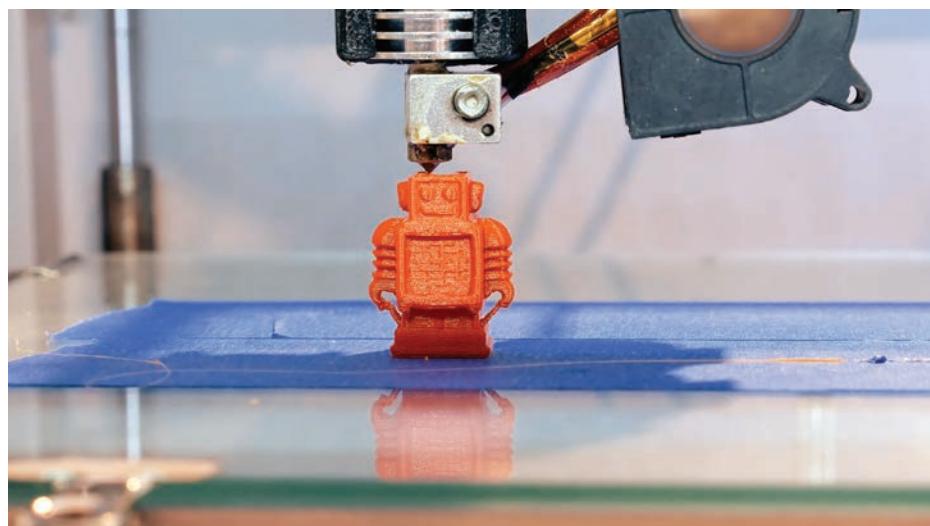
on a countertop or desktop clears a workspace for other work-related activities. As a result, such devices are popular in homes and small office settings.

Mobile print solutions enable users to wirelessly send documents, email messages and attachments, presentations, and even boarding passes from any smartphone, tablet, or laptop to any mobile-enabled printer in the world. For example, PrinterOn Enterprise enables any print requests from any mobile or fixed device to be routed to any of over 10,000 printers worldwide that are configured with the PrinterOn Enterprise service. Mobile users who use the service only need to access a directory of PrinterOn printers and locations and then send an email with the attachment to be printed to the email address of the printer. American Airlines Admiral Club, Delta Sky Club, Embassy Suites, and DoubleTree by Hilton have installed PrinterOn printers at many of their locations.

Plotters are a type of hard-copy output device used for general design work. Businesses typically use plotters to generate paper or acetate blueprints, schematics, and drawings of buildings or new products. Standard plot widths are 24 inches and 36 inches, and the length can be whatever meets the need—from a few inches to many feet.

### **3D Printers**

3D printers have created a major breakthrough in how many items will be “manufactured.” See Figure 4.6. 3D printing technology takes a three-dimensional model of an object stored on a computer and sends it to a 3D printer to create the object using strands of a plastic filament or synthetic powder. The filament comes in spools of various colors and is fed through a heated extruder that moves in several directions to place super thin layers on top of each other. The stacks are then bonded together, often using ultraviolet light, to create a 3D object. 3D printers come with a wide range of capabilities in terms of how fast they can build objects and how large of an object they can build. 3D printers for home use typically run \$1,000 and up, while commercial 3D printers can cost tens of thousands of dollars.



Krylo Givin/Shutterstock.com

**FIGURE 4.6**

#### **3D printer**

3D print technology is making it possible to print objects ranging from everyday objects to houses.

3D printing is commonly used by aerospace firms, auto manufacturers, and other design-intensive companies. It is especially valuable during the conceptual stage of engineering design when the exact dimensions and material strength of the prototype are not critical. Some architectural design firms are using 3D printers to create full-color models of their projects to show clients. Cincinnati Children’s Hospital uses 3D printing to create models of patients’ hearts so that physicians can plan their surgery.<sup>8</sup>

The automotive, electronics, and toy industries are early adopters of using 3D printing to improve upon traditional manufacturing processes. Ford Motor Company uses 3D printing to design the new engine cover of its next-generation Mustang. Following traditional methods, an engineer would first create a computer model and then wait for about four months for a prototype to be produced, at a cost of \$500,000. Using 3D printing, Ford can print the prototype in just four days at a cost of only \$3,000.<sup>9</sup>

3D printing can cut costs and reduce the waste and carbon footprint associated with traditional manufacturing. With 3D printing, production and assembly can be local, with no need to ship products thousands of miles to their destination. Only the raw materials needed to create the object—be it carbon fiber, metal powder, plastic filament, or some other substance—are used. Product parts can be replaced using parts manufactured with 3D printing so the entire product doesn't have to be disposed of and replaced each time it malfunctions.

Biomedical engineers are exploring a process called **bioprinting**, which uses 3D printers to build human parts and organs from actual human cells. For example, bioprinting is being used to create custom breast implants and grafts for cancer patients using the recipient's own fat and skin cells.<sup>10</sup> Regenerative medicine pioneer Organovo is able to build blood vessels and cardiac tissue via a 3D printer that dispenses cells instead of ink. The firm plans to begin selling 3D printed liver tissue.<sup>11</sup>



## Critical Thinking Exercise

### Time to Upgrade Your Computer

#### ► TECHNOLOGY AGILITY

You are shopping to significantly upgrade your current personal laptop computer and printer. You are heavy into gaming, film editing, and photo shopping. You need a laptop with a powerful CPU and high-quality screen plus a fast, high-quality, color printer. You have a budget of \$2,500 for the hardware.

#### Review Questions

1. What features and specifications can you use to evaluate various laptops including the CPU and screen?
2. What features and specifications can you use to evaluate various printers?

#### Critical Thinking Questions

1. Either go online or visit your local computer shop to identify and price one or two computers that best meet your needs and stay within your budget.
2. Do the same to identify and price one or two printers that best meet your needs.

## Computer System Classes

In general, computers can be classified as either special-purpose or general-purpose. Special-purpose computers are used for limited applications, for example, by military, government, and scientific research groups such as the CIA and NASA. Other applications include specialized processors found in appliances, cars, and other products. For example, automobile repair shops connect special-purpose computers to your car's engine to identify specific performance problems. As another example, IBM is developing a new generation of computer chips to develop so-called cognitive computers that are designed to mimic the way the human brain works. Rather than being programmed as today's computers are, cognitive computers, such as IBM's Watson computer, are able to learn through experiences and outcomes and mimic human learning patterns.

General-purpose computers are used for a variety of applications, including the business applications you encounter at work and in college. General-purpose computer systems can be divided into three primary classes: portable computers used by one user at a time, nonportable computers used by one person at a time, and systems used by multiple concurrent users. Table 4.3 shows the general ranges of capabilities for various classes of computer systems.

**TABLE 4.3** Classes of computers

**Single-User Portable Computers:** Used to run personal productivity software, access the Internet, read and prepare email and instant messages, play games, listen to music, watch videos, access corporate applications and databases, and enter data at the point of contact.

Factor	Smartphone	Laptop	Notebook	Tablet
<b>Cost</b>	\$120–\$1,000	\$300–\$2,500	\$300–\$800	\$75–\$1,500
<b>Weight (pounds)</b>	<0.5	<8	<6	<2
<b>Screen size (inches)</b>	2–5.5	<20	<12	<13

**Single-User Nonportable Computers:** Meet a wide range of personal computing needs from simply entering data and accessing applications via the Internet to running productivity software to performing computer intensive engineering, computer-aided design, and software development functions.

Factor	Thin Client	Desktop	Nettop	Workstation
<b>Cost</b>	\$200–\$500	\$500–\$3,000	\$150–\$550	\$1,500–\$9,500
<b>Weight (pounds)</b>	<3	20–30	<4	>20

**Multiple-User Computers:** Meet the computing needs of an organization by supporting key functions such as email, printing, security, providing massive data storage and retrieval, and running applications that perform intensive data calculations.

Factor	Server	Mainframe	Supercomputer
<b>Cost</b>	>\$500	>\$75,000	>\$250,000
<b>Weight (pounds)</b>	>25	>100	>100

## Portable Computers

**portable computers:** A computer small enough to carry easily.

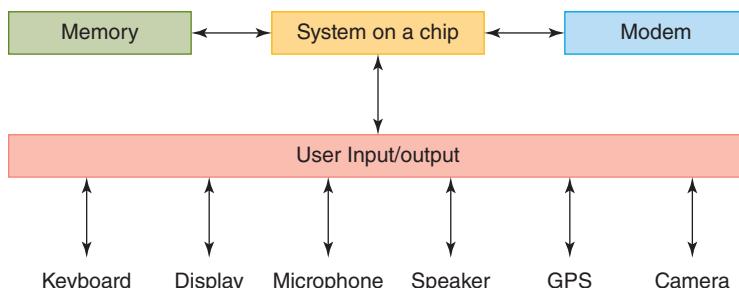
Many computer manufacturers offer a variety of **portable computers**, which are small enough to carry easily. Portable computers include smartphones, laptops, notebooks, and tablets.

### Smartphones

While features and capabilities vary from model to model and manufacturer to manufacturer, with most smartphones you can place calls, download and run apps (e.g., games, contact or to do list manager, and personal and business finance managers), send and receive text messages and email, view documents and files, take and send photos and videos, get driving directions via GPS, browse Web sites, and create a playlist of digital tunes. Smartphones employ a combination chipset called a “system on a chip,” which includes processor cores, RAM (random access memory) and ROM (read-only memory), interface controllers, and voltage regulators, as shown in Figure 4.7. With system on a chip, all the critical components of the smartphone are confined to a relatively small area, making the device faster and more energy efficient and reducing assembly costs.

**FIGURE 4.7**  
**Anatomy of a smartphone**

Smartphones employ a combination chipset called a “system on a chip,” which includes processor cores, ram and rom memory, interface controllers, and voltage regulators.



### Laptop

**laptop:** A personal computer designed for use by mobile users, being small and light enough to sit comfortably on a user's lap.

A **laptop** is a personal computer designed for use by mobile users; it is small and light enough to sit comfortably on a user's lap. Laptops use a variety of flat-panel technologies to produce lightweight and thin display screens with good resolution. In terms of computing power, laptops can match most desktop computers as they come with powerful CPUs as well as large-capacity primary memory and disk storage. This type of computer is highly popular among students and mobile workers who carry their laptops on trips and to meetings and classes. Many personal computer users now prefer a laptop over a desktop because of its portability, lower energy usage, and smaller space requirements.

### Notebooks

Numerous portable computers are smaller than the typical laptop and have various names, including notebook and the even smaller ultrabook. Technically and traditionally, the difference between the laptop, notebook, and ultrabook computer was a matter of size and weight. Technology advances have resulted in much smaller and lighter components so differences in size and weight are no longer as significant. Today, the difference between a laptop, notebook, and ultrabook is mainly what the manufacturer chooses to call its product.

### Tablets

A **tablet** is a portable, lightweight computer that can come with or without a keyboard and allows you to roam the office, home, or factory floor, carrying the device like a clipboard. You can enter text with a writing stylus directly on the screen, thanks to built-in handwriting-recognition software. Other input methods include an onscreen keyboard and speech recognition.

Tablets that support input only via a writing stylus are called slate computers. The convertible tablet PC comes with a swivel screen and can be used as a traditional notebook or as a pen-based tablet PC. Most new tablets come with a front-facing camera for videoconferencing and a second camera for snapshot photos and video. Tablets are especially popular with students and gamers. They are also frequently used in the healthcare, retail, insurance, and manufacturing industries because of their versatility. A tablet computer that comes with a removable keyboard is also called a 2-in-1 tablet/PC.

The Apple iPad is a tablet capable of running the same software that runs on the Apple iPhone and iPod touch devices, giving it a library of well over a million applications. It also runs software developed specifically for the iPad. The device supports Internet access over both wireless and cellular networks, and it includes an onscreen keypad, although a physical keyboard can also be attached. Apple offers a variety of iPad models, ranging from the iPad mini, which weighs 0.73 pounds and has a 7.9-inch screen, up to the iPad Pro, which weighs 1.5 pounds and has a 12.9-inch screen.

A number of computer companies offer tablets to compete with Apple's iPad, including the Amazon Fire, the Inspiron and Venue by Dell, the Nexus 7 and Pixel 2 from Google, the Tab 4 and Yoga 920 from Lenovo, the Surface

Pro from Microsoft, the Shield from Nvidia, the Tablet S and Xperia XZ2 from Sony, and the Encore 2 and Excite by Toshiba.

## Nonportable, Single-User Computers

Nonportable single-user computers include thin client computers, desktop computers, nettop, and workstations. This class of computer is used to meet the unique data processing needs of the individual end users in an organization.

### **Thin Clients**

**thin client:** A low-cost, centrally managed computer with no internal or external attached drives for data storage.

A **thin client** is a low-cost, centrally managed computer with no internal or external attached drives for data storage. These computers have limited capabilities and perform only essential applications, so they remain “thin” in terms of the client applications they include. As stripped-down computers, they do not have the storage capacity or computing power of typical desktop computers, nor do they need it for the role they play. With no hard disk, they never pick up viruses or suffer a hard disk crash. Unlike personal computers, thin clients download data and software from a network when needed, making support, distribution, and updating of software applications much easier and less expensive. Thin clients work well in a cloud-computing environment to enable users to access the computing and data resources available within the cloud. The Chromebook, which runs the Chrome OS operating system, is a highly portable device, is widely used in many schools, and is an example of a thin client.

Since its founding, Certainty Home Loans has helped over 200,000 families finance their homes. Headquartered in Plano, Texas, the company offers home purchase, refinance, and renovation loans with offices in ten southern and southwestern states. The company employs thin clients that are inexpensive, energy efficient, and easy to manage. Data is never stored at the device itself, so if a device goes bad, the solution is simple: unplug it, replace it with another thin client, and send the original device back to headquarters for evaluation or replacement.<sup>12</sup>

### **Desktop Computers**

**desktop computers:** A nonportable computer that fits on a desktop and can provide sufficient computing power, memory, and storage for most business computing tasks.

**Desktop computers** are single-user computer systems that are highly versatile and can provide sufficient computing power, memory, and storage for most business computing tasks.

The Apple iMac is a family of Macintosh desktop computers first introduced in 1998 in which all the components (including the CPU and the disk drives) fit behind the display screen. Core i5, i7, and i9 is a family of Intel desktop computers with a wide range in number of cores, amount of cache memory, and processor speeds.

### **Nettop Computer**

**nettop computers:** A very small, inexpensive desktop computer typically used for Internet access, email, accessing Web-based applications, document processing, and audio/video playback.

**Nettop computers** are a very small, inexpensive desktop computer typically used for Internet access, email, accessing Web-based applications, document processing, and audio/video playback. A key feature of nettop computers is that they require perhaps one-tenth the amount of power to operate as a typical desktop computer.

### **Workstations**

**workstations:** A more powerful personal computer used for mathematical computing, computer-assisted design, and other high-end processing but still small enough to fit on a desktop.

**Workstations** are more powerful than personal computers but still small enough to fit on a desktop. They are used to support engineering and technical users who perform heavy mathematical computing, computer-assisted design (CAD), video editing, and other applications requiring a high-end processor. Such users need very powerful CPUs, large amounts of main memory, and extremely high-resolution graphic displays. Workstations are typically more expensive than the average desktop computer. Some computer manufacturers

are now providing laptop versions of their powerful desktop workstations. The Mac Pro is a series of workstation and server computers based on the high-performance Intel Xeon processor.

Area Sq is a UK-based company that provides expertise in office design, refurbishment, and workplace services. Its space planning consultants create innovative and inspiring office interiors and use powerful Dell workstations to run Autodesk AutoCAD and related software. Area Sq needs high-performance computing to meet the challenging demands of creating 3D models and then rendering those models to put design options in front of clients. If the computer hardware runs slowly, then designers must wait for drawings to regenerate when changes are made and this eats into design time. Reliability is also critical. Rendering can take hours on many projects and a hardware failure can mean losing a full day's worth of work.<sup>13</sup>

## Servers, Mainframes, and Supercomputers

Servers, mainframes, and supercomputers are designed to support workgroups from a small department of two or three workers to large organizations with tens of thousands of employees and millions of customers. This class of computer meets the heavy data processing needs of an organization.

### Server

**server:** A computer employed by many users to perform a specific task, such as running network or Internet applications.

A **server** is a computer employed by many users to perform a specific task, such as running network or Internet applications. While almost any computer can run a server operating system and server applications, a server computer usually has special features that make it more suitable for operating in a multiuser environment. These features include greater memory and storage capacities, faster and more efficient communications abilities, and reliable backup capabilities. A Web server is one specifically designed to handle Internet traffic and communications. An enterprise server stores and provides access to programs that meet the needs of an entire organization. A file server stores and coordinates program and data files. Server systems consist of multiuser computers, including supercomputers, mainframes, and other servers.

Servers are frequently kept in a rack containing multiple servers stacked one above the other simplifying cabling among components and minimizing the required floor space. A rack unit is a unit of measure used to describe the height of a server mounted in a rack. One rack unit is 44.45 mm or 1.75 inches high. A 42U rack would have an internal rack unit height dimension of 73.5 inches (1.8669 m). However, each 42U rack manufacturer's server rack external dimensions will vary. In an equipment rack filled with servers, a special cooling system is needed to prevent excessive heat buildup that would otherwise occur from so many power-dissipating devices that are confined in a small space.

Servers offer great **scalability**, the ability to increase the processing capability of a computer system so that it can handle more users, more data, or more transactions in a given period. Scalability is achieved by adding more, or more powerful, processors. Scaling up adds more powerful processors, and scaling out adds many processors to increase the total data-processing capacity. Most new servers include onboard diagnostic capabilities that enable the server to alert the IS operations group to potential problems, a capability that used to be only available for high-end, mainframe computers.

### Mainframe Computer

**mainframe computer:** A large, powerful computer often shared by hundreds of concurrent users connected to the machine over a network.

A **mainframe computer** is a large, powerful computer shared by dozens or even hundreds of concurrent users connected to the machine over a network. These refrigerator-sized computers helped NASA put astronauts on the moon and are still widely used in large organizations and government agencies. They

can support thousands of users simultaneously and can handle all of the core functions of a corporation. Mainframe computers provide the data-processing power and data storage capacity that enables banks and brokerage firms to deliver new mobile services, credit card companies to detect identity theft, and government agencies to better serve citizens. It is estimated that mainframe computers store 80 percent of the world's corporate data and handle \$6 trillion in annual credit card transactions.<sup>14</sup>

**backward compatibility:** The ability of current mainframes to run software created decades ago.

A key feature of mainframe computers is **backward compatibility** or the ability of current mainframes to run software created decades ago. Many organizations such as airlines, banks, and brokerage firms are reluctant to change their basic transaction processing software. If forced to rewrite this code each time they upgraded to newer, faster hardware they would incur considerable software development costs and raise the risk that the new software may not be as reliable as the old software. Personal computers and cellphones are not considered to have backward compatibility and it is often impossible to run apps that are even a few years old.

IBM's latest mainframe computer, the IBM Z, is capable of running more than 12 billion encrypted transactions per day. The mainframe uses transaction encryption technology to counter cyberattacks against personal and financial data that could cost firms a total of \$8 trillion by 2022.<sup>15</sup> The IBM Z is not cheap; it comes with a \$500,000 starting price.

### Supercomputer

**supercomputers:** One of the most powerful computer systems with the fastest processing speeds.

**Supercomputers** are the most powerful computers with the fastest processing speed and highest performance. They are special-purpose machines designed for applications that require extensive and rapid computational capabilities. Originally, supercomputers were used primarily by government agencies to perform the high-speed number crunching needed in weather forecasting, earthquake simulations, climate modelling, nuclear research, study of the origin of matter and the universe, and weapons development and testing. They are now used more broadly for commercial purposes in the life sciences and the manufacture of drugs and new materials. For example, Procter & Gamble uses supercomputers in the research and development of many of its leading commercial brands, such as Tide and Pampers, to help develop detergent with more soapsuds and improve the quality of its diapers.

Supercomputers are also used to help establish the safety ratings for vehicles sold in the United States. The ratings are based on sophisticated computer simulations, during which supercomputers crunch equations involving many different variables. These computer-generated simulations are combined with data taken from actual crash tests and analyzed to determine safety ratings that many consumers use as one factor in determining which car to buy.

Most new supercomputers are based on a recent architecture that employs graphics processing unit (GPU) chips in addition to traditional central processing unit (CPU) chips to perform high-speed processing. The CPU is designed for sequential serial processing while the GPU is designed to handle multiple tasks in parallel. With GPU-accelerated computing, sequential calculations are performed in the CPU and highly complicated calculations are performed in parallel in the GPU thus providing far superior processing speeds for applications like artificial intelligence, complex simulations, computer-aided design, medical imaging, video editing, and medical imaging.

The speed of supercomputers is measured in petaflops or  $1 \times 10^{15}$  floating point operations per second (FLOPS). For perspective, one petaflop is roughly a million times faster than the typical consumer laptop computer. The fastest supercomputer in the world as of June 2018 is the Summit supercomputer deployed at the Oak Ridge National Laboratory in Oak Ridge, TN. Table 4.4 lists the five most powerful supercomputers in use as of June 2018.

**TABLE 4.4** Five most powerful operational supercomputers (June 2018)

Rank	Name	Where Deployed	Location	Speed (Petaflops)
1	Summit	Oak Ridge National Laboratory (ORNL)	Oak Ridge, TN, United States	122.3
2	Sunway TaihuLight	National Supercomputing Center	Wuxi, China	93
3	Sierra	Lawrence Livermore National Laboratory	Livermore, CA, United States	71.6
4	Tianhe-2A	National Supercomputer Center	Guangzhou, China	33.9
5	AI Bridging Cloud Infrastructure (ABCi)	National Institute of Advanced Industrial Science and Technology (AIST)	University at Shinagawa, Tokyo, Japan,	19.9

SOURCE: "Top 500 the List," June 2018, <https://www.top500.org/lists/2018/06/>

## Quantum Computers

Classical computers, which are the types of computers we have discussed up until now, encode information in bits with each bit representing the value of 1 or 0. These 1s and 0s represent data and act as on/off switches that control how the computer functions. Quantum computers, in contrast, are based on qubits, which operate according to two key principles of quantum physics: superposition and entanglement.

Superposition is a principle of quantum mechanics that says instead of thinking about a particle being in one state or changing between a variety of states, particles are thought of as existing across all the possible states at the same time. Thus, with superposition each qubit can represent *both* a 1 and a 0 at the same time. Entanglement means that qubits in a superposition can be interrelated with each other; that is, the state of one qubit (whether it is a 1 or a 0) can depend on the state of another. As a result, qubits can act as far more sophisticated switches, enabling quantum computers to function in ways that allow them to solve difficult problems that are impossible to solve using classical computers or that would take them an exceedingly long time to solve.<sup>16</sup>

As of 2018, researchers have built fully programmable five-qubit quantum computers but such machines have limited capabilities. A near term goal is to build a 50-qubit computer that would achieve quantum supremacy—such a quantum computer would provide a computing capacity beyond that of any current or possible future classical supercomputer. Such systems are likely to be commercially available as early as 2022. By the end of the next decade, quantum computers on the order of 100,000-qubit systems will be available.<sup>17</sup> These computers will provide prodigious amounts of computer capacity and may be applied in the following ways:

- Enable advancements in the materials, chemistry, and drug industries by making accurate molecular-scale models possible for the discovery of new materials and drugs
- Model the behavior of atoms and particles at unusual conditions (for example, very high energies that can be only created in the Large Hadron Collider) without actually having to create those unusual conditions
- Improve weather forecasting by allowing for more detailed and accurate models

- Analyze the huge amounts of data gathered by satellites and surveillance cameras
- Enhance and analyze telescopic images to help astronomers spot more exoplanets, and help quickly identify which ones have the most potential to harbor life

One major concern is that quantum computers will be so powerful that they will be able to decrypt and read secret messages communicated over the Internet using the current encryption technologies. New encryption process will need to be designed and implemented.



## Critical Thinking Exercise

### Justifying Investment in Supercomputers

#### ► ANALYTICAL THINKING

You have been appointed to a committee tasked with lobbying the state and federal government for \$25 million in public funds to build and install a new supercomputer and associated hardware to support research performed by the university.

#### Review Questions

1. What capabilities does a supercomputer provide that other classes of computers cannot?
2. What hardware in addition to the supercomputer may be necessary to support the research?

#### Critical Thinking Questions

1. What advantages does use of a supercomputer have over creating a grid computing network?
2. In a single sentence each, briefly describe three different research projects that would require the power of a supercomputer.

## Server Farm, Data Centers, and Green Computing

This section will cover three topics that provide a good overview of what the computer industry and various organizations are doing to meet their computing needs in a more efficient and environmentally friendly manner.

### Server Farms

Often, an organization will house a large number of servers in the same room, where access to the machines can be controlled and authorized support personnel can more easily manage and maintain the servers. Such a facility is called a **server farm**. Apple, Google, Microsoft, the U.S. government, and many other organizations have built billion-dollar server farms in small rural communities where both land and electricity are cheap.

Server manufacturers are competing heavily to reduce the power required to operate their servers and are making “performance per watt” a key part of their product differentiation strategy. Low power usage is a critical factor for organizations that run server farms made up of hundreds or even thousands of servers. Typical servers draw up to 220 watts, although new servers based on Intel’s Atom microprocessor draw 8 or fewer watts. The annual power savings from such low-energy usage servers can amount to tens of thousands of dollars for operators of a large server farm. Server farm operators are also looking for low-cost, clean, renewable energy sources. For example, Google purchases renewable energy from wind and solar farms.<sup>18</sup>

**server farm:** A facility that houses a large number of servers in the same room, where access to the machines can be controlled and authorized support personnel can more easily manage and maintain the servers.

**blade server:** A server that houses many individual computer motherboards that include one or more processors, computer memory, computer storage, and computer network connections.

A **blade server** houses many computer motherboards that include one or more processors, computer memory, computer storage, and computer network connections. These all share a common power supply and air-cooling source within a single chassis. By placing many blades into a single chassis, and then mounting multiple chassis in a single rack, the blade server is more powerful but less expensive than traditional systems based on mainframes or server farms of individual computers. In addition, the blade server approach requires much less physical space than traditional server farms.

## Data Center

**data center:** A climate-and-access-controlled building or a set of buildings that houses the computer hardware that delivers an organization's data and information services.

A **data center** is a climate-and-access-controlled building or a set of buildings that houses the computer hardware that delivers an organization's data and information services.

Switch is a Las Vegas-based technology infrastructure organization whose core business is the design, construction, and operation of advanced data centers. Switch is the largest data center provider in Las Vegas with over 2 million square feet and whose facilities can generate 315 Megawatts of power. This is sufficient energy to power over 200,000 homes. The firm is known for its proprietary data center design and futuristic interiors. Switch customers include Amazon Web services, eBay, Hulu, and NASA.

Traditional data centers consist of warehouse-size buildings filled with row upon row of server racks and powerful air-conditioning systems designed to remove dust and humidity from the air and offset the heat generated by the processors. Such data centers can use as much energy as a small city and run up a power bill of millions of dollars per year. Indeed, energy costs can amount to 25 percent of the total cost of operating a data center, with hardware expenses and labor costs the other 75 percent. Businesses and technology vendors are working to develop data centers that run more efficiently and require less energy for processing and cooling.

About half the energy usage of a traditional data center goes to operate its computers. The other half goes to cooling the computers, removing dust and humidity from the air, and lighting the facility, along with other systems that sustain the data center. Such a data center has a power usage effectiveness (PUE) of 2.0.(PUE = total power consumed/power required to run the computers).The ideal goal is a PUE of 1.0, which would indicate that all the power goes to running the computers. Google has been able to build data centers that operate with a PUE of 1.09.<sup>19</sup>

In a further attempt to lower ongoing operating costs, many organizations are locating their data centers in areas with milder climates and lower energy rates and land costs. For organizations in the United States, this translates to rural locations in the south and the northwest. Apple, Google, and Facebook all operate major data centers in rural North Carolina.

The ability to absorb the impact of a disaster (e.g., hurricane, earthquake, terrorism attack, or war) and quickly restore services is a critical concern when it comes to the planning for new data centers. As a result, data centers of large information systems service organizations are often distributed among multiple locations in different areas of the country or even different countries to ensure continuous operations in the event of a disaster. If one data center in such an arrangement is affected by a disaster, its work load could be redirected to one or more of the distributed data centers not affected. Google has distributed its data centers with 8 in North America, 1 in South America, 2 in Asia, and 4 in Europe.<sup>20</sup>

Electric power is essential to the operation of a data center to run not only the servers and computers but also data storage devices, fire protection systems, physical security systems, and the HVAC (heating, ventilation, and air conditioning) system that controls the ambient environment (temperature, humidity, air flow, and air filtering) necessary for the safe operation of all the hardware. Power outages are not uncommon and can result from bad weather, natural disasters, acts of terrorism, equipment failure, power line damage, and other causes. An organization can incur significant financial losses and loss of customer goodwill if they are unable to conduct business for an extended length of time. As a result, most data centers employ battery operated uninterruptible power sources (UPS) that can provide several hours to a few days of backup power. Organizations needing guaranteed backup power longer than this will employ backup power generators to ensure that their critical systems can continue to run indefinitely even if the utility company cannot deliver power.

#### **four tiers of data center classification:**

**classification:** A system that enables organizations to quantify and qualify their ability to provide a predictable level of performance.

The Uptime Institute is a U.S. advisory group that has defined **four tiers of data center classification** to enable organizations to quantify and qualify their ability to provide a predictable level of performance based on expected annual downtime, fault tolerance, and power outage protection. These parameters are summarized in Table 4.5.<sup>21</sup> Tiers 1 and 2 may be appropriate for small organizations where a business disruption of several hours to a few days would not have a serious business impact and critical activities could be managed manually without computer assistance. Tiers 3 and 4 are needed by large organizations where a business disruption of a few hours would have serious financial consequences due to the inability to process customer orders, plan product shipments, manage manufacturing operations, and perform other critical activities. Tier 3 and 4 data centers employ redundant hardware, powerrelated devices, and alternate power sources. If cost were not a factor, organizations would implement a tier 3 or 4 data center; however, this should only be done when the cost of downtime associated with a tier 1 or 2 data center exceeds the cost of upgrading to a tier 3 or 4 data center.

**TABLE 4.5** Classification of data centers by tiers

Feature	Tier 1	Tier 2	Tier 3	Tier 4
<b>Expected annual downtime</b>	28.8 hours	22 hours	1.6 hours	26.3 minutes
<b>Fault tolerance</b>	No redundancy	Partial	N+1	2N+1
<b>Power outage protection</b>	None	A few hours	72 hours	96 hours

## Green Computing

Electronic devices such as computers and smartphones contain hundreds—or even thousands—of components, which are, in turn, composed of many different materials, including some [such as beryllium, cadmium, lead, mercury, brominated flame retardants (BFRs), selenium, and polyvinyl chloride] that are known to be potentially harmful to humans and the environment. Electronics manufacturing employees and suppliers at all steps along the supply chain and manufacturing process are at risk of unhealthy exposure to these raw

**green computing:** Concerned with the efficient and environmentally responsible design, manufacture, operation, and disposal of IT-related products, including all types of computing devices (from smartphones to supercomputers), printers, printer materials such as cartridges and toner, and storage devices.

materials. Users of these products can also be exposed to these materials when using poorly designed or improperly manufactured devices. Care must also be taken when recycling or destroying these devices to avoid contaminating the environment.

**Green computing** is concerned with the efficient and environmentally responsible design, manufacture, operation, and disposal of IT-related products, including all types of computing devices (from smartphones to supercomputers), printers, printer materials such as cartridges and toner, and storage devices. Green computing has three goals: (1) reduce the use of hazardous material, (2) allow companies to lower their power-related costs, and (3) enable the safe disposal or recycling of computers and computer-related equipment. Many business organizations recognize that going green is in their best interests in terms of public relations, employee safety, and the community at large. These organizations also recognize that green computing presents an opportunity to substantially reduce total costs over the life cycle of their IT equipment.

The United States generates more e-waste (includes discarded cell phones, computers, copiers, DVD players, fax machines, monitors, printers, TVs, VCRs) than any other country in the world—9.4 million tons/year. Only about 12.5 percent of this is recycled.<sup>22</sup> E-waste is the fastest growing municipal waste stream in the United States, according to the EPA. Because it is impossible for manufacturers to ensure safe recycling or disposal, the best practice would be for them to eliminate the use of toxic substances, particularly since recycling of used computers, monitors, and printers has raised concerns about toxicity and carcinogenicity of some of the substances. However, until manufacturers stop using these toxic substances, safe disposal and reclamation operations must be carried out carefully to avoid exposure in recycling operations and leaching of materials, such as heavy metals, from landfills and incinerator ashes. In many cases, recycling companies export large quantities of used electronics to companies in undeveloped countries. Unfortunately, many of these countries do not have strong environmental laws, and they sometimes fail to recognize the potential dangers of dealing with hazardous materials. In their defense, these countries point out that the United States and other first-world countries were allowed to develop robust economies and rise up out of poverty without the restrictions of strict environmental policies.

**electronic product environmental assessment tool (EPEAT):** A system that enables purchasers to evaluate, compare, and select electronic products based on a total of 51 environmental criteria.

**Electronic Product Environmental Assessment Tool (EPEAT)** is a system that enables purchasers to evaluate, compare, and select electronic products based on a total of 51 environmental criteria. Products are ranked in EPEAT according to three tiers of environmental performance: Bronze (meets all 23 required criteria), Silver (meets all 23 of the required criteria plus at least 50 percent of the optional criteria), and Gold (meets all 23 required criteria plus at least 75 percent of the optional criteria), as shown in Table 4.6. EPEAT was first implemented in 2006 with Computer and Displays (IEEE 1680.1 standard) and has now expanded to Imaging Equipment, under the IEEE 1680.2 standard from January 2013. EPEAT is managed by the Green Electronics Council and currently evaluates more than 4,400 products from more than 60 manufacturers across 43 countries.<sup>23</sup>

Individual purchasers as well as corporate purchasers of computers, printers, scanners, and multifunction devices can use the EPEAT website ([www.epeat.net](http://www.epeat.net)) to screen manufacturers and models based on environmental attributes. Since 2007, U.S. Federal agency purchasers have been directed to meet an annual commitment of 95 percent or higher EPEAT purchasing in all covered product categories, first by Presidential Executive Order and then by regulatory requirement.<sup>24</sup>

**TABLE 4.6** EPEAT product tiers for computers

Tier	Number of Required Criteria That Must Be Met	Number of Optional Criteria That Must Be Met
Bronze	All 23	None
Silver	All 23	At least 50%
Gold	All 23	At least 75%

SOURCE: "EPEAT Criteria," EPEAT, [www.epeat.net/resources/criteria-2](http://www.epeat.net/resources/criteria-2), accessed March 17, 2018.

The European Union's Restriction of Hazardous Substances Directive, which took effect in 2006, restricts the use of many hazardous materials in computer manufacturing. The directive also requires manufacturers to use at least 65 percent reusable or recyclable components, implement a plan to manage products at the end of their life cycle in an environmentally safe manner, and reduce or eliminate toxic material in their packaging. The state of California has passed a similar law, called the Electronic Waste Recycling Act. Because of these two acts, manufacturers had a strong motivation to remove brominated flame retardants from their PC casings.

Lenovo is a Chinese manufacturer of personal computers, tablets, smartphones, workstations, servers, electronic storage devices, and printers. Since 2007, the company's product development teams have been using increasing amounts of recycled plastics to meet new customer requirements, satisfy corporate environmental objectives and targets, and achieve EPEAT Gold registrations for its products. The company's efforts have resulted in the avoidance of up to 248 million pounds of CO<sub>2</sub> emissions since 2007.<sup>25</sup>



### Critical Thinking Exercise

#### Cost/Benefits of Green Computing

##### ► SOCIAL RESPONSIBILITY

Your organization wants to update the four-year-old laptop computers carried by its 200 sales and customer service reps to the latest technology. As a member of the sales organization, you have been asked to participate in choosing the portable computing device to be used. The committee spent considerable time defining the requirements the replacement device must meet and has narrowed its choice down to two contenders. They are both 2-in-1 tablets with dual processor CPUs each running at over 2.4 MHz. Both have screens that are about 12.3 inches, and both come with SSD and 128 GB of storage capacity. In other words, both devices are almost identical in terms of hardware specifications. However, one device meets all the EPEAT requirements to be rated as a gold product and costs \$150 more than the other choice that is rated a bronze product.

#### Review Questions

1. Why might the committee decide that 2-in-1 tablets versus just a regular tablet or laptop are necessary for the sales and customer service reps?
2. Should the committee consider tablets with touch screens or a screen that can interact with ink enabled pens? Why or why not?

#### Critical Thinking Questions

1. What additional steps should the committee take before reaching a final decision?
2. Should the committee choose more expensive device at an additional cost of \$30,000 to the company? If so, how can they justify this choice?

## System Software

**system software:** Software that includes operating systems, utilities, and middleware that coordinate the activities and functions of the hardware and other programs throughout the computer system.

**application software:** Programs that help users solve particular computing problems.

Software consists of computer programs that control the workings of computer hardware. Software can be divided into two types: systems software and application software. **System software** includes operating systems, utilities, and middleware that coordinate the activities and functions of the hardware and other programs throughout the computer system. **Application software** consists of programs that help users solve computing problems. Examples include a spreadsheet program or a program that captures and displays data that enables monitoring of a manufacturing process.

The effective use of software can have a profound impact on individuals and organizations. It can make the difference between profits and losses and between financial health and bankruptcy. Gartner estimates that around \$421 billion will be spent worldwide on enterprise software (excluding consumer spending) in 2019.<sup>26</sup> This is far different from when computers first were available; software was given away and customers paid only for the hardware. Indeed, the software industry was born in 1969 when IBM decided to unbundle—and charge customers separately for—its software and services. Although business computers had been in use since the mid-1950s, hardware manufacturers had previously bundled software with their hardware without charging separately for it.

The primary role of system software is to control the operations of computer hardware. System software also supports the problem-solving capabilities of application programs. System software can be divided into three types: operating systems, utility programs, and middleware.

**operating system (OS):** A set of computer programs that controls the computer hardware and acts as an interface to application software.

**kernel:** The heart of the operating system that controls the most critical processes of the OS.

## Operating Systems

An **operating system (OS)** is a set of programs that controls a computer's hardware and acts as an interface with application software; see Figure 4.8. The **kernel**, as its name suggests, is the heart of the OS and controls its most critical processes. The kernel ties all OS components together and regulates other programs. An operating system can control one or more computers, or it can

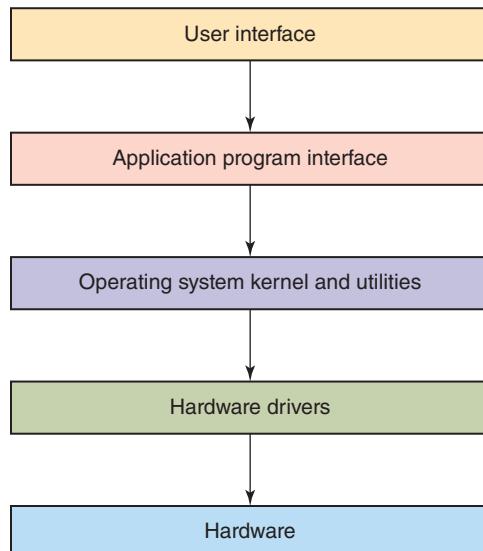


FIGURE 4.8

### Role of operating systems

The role of the operating system is to act as an interface between application software and hardware.

allow multiple users to interact with one computer. The various combinations of OSs, computers, and users include the following:

- Single computer with a single user. This system is commonly used in personal computers, tablets, and smartphones that support one user at a time. Examples of OSs for this setup include Microsoft Windows, macOS, and Google Android.
- Single computer with multiple simultaneous users. This type of system is used in larger server or mainframe computers that support hundreds or thousands of people, all using the computer at the same time. Examples of OSs that support this kind of system include UNIX, z/OS, and HP-UX.
- Multiple computers with multiple users. This type of system is used in computer networks, including home networks with several computers attached as well as large computer networks with hundreds of computers attached, supporting many users, who may be located around the world. Network server OSs include Red Hat Enterprise Linux Server, Windows Server, and Mac OS X Server.
- Special-purpose computers. This type of system is typical of a number of computers with specialized functions, such as those that control sophisticated military aircraft, digital cameras, or home appliances. Examples of OSs designed for these purposes include Windows Embedded, Symbian, and some distributions of Linux.

### **Functions Performed by the Operating System**

The programs that make up the OS perform a variety of activities, including the following:

- Control common computer hardware functions such as accepting input from the keyboard, retrieving data from a storage device, and displaying data on the screen.
- Provide a user interface and manage input/output operations.
- Provide a degree of hardware independence so that a software program can run on multiple computers, without concern for the specific underlying hardware.
- Manage memory is accessed, maximizing the use of available memory and storage to provide optimum efficiency.
- Manage processing tasks
- Provide networking capabilities so that computers can join together in a network to send and receive data and share computing resources
- Control access to system resources to provide a high level of security against unauthorized access to the users' data and programs as well as record who is using the system and for how long.
- Manage files to ensure that files are available when needed and that they are protected from access by unauthorized users.

Some operating systems provide sight interfaces that enable a computer to perform different commands or operations depending on where a person is looking on the screen. Some companies, including Neuralink backed by Elon Musk, are experimenting with sensors attached to the human brain to create interfaces that can detect brain waves and control a computer as a result. Sight and brain interfaces can be very helpful to disabled individuals.<sup>27</sup>

### **Task Management**

Operating systems use the following five approaches to task management to increase the amount of processing that can be accomplished in a given amount of time:

- Multiuser. Enables two or more users to run programs at the same time on the same computer. Some operating systems permit hundreds or even

thousands of concurrent users. The ability of the computer to handle an increasing number of concurrent users smoothly is called scalability.

- Multiprocessing. Supports running a program on more than one CPU.
- Multitasking. Enables more than one program to run concurrently.
- Multithreading. Enables different threads of a single program to run concurrently. A thread is a set of instructions within an application that is independent of other threads. For example, in a spreadsheet program, the thread to open the workbook is separate from the thread to sum a column of figures.
- Real-time. Responds to input instantly. To do this, the operating system task scheduler can stop any task at any point in its execution if it determines that another higher priority task needs to run immediately. Real-time operating systems are used to control the operation of jet engines, the deployment of air bags, and the operation of antilock braking systems—among other uses.

Not all operating systems employ all these approaches to task management. For example, the general-purpose operating systems with which we are most familiar (e.g., Windows and Mac OS) cannot support real-time processing.

## Current Operating Systems

Today's operating systems incorporate sophisticated features and capabilities. Table 4.7 classifies a few current operating systems by sphere of influence.

**TABLE 4.7** Operating systems by sphere of influence

Personal	Workgroup	Enterprise
Microsoft Windows	Microsoft Windows Server	Microsoft Windows Server
Mac OS X, iOS	Mac OS X Server	—
Linux	Linux	Linux
Google Android, Chrome OS	UNIX	UNIX
HP webOS	IBM i and z/OS	IBM i and z/OS
—	HP-UX	HP-UX

From time to time, software manufacturers drop support for older operating systems—meaning that although computers and software running under these operating systems will continue to run, the operating system manufacturer will no longer provide security fixes and updates. Without such patches, the users' computers are more susceptible to being infected by viruses and malware. For example, Google dropped support for Windows XP and Vista users running on its Chrome browser.<sup>28</sup>

Discontinuance of support is a strong reason to upgrade to new software. However, many organizations take the approach that “if it ain’t broke, don’t fix it.” In their view, other projects take priority over updating software that is still functioning. However, this approach can lead to interruptions in key systems. For example, planes were grounded for several hours at Paris’ busy Orly airport when a computer that links air traffic control systems with France’s main weather bureau stopped working. The computer was running on Windows 3.1, a 25-year-old operating system dropped from support by Microsoft over a dozen years ago.<sup>29</sup>

### **Microsoft PC Operating Systems**

In 1980, executives from IBM approached Microsoft's Bill Gates regarding the creation of an operating system for IBM's first personal computer. That operating system, which was ultimately called Microsoft Disk Operating System (MS-DOS), was based on Microsoft's purchase of the Quick and Dirty Operating System (QDOS) written by Tim Paterson of Seattle Computer Products. Microsoft bought the rights to QDOS for \$50,000. QDOS, in turn, was based on Gary Kildall's Control Program for Microcomputers (CP/M).

As part of its agreement with Microsoft, IBM allowed Microsoft to retain the rights to MS-DOS and to market MS-DOS separately from the IBM personal computer. The rest is history, with Gates and Microsoft earning a fortune from the licensing of MS-DOS and its descendants.<sup>30</sup> MS-DOS, which had a command-based interface that was difficult to learn and use, gave way to the more user-friendly Windows 1.0 operating system in 1985. This was Microsoft's first true attempt at a graphical user interface and it relied heavily on use of a mouse before the mouse was a common computer input device.

With its launch of Windows 10, Microsoft announced that it is moving away from its usual practice of releasing major new versions of its Windows operating system every few years. Instead, the company provides ongoing, incremental upgrades and improvements, rolled out automatically, a few times each year. Unless users change the automatic update setting, they receive these updates as soon as they come out. Organizations, whose information systems professionals desire minimal change in order to ensure reliable operations of corporate applications, may elect to opt out of such frequent updates. Microsoft hopes that the automatic, rapid update cycle will force users to stay current so that all hardware devices work as intended, new features are added to existing software, and ensure that the latest security patches are installed for users' safety.

The Windows 10 operating system is built on a single, common kernel called OneCore that works across a variety of devices, from phones, tablets, personal computers, large-screen displays, the Xbox, and even the HoloLens (the Microsoft headband that enables users to view holograms). This means that application developers working with Windows 10 can target the same core environment for their apps, and such apps will work across a range of screen sizes and devices including computers, tablets, and smartphones. This represents the achievement of a goal that Microsoft has had for more than 20 years: Windows Everywhere with a potential market of one billion users.<sup>31</sup>

### **Apple Computer Operating Systems**

In July 2001, Mac OS X was released as an entirely new operating system for the Mac. Based on the UNIX operating system, Mac OS X included a new user interface with luminous and semi-transparent elements, such as buttons, scroll bars, and windows along with fluid animation to enhance the user's experience.

Since its first operating system release, Mac OS X 10.0 in 2001, Apple has upgraded OS X almost every year. The first eight versions of the OS were named after big cats, the latest are named after places in California. OS X 10.13, also known as macOS High Sierra, is Apple's latest operating system. macOS Sierra offers many updates to provide improved security and performance as well as longer battery life.<sup>32</sup>

Because macOS runs on Intel processors, Mac users can set up their computers to run both Windows and macOS and select the platform they want to work with when they boot their computers. Such an arrangement is called dual booting. While Macs can dual boot into Windows, the opposite is not true. macOS cannot be run on any machine other than an Apple device. However, Windows PCs can dual boot with Linux and other OSs.

## Linux

Linux is an OS developed in 1991 by Linus Torvalds as a student in Finland. The OS is distributed under the GNU General Public License, and its source code is freely available to everyone. It is, therefore, called an open-source operating system.

Individuals and organizations can use the open-source Linux code to create their own distribution (flavor) of Linux. A distribution consists of the Linux kernel (the core of the operating system)—which controls the hardware, manages files, separates processes, and performs other basic functions—along with other software. This other software defines the terminal interface and available commands, produces the graphical user interface, and provides other useful utility programs. A Linux distributor takes all the code for these programs and combines it into a single operating system that can be installed on a computer. The distributor may also add finishing touches that determine how the desktop looks, what color schemes and character sets are displayed, and what browser and other optional software are included with the operating system. Typically, the distribution is “optimized” to perform in a particular environment, such as for a desktop computer, server, or TV cable box controller.

Hundreds of distributions of Linux have been created. Many distributions are available as free downloads. Three of the most widely used distributions come from software companies Red Hat, SUSE, and Canonical. Although the Linux kernel is free software, both Red Hat and SUSE produce retail versions of the operating system that earn them revenues through distribution and service of the software. openSUSE is the distribution sponsored by SUSE.

Paddy Power Betfair is a large online betting company based in Dublin, Ireland that must handle 130 million transactions each day in a fast and secure manner. Its systems must operate reliably in a 24 × 7 environment that provides for updates and maintenance without affecting customers. The firm selected the Red Hat Enterprise Linux operating system to provide a stable and secure platform to support its data center.<sup>33</sup>

## Google Android and Apple iOS

Smartphones now employ full-fledged personal computer operating systems such as the Google Android and Apple iOS that determine the functionality of your phone and the applications that you can run. These operating systems have software development kits that allow developers to design thousands of apps providing a myriad of mobile services. When it comes to smart phone operating systems, Google Android has achieved over 80 percent of the worldwide market share and there are over 3.3 million apps available. Apple iOS holds the remaining share of the market and there are over 2.2 million apps available.<sup>34,35,36</sup> For tablet operating systems, Android has a 65 percent worldwide market share and iOS has a 33 percent market share.<sup>37</sup>

## Windows Server

Microsoft designed the Windows Server workgroup operating system to perform a host of tasks that are vital for Web sites and corporate Web applications. For example, Microsoft Windows Server can be used to coordinate and manage large data centers. Windows Server delivers benefits such as a powerful Web server management system, virtualization tools that allow various operating systems to run on a single server, advanced security features, and robust administrative support. Windows Home Server allows individuals to connect multiple PCs, storage devices, printers, and other devices into a home network. Windows Home Servers provides a convenient way for home users to store and manage photos, video, music, and other digital content. It also provides backup and data recovery functions.

## UNIX

UNIX is a powerful OS originally developed by AT&T for minicomputers—the predecessors of servers, which were larger and more powerful than PCs but smaller and less powerful than mainframes. UNIX can be used on many computer system types and platforms, including workstations, servers, and mainframe computers. UNIX also makes it easy to move programs and data among computers or to connect mainframes and workstations to share resources. There are many variants of UNIX, including HP-UX from Hewlett-Packard Enterprise, AIX from IBM, and Solaris from Oracle. The UNIX platform (a computer capable of running the UNIX operating system plus the operating system itself) is considered a high-cost platform compared to Linux and Windows Server.

The Credit Information Bureau India Limited (CIBIL) collects consumer financial data to create credit reports and scores that are provided to lenders to help them evaluate applications for loans. This is a very high-volume business with millions of reports generated each day. CIBIL employs blade servers running the HP-UX operating system to meet this demand.<sup>38</sup>

## Mac OS X Server

The Mac OS X Server is the first modern server OS from Apple Computer, and it is based on the UNIX OS. Designed for OS X and iOS, OS X Server makes it easy to collaborate, develop software, host Web sites and wikis, configure Mac and iOS devices, and remotely access a network. Smartphone users running iOS can now open, edit, and save documents on OS X Server.

## Running Multiple Operating Systems with Server Virtualization

During the 1990s, organizations used to dedicate one server to each application. This allowed easy, although expensive backup in the event of a server failure. The application would simply be moved to a standby server. It also avoided software incompatibility issues between the operating system running on the server and the operating system on which the application could run. The one and only one operating system running on the server would be one on which the application could run. With advances in the speed and computing power of servers, the individual applications were only using 25 percent or less of the server hardware capacity—very wasteful.

**Server virtualization** is an approach to improving hardware utilization by logically dividing the resources of a single physical server to create multiple logical servers called virtual machines. Each virtual machine acts as its own dedicated machine. The server on which one or more virtual machines are running is called the host server. Each virtual machine includes its own guest operating system to manage the user interface and control how the virtual machine uses the host server's hardware. Thus, several different operating systems can run on a virtualized server.

The **hypervisor** is a virtual server program that controls the host processor and resources, allocates the necessary resources to each virtual machine, and ensures that they do not disrupt each other. VMware from Dell Technologies and Microsoft Hyper-V are the two dominant hypervisor vendors. Over three-fourths of organizations employ virtualization.<sup>39</sup> Figure 4.9 depicts the server virtualization environment.

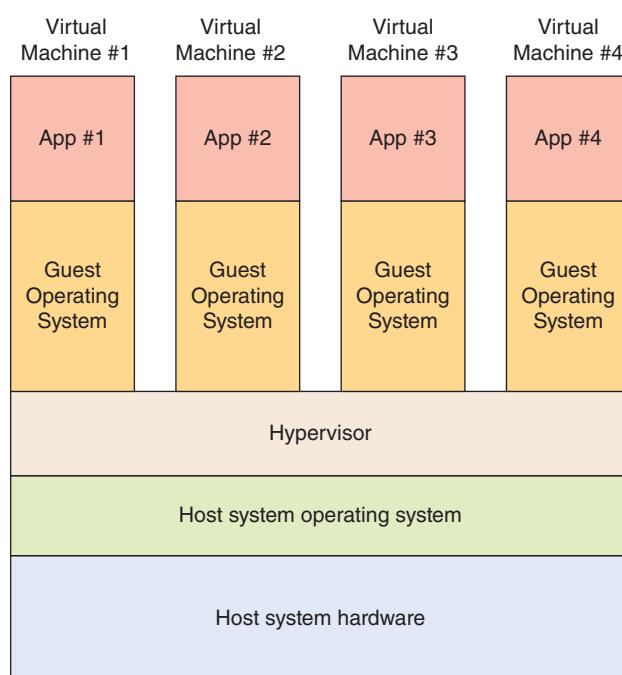
With server virtualization, the server can run several server applications concurrently and operate at much higher level of total capacity—perhaps 80 percent or more. As a result, a data center with say 400 physical servers could be converted to a virtualized environment with perhaps as few as 24 virtualized servers. There would be a huge savings in capital costs for hardware and because there are fewer servers, there would be additional ongoing savings in energy costs to power the servers and cool the data center. Also, fewer software licenses are required for fewer physical machines and fewer personnel

**server virtualization:** A method of logically dividing the resources of a single physical server to create multiple logical servers, each acting as its own dedicated machine.

**hypervisor:** A virtual server program that controls the host processor and resources, allocates the necessary resources to each virtual system, and ensures that they do not disrupt each other.

**FIGURE 4.9**  
**Server virtualization**

Virtualization is an approach to improving hardware utilization by logically dividing the resources of a single physical server to create multiple logical servers called virtual machines.



are required to operate and maintain the servers. Thus, server virtualization provides three benefits: (1) lower capital costs for hardware, (2) savings in energy costs to operate and cool the data center, and (3) savings in software licenses and personnel costs.

PKO Bank Polski S.A. is the largest commercial bank in Poland providing service to over 9 million customers. The bank's information systems must operate  $24 \times 7$  with a goal of less than 1 hour of unscheduled downtime per year. Server virtualization is now a standard for critical applications at the bank and this strategy has reduced hardware related costs, cut unscheduled downtime for applications, and reduced the time spent on problem solving.<sup>40</sup>

### Enterprise Operating Systems

Mainframe computers, often referred to as "Big Iron," provide the computing and storage capacity required for massive data-processing environments, and they provide systems that can support many users while delivering high performance and excellent system availability, strong security, and scalability. A wide range of application software has been developed to run in the mainframe environment, making it possible to purchase software to address almost any business problem. Examples of mainframe OSs include z/OS from IBM, HP-UX from Hewlett-Packard, and Linux. The z/OS is IBM's first 64-bit enterprise OS and is capable of handling very heavy workloads, including serving thousands of concurrent users and running an organization's critical applications. (The z stands for zero downtime.)

### Embedded Operating Systems

An **embedded system** is a computer system that is implanted in and dedicated to the control of another device often within a larger mechanical or electrical system. An embedded system is designed with one purpose in mind while a general-purpose computer can be used for many tasks. Embedded systems control many devices in common use today, including video game consoles, ATM machines, TV cable boxes, digital watches, digital cameras, MP3 players, calculators, microwave ovens, washing machines, and traffic lights. The typical car contains many embedded systems, including those that control antilock brakes, air bag deployment, fuel injection, active suspension devices, transmission control, and cruise control.

**embedded system:** A computer system (including some sort of processor) that is implanted in and dedicated to the control of another device.

The U.S. power grid is extremely complex consisting of over 200,000 miles of transmission lines managed by some 500 companies. The grid is designed so that peak energy demand in one area of the country can be met by using electricity generated elsewhere. Embedded computers are used to monitor energy generation, transmission, distribution, and usage, thus enabling intelligent real-time decisions regarding its operation to be made. See Figure 4.10. Alarmingly, as Ted Koppel points out in his book *Lights Out*, a well-designed cyberattack on the power grid could cripple our power grid affecting tens of millions of people.

**FIGURE 4.10**  
**Electrical grid near urban area**

U.S. Power grid relies on embedded systems to help control and manage its operation.



urbans/Shutterstock.com

An embedded operating system is designed to run in computers with a limited amount of memory and it must be highly reliable. As a result, it may not perform many of the functions that nonembedded computer operating systems provide, just those functions that are required by the specialized application it runs. Furthermore, unlike other operating systems, an embedded operating system does not load and execute multiple applications. An embedded operating system is only able to run a single application. Some of the more popular OSs for embedded systems include Google Android Things, the Windows IoT family of Microsoft embedded operating systems, many variations of embedded Linux, Lynx Software's LynxOS, Blackberry's QNX used to build autonomous cars, and Wind River's VxWorks.

Swiss-based Liebherr collaborated with Microsoft to create the SmartDeviceBox to provide interesting new capabilities to their refrigerators. Based on the Windows 10 IoT Core operating system, the SmartDeviceBox is about twice the size of a large USB drive and plugs directly into a port on most of the brand's newest refrigerators. With it you can view the status of your refrigerator online and make changes to its settings from any location. If a problem occurs with your refrigerator (e.g., the temperature varies outside the desired setting), you are notified by means of an alarm message sent to your smartphone or tablet. The Media Intelligence Assistant voice module enables you to verbally add additional groceries to your shopping list which you can access via a mobile app while you are in the supermarket.<sup>41</sup>

The Wii gaming console uses an embedded operating system based on the Linux kernel. Linux is a popular choice for embedded systems because it is free and highly configurable. It has been used in many embedded systems, including e-book readers, ATMs, smartphones, networking devices, and media players.

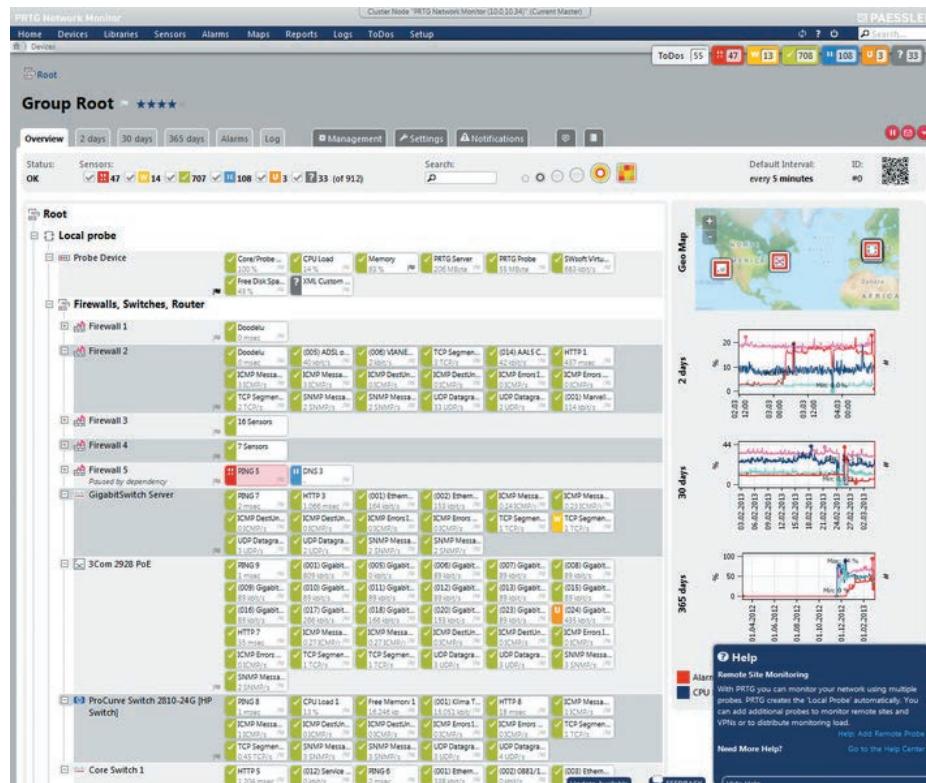
### Utility Programs

**utility programs:** A program that helps to perform maintenance or correct problems with a computer system.

**Utility programs** perform a variety of tasks typically related to system maintenance or problem correction. For example, there are utility programs designed to merge and sort sets of data, keep track of computer jobs being run, compress data files before they are stored or transmitted over a network (thus saving space and time), and perform other important tasks.

Just as your car engine runs best if it has regular maintenance, computers also need regular maintenance to ensure optimal performance. Over time, your computer's performance can start to diminish as system errors occur, files clutter your hard drive, and security vulnerabilities materialize. Sysinternals Suite is a collection of Windows utilities that can be downloaded for free from the Microsoft TechNet Web site. These utilities can be used to boost the performance of a slow PC, repair errors in the registry and on a hard drive, remove unnecessary files, improve system security and privacy, and optimize sluggish system processes.

Although many PC utility programs come installed on computers, you can also purchase utility programs separately. There are hardware utilities that can be used to check the status of all parts of the PC, including hard disks, memory, modems, speakers, and printers. Disk utilities check the hard disk's boot sector, file allocation tables, and directories and analyze them to ensure that the hard disk is not damaged. Antivirus and antimalware utilities can be used to constantly monitor and protect a computer. If a virus or other malware is found, it can often be removed. File-compression utilities can reduce the amount of disk space required to store a file or reduce the time it takes to transfer a file over the Internet. Both Windows and Mac operating systems let you compress or decompress files and folders. A broad range of network- and systems-management utility software is available to monitor hardware and network performance and trigger an alert when a server is crashing or a network problem occurs. IBM's Tivoli Netcool Network Management, Hewlett-Packard's Automated Network Management Suite, and Paessler's PRTG Network Monitor can be used to solve computer network problems and help save money (see Figure 4.11).



**FIGURE 4.11**  
**PRTG network monitor**

PRTG network monitor and other network utility software can help you to keep track of network components, traffic flows, and network performance.

Source: Paessler AG

Managing the vast array of operating systems for smartphones and mobile devices has been difficult for many companies. Many organizations unwisely allow employees to connect to corporate databases using smartphones and mobile devices with little or no guidance. Utility programs called mobile device

management (MDM) software can help a company manage security, enforce corporate strategies, and control downloads and content streaming from corporate databases into smartphones and mobile devices. They can even be used to wipe a device of all apps and data if it is lost or stolen. Brookdale Senior Living is a major owner and operator of senior living communities, operating over 1,100 senior living communities and retirement communities in the United States. The organization employs MDM software to enable the clinical staff to safely access and update medical records from remote sites and ensure that sensitive patient data is always secure.<sup>42</sup>

**middleware:** Software that allows various systems to communicate and exchange data.

**service-oriented architecture (SOA):** A software design approach based on the use of discrete pieces of software (modules) to provide specific functions as services to other applications.

**application programming interfaces (API):** A set of programming instructions and standards that enable one microservice to access and use the services of another microservice.

### Middleware

**Middleware** is software that provides messaging services that allow different applications to communicate and exchange data. Middleware is software that lies between an operating system and the applications running on it. For example, it can be used to transfer a request for information from a corporate customer on the company Web site to a traditional database on a mainframe computer and to return the results of that information request to the customer on the Internet.

The use of middleware to connect disparate systems has evolved into an approach for developing software and systems called SOA. **Service-oriented architecture (SOA)** is a software design approach based on the use of discrete pieces of software (modules) to provide specific functions (such as displaying a customer's bill statement) as services to other applications. Each module is built in such a way that ensures that the service it provides can exchange information with any other service without human interaction and without the need to make changes to the underlying program itself. In this manner, multiple modules can be combined to provide the complete functionality of a large, complex software application. Systems developed with SOA are highly flexible, as they allow for the addition of new modules that provide new services required to meet the needs of the business as they evolve and change over time.

Many organizations have taken the SOA approach to the extreme and built complex applications using a series of smaller specialized applications called microservices. Each microservice performs a single well-defined function. Microservices communicate to one another using agreed upon interfaces called **application programming interfaces (API)**. This enables many microservices to be linked together in Lego fashion to create a large, complex, multifunctional application. A major advantage of the SOA approach is that a microservice built for one application may be reused in another application to perform the same function. Reapplication of proven microservices greatly reduces software development time and improves software quality.

Expedia, Inc., the U.S. travel company, employs a software development strategy based on microservices. Its Checkout online payment function that supports billions of dollars in transactions and has a huge number of features has been subdivided into a series of much smaller and more logical-like sets of microservices. The benefit of smaller, segmented applications is that Expedia can update these microservices quicker or quickly add new microservices providing new services. Currently Expedia follows a weekly deployment cycle but will eventually shorten this to daily software releases allowing developers to try out new ideas and add new features quickly.<sup>43</sup>



### Critical Thinking Exercise

#### Embedded System for Smart Oven

##### ► TECHNOLOGY AGILITY

You are designing an app and a state-of-the-art “smart” oven that can be controlled remotely via smartphone. The app allows the user to select cooking time, temperature, start, stop, set time of day, and cancel. The oven has a display to show the

cooking time left, temperature, and time of day. In addition, the oven has a heating element for cooking the food, a door sensor to sense when the door is open, and a weight sensor to detect if there is an item in the oven. A beeper sounds when the cooking time is expired. It is possible to cook at item for a period of time at one temperature, stop, and then reset the temperature and cook for a while at another temperature. Cooking is only permitted when the door is closed and when there is something in the oven. Cooking can be interrupted at any time by opening the oven door or entering the stop command to the app. Cooking is terminated when the timer elapses. When the door is open a lamp inside the oven is switched on; when the door is closed the lamp is off.

### Review Questions

1. What operating systems could be employed in the smartphone?
2. What operating systems could be employed in the embedded system to control the oven? Must this be a real-time operating system? Why or why not?

### Critical Thinking Questions

1. What safety features should be designed into the software? Should these features be programmed into the smartphone app or the software that operates the stove or both?
2. What are some creative additional features that might be designed into the oven?

## Application Software

The primary function of application software is to apply the power of a computer system to enable people, workgroups, and entire enterprises to solve problems and perform specific tasks. Millions of software applications have been created to perform a variety of functions on a wide range of operating systems and device types. The following are some of the dozens of categories of applications:

Business	Genealogy	Personal information manager
Communications	Language	Photography
Computer-aided design	Legal	Public safety
Desktop publishing	Library	Science
Educational	Medical	Simulation
Entertainment	Multimedia	Video
Gaming	Music	Video games

In almost any category of software, you will find many options from which to choose. For example, Microsoft Internet Explorer and Edge, Mozilla Firefox, Google Chrome, Apple Safari, and Opera are all popular Web browsers that enable users to surf the Web. The availability of many software options enables users to select the software that best meets the needs of the individual, workgroup, or enterprise. For example, the Procter & Gamble Company, a large, multi-national organization, chose the SAP Enterprise Resource Planning software with its vast array of options, features, and functionality to meet its complex global accounting needs. However, a small neighborhood bakery might decide that Intuit's QuickBooks, an accounting software package designed for small businesses, meets its simple accounting needs.

## Overview of Application Software

Proprietary software and off-the-shelf software are two important types of application software. The relative advantages and disadvantages of proprietary software and off-the-shelf software are summarized in Table 4.8. The primary advantages of proprietary software are that you are directly involved in the development of the software and so are more likely to get the features that are needed. You also have control over the changes made to the software to meet evolving needs. The disadvantages of proprietary software are that it can take a significant amount of time and resources to develop, in-house system development staff may be hard-pressed to provide the required level of ongoing support and maintenance, and there is significant risk the project may exceed budget and schedule. The advantages of off-the-shelf software are the initial cost is likely less, the users can evaluate the features of the software to ensure that it meets their needs, and the software is likely to be of high quality. The disadvantages of off-the-shelf software are it may come with features not needed, it may lack important features necessitating expensive customization, and the software may not match current work processes and data standards.

**TABLE 4.8** Comparison of proprietary and off-the-shelf software

Proprietary Software		Off-the-Shelf Software	
Advantages	Disadvantages	Advantages	Disadvantages
You can get exactly what you need in terms of features, reports, and so on.	It can take a long time and a significant amount of resources to develop required features.	The initial cost is lower because the software firm can spread the development costs across many customers.	An organization might have to pay for features that it does not require and never uses.
Being involved in the development offers more control over the results.	In-house system development staff may be hard-pressed to provide the required level of ongoing support and maintenance because of pressure to move on to other new projects.	The software is likely to meet the basic business needs. Users have the opportunity to more fully analyze existing features and the performance of the package before purchasing.	The software might lack important features, thus requiring future modification or customization. This can be very expensive, and because users will eventually be required to adopt future releases of the software, the customization work might need to be repeated.
You can more easily modify the software and add features. This can help you to counteract an initiative by competitors or to meet new supplier or customer demands.	The features and performance of software that has yet to be developed presents more potential risk.	The package is likely to be of high quality because many customer firms have tested the software and helped identify its bugs.	The software might not match current work processes and data standards.

**proprietary software:** One-of-a-kind software designed for a specific application and for an individual company, organization, or person that uses it.

**Proprietary software** is one-of-a-kind software designed for a specific application and for an individual company, organization, or person that uses it. Proprietary software can give a company a competitive advantage by providing services or solving problems in a unique manner—better than methods used by a competitor. For example, Amazon's proprietary e-commerce software employs its patented 1-Click checkout process that enables customers to complete a purchase with a single click using payment credentials and shipping information previously stored with Amazon. This eliminates the tedious and

error prone step of manually entering payment card and shipping address information. 1-Click also enables Amazon Echo owners to complete a purchase with a single voice command. Other companies that wish to employ the 1-Click checkout process must pay a license fee to Amazon, thus the software has created a competitive advantage. It is estimated that Amazon's exclusive hold on this process has earned it billions in licensing fees.<sup>44</sup>

**off-the-shelf software:** Software produced by software vendors to address needs that are common across businesses, organizations, or individuals.

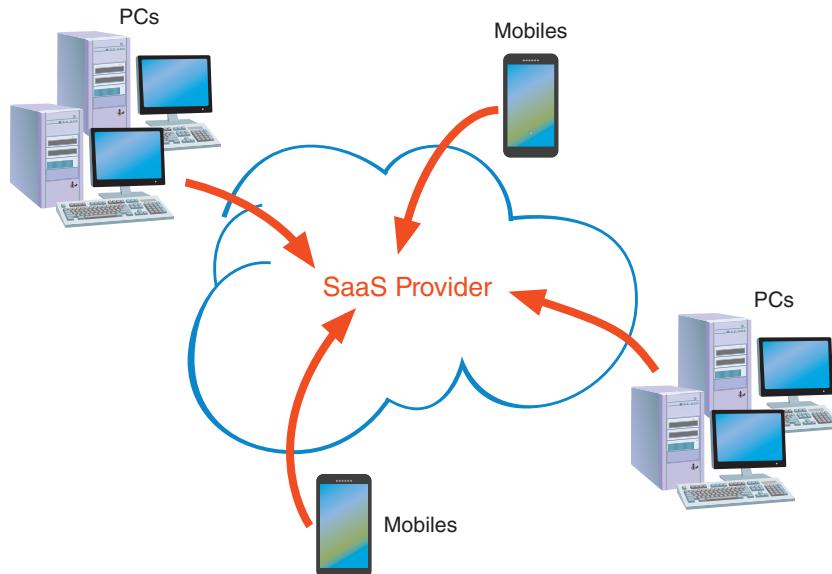
**Off-the-shelf software** is produced by software vendors to address needs that are common across businesses, organizations, or individuals. Literally thousands of small, medium, and large companies around the world employ off-the-shelf software from German software manufacturer SAP to support their routine business processes, maintain records about those processes, and provide extensive reporting and data analysis capabilities.

## Software as a Service (SaaS)

**Software as a service (SaaS)** is a software distribution model under which a third-party provider hosts applications and makes them available to subscribers over the Internet as shown in Figure 4.12. In most cases, subscribers pay a monthly service charge or a per-use fee. Many business activities are supported by SaaS. SaaS providers include Oracle, SAP, NetSuite, Salesforce, Google, and many others. There are several advantages associated with the SaaS model, as follows:

- SaaS applications are available from any computer or any device—anytime, anywhere. Users simply logon to the SaaS vendor's Web site and enter a logon and password to access the software and their data.
- Since the SaaS provider manages all upgrades and new releases, there are no software patches for customers to download or install. This frees up time for members of the IS organization and ensures users always have access to the latest most up-to-date version of the software.
- The cost associated with upgrades and new releases are lower than the traditional software licensing model that usually forces the user to buy an upgrade package and install it.
- The SaaS provider manages service levels and availability, so there's no need for subscribers to add hardware, software, or communications capacity as the number of users increases.

**FIGURE 4.12**  
**Software as a service**



Google's Chromebook line of personal computers employ the SaaS model. Built by Samsung and Acer, Chromebooks include only an Internet browser—with all software applications accessed through an Internet connection. Rather than installing, storing, and running software on the Chromebook, users access software that is stored on and delivered from a Web server. Typically, the data generated by the software is also stored on the Web server.

## Personal Application Software

Hundreds of thousands of personal software applications are available to meet the needs of individuals at school, home, and work—with new applications released daily. New computer software under development, along with existing GPS technology, for example, will enable people to see 3D views of where they are, along with directions and 3D maps to where they would like to go. The features of some popular types of personal application software are summarized in Table 4.9. In addition to these general-purpose programs, thousands of other personal computer applications perform specialized tasks that help users prepare their taxes, get in shape, lose weight, get medical advice, write wills and other legal documents, repair their computers, fix their cars, write music, and edit pictures and videos. This type of software, often called user software or personal productivity software, includes the general-purpose tools and programs that support individual needs.

**TABLE 4.9** Examples of personal application software

Type of Software	Use	Example
Word processing	Create, edit, and print text documents	Apache OpenOffice Writer Apple Pages Corel Write Google Docs Microsoft Word WordPerfect
Spreadsheet	Perform statistical, financial, logical, database, graphics, and date and time calculations using a wide range of built-in functions	Apache OpenOffice Calc Apple Numbers Google Sheets IBM Lotus 1-2-3 Microsoft Excel
Database	Store, manipulate, and retrieve data	Apache OpenOffice Base Microsoft Access IBM Lotus Approach
Graphics	Develop graphs, illustrations, drawings, and presentations	Adobe FreeHand Adobe Illustrator Apache OpenOffice Impress Microsoft PowerPoint
Personal information management	Helps people, groups, and organizations store useful information, such as a list of tasks to complete or a set of names and addresses	Google Calendar Microsoft Calendar Microsoft Outlook One Note
Project management	Plan, schedule, allocate, and control people and resources (money, time, and technology) needed to complete a project according to schedule	Microsoft Project Scitor Project Scheduler
Financial management	Track income and expenses and create reports to create and monitor budgets (some programs also have investment portfolio management features)	GnuCash Intuit Mint Intuit Quicken Moneydance You Need a Budget (YNAB)
Desktop publishing (DTP)	Use with personal computers and high-resolution printers to create high-quality printed output, including text and graphics; various styles of pages can be laid out; art and text files from other programs can also be integrated into published pages	Adobe InDesign Apple Pages Corel Ventura Publisher Microsoft Publisher QuarkXpress

## Software Suites and Integrated Software Packages

**software suite:** A collection of programs packaged together and sold in a bundle.

A **software suite** is a collection of programs packaged together and sold in a bundle. A software suite might include a word processor, a spreadsheet program, a database management system, a graphics program, communications and note-taking tools, and organizers. Some suites support the development of Web pages. Some offer a speech-recognition feature—so that applications in the suite can accept voice commands and record dictation. Software suites offer many advantages. The software programs within a suite have been designed to work similarly—after you learn the basics for one application, the other applications are easy to learn and use. Buying software in a bundled suite is cost effective; the programs usually sell for a fraction of what they would cost individually.

Table 4.10 lists the most popular general-purpose software suites for personal computer users. Most of these software suites include a spreadsheet program, a word processor, a database program, and graphics presentation software. All can exchange documents, data, and diagrams. In other words, you can create a spreadsheet and then cut and paste that spreadsheet into a document created using the word-processing application.

**TABLE 4.10** Major components of leading software suites

Personal Productivity Function	Microsoft Office	Corel WordPerfect Office	Apache OpenOffice	Apple iWork	G Suite (Google Apps)
Word processing	Word	WordPerfect	Writer	Pages	Docs
Spreadsheet	Excel	Quattro Pro	Calc	Numbers	Sheets
Presentation graphics	PowerPoint	Presentations	Impress and Draw	Keynote	Slides
Database	Access	Paradox	Base	N/A	N/A

Microsoft, Apple, and Google also offer Web-based productivity software suites that do not require the installation of any software on your device except a Web browser. Figure 4.13 depicts the Microsoft Office 365 Software as a Service. These Software as a Service cloud-based applications cost on the order of \$10 per user per month depending on the features and the amount of cloud-based storage requested.

Whirlpool is a leading manufacturer and marketer of major home appliances with 68,000 employees and 66 manufacturing and technology research centers around the world. A key challenge it faces is the need to innovate faster. Its CIO believes that Google Apps helps to connect its employees to think, share ideas, and move faster to bring products to the marketplace. This enables Whirlpool to unleash the talent in the company without a lot of IT support.<sup>45</sup>

## Other Personal Application Software

In addition to the software already discussed, many other interesting and powerful application software tools are available for personal and business use, as follows:

- CreditKarma Tax, TaxAct, Tax Slayer, and TurboTax are popular tax-preparation programs that each year saves millions of people many hours and even dollars in preparing their taxes.
- With just a quick online search, you can find software for creating Web sites, composing music, and editing photos and videos. MuseScore, for example, enables you to create, play back, and print sheet music.

**FIGURE 4.13**

### Office 365 software as a service

Microsoft Office 365 is a web-based application suite that offers basic software suite features over the internet using cloud computing.



#### What's included

Get the latest Office, business-class email, document sharing, and web meetings—rich productivity services for modern users with the IT flexibility and control you need.

#### Office applications



#### Compliance and BI

Control access, prevent data loss, and gain insight fast with advanced tools

#### IT flexibility and control

Deploy on your terms and monitor your system's health in real time

- Many people use educational and reference software and software for entertainment, games, and leisure activities. Game-playing software is popular and can be very profitable for companies that develop games and various game accessories, including virtual avatars such as colorful animals, fish, and people.
- Some organizations have launched programs designed to promote physical activity by incorporating the use of active video games (e.g., Wii Boxing and Dance Dance Revolution) into broader physical education programs. Retirement communities also use video games to keep seniors physically active.
- Engineers, architects, and designers often use computer-assisted design (CAD) software to design and develop buildings, electrical systems, plumbing systems, and more. AutoSketch, CorelCAD, and AutoCAD are examples of CAD software.
- Other programs perform a wide array of statistical tests. Colleges and universities offer many courses in statistics that use this type of application software. Two popular statistical analytics applications in the social sciences are SPSS and SAS.

Software companies are even developing mobile apps that are changing the whole dating scene. For example, SceneTap, an application for iPhones and Android devices, can determine the number of people at participating bars, pubs, or similar establishments and the ratio of males to females. The application uses video cameras and facial-recognition software to identify males and females. SocialCamera, an application for Android phones, allows people to take a picture of someone and then search their Facebook friends for a match. However, many people consider facial-recognition software a potential invasion to privacy.

## Mobile Application Software

The number of applications (apps) for smartphones and other mobile devices has exploded in recent years. Besides the proprietary apps that come with these devices, hundreds of thousands of mobile apps have been developed by third parties. As of April 2018, Apple's App Store had over 2.1 million apps

available for iOS device users. Android users could choose from over 2.8 million mobile apps on Google's Play Store. The Windows store had 700,000 apps, and Amazon had 400,000 apps available.<sup>46</sup>

Table 4.11 lists a few mobile application categories. Many apps are free, whereas others range in price from 99 cents to hundreds of dollars.

**TABLE 4.11** Categories of mobile applications

Category	Description
Books and reference	Access e-books, subscribe to journals, or look up information on the Merriam-Webster or Wikipedia Web sites
Business and finance	Track expenses, trade stocks, and access corporate information systems
Entertainment	Access all forms of entertainment, including movies, television programs, music videos, and information about local night life
Games	Play a variety of games, from 2D games such as Pacman and Tetris to 3D games such as Need for Speed, Call of Duty, and Minecraft
Health and fitness	Track workout and fitness progress, calculate calories, and even monitor your speed and progress from your wirelessly connected Nike shoes
Lifestyle	Find good restaurants, make a dinner reservation, select wine for a meal, and more
Music	Find, listen to, and create music
News and weather	Access major news and weather providers, including Reuters, AP, the <i>New York Times</i> , and the Weather Channel
Photography	Organize, edit, view, and share photos taken on your phone's camera
Productivity and utilities	Create grocery lists, practice PowerPoint presentations, work on spreadsheets, synchronize with PC files, and more
Social networking	Connect with others via major social networks, including Facebook, Twitter, and Instagram
Sports	Keep up with your favorite team or track your own golf scores
Travel and navigation	Use the GPS in your smartphone to get turn-by-turn directions, find interesting places to visit, access travel itineraries, and more

## Workgroup Application Software

**workgroup application software:** Software designed to support teamwork, whether team members are in the same location or dispersed around the world. Examples of workgroup software include group-scheduling software, electronic mail, instant messaging, project management, and other software that enables people to share ideas. IBM Notes and Domino are examples of workgroup software from IBM. (Notes runs on the end user's computing device, while Domino runs on a server and supports the end user). Web-based software is ideal for group use. Because documents are stored on an Internet server, anyone with an Internet connection can access them easily.

**Workgroup application software** is designed to support teamwork, whether team members are in the same location or dispersed around the world. Examples of workgroup software include group-scheduling software, electronic mail, instant messaging, project management, and other software that enables people to share ideas. IBM Notes and Domino are examples of workgroup software from IBM. (Notes runs on the end user's computing device, while Domino runs on a server and supports the end user). Web-based software is ideal for group use. Because documents are stored on an Internet server, anyone with an Internet connection can access them easily.

Personal application software can extend into the workgroup application arena. For example, Apple, Google, and Microsoft all provide workgroup options of its online applications, which allow users to share documents, spreadsheets, presentations, calendars, and notes with other specified users or anyone on the Web. This sharing makes it convenient for several people to contribute to a document without concern for software compatibility or storage.

## Enterprise Application Software

**enterprise application:** Software used to meet organization-wide business needs and typically shares data with other enterprise applications used within the organization.

An **enterprise application** is software used to meet organization-wide business needs and typically shares data with other enterprise applications used within the organization. Enterprise applications support processes in logistics, manufacturing, human resources, marketing and sales, order processing, accounting, inventory control, customer relationship management, and other essential business functions. These processes require cross-functional collaboration with employees from multiple organizational units, and even people outside the organization such as customers, suppliers, and government agencies. Enterprise applications are required to comply with an organization's security guidelines and may also be required to comply with standards defined by government agencies or industry groups to which the organization belongs. For example, all organizations that store, process, and transmit cardholder data strive to meet the Payment Card Industry Data Standard which provides a framework of specifications, tools, measurements, and support resources to help organizations ensure the safe handling of cardholder information.

The total cost, ease of installation, level of training and support required, and the ability to integrate the software with other enterprise applications are the major considerations of organizations when selecting enterprise software. The ability to run enterprise applications on smartphones and other mobile devices is becoming a priority for many organizations.

Enterprise software also helps managers and workers stay connected. At one time, managers and workers relied on email to stay in touch with each other, but business collaboration and enterprise social networking tools—such as Asana, blueKiwi, Yammer, and Jive—are replacing traditional email and text messaging.

But how are all these systems actually developed and built? The answer is through the use of programming languages, some of which are discussed in the next section.

## Programming Languages

**programming languages:** Sets of keywords, commands, symbols, and rules for constructing statements by which humans can communicate instructions to a computer.

Both system and application software are written in coding schemes called programming languages that provide instructions to the computer system so that it can perform a processing activity. Information systems professionals work with different **programming languages**, which are sets of keywords, commands, symbols, and rules for constructing statements that people can use to communicate instructions to a computer. Programming involves translating what a user wants to accomplish into a code that the computer can understand and execute. Program code is the set of instructions that signal the CPU to perform circuit-switching operations. In the simplest coding schemes, a line of code typically contains a single instruction such as, "Retrieve the data in memory address X." The instruction is then decoded during the instruction phase of the machine cycle.

Like writing a report or a paper in English, writing a computer program in a programming language requires the programmer to follow a set of rules. Each programming language uses symbols, keywords, and commands that have special meanings and usage. Each language also has its own set of rules, called the syntax of the language. The language syntax dictates how the symbols, keywords, and commands should be combined into statements capable of conveying meaningful instructions to the CPU. Rules such as "statements must terminate with a semicolon," and "variable names must begin with a letter," are examples of a language's syntax. A variable is a quantity that can take on different values. Program variable names such as SALES, PAYRATE, and TOTAL follow the sample rule shown above because they start with a letter, whereas variables such as %INTEREST, \$TOTAL, and #POUNDS do not.

**compiler:** A special software program that converts the programmer's source code into the machine-language instructions, which consist of binary digits.

With higher-level programming languages, each statement in the language translates into several instructions in machine language. A special software program called a **compiler** translates the programmer's source code into the machine-language instructions, which consist of binary digits. A compiler creates a two-stage process for program execution. First, the compiler translates the program into a machine language; second, the CPU executes that program. Another programming approach is to use an interpreter, which is a language translator that carries out the operations called for by the source code. An interpreter does not produce a complete machine-language program. After the statement executes, the machine-language statement is discarded, the process continues for the next statement, and so on.

Most software today is created using an integrated development environment. An integrated development environment (IDE) combines all the tools required for software engineering into one package. For example, the popular IDE Microsoft Visual Studio includes an editor that supports several visual programming interfaces and languages (visual programming uses a graphical or “visual” interface combined with text-based commands), a compiler and an interpreter, programming automation tools, a debugger (a tool for finding errors in the code), and other tools that provide convenience to the developer. Software developers for Google's Android smartphone platform use the Java programming language along with the Android Studio with built-in Android Developer Tools to streamline their Android app development. This is an example of a software development kit (SDK), which is a set of tools that enable the creation of software for a particular platform. They can also use special code libraries provided by Google for Android functionality, and they test out their applications in an Android Emulator.<sup>47</sup>

IDEs and SDKs have made software development easier than ever. Many novice coders, including some who might have never considered developing software, are publishing applications for popular platforms such as Facebook and the iPhone.

Table 4.12 lists some of the most commonly used programming languages and identifies how they are used.

**TABLE 4.12** Popular programming languages and what they are used to build

Language	Application Software	System Software	Embedded Systems	Websites	Data Analysis	Games
Assembly		X				
C	X	X	X	X	X	X
C ++	X		X		X	X
CSS				X		
HTML				X		
Java	X		X	X	X	X
Java Script				X		
Perl					X	
PHP				X		
Python			X		X	X
R					X	
SAS					X	
SQL					X	

## Software Licenses

### **end user license agreement (EULA):**

The legal agreement between the software manufacturer and the user of the software that stipulates the terms of usage.

When people purchase software, they do not own the software, but rather they are licensed to use the software on a computer. The **End User License Agreement (EULA)** is the legal agreement between the software manufacturer and the user of the software that stipulates the terms of usage. The EULA is displayed with the installation dialog and requires the user to “Accept” the terms of the EULA to complete installation. The EULA is written to protect the software manufacturer and generally disclaims all liabilities for loss of data and errors in calculation when the software is running. Software users are also prohibited from copying the software or giving it to others. Licenses that accommodate multiple users are usually provided at a discounted price. There are three primary types of end user licenses:

- A single-user license allows the program to be installed and used on one CPU that is not accessed by other users over a network. The software can be used only on a single computer, and other users cannot access or run the software while connected to your computer.
- Individual/multiuser licenses are volume licenses that allow the licensee to install the software on a certain number of computers. The licensee must satisfy a minimum purchase requirement to receive a reduced price. When purchasing the licenses, the licensee usually receives one copy of the media and documentation, with the option of purchasing more.
- Network/multiuser licenses require that you have a single copy of the software residing on a file server. With per server licensing, a specified number of client access licenses (CALs) are associated with a particular server. The number of devices that can legally access that server simultaneously is limited to the number of CALs purchased for that particular server.

Bitmanagement Software, a German software manufacturer, accused the U.S. Navy of copying some 558,000 copies of its 3D modelling software BS Contract without purchasing the necessary software licenses. The firm filed suit in the U.S. Court of Federal Claims seeking damages of \$596 million or about \$1,067 per copy.<sup>48</sup>

## Open-Source Software

**open-source software:** Software that is distributed, typically for free, with the source code also available so that it can be studied, changed, and improved by its users.

**Open-source software** is software that is distributed, typically for free, with the source code also available so that it can be studied, changed, and improved by its users. Over time, open-source software evolves in response to the combined contributions of its users. The Code For America (CFA) organization, for example, used open-source software to develop a map-based app for the city of Boston that allows individuals, small businesses, and community organizations to volunteer to shovel out specific hydrants that might be completely covered with snow in the winter. After creating the app for Boston, CFA made its efforts available for free to other cities and municipalities. Table 4.13 provides examples of popular open-source software applications.

Open-source software is not completely devoid of restrictions. Much of the popular free software in use today is protected by the GNU General Public License (GPL). The GPL grants you the right to do the following:

- Run the program for any purpose
- Study how the program works and adapt it to your needs
- Redistribute copies so you can help others
- Improve the program and release improvements to the public

Why would an organization run its business using software that's free? Can something that's given away over the Internet be stable, reliable, or sufficiently supported to place at the core of a company's day-to-day operations? The

**TABLE 4.13** Examples of open-source software

Software	Category
Apache HTTP Server	Web server
Apache OpenOffice	Application software
Drupal	Web publishing
Firefox	Web browser
Gimp	Photo editing
Grisbi	Personal accounting
Linux	Operating system
MySQL	Database software
ProjectLibre Open Project	Project management

answer is surprising—many believe that open-source software is often *more* reliable and secure than commercial software. How can this be? First, because a program's source code is readily available, users can fix any problems they discover. A fix is often available within hours of a problem's discovery. Second, because the source code for a program is accessible to thousands of people, the chances of a bug being discovered and fixed before it does any damage are much greater than with traditional software packages.

However, using open-source software does have some disadvantages. Although open-source systems can be obtained for next to nothing, the up-front costs are only a small piece of the total cost of ownership that accrues over the years that the system is in place. Some claim that open-source systems contain many hidden costs, particularly in terms for user support and debugging. Licensed software comes with guarantees and support services, whereas open-source software does not. Still, many businesses appreciate the additional freedom that open-source software provides. The question of software support is typically the biggest stumbling block to the acceptance of open-source software at the corporate level. Getting support for traditional software packages is easy—you call a company's toll-free support number or access its Web site. But how do you get help if an open-source package doesn't work as expected? Because the open-source community lives on the Internet, you look there for help. Through the use of Internet discussion areas, you can communicate with others who use the same software, and you might even reach someone who helped develop it. Ideally, users of popular open-source packages can get correct answers to their technical questions within a few hours of asking for help on the appropriate Internet forum. Another approach is to contact one of the many companies emerging to support and service such software—for example, Red Hat for Linux and Sendmail, Inc., for Sendmail. These companies offer high-quality, for-pay technical assistance.

Burton Snowboards was founded in 1977 by Jake Burton, who sold his first snowboards out of his Vermont barn. As part of an upgrade of the company's existing SAP and Oracle applications, Burton decided to migrate its operating platform to SUSE Linux Enterprise Server, an open-source solution. SUSE, which is certified by both SAP and Oracle, offered the company a highly dependable and flexible platform for its business-critical systems. With SUSE, Burton is able to quickly make its own updates to adapt to changing business needs, but it also has access to ongoing support, including technical information and expert

advice available through the SUSE Web site—all with the lower software cost that an open-source solution offers.<sup>49</sup>

## Software Upgrades

Software companies revise their programs periodically. Software upgrades, which are an important source of increased revenue for software manufacturers, vary widely in the benefits that they provide, and what some people call a benefit, others might call a drawback. Deciding whether to upgrade to a new version of software can be a challenge for corporations and people with a large investment in software. Some organizations choose not to immediately download the most current software version or upgrade unless it includes significant improvements or capabilities. Most organizations have limited IS resources and must balance effort spent on software upgrades and effort spent on new projects expected to yield new business benefits. Often, software upgrade projects are assigned lower priority.

Developing a software upgrade strategy is important for many businesses. American Express, for example, has standardized its software upgrade process around the world to make installing updated software faster and more efficient. The standardized process also helps the company make sure that updated software is more stable, with fewer errors and problems.



### Critical Thinking Exercise

#### Architectural Firms Looks at Software as a Service

##### ► FINANCE

You are a financial analyst for a mid-size architectural firm with some 100 employees located in three cities across the United States. The firm consistently earns over \$30 million in annual revenue by providing engineering and design services that cover a variety of structures and systems, from building brand new facilities to renovating and rehabilitating those that already exist. It specializes in providing exceptional design services for HVAC, electrical, piping, fire protection, and lighting systems.

The firm currently has a perpetual license for state-of-the-art computer-aided design and drafting software for its 50 architects and engineers at a cost of \$6,000 for each copy. The software is periodically in need of software patches to fix bugs and/or security issues. These are provided at no additional cost. However, there is a \$400/year charge per user for technical support. Patches are centrally managed and applied each quarter to all copies by a member of the firm's IT staff. This typically requires that an IT support person spend about 1 hour with each user and their computer. The software manufacturer provides a major new release every three years at an upgrade cost of \$4,000.

You have been asked to evaluate the advisability of moving to a software as a service solution and paying a monthly fee \$300 per user that includes all technical support, software support, and upgrades to new releases.

#### Review Questions

1. What are the costs over a six-year period associated with the current arrangement? What would be the costs with the software as a service solution?
2. What advantages are associated with the software as a service approach?

#### Critical Thinking Questions

1. What potential problems are associated with the software as a service approach?
2. Would you recommend that the firm move from the current arrangement to a software as a service approach? Why or why not?

## Summary

### Principle:

**The computer hardware industry is rapidly changing and highly competitive, creating an environment ripe for technological breakthroughs.**

Computer hardware should be selected to meet specific user and business requirements. These requirements can evolve and change over time.

Computer system hardware components include devices that perform input, processing, data storage, and output. These include the processor, memory, buses, and input/output devices that all cooperate to execute program instructions following a fetch, decode, execute, and store process.

A multicore processor is one that combines two or more independent processors into a single computer so that the independent processors can share the workload.

Computer system processing speed is affected by clock speed, which is measured in gigahertz (GHz). As the clock speed of the CPU increases, more heat is generated, which can corrupt the data and instructions the computer is trying to process. Bigger heat sinks, fans, and other components are required to eliminate the excess heat. Chip designers and manufacturers are exploring various means to avoid heat problems in their new designs.

An integrated circuit—such as a processor or memory chip—is a set of electronic circuits on one small chip of semiconductor material. A fab or foundry is a factory where integrated circuits are manufactured. Fabless manufacturers outsource their manufacturing to foundry companies who fabricate the design.

Multiprocessing involves the simultaneous execution of two or more instructions at the same time.

Parallel processing is the simultaneous execution of the same task on multiple processors to obtain results more quickly. Massively parallel processing involves linking many processors to work together to solve complex problems.

Grid computing is the use of a collection of computers, often owned by multiple individuals or organizations that work in a coordinated manner to solve a common problem.

### Principle:

**Computer hardware must be carefully selected to meet the evolving needs of the organization and its supporting information systems.**

Computer systems are generally divided into three classes: single-user portable computers, nonportable single-user systems, and multiuser systems.

Single-user portable computer systems include smartphones, laptops, notebooks, and tablets.

Nonportable single-user systems include thin client, desktop, nettop, and workstation computers. Some thin clients are designed to be highly portable.

Multiuser systems include servers, blade servers, mainframes, and supercomputers.

Scalability is the ability to increase the processing capability of a computer so that it can handle more users, more data, or more transactions in a given period.

### Principle:

**The computer hardware industry and users are implementing green computing designs and products.**

A server farm houses a large number of servers in the same room, where access to the machines can be controlled and authorized support personnel can more easily manage and maintain the servers.

A data center is a climate-and-access-controlled building or a set of buildings that houses the computer hardware that delivers an organization's data and information services. The rapid growth in data centers is stimulated by the increased demand for additional computing and data storage capacity and by the trend toward consolidating from many data centers down to a few.

Organizations and technology vendors are trying several strategies to lower the ongoing cost of data center operations.

The ability to absorb the impact of a disaster and quickly restore services is a critical concern when it comes to planning for new data centers. As a result, organizations may distribute their data centers over a wide geographical area.

The Uptime Institute has defined four tiers of data center classification to enable organizations to quantify and qualify their ability to provide a predictable level of performance. The classifications are based on expected annual downtime, fault tolerance, and power outage protection.

Green computing is concerned with the efficient and environmentally responsible design, manufacture, operation, and disposal of IT-related products.

Many business organizations recognize that going green can reduce costs and is in their best interests in terms of public relations, safety of employees, and the community at large.

Three specific goals of green computing are to reduce the use of hazardous material, lower power-related costs, and enable the safe disposal and/or recycling of IT products.

The Electronic Product Environmental Assessment Tool can be used by purchasers of electronic products to evaluate, compare, and select products based on a set of environmental criteria.

## Principle:

**Software is valuable in helping individuals, workgroups, and entire enterprises achieve their goals.**

Software can be divided into two types: system software and application software.

System software includes the operating system, utility programs, and middleware that coordinate the activities and functions of the hardware and other programs throughout the computer system.

Application software consists of programs that help users solve computer problems.

The operating system is a set of programs that controls a computer's hardware and acts as an interface with application software. It performs several functions.

An application programming interface is a set of programming instructions and standards that enable one software program to access and use the services of another software program.

There are many different operating systems designed to work in the personal, workgroup, and enterprise sphere of influence.

Server virtualization is an approach to improving hardware utilization by logically dividing the resources of a single server to create virtual servers. Each virtual server acts as its own dedicated machine.

Server virtualization can provide savings in four areas: lower capital costs for hardware, decreased energy costs to power the servers and cool the data center, decrease the number of software licenses that must be purchased, and lessen the number of personnel required to operate and support the servers.

Utility programs perform a variety of tasks typically related to system maintenance or problem correction.

Middleware is software that provides messaging services that allow different applications to communicate and exchange data.

Service-oriented architecture is a software design approach based on the use of discrete pieces of software to provide specific functions as services to other applications.

### Principle:

**Organizations typically use off-the-shelf application software to meet common business needs and proprietary application software to meet unique business needs and provide a competitive advantage.**

The initial cost of off-the-shelf software is lower, it is more likely to meet the basic business needs, and the software is likely to be of high quality.

Proprietary software can take a long time to develop, in-house staff may be hard-pressed to provide the necessary level of support, and there is greater risk it will fail to work as needed.

Software as a service (SaaS) is a software distribution model under which a third-party provider hosts applications and makes them available to subscribers over the Internet. This approach has the following advantages: SaaS applications are available from any device, anywhere, anytime; the SaaS provider manages all upgrades and new releases; the costs associated with upgrades and new releases are lower than the traditional software licensing model; the SaaS provider manages service levels and availability.

There are many programming languages. They are used to build application software, system software, embedded systems, Web sites, and games. They are also used to perform data analysis.

There are three types of End-User License Agreements—single-user license, individual/multiuser license, and network/multiuser license.

Open-source software is software that is distributed, typically for free, with the source code also available so that it can be studied, changed, and improved by its users.

Because an open-source program's source code is available, users can fix any problems they discover. Open-source software does not come with guarantees and support services.

Software upgrades are an important source of increased revenue for software manufacturers. Organizations must balance effort spent on software upgrades and effort spent on new projects expected to yield new business benefits.

## Key Terms

application programming interfaces (API)	desktop computer
application software	Electronic Product Environmental Assessment Tool (EPEAT)
backward compatibility	embedded system
bioprinting	End User License Agreement (EULA)
blade server	enterprise application
bus	four tiers of data center classification
byte (B)	gigahertz (GHz)
cache memory	graphics processing unit (GPU)
clock speed	green computing
compiler	grid computing
computer graphics card	hard disk drive (HDD)
coprocessor	hypervisor
core	input/output devices
data center	

- integrated circuit (IC)
- kernel
- laptop
- magnetic tape
- main memory
- mainframe computer
- massively parallel processing system
- memory
- middleware
- multicore processor
- multiprocessing
- nettop computers
- off-the-shelf software
- open-source software
- operating system (OS)
- parallel processing
- programming languages
- portable computers
- proprietary software
- Radio Frequency Identification (RFID)
- random access memory (RAM)
- read-only memory (ROM)
- redundant array of independent/inexpensive disks (RAID)
- scalability
- secondary storage
- semiconductor fabrication plant
- server
- server farm
- service-oriented architecture (SOA)
- server virtualization
- software as a service (SaaS)
- software suite
- solid state storage device (SSD)
- system software
- supercomputers
- tablet
- thin client
- utility program
- virtual tape
- workgroup application software
- workstation

## Self-Assessment Test

**The computer hardware industry is rapidly changing and highly competitive, creating an environment ripe for technological breakthroughs.**

1. The primary hardware component of a computer responsible for routing data and instructions to and from the various components of a computer is the \_\_\_\_\_.
2. \_\_\_\_\_ provide data and instructions to the computer and receive results from it.
3. A key difference between grid computing, multiprocessing, and parallel processing is that \_\_\_\_\_.
  - a. parallel processing is only employed with supercomputers
  - b. grid computing is only employed with supercomputers
  - c. multiprocessing only applies to server computers
  - d. grid computing relies on a community of computers acting together

**Computer hardware must be carefully selected to meet the evolving needs of the organization and its supporting information systems.**

4. A \_\_\_\_\_ is a class of computer used by people on the move to run personal productivity software, access the Internet, read and

prepare email and instant messages, play games, listen to music, access corporate applications and databases, and enter data at the point of contact.

- a. single-user nonportable computer
  - b. single-user portable computer
  - c. multiple-user computer
  - d. notebook computer
5. \_\_\_\_\_ are three subclasses of computers associated with the multiple-user computer.
    - a. Smartphone, laptop, notebook, and tablet
    - b. Thin client, desktop, nettop, and workstation
    - c. Server, mainframe, and supercomputer
    - d. Notebook, server, and nettop

**The computer hardware industry and users are implementing green computing designs and products.**

6. The class of computer used to support workgroups from a small department of two or three workers to large organizations with tens of thousands of employees and millions of customers is the \_\_\_\_\_.
7. A data center designed to have an expected annual downtime of less than 30 minutes and able to handle a power outage of up to four days is a tier \_\_\_\_\_ data center.

- a. 1
- b. 2
- c. 3
- d. 4

8. \_\_\_\_\_ is not a specific goal of green computing.
- a. Reducing the use of hazardous material
  - b. Lowering power-related costs
  - c. Combating global climate change
  - d. Enabling the safe disposal and/or recycling of IT products

**Software is valuable in helping individuals, work-groups, and entire enterprises achieve their goals.**

9. The two basic types of software are application software and \_\_\_\_\_ software.
10. The operating system plays no role in controlling access to system resources to provide a high level of security against unauthorized access to the users' data and programs as well as record who is using the system and for how long. True or False?
11. Which of the following is not associated with the implementation of server virtualization?
- a. Lower capital costs for hardware
  - b. Decreased energy costs to power the servers and cool the data center
  - c. Increase in the number of software licenses that must be purchased
  - d. Fewer personnel required to operate and support the servers.
12. \_\_\_\_\_ is a software design approach based on the use of discrete pieces of software (modules) to provide specific functions (such as displaying a customer's bill statement) as services to other applications.
- a. Server virtualization
  - b. Multiprocessing
  - c. Grid computing
  - d. Service-oriented architecture
13. \_\_\_\_\_ is a class of software used to meet organization-wide business needs and typically shares data with other enterprise applications used within the organization.

**Organizations typically use off-the-shelf application software to meet common business needs and**

**proprietary application software to meet unique business needs and provide a competitive advantage.**

14. When comparing off-the-shelf software to proprietary software, which of the following statements is *not* true:
- a. Off-the-shelf software might not match current work processes and data standards.
  - b. The initial cost of the off-the-shelf software is likely greater.
  - c. Off-the-shelf software may include features that the organization or user does not require and never uses.
  - d. Off-the-shelf software may lack important features thus requiring future modification or customization.
15. Which of the following is not a true statement about the software as a service model.
- a. SaaS applications are available from any computer or any device—anytime, anywhere.
  - b. There are no software patches for customers to download or install.
  - c. The cost associated with upgrades and new releases are lower than the traditional model.
  - d. The SaaS subscriber must manage service levels and availability, so there may be a need to add hardware, software, or communications capacity as the number of users increases.
16. Spreadsheet, word processor, and graphics presentation software are used in the \_\_\_\_\_ sphere of influence.
17. Programming languages are commonly used to perform data analysis and build application software, system software, embedded systems, Web sites, and \_\_\_\_\_.
18. The three primary types of end user license agreements are individual/multiuser, network/multiuser, and \_\_\_\_\_.
19. \_\_\_\_\_ is a form of software that is distributed, typically for free, with the source code studied, changed, and improved solely by the original developers.
- a. Software as a Service
  - b. Licensed software
  - c. A software suite
  - d. Open-source software

## Self-Assessment Test Answers

1. bus
2. input/output devices
3. d
4. b
5. c
6. Multiple-user computer
7. d
8. c
9. system
10. false

- 11. c
- 12. d
- 13. enterprise
- 14. b
- 15. d
- 16. single-user
- 17. games
- 18. single-user
- 19. d

## Review and Discussion Questions

1. What fundamental hardware component provides the processor with a working storage area to hold program instructions and data?
2. What is the role of the processor of a computer?
3. Explain the difference between multiprocessing, parallel processing, and grid computing.
4. The single-user portable class of computers includes which commonly used four subclasses of computers?
5. Which class of computer includes servers, mainframes, and supercomputers?
6. What subclass of computer is a low-cost, centrally managed computer with no internal or external attached drives for data storage?
7. Identify three features that distinguish tier 1, 2, 3, and 4 data centers.
8. State three primary goals of the “green computing” program.
9. Name two basic kinds of software and identify their associated subclasses.
10. Identify at least four functions performed by the operating system.
11. State three cost savings benefits associated with server virtualization.
12. Describe how the service-oriented architecture approach is used to build software and microservices.
13. Identify three advantages of off-the-shelf software versus proprietary software.
14. State four key advantages of the software as a service model.
15. Give an example of how application software is used in the workgroup sphere of influence.
16. What are programming languages used for other than to build application software, systems software, embedded systems, and Web sites?
17. Identify the three primary types of end user license agreements.
18. In comparison to licensed software, how is open-source software used and supported?

## Business-Driven Decision-Making Exercises

1. You are a new buyer in the Purchasing organization of a large multinational firm with operations in North America, Europe, and Asia. One of your responsibilities includes working with the information systems organization to acquire the best value single-user portable computers for the firm. The firm is on a three-year replacement cycle for these devices and each year acquires roughly 7,000 portables and associated accessories at a cost of about \$10 million. As you review the previous year's purchasing recommendation, you notice that the choice of hardware vendors was based solely on getting the most powerful computers at the lowest possible price. There was no consideration of the environmental impact of these devices, their energy efficiency, and the level of hardware maintenance effort required to keep them running. Should you attempt to introduce these factors into the purchasing decision? You are concerned that the others involved in the selection of laptop vendors may ignore your

suggestions and view you as a newcomer critical of previous practices. Should you drop this line of thought? If not, what is the best way to proceed to ensure these factors are given consideration?

2. Your organization is considering using software from a software manufacturer that offers three different licensing options: (1) a perpetual license at a cost of \$3,750 with an upgrade to the next release fee of \$2,500; (2) a monthly subscription license at a cost of \$175 per month; and (3) an annual subscription license at a cost of \$1,500 per year. Technical support and all access to all new releases of the software are included with the subscription licenses but cost an additional \$35 per month with the perpetual license option. The software manufacturer intends to make a major upgrade within the next year or two. Your organization will need 20 copies of the software and intends to use this software for at least the next five years. Which licensing option is best for your organization?

## Teamwork and Collaboration Activities

1. You and the members of your team have been assigned to evaluate the economic feasibility of upgrading your organization's server farm from a collection of various models of stand-alone computers to a smaller number of virtualized servers. The current set of 500 servers are all 3–7 years old. The plan is to auction off the old servers and replace them with new, more powerful, and more energy efficient servers. Because of virtualization, fewer servers will be needed, less floor space will be required, the cost to operate the fewer, more efficient servers will be reduced, and the cost to cool the data center will be reduced. What basic facts must your team gather to be able to do a cost comparison (initial cost of all hardware and software licenses, ongoing operating costs to run the servers and cool the data center) of continuing to run the server farm as is versus upgrading to new, virtualized servers? Develop a spreadsheet that would enable you to do this comparison.
2. With the other members of your team, identify three humanitarian causes or scientific programs that could benefit from grid computing. For each cause or program, identify a specific goal to be accomplished through grid computing. What advantages might favor the use of public involved grid computing versus the use of a privately funded supercomputer?

## Career Exercises

1. You are a member of your company's finance function and have been assigned to work with a multi-functional team to assess the reliability of your organization's large data center. What other business functions should be represented on this team? Develop a basic set of 4 or 5 questions that you would ask to determine if the organization needs to upgrade from its current tier 2 data center to a tier 3 or 4 data center. Who are the key people (by title and business function) who need to answer these questions? Should anyone outside the team be interviewed? If so, whom (again, by title and business function)?
2. "Spreadsheets, even after careful development, contain errors in 1 percent or more of all formula cells," according to Ray Panko, a professor of IT management at the University of Hawaii and an authority on bad spreadsheet practices. This means that in large spreadsheets there could be dozens of undetected errors. Imagine that you are a member of your organization's Internal Audit function. You wish to make management more aware of this potential problem and to implement measures that should be taken to ensure the accuracy of spreadsheets that are used to make key business decisions. How would you begin to address this problem?

## Case Study

### ► DECISION MAKING

#### **Facebook Building Efficient, Reliable Data Centers**

Facebook is a social networking Web site and service where users can post comments, share photographs and links to news or other interesting content on the Web, play games, chat live, and even stream live video. As of June 2017, Facebook had 2 billion monthly active users and this number is increasing at a rate of 17 percent per year. Two of its other apps, Facebook Messenger and WhatsApp, have over 1.2 billion active users.

All these users require lots and lots of computing capacity to meet their data processing needs and huge amounts of data storage to hold all their data, photos, and videos. For example, just to load a user's home page can require pulling data from hundreds of servers,

processing tens of thousands of individual pieces of data, and delivering the selected data in less than one second. With more people going live and sharing video, Facebook must continually add new data centers to keep up with the demand. Facebook spent \$2.5 billion on data centers, servers, network infrastructure, and office buildings in 2015.

Facebook already has existing data centers in Prineville, Oregon; Forest City, North Carolina, Lulea, Sweden; and Altoona, Iowa. Additional data centers are being built or planned for Fort Worth, Texas; Clonee, Ireland; Los Lunas, New Mexico; Papillon, Nebraska; New Albany, Ohio; Ashburn, Virginia, and Odense, Denmark. These data centers are large football field-sized buildings each housing tens of thousands of servers all networked together and to the

outside world. Building and outfitting each data center is a major project typically lasting 12 months or more and costing over \$500 million.

A small group of Facebook engineers spent two years designing and building Facebook's first data center in Prineville including software, servers, racks, power supplies, and cooling. When completed, the data center was 38 percent more energy efficient to build and 24 percent less expensive to run than the data centers Facebook rented from other organizations.

Facebook uses servers powered by chips from both Intel and AMD with custom designed motherboards and chassis. It has also investigated energy efficient ARM-powered servers. Facebook hardware engineers remove everything from the servers that is not necessary for example no bezels, no paints, no extra expansion slots, no mounting screws. The servers are mounted into a rack which holds 90 servers in three columns. Cabling and power supplies are moved to the front of the servers so Facebook technicians can work on the equipment from the cold aisle, rather than the enclosed, 100 degree plus hot backside of the server. The servers are outfitted with custom power supplies that enable them to take power directly from the source eliminating the need for step-down units as power passes through the UPS systems and power distribution units. In the event of a power outage, the batteries keep the servers running until the building's backup generators can kick on.

In April 2011, Facebook, together with Intel, Rackspace, Goldman Sachs, and Andy Bechtolsheim (billionaire co-founder of both Artista Networks and Sun Microsystems), launched the Open Compute Project Foundation. The Foundation is targeted at redesigning hardware to support the increasing demands of users for more efficient, flexible, and

scalable hardware and data centers. This is made possible by the sharing of details of its energy efficient data center design, as well as custom designs for servers, network switches, power supplies, and UPS units. This approach marks a radical departure from industry practice which typically regards such information as intellectual property to be tightly protected. The Open Compute servers represent a significant improvement in energy efficiency and a substantial reduction in server cost.

### Critical Thinking Questions

1. Identify three good reasons why a Tier 2 data center would not meet Facebook's needs.
2. Your organization has decided to outsource its data center operations. You are responsible for performing an initial assessment of service organizations that wish to compete for this business. Develop a set of six questions you can use to determine if an organization's data center is a 1, 2, 3, or 4 data center.
3. Based on business needs, should the data center at your place of work (or university) be designed and operating as a tier 1, 2, 3, or 4 data center? Explain why.

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## Principles

A well-designed and well-managed database is an extremely valuable tool in supporting decision making.

## Learning Objectives

- Distinguish data from information and knowledge.
- Identify six benefits gained through use of high-quality data.
- Define the components of the data hierarchy including attribute, entity, record, file, and database.
- Define the term database management system.
- Identify six functions performed by a database management system.
- Define the roles of the database schema, data definition language, and data manipulation language.
- Define the term data cleansing.
- Identify seven key questions that must be answered when designing a database.
- Identify six fundamental characteristics of the relational database model.
- State the purpose of data normalization.
- Identify two key benefits of enforcing the ACID properties on SQL databases.
- Identify two advantages associated with database as a service (DaaS).

A strong data management program is needed to ensure high-quality data.

- Distinguish between data management and data governance.
- Identify three factors driving the need for data management.
- Identify four key responsibilities of the data governance team.
- Define the role of a database administrator.

# IS in Action

## Genomics England Finds Scientific Insights Through Database as a Service

### ► INFORMATION TECHNOLOGY

One of the largest scientific collaborations in history, the Human Genome Project was dedicated to reading the complete genetic code, or genome, of a human being. The 100,000 Genomes Project is building on the discoveries of the Human Genome Project to develop lifesaving treatments for patients with conditions ranging from common cancers to rare diseases. Genomics England, which is owned by the United Kingdom's Department of Health and Social Care, runs the 100,000 Genomes Project as part of the country's National Health Service (NHS).

A genome consists of DNA, which scientists read letter-by-letter in a process known as sequencing. The first genome sequencing took 13 years and about £2 billion (\$2.6 billion), but with advances in the technology, a human genome can now be sequenced in a few days for less than \$1,300. The goal of the 100,000 Genomes Project is to bring the benefits of genomic data analysis into mainstream healthcare services.

To achieve this goal, project organizers need access to high-quality data stored in a secure database, which is a well-designed, organized, and carefully managed collection of data. In addition to technical genomic data, the 100,000 Genomes Project stores personal and confidential details about patients with cancer and rare diseases. The collected data for the project includes the age, medical conditions, diagnosis, symptoms, and treatment outcomes of each patient so that researchers can associate health details with genetic information. Connecting the details in a database allows healthcare professionals to make better decisions. For example, if a project participant had a poor outcome that researchers were able to link to a specific genetic characteristic, physicians might decide to prescribe more powerful treatments for future patients with similar genes.

Because researchers in the 100,000 Genomes Project handle sensitive health information, they face special requirements for storing the data. A typical database is a file containing data about an entity (a person, place, or thing) and its attributes (characteristics of the entity). Patient number, name, address, phone number, and date of birth are examples of patient attributes. In a database, at least one of the attributes, such as a patient number, uniquely identifies each entity. To protect the privacy of project participants, however, researchers must remove identifying personal details, such as name and date of birth. They assign each participant a unique code that allows them to track the data while keeping it private and secure.

In addition to privacy, researchers on the project are concerned with maintaining the quality of the data. The project receives digital data—including electronic health records, test results, and medical notes—from many different hospitals and clinics. To avoid errors, such as incomplete information and transmission corruption, the data is subjected to data cleansing, a process of detecting and then correcting or deleting incomplete, incorrect, inaccurate, or irrelevant records in a database.

Acquiring and storing patient data presents one set of challenges; collecting, analyzing, and managing the volume of genomic data presents another. As of July 2018, the 100,000 Genomes Project had worked with 70,000 patients and family members in the United Kingdom to collect 21 petabytes of data (or 21 quadrillion bytes of data). To assess a patient's risk for cancer, for example, researchers first sequence the patient's genome, which produces about 200 GB of raw data. Next, scientists analyze the genome to determine how it differs from a reference genome, a standard approximation of a person's DNA. The faster and more accurately the scientists can process the complex queries that analyze the genomic data, the faster they can determine how to treat patients and help them avoid life-threatening diseases.

The 100,000 Genomes Project sequences an average of 1,000 genomes per week, or 10 terabytes of data per day, an enormous volume for a database. To manage this amount of complex and sensitive data, Genomics England turned to MongoDB, a company headquartered in New York that offers database as a service (DaaS), an arrangement in which a database is stored on a service provider's servers and accessed by the service subscriber over the Internet. Using a computing platform that includes MongoDB as its DaaS, Genomics England was able to cut its hardware and software expenditures and hand off the database administration and maintenance tasks to MongoDB, all while reducing processing time from hours to milliseconds.

Using a DaaS means that 1,500 NHS healthcare professionals and 2,500 researchers and trainees around the world can access the genomic data from anywhere and at any time. “Managing clinical and genomic data at this scale and complexity has presented interesting challenges,” says August Rendon, director of bioinformatics at Genomics England. “That’s why adopting MongoDB has been vital to getting the 100,000 Genomes Project off the ground. It has provided us with great flexibility to store and analyze these complex data sets together. This will ultimately help us to realize the benefits of the project—delivering better diagnostic approaches for patients and new discoveries for the research community.”

DaaS offers flexibility, lower hardware and software expenditures, and lower operating costs than a traditional database—important considerations for a government agency. Another significant advantage of using a DaaS such as MongoDB is that it provides greater security than a local solution. A DaaS provider hosts data in a secure environment, encrypts and backs up the data, and allows users to access it only through multifactor authentication. MongoDB ensures the highest levels of protection for the sensitive data that the 100,000 Genomes Project collects.

Even after the 100,000 Genomes Project ends, researchers in academic institutions and biotechnology organizations will continue working with the genomic data to develop new treatments, diagnostics, devices, and medicines for patients worldwide. Those patients will benefit from the 100,000 Genome Project’s initial efforts to store high-quality data in a database connecting patient and genomic information.

**As you read further about database systems and management, consider the following:**

- What major competitive advantages can organizations gain from the effective use of database as a service (DaaS)?
- What challenges do organizations, particularly those in healthcare fields, face when collecting and managing data from clients or customers?

## Why Learn about Database Systems and Data Management?

The world around us is constantly changing and evolving. This creates new challenges and opportunities for innovation for organizations around the world. Database systems make it possible to capture data about these changes, store it, update it, and make this data available for analysis and decision making. The data can be used to recognize these new challenges and opportunities. It can also be used to track progress toward meeting key organizational goals and identifying when a change in tactics or strategy is needed.

McDonald’s implemented a database system to capture and report consumer data to measure their satisfaction from the national level down to individual restaurants. The data is analyzed to spot trends and identify opportunities as well as potential problem areas. Major oil company Exxon has multiple

billion-dollar projects going at one time to develop a new oilfield or construct a new deep-sea drilling rig. It employs database technology to keep track of the status of these critical projects. The Harris Poll surveys gather data about voters and customers. The results are stored in a database so they can be analyzed by a set of standard demographics including gender, age, region, income, and education. The U.S. Food and Drug Administration implemented a database that contains information on adverse event and medication error reports submitted to the FDA. The database is a useful tool for the FDA to identify new safety concerns that might be related to a marketed product.

In addition to these specific applications, almost every organization employs numerous database applications. The accounting function of an organization uses several databases to track purchases, record sales, generate invoices, and make payments. The human resources function uses a database to manage employee records and provide required data to government agencies. The manufacturing function uses multiple databases to track production, inventory, and distribution. The sales organization uses databases to capture information about product sales, promotions, and customers to measure the effectiveness of its marketing strategies and to plan new strategies.

Before these databases can be built, they must be carefully designed to ensure that they will meet the needs of the organization. A team of IS and non-IS employees work together to define the processes by which the data is obtained, certified fit for use, stored, secured, and processed. The goal is to ensure that the accessibility, reliability, and timeliness of the data meets the needs of the data users within the organization. Whether you will be involved in the design of a database application, capture and provide data to the database, or use the database for analysis and decision making, you need to understand database systems and data management.

## Database Fundamentals

Without data and the ability to process it, an organization cannot successfully complete its business activities. It cannot pay employees, send out bills, order new inventory, or produce information to assist managers in decision making. Recall that data consists of raw facts, such as employee numbers and sales figures. For data to be transformed into useful information, it must first be organized in a meaningful way.

A **database** is a well-designed, organized, and carefully managed collection of data. Like other components of an information system, a database should help an organization achieve its goals. A database can contribute to organizational success by providing managers and decision makers with timely, accurate, and relevant information built on data. Organizations routinely capture and store data about customers, orders, products, and employees in databases. These databases help companies analyze information to reduce costs, increase profits, add new customers, track past business activities, improve customer service, and identify new market opportunities.

Starbucks collects data from roughly 100 million transactions each week from customer purchases at its 29,000 stores worldwide. This data is collected and stored in a database where it is used to support many business decisions—how much inventory to stock at each store, how many workers to schedule based on expected demand, where to open new stores to minimize cannibalization of sales at nearby stores, and which discounts and rewards to send customers to stimulate demand.<sup>1</sup>

Databases are becoming ever more important to organizations as they deal with rapidly increasing amounts of information. Indeed, most organizations have multiple databases (e.g. customer database, product database, employee database).

**database:** A well-designed, organized, and carefully managed collection of data.

## Data, Information, and Knowledge

**data:** Raw facts such as an employee number or total hours worked in a week.

**information:** A collection of data organized and processed so that it has additional value beyond the value of the individual facts.

**Data** consists of raw facts, such as an employee number, total hours worked in a week, an inventory part number, or the number of units produced on a production line. As shown in Table 5.1, several types of data can represent these facts. **Information** is a collection of data organized and processed so that it has additional value beyond the value of the individual facts. For example, a sales manager may want individual sales data summarized so it shows the total sales for the month, sales by salesperson, or sales by product line. Providing information to customers can also help companies increase revenues and profits. For example, social shopping Web site Kaboodle brings shoppers and sellers together electronically so they can share information and make recommendations while shopping online. The free exchange of information stimulates sales and helps ensure shoppers find better values.

**TABLE 5.1** Types of data

Data	Represented By
Alphanumeric data	Numbers, letters, and other characters
Audio data	Sounds, noises, or tones
Image data	Graphic images and pictures
Video data	Moving images or pictures

Another way to appreciate the difference between data and information is to think of data as the individual items in a grocery list—crackers, bread, soup, cereal, coffee, dishwashing soap, and so on. The grocery list becomes much more valuable if the items in the list are arranged in order by the aisle in which they are found in the store—bread and cereal in aisle 1, crackers and soup in aisle 2, and so on. Data and information work the same way. Rules and relationships can be set up to organize data so it becomes useful, valuable information.

The value of the information created depends on the relationships defined among existing data. For instance, you could add specific identifiers to the items in the list to ensure that the shopper brings home the correct item—whole wheat bread and Kashi cereal in aisle 1, saltine crackers and chicken noodle soup in aisle 2, and so on. By doing so, you create a more useful grocery list.

Turning data into information is a process or a set of logically related tasks performed to achieve a defined outcome. The process of defining relationships among data to create useful information requires **knowledge**, which is the awareness and understanding of a set of information and the ways in which that information can be made useful to support a specific task or reach a decision. In other words, information is essentially data made more useful through the application of knowledge. For instance, there are many brands and varieties of most items on a typical grocery list. To shop effectively, the grocery shopper must have an understanding of the needs and desires of those being shopped for so that he knows to purchase one can of Campbell's (not the store brand!) low-sodium chicken noodle soup for the family member who is diabetic along with two cans of Campbell's regular chicken soup for everyone else.

**knowledge:** The awareness and understanding of a set of information and the ways that information can be made useful to support a specific task or reach a decision.

In some cases, people organize or process data in a simple three-step process of collect data, organize data, and analyze data.

## The Value of Information

The value of information is directly linked to how it helps decision makers achieve their organization's goals. Valuable information can help people perform tasks more efficiently and effectively. Many businesses assume that reports are based on correct, quality information, but, unfortunately, that is not always true. For example, Experian (a global information services firm that provides credit services, marketing services, decision analytics, and consumer services) estimates that on average, 22 percent of an organization's customer contact data is wrong.<sup>2</sup> Companies can easily waste over \$100 per inaccurate customer contact data record on things like direct-mail marketing sent to wrong addresses and the inability to properly track leads. For an organization with 100,000 customers and a 22 percent error rate, that projects to a loss of \$2.2 million. A more recent study reveals that 84 percent of CEO's are concerned about the quality of the data they are basing their decisions on.<sup>3</sup>

## Benefits Gained Through Use of High-Quality Data

Fundamental to the quality of a decision is the quality of the data used to reach that decision. Any organization that stresses the use of advanced information systems and sophisticated data analysis before data quality is doomed to make many wrong decisions. Table 5.2 lists the characteristics that determine the quality of data. The importance of each of these characteristics varies depending on the situation and the kind of decision you are trying to make. For example, with market intelligence data, some inaccuracy and incompleteness is acceptable, but timeliness is essential. Market intelligence data may alert you that a competitor is about to make a major price cut. The exact details and timing of the price cut may not be as important as being warned far enough in advance to enable your organization to plan how to react. On the other hand, accuracy and completeness are critical for data used in accounting for the management of company assets, such as cash, inventory, and equipment.

High-quality data represents a precious asset of any organization. Not only will high-quality data improve decision making, increase customer satisfaction, increase sales, improve innovation, improve productivity, but it will also ensure that you are fully complying with regulatory requirements that may apply to your organization.

### ***Improve Decision Making***

Data drives all the major decisions in the world today from attending to customer needs to developing strategies for gaining competitive advantage. Without high-quality data, any decision we make is based on inference and conjecture with little evidence to support good decision making. With high-quality data, the guesswork and risk taking in decision making are removed. The better the data quality, the more confidence users have in the decisions they make, the lower the risk of a poor decision, and the more likely the decision will achieve the desired results.

### ***Increase Customer Satisfaction***

Today customers expect a personalized shopping experience and the better the quality of your data, the easier it is to deliver the personalized approach your customers require. On the other hand, customer satisfaction with your store, Web site, or product will certainly be lower if the data quality is poor. Every customer

**TABLE 5.2** Nine characteristics of quality information

Characteristic	Definition
Accessible	Information should be easily accessible by authorized users so they can obtain it in the right format and at the right time to meet their needs.
Accurate	Accurate information is error free. In some cases, inaccurate information is generated because inaccurate data is fed into the transformation process from data to information. This is commonly called garbage in, garbage out.
Complete	Complete information contains all the important facts. For example, an investment report that does not include all important costs is not complete.
Economical	Information should also be relatively economical to produce. Decision makers must always balance the value of information with the cost of producing it.
Relevant	Relevant information is important to the decision maker. Information showing that lumber prices might drop is probably not relevant to a computer chip manufacturer.
Reliable	Reliable information can be trusted by users. In many cases, the reliability of the information depends on the reliability of the data-collection method. In other instances, reliability depends on the source of the information. A rumor from an unknown source that oil prices might go up may not be reliable.
Secure	Information should be secure from access by unauthorized users.
Timely	Timely information is delivered when it is needed. Knowing last week's weather conditions will not help when trying to decide what coat to wear today.
Verifiable	Information should be verifiable. This means that you can check it to make sure it is correct, perhaps by checking many sources for the same information.

wants to pay a fair, correct price for the product they want without experiencing issues that bad data could cause. Customers become quite upset when there are billing errors in their statements even if the amount is relatively small. Customer ill will is created whether the billing errors were intentional or not.

### **Increase Sales**

High-quality data can increase sales by enabling more accurate consumer targeting and communications. This is especially important in an omnichannel environment where an organization is using the same business strategy across all marketing channels including Internet, brick-and-mortar stores, television, radio, and direct mail. It is essential that a database of high-quality data about customers, products, prices, promotions, and so on be available across all channels.

High-quality data can also increase sales by enabling salespeople to make successful up-sell and cross-sell suggestions. Cross-selling involves inviting customers to purchase an item related to what they are primarily interested in. Up-selling involves encouraging customers to buy a comparable, but higher-end product. Salesperson suggestions for a cross-sell or upsell that's

completely out of left field will not only frustrate customers—they could endanger their relationship with your company. Salespeople need high-quality data about the customer and all their interactions with your organization to ensure that their suggestions are consistent with the customer's needs and circumstances.

### **Improve Innovation**

High-quality data on the operations of the business is the primary ingredient of any process improvement effort. Such efforts are often aimed at improving worker efficiency, product and/or service quality, or the customer experience. Successful innovation improves the business outlook and attracts new business while enhancing the ability to retain existing clients and customers. Organizations that can use their data assets to drive critical business innovations will gain a distinct advantage in the years to come.

### **Raise Productivity**

Good quality data enables employees to be more productive. Instead of spending time researching the reasons for and correcting data errors, they can focus on their core mission. Should bad data slip through and update the information in a database, it may result in actions that require considerable effort to correct (e.g. incorrect bills sent to customers, inaccurate inventory counts resulting in unnecessary purchase orders, etc.).

### **Ensure Compliance**

There are several governmental and industry regulations such as General Data Protection Regulation (GDPR), Health Insurance Portability and Accountability Act (HIPAA), and Payment Card Industry-Data Security Standard (PCI-DSS). These regulations and many others place specific requirements on how certain types of data are managed, protected, and reported. If the data is not accurate, there can be severe consequences, including significant fines and more. In the case of a hospital or medical practice, medical coding and billing mistakes may trigger audits and investigations. Such mistakes may even lead to charges of fraud, forever damaging the reputation of the hospital or medical practice.

## **The Data Hierarchy**

**entity:** A person, place, or thing for which data is collected, stored, and maintained.

**file:** A collection of similar entities.

**attribute:** A characteristic of an entity.

**domain:** The range of allowable values for a data attribute.

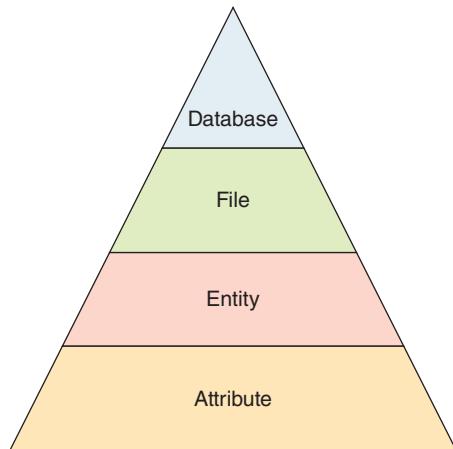
An **entity** is a person, place, or thing (object) for which data is collected, stored, and maintained. Examples of entities include employees, products, and customers. Most organizations organize and store data as collections of entities or a **file**.

An **attribute** is a characteristic of an entity. For example, employee number, last name, first name, hire date, and department number are attributes for an employee. The inventory number, description, number of units on hand, and location of the inventory item in the warehouse are attributes for items in inventory. Customer number, name, address, phone number, credit rating, and contact person are attributes for customers. Attributes are usually selected to reflect the relevant characteristics of entities such as employees or customers. Each attribute can be constrained to a range of allowable values called its **domain**. For instance, the domain for an attribute such as type of employee could be limited to the three characters F (full-time), P (part-time), or C (contractor). If someone tried to enter a “1” in the type of employee field, the data would not be accepted. The domain for pay rate would not include negative numbers. In this way, defining a domain can increase data accuracy. The

**data item:** The specific value of an attribute.

specific value of an attribute, called a **data item**, can be found in the record describing an entity. The data hierarchy of attribute, entity, file, and database is shown in Figure 5.1. Table 5.3 shows a simple database with the Employee ID as the primary key for each entity in the database.

**FIGURE 5.1**  
**The data hierarchy**



**TABLE 5.3** Keys and attributes

The key field is the employee id which uniquely identifies each employee. The attributes include employee first name, last name, and middle name, hire date, current department, etc.

Employee ID	Last Name	First Name	Middle Name	Hire Date	Current Dept	Etc.
041287	Baker	James	Francis	09/30/2010	215	
051345	Andersen	James	Scott	01/23/2011	314	
062345	Brown	Alison	Sarah	03/25/2011	222	
062437	Sanders	Joanne	Amelia	03/23/2012	215	

Many organizations create databases of attributes and enter data items to store data needed to run their day-to-day operations. For instance, database technology is an important weapon in the fight against crime and terrorism, as discussed in the following examples:

- The Offshore Leaks Database contains the data about some 680,000 secretive offshore companies, trusts, and funds created in 200 countries around the world. Although creating offshore accounts is legal in most countries, offshore accounts are also established to enable individuals and organizations to evade paying the taxes they would otherwise owe. The database has been used by law enforcement and tax officials to identify potential tax evaders.<sup>4</sup>
- The National Integrated Ballistic Information Network (NIBIN) is managed by the Bureau of Firearms, Tobacco, Firearms, and Explosives. A key element of the network is a database of digital images of spent bullets and cartridge cases that were retrieved from crime scenes or test fired from weapons found at a crime scene or on a suspect.<sup>5</sup>
- The Global Terrorism Database (GTD) is a database including data on over 140,000 terrorist events that occurred around the world. For each terrorist event, information is available regarding the date and location of the event, the weapons used, the nature of the target, the number of casualties, and, when identifiable, the group or individual responsible.<sup>6</sup>

- Pawnshops are required by law to report their acquisitions to law enforcement by providing a description of each item pawned or sold along with any identifying numbers, such as a serial number. Leads Online is a nationwide online database system that can be used to fulfill this reporting responsibility and enable law enforcement officers to track merchandise that is sold or pawned in shops throughout the nation.<sup>7</sup>

**record:** A collection of attributes about a specific entity.

**primary key:** An attribute or set of attributes that uniquely identifies the record.

A collection of attributes about a specific entity is a **record**. A **primary key** is an attribute or set of attributes that uniquely identifies the record. No other record can have the same primary key. For an employee record, such as the ones shown in Table 5.3, the employee ID is an example of a primary key. The primary key is used to distinguish records so that they can be accessed, organized, and manipulated. Primary keys ensure that each record in a file is unique. For example, eBay assigns an “Item number” as its primary key for items to make sure that bids are associated with the correct item. See Figure 5.2.

The screenshot shows an eBay item listing for a 2013 Chevrolet Malibu Eco. The item is a silver sedan. The price is listed as US \$26,160.00 with a "Make Offer" button. The seller has a 100% positive feedback rating. The item number is 110868309963, it is new, and the seller offers local pick-up only. The listing includes coverage information and a link to order an independent inspection.

**FIGURE 5.2**

### Primary key

eBay assigns an item number as a primary key to keep track of each item in its database.  
[www.ebay.com](http://www.ebay.com)

**foreign key:** An attribute in one table that refers to the primary key in another table.

A **foreign key** is an attribute in one table that refers to the primary key in another table. It serves as a cross-reference enabling the data in the two tables to be related. For example, imagine a relational database that includes a customer table and an order table. A relationship can be created between the tables by including the foreign key customer ID in the order table. Customer ID is the primary key of the customer table. The customer ID in the order table enables orders to be cross-referenced to customers.

## The Database Approach

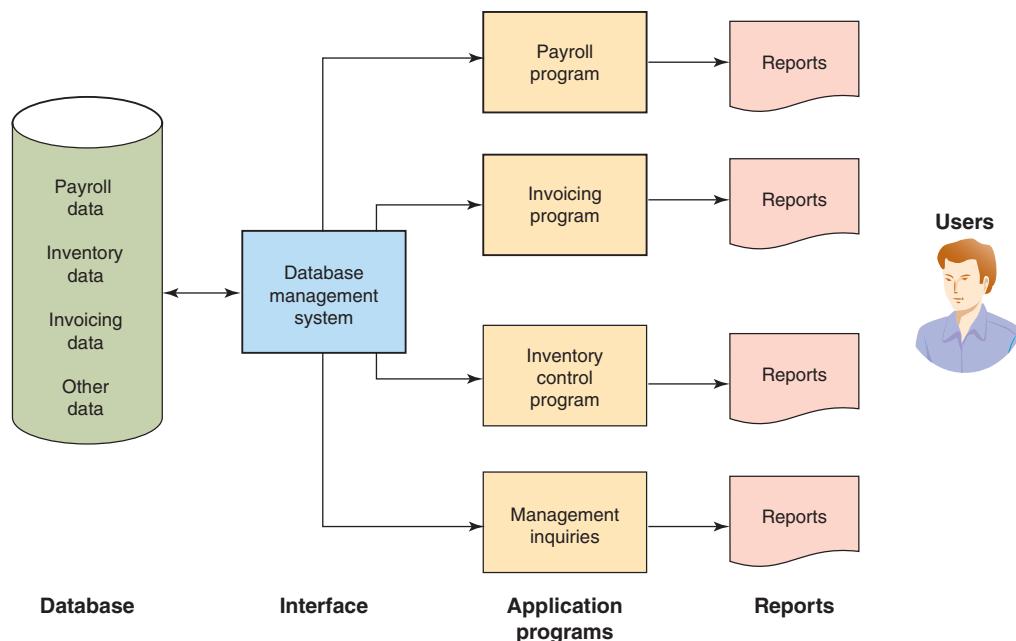
Today most organizations employ the **database approach to data management**, where multiple information systems share a pool of related data. A database offers the ability to share data and information resources. Federal law enforcement databases, for example, often include the results of DNA tests as an attribute for convicted criminals. The information can be shared with law enforcement officials around the country. Often, distinct yet related databases are linked to provide enterprise-wide databases. For example, many Walgreens stores include in-store medical clinics for customers. Walgreens uses

**database approach to data management:** An approach to data management where multiple information systems share a pool of related data.

**database management system (DBMS):** A group of programs used to access and manage a database as well as provide an interface between the database and its users and other application programs.

an electronic health records database that stores the information of all patients across all its stores. The database provides information about customers' interactions with the clinics and pharmacies.

To use the database approach to data management, additional software—a database management system (DBMS)—is required. A **database management system (DBMS)** consists of a group of programs provided by the DBMS supplier that are used to access and manage a database as well as provide an interface between the database and its users and other application programs. A DBMS provides a single point of management and control over data resources, which can be critical to maintaining the integrity and security of the data. An organization's databases, its DBMS, and the application programs that create and access the databases make up a database environment. Figure 5.3 illustrates the database approach.



**FIGURE 5.3**  
**Database approach to data management**

In a database approach to data management, multiple information systems share a pool of related data.

## Database Activities

Databases are used to provide a user view of the database, to add and modify data, to store and retrieve data, to manipulate the data and generate reports, to provide security management, and to provide database backup and recovery services. Each of these activities is discussed in greater detail in the following sections.

### Providing a User View

Because the DBMS is responsible for providing access to a database, one of the first steps in installing and using a large relational database involves “telling” the DBMS the logical and physical structure of the data and the relationships among the data for each user. This description is called a schema (as in a schematic diagram). In a relational database, the **schema** defines the tables, the attributes in each table, and the relationships between attributes and tables. Database management systems, such as Oracle or Access, typically use schemas to define the tables and other database features associated with a person or

**schema:** A description that defines the logical and physical structure of the database by identifying the tables, the attributes in each table, and the relationships between attributes and tables.

user. The DBMS can reference a schema to find where to access the requested data in relation to another piece of data. A database schema can be represented in a visual diagram showing the database objects and their relationship with one another, as shown in Figure 5.4.

**FIGURE 5.4**  
**Database schema represented in a visual diagram**

Students	Courses	Grades
student_id (key)	course_no (key)	course_no (key)
last_name	section_no (key)	section_no (key)
first_name	title	student_id(key)
middle_name	professor	semester
Salutation	days	year
date_of_birth	times	grade
address_line1	prereq	

### **Creating and Modifying the Database**

**data definition language (DDL):** A collection of instructions and commands used to define and describe data and relationships in a specific database.

The database schema can also be defined using a data definition language. A **data definition language (DDL)** is a collection of instructions and commands used to define and describe data and relationships in a specific database. Table 5.4 shows a simplified example of a DDL used to define a single database table.

**TABLE 5.4** Database schema of the student table expressed in DDL

CREATE TABLE students (		
student_id	INTEGER (9)	PRIMARY KEY
last_name	VARCHAR (40)	not null
first_name	VARCHAR (20)	not null
middle_name	VARCHAR (20)	not null
salutation	VARCHAR (8)	not null
date_of_birth	DATE	not null
gender	INTEGER (1)	not null
address-line1	VARCHAR (30)	not null
and so forth		
);		

**data dictionary:** A detailed description of the data stored in the database.

Another important step in creating a database is to establish a **data dictionary**, a detailed description of the data stored in the database. Among other details, the data dictionary contains the following information for each data item:

- Name of the data attribute
- Aliases or other names that may be used to describe the item
- Range of values that can be used (domain)
- Type of data (such as alphanumeric or numeric)
- Number of bytes of storage needed for the item

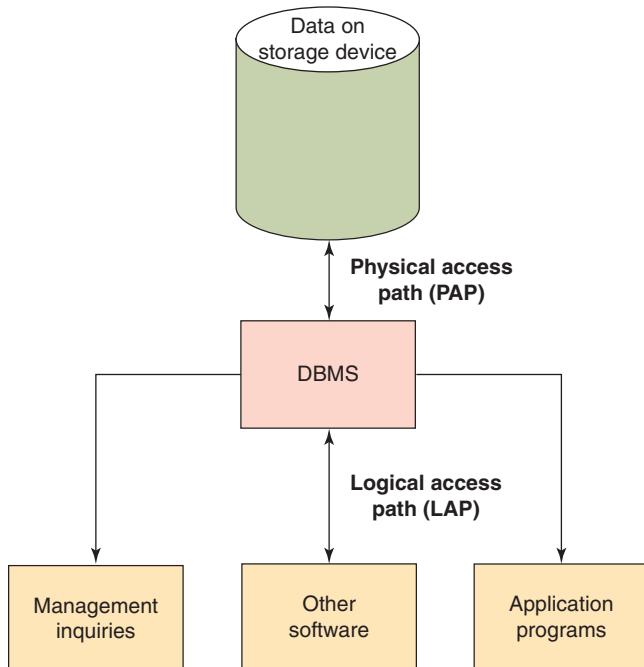
A data dictionary is a valuable tool for maintaining an efficient database that stores reliable information with no redundancy, and it simplifies the process of modifying the database when necessary. Data dictionaries also help

computer and system programmers who require a detailed description of data elements stored in a database to create the code to access the data.

Adherence to the standards defined in the data dictionary also makes it easy to share data among various organizations. For example, The National Syndromic Surveillance Program (NSSP) is designed to enable the early detection of outbreaks resulting from biological terrorism or naturally occurring highly contagious diseases. The system enables the Centers for Disease Control and Prevention to track the number of people affected, the rate of spread, and the rate of mortality. Hopefully, this early warning will enable health professionals to mobilize a rapid response and thereby reduce the number of deaths. The system's success depends on the ability to rapidly collect, evaluate, share, and store syndromic surveillance data. A data dictionary (current version NSSP v32 documented at <https://www.cdc.gov/nssp/biosense/docs/NSSP-Data-Dictionary.xlsx>) was created to ensure standardization and consistent definition of all key elements captured by this system to ensure the easy sharing of high-quality data.<sup>8</sup>

### **Storing and Retrieving Data**

One function of a DBMS is to be an interface between an application program and the database. When an end user, application program, or other software needs data from the database, it requests the data through the DBMS. Suppose that to calculate the total price of a new car, a pricing program needs price data on the engine option—for example, six cylinders instead of the standard four cylinders. The application program requests this data from the DBMS. In doing so, the application program follows a logical access path (LAP). Next, the DBMS, working with various system programs, accesses a storage device, such as a disk drive or solid-state storage device (SSD), where the data is stored. When the DBMS goes to this storage device to retrieve the data, it follows a path to the physical location—physical access path (PAP)—where the price of this option is stored. In the pricing example, the DBMS might go to a disk drive to retrieve the price data for six-cylinder engines. This relationship is shown in Figure 5.5.



**FIGURE 5.5**  
**Logical and physical access paths**

When an application requests data from the dbms, it follows a logical access path to the data. When the dbms retrieves the data, it follows the physical access path to the data.

This same process is used if a user wants to get information from the database. First, the user requests the data from the DBMS. For example, a user might give a command, such as LIST ALL OPTIONS FOR WHICH PRICE IS GREATER THAN \$200. This is the logical access path. Then, the DBMS might

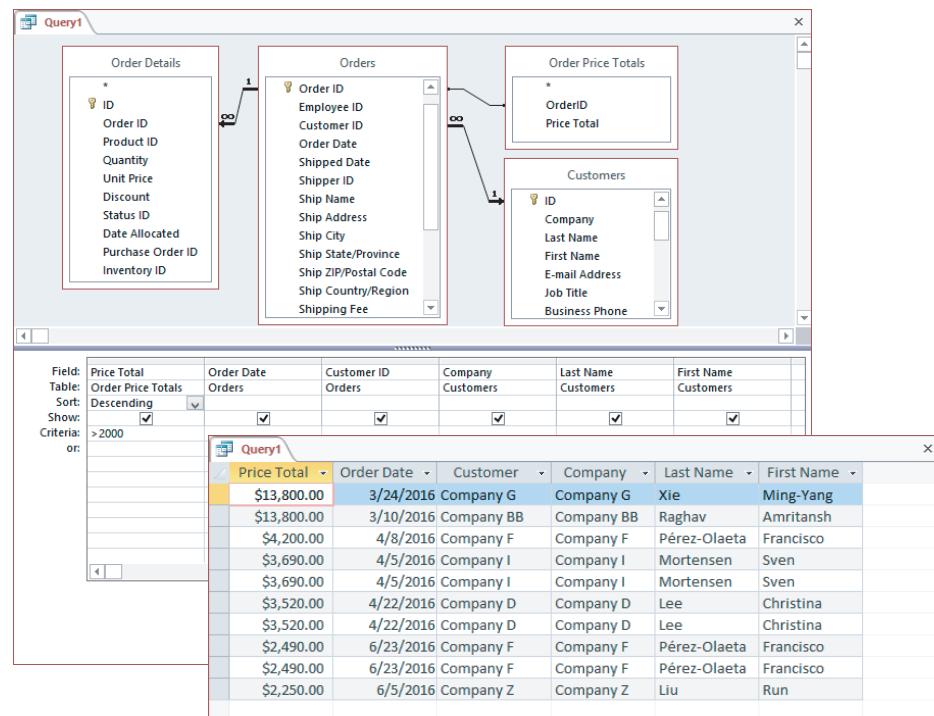
go to the options price section of a disk to get the information for the user. This is the physical access path.

Two or more people or programs attempting to access the same record at the same time can cause a problem. For example, an inventory control program might attempt to reduce the inventory level for a product by 10 units because 10 units were just shipped to a customer. At the same time, a purchasing program might attempt to increase the inventory level for the same product by 200 units because inventory was just received. Without proper database control, one of the inventory updates might be incorrect, resulting in an inaccurate inventory level for the product. **Concurrency control** can be used to avoid this potential problem. One approach is to lock out all other application programs from access to a record if the record is being updated or used by another program.

**concurrency control:** A method of dealing with a situation in which two or more users or applications need to access the same record at the same time.

### Manipulating Data and Generating Reports

After a DBMS has been installed, employees, managers, and other authorized users can use it to review reports and obtain important information. Using a DBMS, a company can manage this requirement. Some databases use Query by Example (QBE), which is a visual approach to developing database queries or requests. With QBE, you can perform queries and other database tasks by opening windows and clicking the data or features you want—similar to the way you work with Windows and other GUI (graphical user interface) operating systems and applications. See Figure 5.6.



**FIGURE 5.6**  
**Query by example**

Some databases use query by example (qbe) to generate reports and information. Microsoft product screenshots used with permission from Microsoft Corporation

In other cases, database commands can be used in a programming language. For example, commands written in the C++ programming language can be used in simple programs that will access or manipulate certain pieces of data in the database. Here's another example of a DBMS query:

```
SELECT * FROM EMPLOYEE WHERE JOB_CLASSIFICATION='C2.'
```

**data manipulation language (DML)**

**(DML):** A specific language, provided with a DBMS, which allows users to access and modify the data, to make queries, and to generate reports.

The asterisk (\*) tells the program to include all columns from the EMPLOYEE table. In general, the commands that are used to manipulate the database are part of the **data manipulation language (DML)**. This specific language, provided with the DBMS, allows managers and other database users to access and modify the data, to make queries, and to generate reports. Again, the application programs go through schemas and the DBMS before getting to the data stored on a device such as a disk.

After a database has been set up and loaded with data, it can produce desired reports, documents, and other outputs such as that shown in Table 5.5. These outputs usually appear in screen displays or on hard copy printouts. The output-control features of a database program allow a user to select the records and fields that will appear in a report. Formatting controls and organization options (such as report headings) help users customize reports and create flexible, convenient, and powerful information-handling tools.

**TABLE 5.5** Sample report ten largest orders for 2020

#	Invoice #	Order Date	Company	Salesperson	Sales Amount
1	102345	3/12/2020	Acme Plumbing	Davis	\$132,432
2	104256	6/12/2020	Joiner Appliances	Kohl	\$122,567
3	100345	5/4/2020	Smith Bros	Ruberg	\$120,432
4	104557	7/3/2020	City-Wide Appliances	Brown	\$109,356
5	103678	5/21/2020	Joiner Appliances	Kohl	\$100,452
6	104125	6/7/2020	Acme Plumbing	Davis	\$100,234
7	104892	8/2/2020	Smith Bros	Davis	\$ 97,179
8	103885	6/22/2020	City-Wide Appliances	Brown	\$ 95,234
9	105894	9/30/2020	Joiner Appliances	Kohl	\$ 92,341
10	102634	4/1/2020	Smith Bros	Ruberg	\$ 90,007

A DBMS can produce a wide variety of documents, reports, and other output that can help organizations make decisions and achieve their goals. Often, organizations have standard reports that are run on a regular basis. The most common reports select and organize data to present summary information about some aspect of company operations. For example, accounting reports often summarize financial data such as current and past due accounts. Many companies base their routine operating decisions on regular status reports that show the progress of specific orders toward completion and delivery.

### Security Management

The DBMS security management function helps ensure that data are protected against access by unauthorized users, physical damage, operating system failure, and simultaneous updating of the same data by multiple users. An especially powerful feature of the DBMS security function is the capability to define and enforce user access privileges that control who can access what data and what they can do with that data (e.g. read only, add/delete/change the data). Good security practices recommend that users are granted the minimum privileges to do their jobs. For example, an entry level payment clerk from the accounts payable function should not be given the ability to modify the payment amount or the payee to avoid potential fraud. However, this privilege may be granted to the accounts payable supervisor. The DBMS security functions are generally planned, implemented, and maintained by a database administrator and/or other information security professional.

## Backup and Recovery

The DBMS also provides backup and recovery services. For example, if there is a power outage, recovery management enables the database to be brought back up safely and without loss of data following the outage. Backup management refers to making backup copies of all or portions of the database. In the event the database is lost, damaged, or destroyed, the backup copies can be used to restore the database.

## Data Cleansing

**data cleansing:** The process of detecting and then correcting or deleting incomplete, incorrect, inaccurate, or irrelevant records that reside in a database.

Data used in decision making must be accurate, complete, economical, flexible, reliable, relevant, simple, timely, verifiable, accessible, and secure. **Data cleansing** is the process of detecting and then correcting or deleting incomplete, incorrect, inaccurate, or irrelevant records that reside in a database. The goal of data cleansing is to improve the quality of the data used in decision making. The “bad data” may have been caused by user data-entry errors or by data corruption during data transmission or storage. Data cleansing is different from data validation, which involves the identification of “bad data” and its rejection at the time of data entry.

One data cleansing solution is to identify and correct data by cross-checking it against a validated data set. For example, street number, street name, city, state, and zip code entries in an organization’s database may be cross-checked against the United States Postal Zip Code database. Data cleansing may also involve standardization of data, such as the conversion of various possible abbreviations (St., St, st., st) to one standard name (Street).

Data enhancement augments the data in a database by adding related information—such as using the zip code information for a given record to append the county code or census tract code. The cost of performing data cleansing can be quite high. It is prohibitively expensive to eliminate all “bad data” to achieve 100 percent database accuracy.

## Database Design

Because today’s organizations must keep track of and analyze so much data, it is necessary to keep the data well organized so that it can be used effectively. A database should be designed to store all data relevant to the business and to provide quick access and easy modification. Moreover, it must reflect the business processes of the organization. When designing a database, an organization must carefully consider the following questions:

- **Content.** What data should be collected and at what cost?
- **Access.** What data should be provided to which users and when?
- **Logical structure.** How should data be arranged so that it makes sense to a given user?
- **Physical organization.** Where should data be physically located?
- **Response time.** How quickly must the data be updated and retrieved so it can be viewed by the users?
- **Archiving.** How long must this data be stored?
- **Security.** How can this data be protected from unauthorized access?

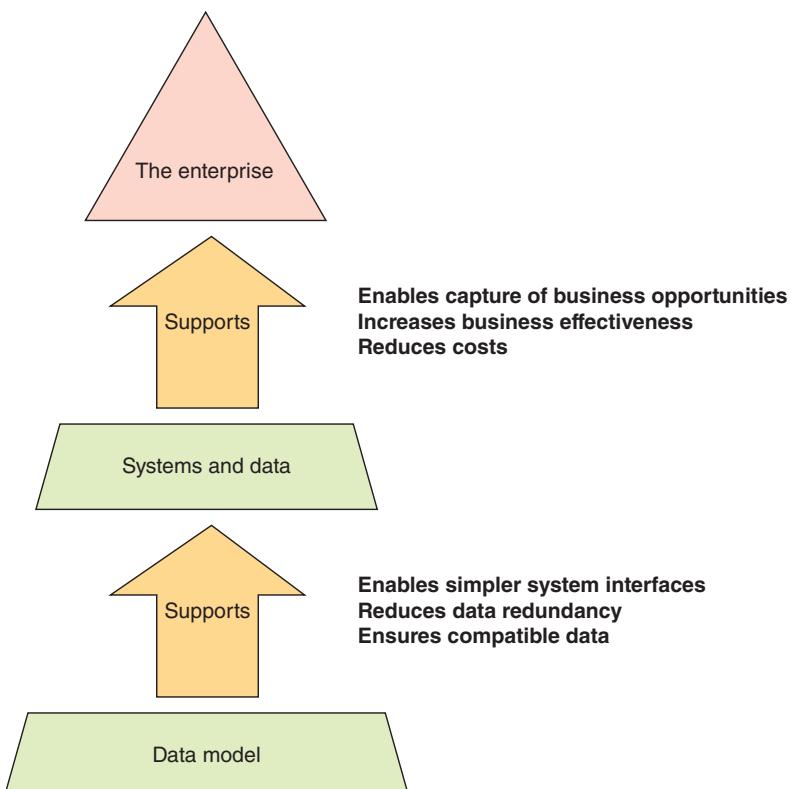
One of the tools used to design a database is the data model. Data modelling is commonly done either at the organizational level or at the level of a specific business application. When done at the organizational level, this procedure is called enterprise data modelling. Enterprise data modelling is an approach that starts by investigating the general data and information needs of the organization at the strategic level and then moves on to examine more specific data and information needs for the functional areas and departments within the organization.

**enterprise data model:** A data model that identifies the data entities and data attributes of greatest interest to the organization along with their associated standard data definitions, data length and format, domain of valid values, and any business rules for their use.

The **enterprise data model** identifies the data entities and data attributes of greatest interest to the organization along with their associated standard data definitions, data length and format, domain of valid values, and any business rules for their use (e.g. if product type is 123, then days to ship must be greater than 5). The enterprise data model as shown in Figure 5.7 is a valuable resource with the following benefits:

- Provides a roadmap of the organization's current and future data that serves as an initial starting point for the development of new applications that will be able to integrate and exchange data.
- Avoids costly and inefficient data redundancy where the same data entities or data attributes are captured in more than one application or stored in more than one database.
- Identifies gaps in the data needed to support the organization so that plans can be made to capture or acquire the needed data.
- Provides a benchmark against which to evaluate the extent to which a vendor's software package meets the organization's data needs.

Occasionally, an organization will purchase an industry-standard enterprise model for their industry from a vendor or industry group. For example, the IBM Healthcare Provider Data Model is an enterprise data model that can be adopted by a healthcare provider organization to organize and integrate clinical, research, operational, and financial data.<sup>9</sup> At one time, the University of North Carolina Health Care System had a smorgasbord of information system hardware and software that made it difficult to integrate data from its existing legacy systems. The organization used the IBM Healthcare Provider Data Model to guide its efforts to simplify its information system environment and improve the integration of its data. As a result, it was able to eliminate its dependency on outdated technologies, build an environment that supports efficient data management, and integrate data from its legacy systems to create a source of data to support future data analysis requirements.<sup>10</sup>



**FIGURE 5.7**  
**Enterprise data model**  
The enterprise data model provides a roadmap for building database and information systems.

**entity-relationship (ER)**

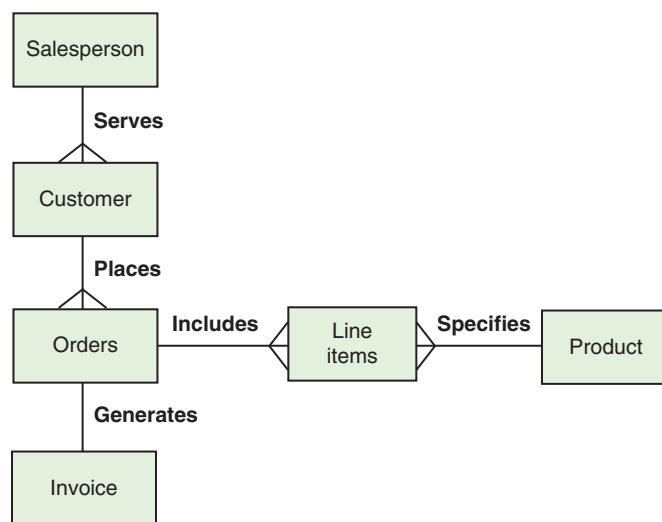
**diagram:** A data model that uses basic graphical symbols to show the organization of and relationships between data.

The **entity-relationship (ER) diagram** is a data model used to analyze and communicate data needs at the individual project or application level using graphical symbols to identify data entities and their associated data attributes as well as the relationships among the entities of interest. There are many notation styles that can be used in drawing an ER diagram.

ER diagrams ensure that the relationships among the data entities in a database are correctly structured so that any application programs developed are consistent with business operations and user needs. In addition, ER diagrams can serve as reference documents after a database is in use. If changes are made to the database, ER diagrams help design them. Figure 5.8 shows an ER diagram for an order database for a specific organization. In this database design, one salesperson serves many customers. This is an example of a one-to-many relationship, as indicated by the one-to-many symbol (the “crow’s-foot”) shown in the figure. The ER diagram also shows that each customer can place one-to-many orders, that each order includes one-to-many line items, and that many line items can specify the same product (a many-to-one relationship). This database can also have one-to-one relationships. For example, one order generates one invoice.

**FIGURE 5.8**  
**Entity-relationship (ER)**  
**diagram for a customer order**  
**database**

Development of ER diagrams helps ensure that the logical structure of application programs is consistent with the data relationships in the database.



### Critical Thinking Exercise

## Cleansing the Customer Relationship Management Database

### ► DECISION MAKING

Several sales and marketing managers are requesting a data cleansing operation on the Customer Relationship Management (CRM) database. This is a critical database for the organization that stores and manages prospect and customer data like contact data and account activity including purchases, interactions with the organization, and responses to previous marketing initiatives. It also captures and stores data about sales leads and sales opportunities. Members of the sales and marketing functions want the records of all customers who have not purchased any of your products in the past six months to be purged from the database. Similarly, all leads who have not responded to any marketing initiative in the past six months should be purged. They also want all leads and customers with invalid email addresses deleted.

### Review Questions

1. What else is involved in data cleansing besides purging records considered no longer necessary?
2. Which of the fundamental database design questions needs to be reviewed?

### Critical Thinking Questions

- Identify three or four data attributes that may need to be updated and/or corrected in the CRM database.
- Is it possible that the data cleansing requested could result in the loss of valuable data? Explain your answer.

## Relational Databases

**relational database model:** A simple but highly useful way to organize data into collections of two-dimensional tables called relations.

The **relational database model** is a simple but highly useful way to organize data into collections of two-dimensional tables called relations, as shown in Figure 5.9. A relational database has six fundamental characteristics:

- Data is organized into collections of two-dimensional tables called relations.
- Each row in the table represents an entity and each column represents an attribute of that entity.
- Each row in a table is uniquely identified by a primary key.
- The type of data a table column can contain can be specified as integer number, decimal number, date, text, etc.
- The data in a table column can be constrained to be of a certain type (integer, decimal number, date, character, etc.), a certain length, or to have a value between two limits.
- Primary and foreign keys enable relationships between the tables to be defined.
- User queries are used to perform operations on the database like adding, changing, or deleting data and selecting, projecting, and joining existing data in existing tables.

**Data Table 1: Project Table**

Project	Description	Dept. number
155	Payroll	257
498	Widgets	632
226	Sales manual	598

**Data Table 2: Department Table**

Dept. number	Dept. name	Manager SSN
257	Accounting	005-10-6321
632	Manufacturing	549-77-1001
598	Marketing	098-40-1370

**FIGURE 5.9**

### Relational database model

In the relational model, data is placed in two-dimensional tables, or relations. As long as they share at least one common attribute, these relations can be linked to provide output useful information. In this example, all three tables include the dept. number attribute.

**Data Table 3: Manager Table**

SSN	Last name	First name	Hire date	Dept. number
005-10-6321	Johns	Francine	10-07-2013	257
549-77-1001	Buckley	Bill	02-17-1995	632
098-40-1370	Fiske	Steven	01-05-2001	598

## Manipulating Data in a Relational Database

After entering data into a relational database, users can make inquiries and analyze the data. Basic data manipulations include selecting, projecting, and joining.

**selecting:** Manipulating data to eliminate rows according to certain criteria.

**projecting:** Manipulating data to eliminate columns in a table.

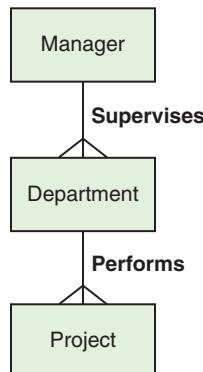
**joining:** The combining of two or more tables through common data attributes to form a new table with only the unique data attributes.

**Selecting** involves eliminating rows according to certain criteria. Suppose the department manager of a company wants to use a project table that contains the project number, description, and department number for all projects a company is performing. The department manager might want to find the department number for Project 226, a sales manual project. Using selection, the manager can eliminate all rows except the one for Project 226 and see that the department number for the department completing the sales manual project is 598.

**Projecting** involves eliminating columns in a table. For example, a department table might contain the department number, department name, and Social Security number (SSN) of the manager in charge of the project. A sales manager might want to create a new table that contains only the department number and the Social Security number of the manager in charge of the sales manual project. The sales manager can use projection to eliminate the department name column and create a new table containing only the department number and Social Security number.

As long as the tables share at least one common data attribute, the tables in a relational database can be linked to provide useful information and reports.

**Joining** is the combining of two or more tables through common data attributes to form a new table with only the unique data attributes. It is one of the keys to the flexibility and power of relational databases. Suppose the president of a company wants to find out the name of the manager of the sales manual project as well as the length of time the manager has been with the company. Assume that the company has Manager, Department, and Project tables, as shown in Figure 5.10.



**FIGURE 5.10**  
**ER diagram**

This diagram shows the relationship among the manager, department, and project tables.

Note the crow's-foot by the Project table. This symbol indicates that a department can have many projects. The manager would make the inquiry to the database, perhaps via a laptop computer. The DBMS would start with the project description and search the Project table to find out the project's department number. It would then use the department number to search the Department table for the manager's Social Security number. The department number is also in the Department table and is the common element that links the Project table to the Department table. The DBMS uses the manager's Social Security number to search the Manager table for the manager's hire date. The manager's Social Security number is the common element between the Department table and the Manager table. The final result is that the manager's name and hire date are presented to the president as a response to the inquiry. Figure 5.11 shows the linking between the Project, Department, and Manager tables needed to answer this inquiry.

**Data Table 1: Project Table**

Project number	Description	Dept. number
155	Payroll	257
498	Widgets	632
226	Sales manual	598

**Data Table 2: Department Table**

Dept. number	Dept. name	Manager SSN
257	Accounting	005-10-6321
632	Manufacturing	549-77-1001
598	Marketing	098-40-1370

**Data Table 3: Manager Table**

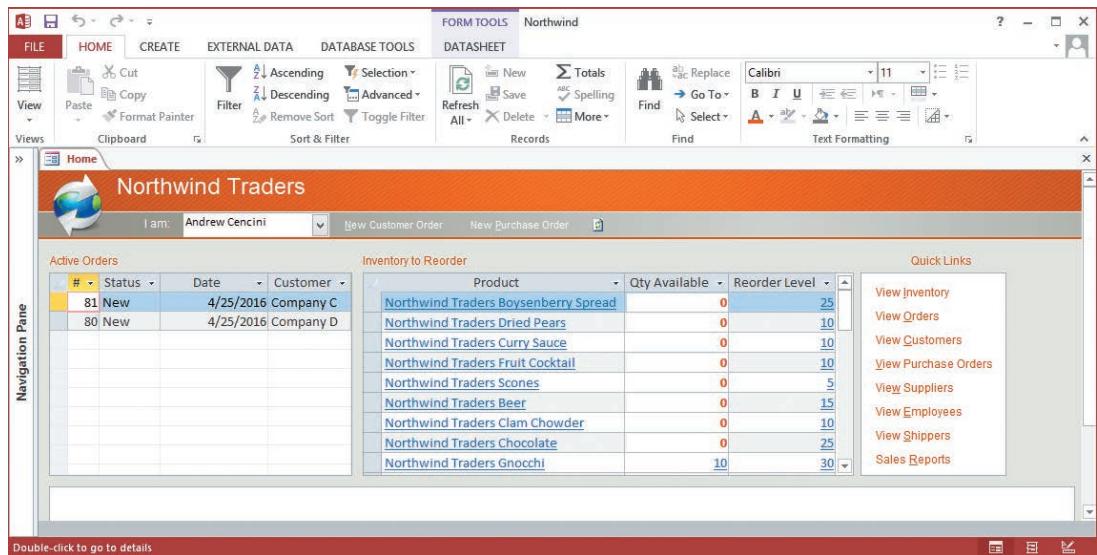
SSN	Last name	First name	Hire date	Dept. number
005-10-6321	Johns	Francine	10-07-2013	257
549-77-1001	Buckley	Bill	02-17-1995	632
098-40-1370	Fiske	Steven	01-05-2001	598

**FIGURE 5.11**  
**Linking data tables to answer an inquiry**

To find the name and hire date of the manager working on the sales manual project, the president needs three tables: project, department, and manager. The project description (sales manual) leads to the department number (598) in the project table, which leads to the manager's social security number (098-40-1370) in the department table, which leads to the manager's last name (fiske) and hire date (01-05-2001) in the manager table.

One of the primary advantages of a relational database is that it allows tables to be linked, as shown in Figure 5.11. This linkage reduces data redundancy and allows data to be organized more logically. The ability to link to the manager's Social Security number stored once in the Manager table eliminates the need to store it multiple times in the Project table.

The relational database model is widely used. It is easier to control, more flexible, and more intuitive than other approaches because it organizes data in tables. As shown in Figure 5.12, a relational database management system, such as Microsoft Access, can be used to store data in rows and columns. In this figure, hyperlink tools available on the ribbon/toolbar can be used to create, edit, and manipulate the database. The ability to link relational tables also allows users to relate data in new ways without having to redefine complex relationships. Because of the advantages of the relational model, many companies use it for large corporate databases, such as those for marketing and accounting.



**FIGURE 5.12**  
**Building and modifying a relational database**

Relational databases provide many tools, tips, and shortcuts to simplify the process of creating and modifying a database.

Databases based on the relational model include Oracle, IBM DB2, Microsoft SQL Server, Microsoft Access, MySQL, Sybase, and others. The relational database model has been an outstanding success and is dominant in the commercial world today, although many organizations are beginning to use new nonrelational models to meet some of their business needs.

**Data normalization** is the process of organizing the data in a relational database to eliminate data redundancy (all data is stored in only one place) and ensure data dependencies make sense (only storing related data in a table). Data normalization is a rigorous multi-step process that ensures that relational databases take up minimal storage space, resulting in improved database performance. This involves dividing a relational database into two or more tables and defining relationships between the tables. Data normalization also isolates data so that additions, deletions, and modifications of an attribute can be made in just one table and then propagated through the rest of the database via the defined relationships. This simplifies database maintenance as various attributes change.

## SQL Databases

**SQL** is a special-purpose programming language for accessing and manipulating data stored in a relational database. SQL was originally defined by Donald D. Chamberlin and Raymond Boyce of the IBM Research Center and described in their paper “SEQUEL: A Structured English Query Language,” published in 1974. Their work was based on the relational database model described by Edgar F. Codd in his ground-breaking paper from 1970, “A Relational Model of Data for Large Shared Data Banks.” It presented a set of thirteen database management system rules he considered as the prerequisites to consider a database management system a relational database management system.

SQL databases conform to **ACID properties** (atomicity, consistency, isolation, durability), which were defined by Jim Gray soon after Codd’s work was published. These properties guarantee database transactions are processed reliably and ensure the integrity of data in the database. Basically, these principles mean that data is broken down to atomic values—that is, values that have no component parts—such as employee\_ID, last\_name, first\_name, address\_line\_1,

**data normalization:** The process of organizing the data in a relational database to eliminate data redundancy (all data is stored in only one place) and ensure data dependencies make sense (only storing related data in a table).

**SQL:** A special-purpose programming language for accessing and manipulating data stored in a relational database.

**ACID properties:** Properties (atomicity, consistency, isolation, durability) that guarantee relational database transactions are processed reliably and ensure the integrity of data in the database.

address\_line\_2, and city. The data in these atomic values remains consistent across the database. The data is isolated from other transactions until the current transaction is finished, and it is durable in the sense that the data should never be lost.<sup>11</sup>

SQL databases rely upon concurrency control by locking database records to ensure that other transactions do not modify the database until the first transaction succeeds or fails. As a result, 100 percent ACID-compliant SQL databases can suffer from slow performance.

In 1986, the American National Standards Institute (ANSI) adopted SQL as the standard query language for relational databases. Since ANSI's acceptance of SQL, interest in making SQL an integral part of relational databases on both mainframe and personal computers has increased. SQL has many built-in functions, such as average (AVG), the largest value (MAX), and the smallest value (MIN). Table 5.6 contains examples of SQL commands.

**TABLE 5.6** Examples of SQL commands

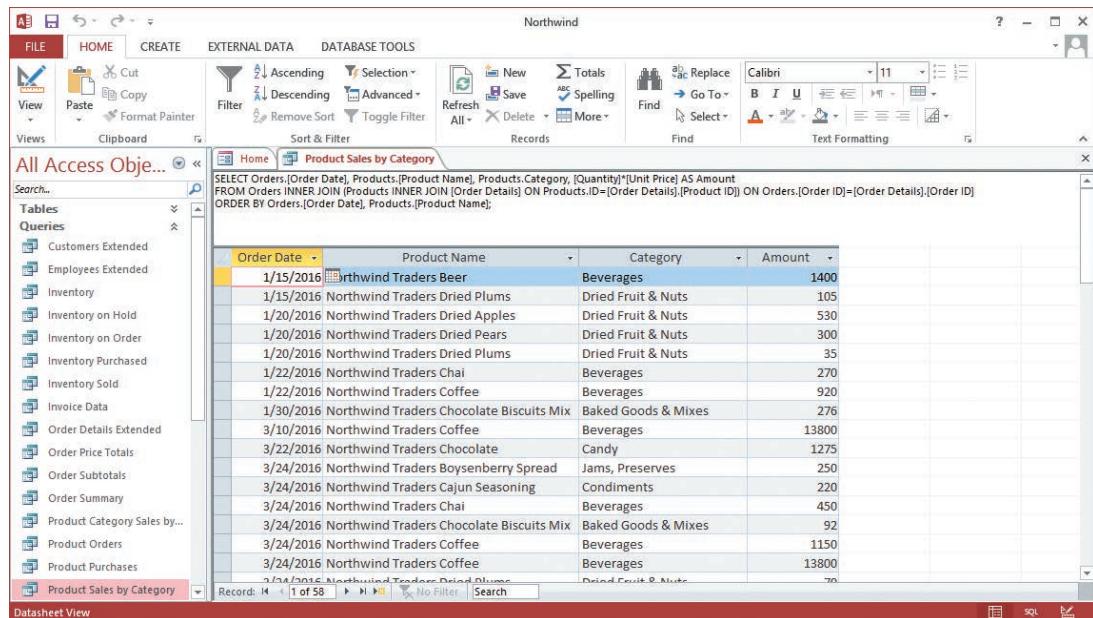
SQL Command	Description
SELECT ClientName, Debt FROM Client WHERE Debt > 1000	This query displays clients (ClientName) and the amount they owe the company (Debt) from a database table called Client; the query would only display clients who owe the company more than \$1,000 (WHERE Debt > 1000).
SELECT ClientName, ClientNum, OrderNum FROM Client, Order WHERE Client. ClientNum=Order.ClientNum	This command is an example of a join command that combines data from two tables: the Client table and the Order table (FROM Client, Order). The command creates a new table with the client name, client number, and order number (SELECT ClientName, ClientNum, OrderNum). Both tables include the client number, which allows them to be joined. This ability is indicated in the WHERE clause, which states that the client number in the Client table is the same as (equal to) the client number in the Order table (WHERE Client.ClientNum=Order.ClientNum).
GRANT INSERT ON Client to Guthrie	This command is an example of a security command. It allows Bob Guthrie to insert new values or rows into the Client table.

SQL allows programmers to learn one powerful query language and use it on systems ranging from PCs to the largest mainframe computers. See Figure 5.13. Programmers and database users also find SQL valuable because SQL statements can be embedded into many programming languages, such as the widely used C++ and Java. Because SQL uses standardized and simplified procedures for retrieving, storing, and manipulating data, many programmers find it easy to understand and use—hence, its popularity.

## Popular Relational Database Management Systems

Many popular database management systems address a wide range of individual, workgroup, and enterprise needs as shown in Table 5.7. The complete DBMS market encompasses software used by people ranging from nontechnical individuals to highly trained, professional programmers and runs on all types of computers from tablets to supercomputers. The entire market generates billions of dollars per year in revenue for companies such as IBM, Oracle, and Microsoft.

Selecting a DBMS begins by analyzing the information needs of the organization. Important characteristics of databases include the size of the database, the number of concurrent users, the performance demanded of the database, the ability of the DBMS to be integrated with other systems, the features of the DBMS, the vendor considerations, and the cost of the database management system.



**FIGURE 5.13**  
**Structured Query Language (SQL)**

SQL has become an integral part of most relational databases, as shown by this example from Microsoft Access 2016.

Microsoft product screenshots used with permission from Microsoft Corporation

**TABLE 5.7** Popular database management systems

Open-Source Relational DBMS	Relational DBMS for Individuals and Workgroups	Relational DBMS for Workgroups and Enterprise
MySQL	Microsoft Access	Oracle
PostgreSQL	IBM Lotus Approach	IBM DB2
MariaDB	Google Base	Sybase Adaptive Server
SQL Lite	OpenOffice Base	Teradata
CouchDB	Airtable	Microsoft SQL Server
MongoDB	Knack	Progress OpenEdge

*Zillow.com* is an online real estate community where homeowners, buyers, sellers, and real estate agents can see what homes are worth, what's for sale, and what local experts have to say about real estate and individual homes. Zillow needed a reliable database that would enable it to quickly process and manage massive amounts of data. Zillow chose MySQL Cluster, a special high availability version of the open-source relational database MySQL.<sup>12</sup>

With **database as a service (DaaS)**, the database is stored on a service provider's servers and accessed by the service subscriber over the Internet, with the database administration handled by the service provider. The big advantage of DaaS is that it eliminates the installation, maintenance, and monitoring of in-house databases thus reducing hardware, software, and staffing related costs. In addition, the service provider can allocate more or less database storage capacity based on an individual customer's changing needs. Customers must depend on the service provider to provide system backup capabilities and to protect customer data from unauthorized access. More than a dozen companies are now offering DaaS services including Amazon, Clustrix, Google, Heroku, IBM, Microsoft, MongoDB, and Oracle. Amazon Relational Database Service

#### database as a service

**(DaaS):** An arrangement where the database is stored on a service provider's servers and accessed by the service subscriber over a network, typically the Internet, with the database administration handled by the service provider.

(Amazon RDS) is a DaaS that enables organizations to set up and operate their choice of a MySQL, Microsoft SQL, Oracle, or PostgreSQL relational database in the cloud. The service automatically backs up the database and stores those backups based on a user-defined retention period.

Airbnb is an online marketplace that enables people to obtain short-term lodging including vacation rentals, apartment rentals, homestays, hostel beds, or hotel rooms in more than 65,000 cities and 191 countries.<sup>13</sup> The company employs Amazon Web Services (AWS) to enable it to support the rapid growth in the number of its users without having to devote constant time and effort to organize and configure its information systems infrastructure. This includes the ability to process and analyze some 50 gigabytes of data daily and store over 10 terabytes of user pictures.<sup>14</sup>



## Critical Thinking Exercise

### Database to Support Film Festival

#### ► DECISION MAKING

You are a member of the Palm Springs Convention and Visitors bureau. The city holds a film festival each spring that draws nearly 150,000 including film industry celebrities and film makers. The festival provides a great opportunity for visitors to get a preview of over 100 films over a two-week period. Participants can also elect to attend special opening and closing night events.

This year, there is a desire to capture data about the visitors and their participation in the festival as well as feedback captured on comment cards submitted by viewers of each film. The data would be used for many purposes. A primary goal is to decide which films and filmmakers are most popular so that the film studios can prepare appropriate marketing campaigns. Another goal is to capture visitors' contact information, so they can be mailed a reminder to register for next year's festival several weeks in advance. The filmmakers would also like to use the visitors' contact information to send them a letter of appreciation for viewing their film and incentives to encourage them to tell their friends about it. You have been asked to lead an effort to develop a simple relational database to meet these needs.

#### Review Questions

1. What key questions need to be answered to begin the design of this database?
2. The Convention and Visitor's bureau employs the Microsoft Office 365 personal productivity software. You are proficient with Excel and are thinking of creating a series of Excel spreadsheets with the necessary data to meet these needs. Is this the way to go? Why or why not?

#### Critical Thinking Questions

1. Identify three tables that are needed to capture the data required to support the identified needs. Identify a primary key and at least 2 or 3 additional attributes for each table.
2. At what stage of this project should you get other stakeholders involved? Why might this be necessary?

## Data Management

**Data management** is an integrated set of functions that defines the processes by which data is obtained, certified fit for use, stored, secured, and processed in such a way as to ensure that the accessibility, reliability, and timeliness of the data meet the needs of the data users within an organization. The Data

**data management:** An integrated set of functions that defines the processes by which data is obtained, certified fit for use, stored, secured, and processed in such a way as to ensure that the accessibility, reliability, and timeliness of the data meet the needs of the data users within an organization.

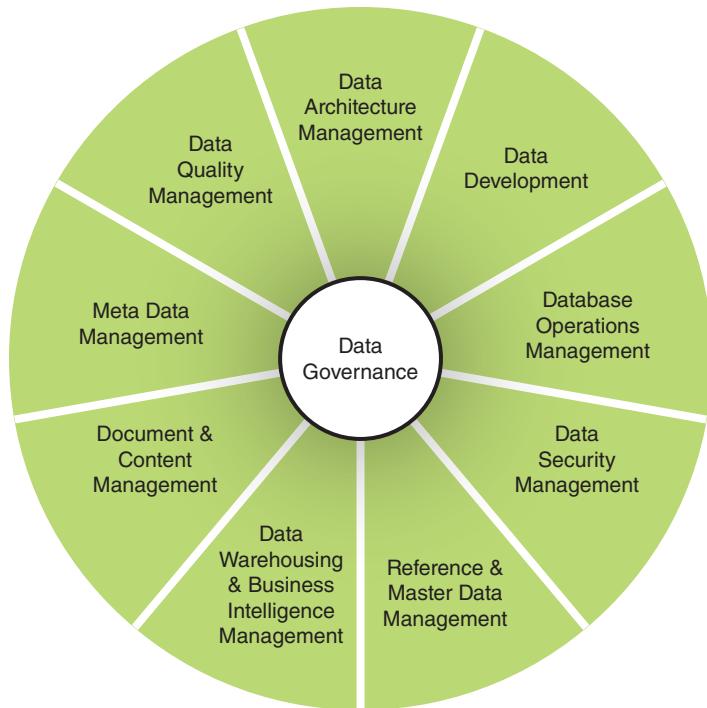
**FIGURE 5.14**  
**Data management**

The data management association (dama) international has identified basic functions associated with data management.

Source: "Body of Knowledge," DMA International, <https://www.dama.org/content/body-knowledge>. Copyright DMA International.

**data governance:** The core component of data management; it defines the roles, responsibilities, and processes for ensuring that data can be trusted and used by the entire organization, with people identified and in place who are responsible for fixing and preventing issues with data.

Management Association (DAMA) International is a nonprofit, vendor-independent, international association whose members promote the understanding, development, and practice of managing data as an essential enterprise asset. This organization has identified the major functions of data management, as shown in Figure 5.14.



**Data governance** is the core component of data management; it defines the roles, responsibilities, and processes for ensuring that data can be trusted and used by the entire organization, with people identified and in place who are responsible for fixing and preventing issues with data.

The need for data management is driven by a variety of factors, including the need to meet external regulations designed to manage risk associated with the misstatement of financial data, the need to avoid the accidental release of sensitive data, and the need to ensure that key business decisions are made using high-quality data. Haphazard or incomplete business processes and controls simply will not meet these requirements. Rigorous management processes are needed to govern data.

Effective data governance requires business leadership and active participation and is an effort best led by business managers and not the information system organization. The data governance team should be a cross-functional and multilevel team, consisting of executives, project managers, line-of-business managers, and IS managers drawn from various areas of the business. The use of a cross-functional team is recommended because data and information systems are used by many different departments and no one individual has a complete view of the organization's data needs.

The data governance team develops a policy that specifies who is accountable for various portions or aspects of the data, including its accuracy, accessibility, consistency, completeness, updating, and archiving. The team defines processes for how the data is to be stored, archived, backed up, and protected from cyberattacks, inadvertent destruction or disclosure, or theft. It develops standards and procedures that define who is authorized to update, access, and use the data. The team also puts in place a set of controls and audit procedures

to ensure ongoing compliance with organizational data policies and government regulations. Two key members of the data governance team are the database administrator and data stewards.

**database administrator (DBA):** A skilled and trained IS professional who holds discussions with business users to define their data needs; applies database programming languages to craft a set of databases to meet those needs; tests and evaluates databases; implements changes to improve the performance of databases; and assures that data is secure from unauthorized access.

A **database administrator (DBA)** is a skilled and trained IS professional who holds discussions with business users to define their data needs; applies database programming languages to craft a set of databases to meet those needs; tests and evaluates databases; monitors their performance and implements change to improve response time for user queries; and assures that data is secure from unauthorized access. Database systems require a skilled database administrator (DBA), who must have a clear understanding of the fundamental business of the organization, be proficient in the use of selected database management systems, and stay abreast of emerging technologies and new design approaches. Typically, a DBA has a degree in computer science or management information systems and some on-the-job training with a particular database management system product or more extensive experience with a range of database products. See Figure 5.15.



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### FIGURE 5.15 Database administrator

The role of the database administrator (DBA) is to plan, design, create, operate, secure, monitor, and maintain databases.

**data steward:** An individual responsible for the management of critical data elements, including identifying and acquiring new data sources; creating and maintaining consistent reference data and master data definitions; and analyzing data for quality and reconciling data issues.

**data lifecycle management (DLM):** A policy-based approach to managing the flow of an enterprise's data, from its initial acquisition or creation and storage to the time when it becomes outdated and is deleted.

An important responsibility of a DBA is to protect the database from attack or other forms of failure. DBAs use security software, preventive measures, and redundant systems to keep data safe and accessible. Despite the best efforts of DBAs, database security breaches are all too common. For example, 143 million American consumers had their sensitive personal information (name, address, birth date, social security number) exposed in a 2017 data breach at Equifax, one of the nation's three leading credit bureaus.<sup>15</sup>

The **data steward** is typically a non-IS employee who takes responsibility for the management of critical data entities or attributes. This includes identifying and acquiring new data sources to obtain the desired data entity or attribute; creating and maintaining consistent reference data and master data definitions; analyzing data for quality, and reconciling data issues. Data users consult with a data steward when they need to know what data to use to answer a business question, or to confirm the accuracy, completeness, or soundness of data within a business context. Data stewards advise and guide users and help them get the most value out of the enterprise data warehouse.

**Data lifecycle management (DLM)** is a policy-based approach to managing the flow of an enterprise's data, from its initial acquisition or creation and storage to the time when it becomes outdated and is deleted. See Figure 5.16. Several vendors offer software products to support DLM such as the IBM Information Lifecycle Governance suite of software products.

**FIGURE 5.16****The data life cycle**

A policy-based approach to managing the flow of an enterprise's data, from its initial acquisition or creation and storage to the time when it becomes outdated and is deleted.



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**Critical Thinking Exercise**
**Initiating a Data Management Program**
**► DECISION MAKING**

You are a second-level manager in the Finance department of a mid-sized manufacturing firm that has implemented employee, customer, product, order, and supplier databases. The databases all run on an Oracle database management system installed on a server owned and managed by your firm's small IT organization. Recently you have been receiving a number of complaints from users of the database about extremely slow response time to their queries and report requests. Management has asked you to prepare a set of proposed solutions.

**Review Questions**

1. What advantages might be gained from moving to a database as a service environment?
2. Can you think of any possible disadvantages to this approach?

**Critical Thinking Questions**

1. What additional questions need to be answered before you can decide if the database as a service approach is right for your firm?
2. How might such a move affect you and your role?

## Summary

### Principle:

**A well-designed and well-managed database is an extremely valuable tool in supporting decision making.**

A database is a well-designed, organized, and carefully managed collection of data.

Data consists of raw facts; information is a collection of data organized and processed so that it has additional value beyond the value of the individual facts. Turning data into information is a process performed to achieve a defined outcome. This process requires knowledge, which is the awareness and understanding of a set of information and the ways in which that information can be made useful to support a specific task or reach a decision.

Quality data has nine characteristics. It can be accessible, accurate, complete, economical to produce, relevant, reliable, secure, timely, and verifiable. The importance of each of these characteristics varies depending on the situation and the kind of decision you are trying to make. The value of information is directly linked to how it helps people achieve their organizations' goals.

High quality can provide five benefits: improve decision making, increase customer satisfaction, increase sales, improve innovation, raise productivity, and ensure compliance.

An entity is a generalized class of objects (such as a person, place, or thing) for which data is collected, stored, and maintained. An attribute is a characteristic of an entity. Specific values of attributes—called data items—can be found in the fields of the record describing an entity. A data key is a field within a record that is used to identify the record. A primary key uniquely identifies a record, while a secondary key is a field in a record that does not uniquely identify the record.

A database management system consists of a group of programs used to access and manage a database as well as provide an interface between the database and its users and other application programs.

Schemas are used to describe the entire database, its record types, and its relationships to the DBMS. Schemas are entered into the computer via a data definition language, which describes the data and relationships in a specific database. Another tool used in database management is the data dictionary, which contains detailed descriptions of all data in the database.

A DBMS provides six basic functions: offering user views, creating and modifying the database, storing and retrieving data, manipulating data and generating reports, enabling security management, and providing backup and recovery capabilities. After a DBMS has been installed, the database can be accessed, modified, and queried via a data manipulation language.

A type of specialized data manipulation language is the query language, the most common being Structured Query Language (SQL). SQL is used in several popular database packages today and can be installed in PCs and mainframes.

Data cleansing is the process of detecting and then correcting or deleting incomplete, incorrect, inaccurate, or irrelevant records that reside in the database. The goal of data cleansing is to improve the quality of the data used in decision making.

When building a database, an organization must consider content, access, logical structure, physical organization, archiving, and security of the database.

Enterprise data modelling involves analyzing the data and information needs of an entire organization and provides a roadmap for building database and information systems by creating a single definition and format for data that can ensure compatibility and the ability to exchange and integrate data among systems.

Entity-relationship (ER) diagrams can be used to show the relationships among entities in the organization.

The relational database model places data in two-dimensional tables. Tables can be linked by common data elements, which are used to access data when the database is queried. Each row in a relational database table represents a record, and each column represents an attribute (or field). The allowable values for each attribute are called the attribute's domain.

Database normalization is the process of organizing data in a relational database to eliminate data redundancy and ensure that data dependencies make sense. If done properly, data normalization will ensure that the database takes up minimal data storage and provides improved performance.

A relational database has six fundamental characteristics: 1) Data is organized into collections of two-dimensional tables called relations; 2) each row in the table represents an entity and each column represents an attribute of that entity; 3) each row in a table is uniquely identified by a primary key; 4) the type of data a table column can contain can be specified as an integer number, decimal number, date, text, etc.; 5) the data in a table column can be constrained to be of a certain type (integer, decimal number, data, character, etc.), a certain length, or to have a value between two limits; 6) primary and foreign keys enable relationships between the tables to be defined; and 7) user queries are used to perform operations on the database like adding, changing, or deleting data and selecting, projecting, and joining existing data in existing tables.

SQL is a special-purpose programming language for accessing and manipulating data stored in a relational database.

SQL databases conform to ACID properties of atomicity, consistency, isolation, and durability. These properties guarantee database transactions are processed reliably and ensure the integrity of the data in the database.

Selecting a DBMS begins by analyzing the information needs of the organization. Important characteristics of databases include the size of the database, the number of concurrent users, the performance of the database, the ability of the DBMS to be integrated with other systems, the features of the DBMS, the vendor considerations, and the cost of the database management system.

In database as a service (DaaS) arrangement, the database is stored on a service provider's servers and accessed by the subscriber over a network, typically the Internet. One advantage of DaaS is that it eliminates the installation, maintenance, and monitoring of in-house databases thus reducing hardware, software, and staffing related costs. A second advantage is that the service providers can allocate more or less database storage processing capacity based on an individual customer's changing needs.

### **Principle:**

**A strong data management program is needed to ensure high-quality data.**

Data management is an integrated set of 10 functions that define the processes by which data is obtained, certified fit for use, stored, secured, and processed in such a way as to ensure that the accessibility, reliability, and timeliness of the data meet the needs of the data users within an organization.

Data governance is the core component of data management; it defines the roles, responsibilities, and processes for ensuring that data can be trusted and used by the entire organization with people identified and in place who are responsible for fixing and preventing issues with data.

The need for data management is driven by three factors: 1) the need to meet external regulations designed to manage risk associated with the misstatement of financial data, 2) the need to avoid the accidental release of sensitive data, and 3) the need to ensure that key business decisions are made using high-quality data.

A database administrator (DBA) plans, designs, creates, operates, secures, monitors, and maintains databases. A data steward is typically a non-IS employee who takes responsibility for the management of critical data entities or attributes.

Four key responsibilities of the data governance include: 1) develop a policy that specifies who is accountable for various portions or aspects of the data; 2) define processes for how the data is to be stored, archived, backed up, and protected from cyberattacks, inadvertent destruction or disclosure, or theft; 3) develop standards and procedures that define who is authorized to update, access, and use the data; and 4) put in place a set of controls and audit procedures to ensure ongoing compliance.

Data lifecycle management is a policy-driven approach to managing the flow of an enterprise's data, from its initial acquisition or creation and storage to the time it becomes outdated and is deleted.

## Key Terms

ACID properties	database management system (DBMS)
attribute	domain
concurrency control	enterprise data model
data	entity
data cleansing	entity-relationship (ER) diagram
data definition language (DDL)	file
data dictionary	foreign key
data governance	information
data item	joining
data lifecycle management (DLM)	knowledge
data management	primary key
data manipulation language (DML)	projecting
data normalization	record
data steward	relational database model
database	schema
database administrator (DBA)	selecting
database approach to data management	SQL
Database-as-a-Service (DaaS)	

## Self-Assessment Test

**A well-designed and well-managed database is an extremely valuable tool in supporting decision making.**

1. A collection of raw facts is called \_\_\_\_\_.
  - a. attribute
  - b. information
  - c. data
  - d. knowledge
2. An organization may require high-quality data to avoid fines and penalties for non-conformance to regulatory requirements. True or False?
3. A collection of attributes about a specific entity is a \_\_\_\_\_.
  - a. record
  - b. database
  - c. domain
  - d. file
4. A(n) \_\_\_\_\_ is a person, place, or thing (object) for which data is collected, stored, and maintained.
5. A \_\_\_\_\_ is a collection of similar entities while a(n) \_\_\_\_\_ is a characteristic of an entity.

- a. domain and record
  - b. database and key
  - c. record and foreign key
  - d. file and attribute
6. Which of the following is not a function of the database management system \_\_\_\_\_?
- a. database data normalization and data cleansing
  - b. database backup
  - c. database recovery
  - d. database security
7. A database and a database management system are the same thing. True or False?
8. A collection of instructions and commands to define and describe data and relationship in a specific database is a \_\_\_\_\_.
- a. database schema
  - b. data definition language
  - c. data model
  - d. data manipulation language
9. The process of detecting and then correcting or deleting incomplete, incorrect, inaccurate, or irrelevant records that reside in a database is called \_\_\_\_\_.
- a. data normalization
  - b. data concurrency control
  - c. data management
  - d. data cleansing
10. In the design of a database, it is not necessary to know how long the data must be stored. True or False?
11. The use of primary keys and foreign keys make it impossible to define relationships between the data in two tables of a relational database. True or False?
12. The purpose of data normalization is to \_\_\_\_\_.
- a. remove any inaccurate or incomplete data from the database
  - b. insert newer, more current data into the database
- c. eliminate data redundancies and ensure data dependencies make sense
- d. delete old, obsolete data from the database
13. \_\_\_\_\_ properties of SQL databases help ensure the integrity of data in the database.
14. Which of the following is not an advantage associated with database-as-a-service (DaaS)?
- a. It eliminates the installation, maintenance, and monitoring of in-house databases.
  - b. It reduces hardware, software, and staffing related costs.
  - c. The service provider can allocate more or less database storage capacity based on an individual customer's changing needs.
  - d. The customer has complete responsibility for database security access and database backup.
15. Data governance is a subset of data management. True or False?
16. One of the driving reasons behind the need for data management is to manage risk associated with the misstatement of financial data. True or False?
17. The individual who is responsible for planning, designing, creating, operating, securing, monitoring, and maintaining databases is the \_\_\_\_\_.
18. Which of the following is not a key responsibility of the data governance team?
- a. develop policy that specifies who is accountable for various aspects of the data
  - b. decide which database technology should be used
  - c. define processes for how the data is to be stored, archived, backed up, and protected from cyberattacks
  - d. develop standards and procedures that define who is authorized to update, access, and use the data

## Self-Assessment Test Answers

1. c
2. True
3. a
4. entity
5. d
6. a
7. False
8. a
9. d
10. False
11. False
12. c
13. ACID
14. d
15. False
16. True
17. database administrator
18. b

## Review and Discussion Questions

- Explain the difference between data, information, and knowledge.
- What are six benefits of using high-quality data?
- Define the term database. Define the term database management system. Identify six functions performed by the database management system.
- What roles do database schema, data definition language, and data manipulation play?
- What is the purpose of data cleansing?
- You are working with a database administrator to design a new customer comments database. What seven key questions must be answered to perform a good design?
- What are the six fundamental characteristics of a relational database model?
- Why might an organization wish to go through the process of database normalization for key operational databases?
- What are the benefits associated with enforcement of the ACID properties of SQL databases?
- State two reasons why an organization may wish to implement Database-as-a-Service. Can you identify any potential issues with this approach?
- In your own words, describe the difference between data management and data governance.
- What three factors are driving the need for data management?
- How would you define the role of the database administrator?
- Distinguish between the key responsibilities of the data governance team and those of the database administrator.

## Business-Driven Decision-Making Exercises

- Ticketmaster is a global ticket retailer selling hundreds of millions of tickets to every type of show and venue with total revenue exceeding \$8 billion/year. In 2010, it merged with Live Nation to become Live Nation Entertainment. Customer demand for tickets is very uneven with extremely high demand during the first hours of ticket availability for a popular event, followed by a significant decline in demand. This results in a very uneven demand on computing resources which is difficult to meet. In addition, any system downtime is extremely expensive and can result in lost sales approaching \$1 million per hour.<sup>16,17</sup> What are the pros and cons for Ticketmaster to move its database operations to a Database as a Service provider? What potential data management issues might arise in this transition? Who should be involved in making this decision?
- Your organization has a major problem in collecting on overdue accounts receivable with

\$10 million in outstanding debt. As a result, it is considering making a \$100,000 investment to improve the accuracy of its accounts receivable data. Based on results of competitors in your industry, you can expect to collect about 30% of the outstanding debt or \$3 million by accurately identifying contact data for non-paying customers. The remaining \$7 million of outstanding debt would be turned over to a collection agency. The expected recovery rate is 25%.

How much of the outstanding debt would be recovered through a combination of data quality improvement and collection agency efforts? How much debt would be recovered if the entire \$10 million in outstanding debt were turned over to the collection agency? What is the additional net revenue generated from a combination of data quality improvement and collection agency efforts?

## Teamwork and Collaboration Activities

- As a team, interview a group of managers from your school, place of work, bank, or another organization that the instructor suggests that recently implemented a major database. Your goal is to understand the process the organization went through to develop the database. You also want to identify both the IS people and non-IS people who were involved and their roles. Find out the name of the database and

the data entities and data attributes contained in the database. What database management system did each company select to implement its database, and why? Have the managers and their staff received training in any query or reporting tools? What do they like about their database, and what could be improved? Looking back over it all with 20-20 hindsight, is there anything they would have changed?

2. A company that provides a movie-streaming subscription service uses a relational database to store information on movies to answer customer questions. Each entry in the database contains the following items: Movie ID (the primary key), movie title, year made, movie type, MPAA rating, starring actor #1, starring actor #2, starring actor #3, and director. Movie types are action, comedy, family, drama, horror, science fiction, and western. MPAA ratings are G, PG, PG-13, R, NC-17, and NR (not rated). Work with your team and use a database management system to build a data-entry screen to enter this data. Build a small database with at least a dozen entries.

## Career Exercises

1. Describe the role of a database administrator. What skills, training, and experiences are necessary to fulfill this role? Create a fictitious resume that would be sure to get the candidate strong consideration for a database administrator position at a large consumer packaged goods manufacturer such as Procter & Gamble, Unilever, Kimberly-Clark, etc.
2. *Dice.com* is one of many career Web sites that cater to those pursuing technical careers. Go

Now that the database is built, the employees of the movie-streaming company have proposed several changes that are being considered for the database in the previous exercise. From the following list, choose two database modifications, and then modify the data-entry screen to capture and store this new information. The proposed changes are as follows: a) add the date that the movie was first released to the theatre; b) add the executive producer's name; c) add a customer rating of one, two, three, four, or five stars, based on the number of rentals; and d) add the number of Academy Award nominations.

to the Web site, enter “database administrator” in the search box, and read eight of the search results. What are some of the common requirements among the search results? What database products do you see getting heavy emphasis in the job listings? With this information, how could you best prepare yourself for a career as a database administrator or to work with databases in your line of business?

## Case Study

### ► DATA PROTECTION

#### Biometric Databases Catch Criminals

By the year 2021, the European Union will have a database of fingerprints, photographs for facial recognition, passport numbers and birth dates of all its 350 million citizens. Data that are measurements of a person's body, such as a photograph of their face, are known as biometric data. In the EU, the biometric database will be called CIR, for Common Identity Repository. The database will also allow searches of other databases to match citizens posing with multiple identities, which will aid border control and security agencies. Critics are concerned that with so much information in one database, it will be a target for security breaches. With many agencies having shared access to the biometric database, there could be more exposure and risk to cybercrime and no entity, be it private or government, is invulnerable to security breaches.

Although the United States does not have a country-wide biometric database such as the EU's CIR, law enforcement agencies around the country have access to various databases containing biometric data such as photographs. Many of these agencies are now using facial recognition software to search the database for a specific criminal. This searching is controversial because the US lacks most laws governing the use of searching databases for a facial match. For example, in the states of Maryland and Indiana, the police are allowed to search a database of driver's license photos to recognize a potential criminal, whereas

in Oregon, only the database of mug shots is allowably searchable. Legally, driver's licenses photographs are not considered public record, which presents a dilemma to law enforcement.

In the spring of 2019, San Francisco banned the use of facial recognition by police and city agencies. Lawyers are beginning to weigh into the discussion. At the Georgetown Law Center of Privacy and Technology, a spokesperson, Ms. Garvie said “There is a fundamental absence of transparency around when and how police use face recognition technology. The risks of misidentification are substantial.” (Bosman & Kovaleski, 2019) US citizens and lawyers are not the only groups to be concerned about the government's use of biometric databases. In 2019, the House of Representatives' House Oversight Committee has support from bipartisan groups to control the use of biometrics in government agencies.

Although the US might not have a domestic biometric database for law enforcement, other agencies are currently searching biometric databases to catch criminals. The US Department of Homeland Security has created a large biometric database called HART, short for Homeland Advanced Technical System. The biometrics in this database include facial photos, fingerprints, irises and other distinguishing features like tattoos. In addition, HART can share data from other agencies such as the FBI and the State Department.

The HART database is stored on Amazon's Web Services, AWS. Amazon serves the government's data storage needs through GovCloud. Other government agencies use GovCloud such as NASA, the CIA, and the Defense Department. GovCloud complies with all government regulation requirements and also commercial security and privacy standards. The physical databases are stored in different zones in the United States to ensure continuous data availability and low latency. (Latency is the time it takes for data to travel from the data center to the user.) Each site has its own power supply including air-conditioning in a secured setting. Multiple copies of data are stored (redundancy).

"The use of technology and data is becoming increasingly important to law enforcement," said Major Mike White, Assistant Chief of Staff with the Indiana State Police Department. "With advancements, come the need for secure connectivity and storage without draining the budget. Storage for databases, reports, and video are part of today's challenges for law enforcement technology managers. AWS is quickly becoming a go-to solution for technology needs that won't break the bank."(Business Wire, 2018)

### Critical Thinking Questions

1. Distinguish between the terms data management and data governance. How are biometric databases being managed and how are they being governed? What are the concerns in each segment?
2. Describe the ethical dilemma of using facial recognition by law enforcement agencies. If in the classroom, hold a debate of the pros and cons.

### Notes

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3. Research how criminals are discovered and arrested using a biometric database. Find one example and report on that. Cite your source. Research the ban on use of biometric databases in San Francisco in 2019, to include in your report.

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## Principles

We have entered an era where organizations are grappling with a tremendous growth in the amount of data available and struggling to understand how to manage and make effective use of it.

A number of available tools and technologies allow organizations to take advantage of the opportunities offered by big data.

There are many business intelligence (BI) and analytics techniques that can be used to support improved decision making.

## Learning Objectives

- Identify five key characteristics associated with big data.
- Identify five key challenges associated with big data.

• Distinguish between the terms data warehouse, data mart, and data lake.

• Explain the purpose of each step in the extract, transform, and load process.

• State four ways a NoSQL database differs from an SQL database.

• Identify the two primary components of the Hadoop computing environment.

• Identify the primary advantage of in-memory database in processing big data.

• State the primary difference between business intelligence and analytics.

• Define the role of a data scientist.

• Identify three key organizational components that must be in place for an organization to get real value from its BI/analytics efforts.

• Identify five broad categories of business intelligence/analytics techniques including the specific techniques used in each.

• Identify four potential issues that arise with the use of self-service analytics.

# IS in Action

## Fuels Rapid Growth with Data Science

### ► INFORMATION TECHNOLOGY

A leader in the sharing economy, Airbnb grew from a small business operating out of a San Francisco loft to a high-profile company estimated in early 2019 to be worth at least \$38 billion. Originally called Airbed & Breakfast, the business was conceived by founders Brian Chesky and Joe Gebbia as a way to pay their own rent by offering temporary lodging for paying guests. They expanded their business by developing a website where other hosts could showcase their living spaces and visitors could reserve and pay for them. The site and the service have proven more popular than Chesky and Gebbia ever imagined, leading to rapid growth and enviable brand recognition.

As of spring 2019, Airbnb had more than 6 million properties --ranging from shared rooms to entire homes --listed in more than 80,000 cities worldwide. (That's more listings than the top five hotel brands combined.) According to the company, more than 2 million people stay in an Airbnb property each night. The company has disrupted the hospitality industry by offering an alternative to traditional lodging, especially in popular travel spots during peak periods when hotels often sell out and charge top rates for rooms.

Airbnb credits much of its astonishing growth to data science, the practice of gathering insights and useful information from digital data. A data scientist is an individual who combines strong business acumen, a deep understanding of analytics, and a healthy appreciation of the limitations of data, tools, and techniques to deliver real improvements in decision making. Data scientists examine a business problem from many points of view, determine what kinds of data could help solve the problem, and then select the right tools to extract the data and uncover insights for making organizational decisions.

One of the first seven people hired at Airbnb was Riley Newman, a data scientist. "In the past," Newman says, "data was often referenced in cold, numeric terms...how many listings do we have in Paris? What are the top 10 destinations in Italy?" Now, Newman continues, "We use statistics to understand individual experiences and aggregate those experiences to identify trends across the community; those trends inform decisions about where to drive the business."

At the heart of the Airbnb experience is the search system, which combines dozens of pieces of data to help guests find listings that meet their requirements. At first, Airbnb's search tool returned listings based mainly on location because the company assumed people would want to stay in accommodations near the center of a city. One problem with that approach was that the radius of desirable locations varies widely around the world. Another was that people often wanted to stay in other neighborhoods, such as Brooklyn rather than midtown Manhattan in New York.

"We decided to let our community solve the problem for us," says Newman. After building a robust data set of guest and host interactions, Airbnb was able to provide search results based in part on where people searching for a particular location ended up booking a room. The company continues to refine the search system to help users find unique experiences around the world.

Airbnb uses data science not only to improve its search tool but also to streamline the conversion process: searching for accommodations, contacting a host, and making a reservation. The company also relies on data science to measure and evaluate the Airbnb experience, since that determines whether guests will use Airbnb again and recommend the service to someone else. Additionally, by gathering and arranging data, asking questions, performing "what-if" and statistical analyses, and challenging conventional wisdom, data scientists at Airbnb help people across the company make decisions involving diversity in hiring practices, product offerings, site design, and customer experience.

Airbnb also turned to data scientists to solve an internal company problem regarding data management. As the company continued to grow, the number of tools used to make decisions based on data --especially data from users --also increased. These resources

included data tables, dashboards, and reports. However, employees often did not know which resource to use to find the data they needed. And if they thought a resource was outdated or inaccurate, they sometimes created a new resource, which complicated the problem.

To provide a solution, a group of Airbnb data scientists developed the Dataportal, a system that integrates the company's data resources, making it easy for Airbnb employees to identify and analyze data to inform decision-making. All data flowing into Airbnb from users and employees is now directed to the Dataportal. Searching the Dataportal returns information, often in graphical form, along with background details that provide context for the data and show how it is connected to other data, often leading to new insights and saving search time.

In this way, Airbnb has assembled the three key components it needs to derive real value from its business intelligence and analytics efforts: a solid data management program, creative data scientists, and a strong commitment to data-driven decision making.

### As you read this chapter, consider the following:

- How does a data scientist approach data? What role does the data scientist play in supporting organizational decisions?
- What characteristics make for a successful data scientist? What tools and knowledge does a data scientist need to deliver improvements to an organization?

## Why Learn about Big Data and Analytics?

We are living in the age of big data, with new data flooding us from all directions at the incomprehensible speed of nearly a zettabyte (1 trillion gigabytes or a 1 followed by 21 zeros) per year. What is most exciting about this data is not its amount, but rather the fact that we are gaining the tools and understanding to do something truly meaningful with it. Organizations are learning to analyze large amounts of data not only to measure past and current performance but also to make predictions about the future. These forecasts will drive anticipatory actions to improve business strategies, strengthen business operations, and enrich decision making—enabling the organization to become more competitive.

A wide range of business users can derive benefits from access to data, but most of them lack deep information systems or data science skills. Business users need easier and faster ways to discover relevant patterns and insights into data to better support their decision making and to make their companies more agile. Companies that have access to the same kind of data as their competitors but can analyze it sooner to act faster, can outpace their peers. Providing BI tools and making business analytics more understandable and accessible to these users should be a key strategy of organizations.

Bristol-Myers Squibb and many other pharmaceutical companies are using big data and analytics to move from developing mass therapies for the average person on the street to personalized therapies. This approach to disease treatment and prevention takes into account individual variability in genes, environment, and lifestyle to tailor a solution for a specific individual. United Parcel Service, the package delivery giant, is using big data and analytics to cut costs while dealing with an increase in e-commerce packages. It gathers and analyzes over 1 billion data points each day including data about package weight, origin/destination, shape, and size to optimize the flow of packages across its entire network. Home Depot employs big data and analytics to comb through social media data particularly Pinterest's "Shop the Look" pins. The data enables the firm to target potential shoppers just starting their home improvement journey, picking up key signals they're giving off, like style cues, product tastes, or project interests.

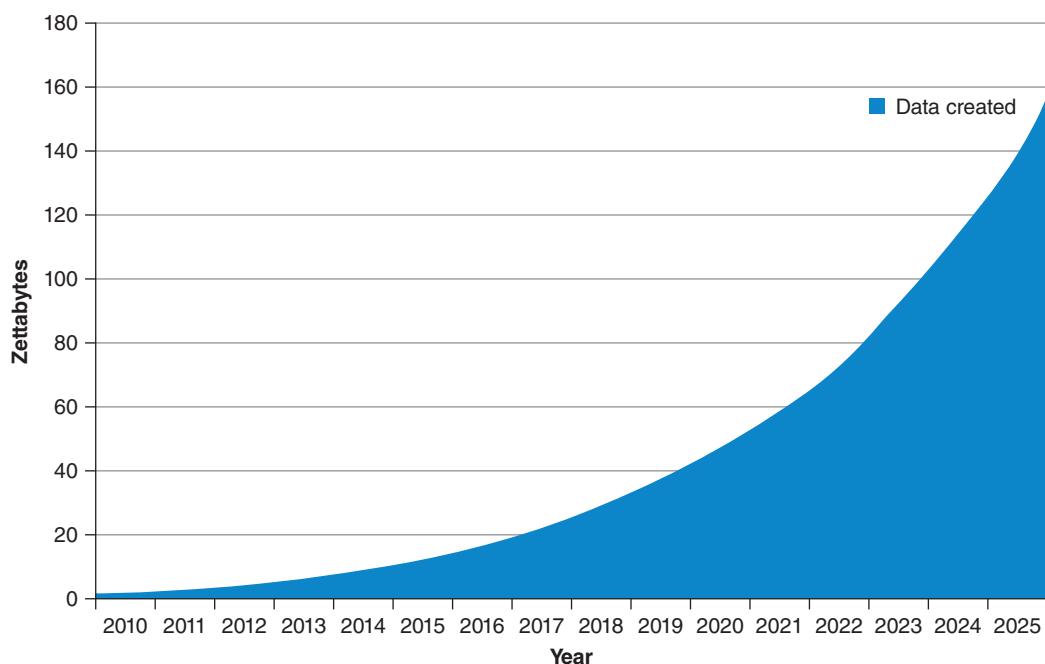
Regardless of your field of study in school and your future career, using big data and analytics will likely be a significant component of your job. As you read this chapter, pay attention to how different organizations use business analytics. This chapter starts by introducing basic concepts related to BI and analytics. Later in the chapter, several BI and analytics tools and strategies are discussed.

## Big Data

**big data:** The term used to describe data collections that are so enormous (terabytes or more) and complex (from sensor data to social media data) that traditional data management software, hardware, and analysis processes are incapable of dealing with them.

**Big data** is the term used to describe data collections that are so enormous (terabytes or more) and complex (from sensor data to social media data) that traditional data management software, hardware, and analysis processes are incapable of dealing with them. There are five key characteristics associated with big data: volume, velocity, value, variety, and veracity.

- **Volume.** In 2017, it was estimated that the volume of data that exists in the digital universe was 16.1 zettabytes (one zettabyte equals one trillion gigabytes). The digital universe is expected to grow tenfold to an amazing 163 zettabytes by 2025 as shown in Figure 6.1. Most of this new data is expected to come from data gathered by embedded systems in such devices as smart meters, security cameras, RFID chips, autonomous automobiles, aircraft engines, medical devices, and home appliances.<sup>1</sup>
- **Velocity.** Velocity refers to the rate at which new data is being generated—now estimated to be on the order of 2.5 quintillion bytes each day (that's 2,500 followed by 15 zeros). This rate is accelerating rapidly, with 90 percent of the data in the world generated in just the past two years!<sup>2</sup>
- **Value.** Value in this context refers to the worth of the data in decision making. The acceleration in the volume of data makes it imperative to quickly “separate the wheat from the chaff” and identify the data truly needed for a particular decision-making scenario, process that data, and take action.
- **Variety.** Data today comes in a variety of formats. Some of the data is what computer scientists call structured data—its format is known in advance, and it fits nicely into traditional databases. For example, the data generated by the well-defined business transactions that are used to update many corporate databases containing customer, product, inventory, financial, and employee data is generally structured data. However, most of the data that an organization must deal with is unstructured



**FIGURE 6.1**  
**Increase in size of the global datasphere**

Source: "Total WW Data to Reach 163ZB by 2025," Storage Newsletter, April 5, 2017, <https://www.storagenewsletter.com/2017/04/05/total-ww-data-to-reach-163-zettabytes-by-2025-idc/>.

data, meaning that it is not organized in any predefined manner. Unstructured data comes from sources such as word-processing documents, social media, email, photos, surveillance video, and phone messages.

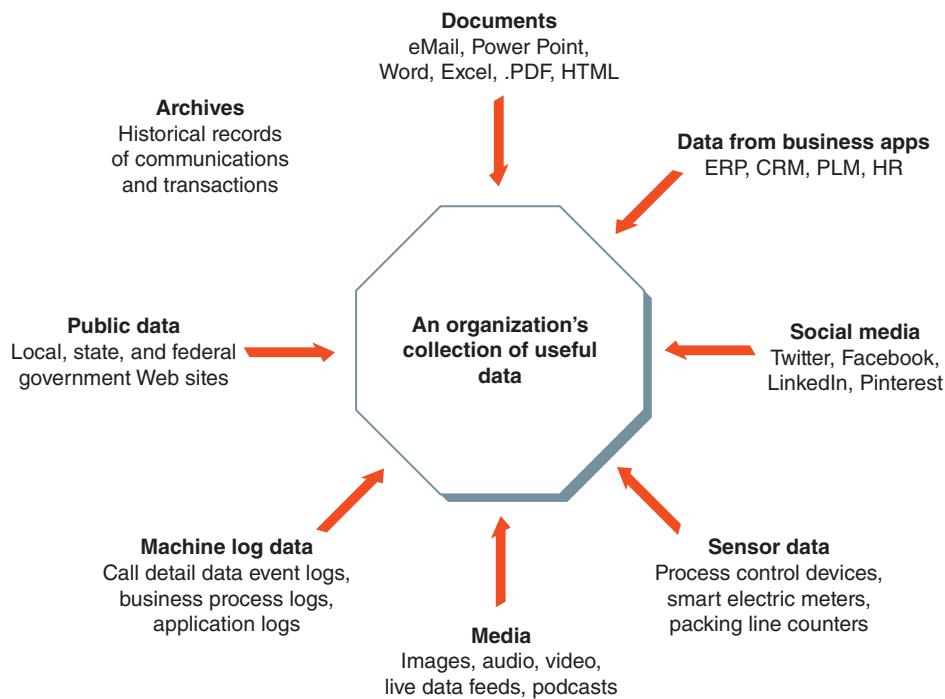
- **Veracity.** Veracity is a measure of the quality of the data. Is the data sufficiently accurate, complete, and current that it can be relied on and trusted to form the basis of good decision making?

## Sources of Big Data

Organizations collect and use data from a variety of sources, including business applications, social media, sensors and controllers that are part of the manufacturing process, systems that manage the physical environment in factories and offices, media sources (including audio and video broadcasts), machine logs that record events and customer call data, public sources (such as government Web sites), and archives of historical records of transactions and communications (see Figure 6.2). Much of this collected data is unstructured and does not fit neatly into traditional relational database management systems. Table 6.1 provides a starter list of some of the many Web portals that provide access to free sources of useful big data sets.

**FIGURE 6.2**  
**Sources of an organization's useful data**

An organization has many sources of useful data.



**TABLE 6.1** Portals that provide access to free sources of useful big data

Data Source	Description	URL
Amazon Web Services (AWS) public data sets	Portal to a huge repository of public data, including climate data, the million song data set, and data from the 1000 Genomes project.	<a href="http://aws.amazon.com/datasets">http://aws.amazon.com/datasets</a>
Bureau of Labor Statistics (BLS)	Provides access to data on inflation and prices, wages and benefits, employment, spending and time use, productivity, and workplace injuries	<a href="http://www.bls.gov">www.bls.gov</a>
CIA World Factbook	Portal to information on the economy, government, history, infrastructure, military, and population of 267 countries	<a href="https://cia.gov/library/publications/the-world-factbook">https://cia.gov/library/publications/the-world-factbook</a>

Data.gov	Portal providing access to over 186,000 government data sets, related to topics such as agriculture, education, health, and public safety	<a href="http://data.gov">http://data.gov</a>
Facebook Graph	Provides a means to query Facebook profile data not classified as private	<a href="https://developers.facebook.com/docs/graph-api">https://developers.facebook.com/docs/graph-api</a>
FBI Uniform Crime Reports	Portal to data on Crime in the United States, Law Enforcement Officers Killed and Assaulted, and Hate Crime Statistics	<a href="https://www.fbi.gov/about-us/cjis/ucr/ucr/">https://www.fbi.gov/about-us/cjis/ucr/ucr/</a>
Justia Federal District Court Opinions and Orders database	A free searchable database of full-text opinions and orders from civil cases heard in U.S. Federal District Courts	<a href="http://law.justia.com/cases/federal/district-courts">http://law.justia.com/cases/federal/district-courts</a>
Gapminder	Portal to data from the World Health Organization and World Bank on economic, medical, and social issues	<a href="http://www.gapminder.org/data">www.gapminder.org/data</a>
Google Finance	Portal to 40 years of stock market data	<a href="http://google.com/finance">http://google.com/finance</a>
Healthdata.gov	Portal to 125 years of U.S. health care data, including national health care expenditures, claim-level Medicare data, and data related to health care quality, epidemiology, and population, among many other topics	<a href="http://www.healthdata.gov">www.healthdata.gov</a>
National Centers for Environmental Information	Portal for accessing a variety of climate and weather data sets	<a href="http://www.ncdc.noaa.gov/data-access/quick-links#loc-clim">www.ncdc.noaa.gov/data-access/quick-links#loc-clim</a>
New York Times	Portal that provides developers access to <i>NYT</i> articles, book and movie reviews, data on political campaign contributions, and other material	<a href="http://developer.nytimes.com/docs">http://developer.nytimes.com/docs</a>
Pew Research Center Internet & Technology	Portal to research on U.S. politics, media and news, social trends, religion, Internet and technology, science, Hispanic, and global topics	<a href="http://www.pewinternet.org/datasets">http://www.pewinternet.org/datasets</a>
U.S. Census Bureau	Portal to a huge variety of government statistics and data relating to the U.S. economy and its population	<a href="http://www.census.gov/data.html">www.census.gov/data.html</a>

## Big Data Uses

Here are just a few examples of how organizations are employing big data to improve their day-to-day operations, planning, and decision making:

- Retail organizations monitor social networks such as Facebook, Google, LinkedIn, Twitter, and Yahoo to engage brand advocates, identify brand adversaries (and attempt to reverse their negative opinions), and even enable passionate customers to sell their products.
- Advertising and marketing agencies track comments on social media to understand consumers' responsiveness to ads, campaigns, and promotions.
- Hospitals analyze medical data and patient records to try to identify patients likely to need readmission within a few months of discharge, with the goal of engaging with those patients to prevent another expensive hospital stay.
- Consumer product companies monitor social networks to gain insight into customer behavior, likes and dislikes, and product perception to identify necessary changes to their products, services, and advertising.
- Financial services organizations use data from customer interactions to identify customers who are likely to be attracted to increasingly targeted and sophisticated offers.
- Manufacturers analyze minute vibration data from their equipment, which changes slightly as it wears down, to predict the optimal time to perform maintenance or replace the equipment to avoid expensive repairs or potentially catastrophic failure.

## Challenges of Big Data

Individuals, organizations, and society in general must find a way to deal with this ever-growing data tsunami to escape the risks of information overload. The challenge is manifold, with a variety of questions that must be answered, including how to choose what subset of data to store, where and how to store the data, how to find those nuggets of data that are relevant to the decision making at hand, how to derive value from the relevant data, and how to identify which data needs to be protected from unauthorized access. With so much data available, business users can have a hard time finding the information they need to make decisions, and they may not trust the validity of the data they can access.

Trying to deal with all this data from so many different sources, much of it from outside the organization, can also increase the risk that the organization fails to comply with government regulations or internal controls (see Table 6.2). The Security and Exchange Commission's efforts to aggressively monitor financial

**TABLE 6.2** Partial list of rules, regulations, and standards with which U.S. information system organizations must comply

Rule, Regulation, or Standard	Intent
Bank Secrecy Act	Detects and prevents money laundering by requiring financial institutions to report certain transactions to government agencies and to withhold from clients that such reports were filed about them
Basel II Accord	Creates international standards that strengthen global capital and liquidity rules, with the goal of promoting a more resilient banking sector worldwide
California Senate Bill 1386	Protects against identity theft by imposing disclosure requirements for businesses and government agencies that experience security breaches that might put the personal information of California residents at risk; the first of many state laws aimed at protecting consumers from identity theft
Global Data Protection Regulation	A set of data privacy requirements that apply across the European Union including non-EU organizations that market to or process information of individuals in the EU. In general, it increases the rights of individuals and gives them more control over their information. It also places obligations on organizations to obtain the consent of people they collect information about and to better manage this data.
Foreign Account Tax Compliance Act	Identifies U.S. taxpayers who hold financial assets in non-U.S. financial institutions and offshore accounts, to ensure that they do not avoid their U.S. tax obligations
Foreign Corrupt Practices Act	Prevents certain classes of persons and entities from making payments to foreign government officials in an attempt to obtain or retain business
Gramm–Leach–Bliley Act	Protects the privacy and security of individually identifiable financial information collected and processed by financial institutions
Health Insurance Portability and Accountability Act (HIPAA)	Safeguards protect health information (PHI) and electronic PHI (ePHI) data gathered in the health care process and standardizes certain electronic transactions within the health care industry
Payment Card Industry (PCI) Data Security Standard	Protects cardholder data and ensures that merchants and service providers maintain strict information security standards
Personal Information Protection and Electronic Documents Act (Canada)	Governs the collection, use, and disclosure of personally identifiable information in the course of commercial transactions; created in response to European Union data protection directives
Sarbanes–Oxley Act	Protects the interests of investors and consumers by requiring that the annual reports of public companies include an evaluation of the effectiveness of internal control over financial reporting; requires that the company's CEO and CFO attest to and report on this assessment
USA PATRIOT Act	This wide-ranging act has many facets; one portion of the Act relating to information system compliance is called the Financial Anti-Terrorism Act and is designed to combat the financing of terrorism through money laundering and other financial crimes

statements and ensure compliance to all accounting standards stems from a long history of companies like Waste Management (1998), Enron (2001), WorldCom (2002), Freddie Mac (2003), American Insurance (2005), Lehman Brothers (2008), Satyam Computer Services (2009), MF Global Holdings (2011), and Tesco (2014) where accounting fraud led to tens of thousands of employees losing their jobs and shareholders losing billions of dollars. A few of the companies had to declare bankruptcy and officers from several of these companies were sentenced to jail terms.

Optimists believe that we can conquer these challenges and that more data will lead to more accurate analyses and better decision making, which in turn will result in deliberate actions that improve matters.

Not everyone, however, is happy with big data applications. Some people have privacy concerns about the fact that corporations are harvesting huge amounts of personal data that can be shared with other organizations. With all this data, organizations can develop extensive profiles of people without their knowledge or consent. Big data also introduces security concerns. Are organizations able to keep big data secure from competitors and malicious hackers? Some experts believe companies that collect and store big data could be open to liability lawsuits from individuals and organizations. Even with these potential disadvantages, many companies are rushing into big data due to the lure of a potential treasure trove of information and new applications.



## Critical Thinking Exercise

### Music Venue Uses BI/Analytics to Understand Its Patrons

#### ► APPLICATION

The Gotham City Music Hall is an independent music venue owned and operated by a small group of investors. It has 3,050 seats and serves as the home for the Gotham City symphony orchestra and ballet company for some 55 performances each year. The dates of these performances are booked at least one year in advance. The investor group attempts to fill open dates with performances by an eclectic group of music groups from the classical, country, jazz, pop, R&B, and rock genres. Both established and new or local groups are recruited to play. The investors make heavy use of data from many sources to gain a better understanding of their patrons, especially their taste in music. They capture data about the buying habits of the more than 300,000 patrons who come to the Music Hall each year through ticketing, concessions, and retail sales data. This data is used to optimize sales in every business line. The investors also gather data about what fans are saying on social media sites. Through surveys and other means, investors accumulate data about how often patrons come to the entertainment district where Music Hall is located and what they experience when they come. All this data is being used to identify which genres and which music groups would be most appealing to its patrons. Using all this data and analytical techniques, the investors are able to forecast future ticket sales for events to an accuracy of plus or minus 20 percent. The accuracy of the forecasts provides the investors with an advantage when negotiating guaranteed minimum revenue with the various music groups.

#### Review Questions

1. The Music Hall investors are gathering lots of data from many different sources. What characteristics does this large collection of data have in common with other large collections of data?
2. What challenges do the investors have in dealing with this vast volume of data?

#### Critical Thinking Questions

1. How might it benefit the investors to know how often fans visit the entertainment district and what they do on those visits?
2. What additional data might be gathered to further improve the accuracy of future ticket sales? How might this data be captured?

## Technologies Used to Manage and Process Big Data

By definition, big data is a set of data so enormous and complex that traditional data management software, hardware, and analysis processes are incapable of dealing with them. As a result, several interesting and powerful technologies have emerged to manage and process big data. This section will discuss data warehouses, the Extract/Transform/Load process, data marts, data lakes, NoSQL databases, Hadoop, and In-Memory databases.

### Data Warehouses, Data Marts, and Data Lakes

The raw data necessary to make sound business decisions is typically stored in a variety of locations and formats. Much of this data is initially captured, stored, and managed by transaction-processing systems that are designed to support the day-to-day operations of an organization. For decades, organizations have collected operational, sales, and financial data with their online transaction processing (OLTP) systems. These OLTP systems put data into databases very quickly, reliably, and efficiently, but they do not support the types of data analysis that today's businesses and organizations require. With data warehouses and data marts, organizations are now able to access the data gathered via OLTP systems and other sources and use it more effectively to support decision making. Table 6.3 summarizes these primary characteristics of a data warehouse.

**TABLE 6.3** Characteristics of a data warehouse

Characteristic	Description
Large	Holds billions of records and petabytes of data
Multiple sources	Data comes from many sources both internal and external thus an extract, transform, load process is required to ensure quality data
Historical	Typically 5 years of data or more
Cross organizational access and analysis	Data accessed, used, and analyzed by users across the organization to support multiple business processes and decision making
Supports various types of analyses and reporting	Drill down analysis, development of metrics, identification of trends

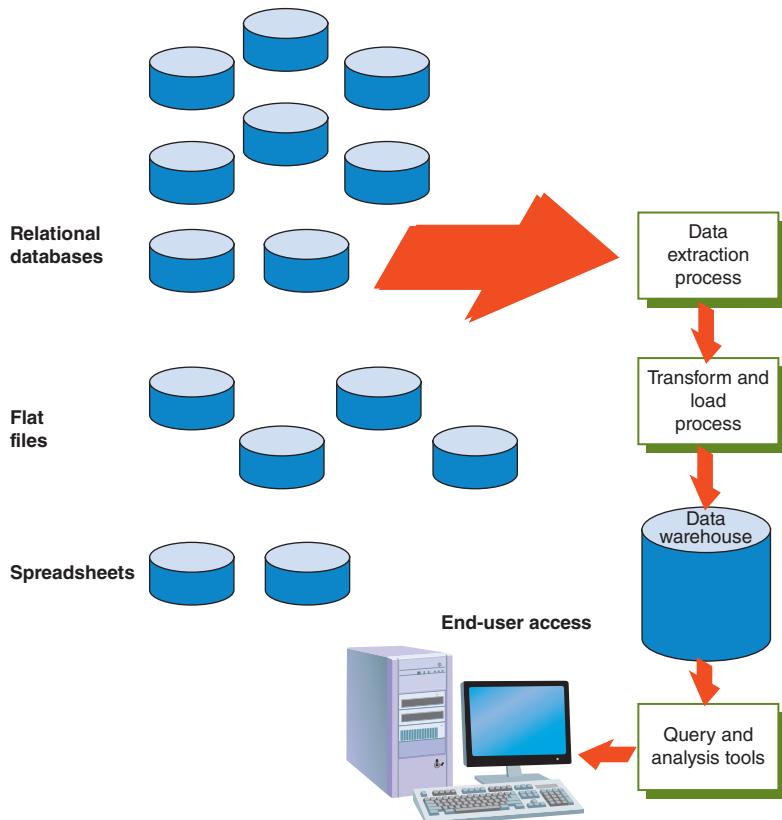
### Data Warehouses

**data warehouse:** A large database that holds business information from many sources in the enterprise, covering all aspects of the company's processes, products, and customers.

A **data warehouse** is a large database that holds business information from many sources in the enterprise, covering all aspects of the company's processes, products, and customers. It is not unusual for a data warehouse to contain data from over a dozen source systems—both systems internal to the organization and potentially data obtained from sources outside the organization (e.g., data aggregators, social media Web sites, government databases, etc.) as shown in Figure 6.3. This data is used by people across the organization to support various processes and decision making. The data in a data warehouse is historical data often going back 5 years or more. The data can be analyzed in many ways. For example, data warehouses allow users to “drill down” to get greater detail or “roll up” to generate aggregate or summary reports. The primary purpose is to relate information in innovative ways and help managers and executives make better decisions.

Banks, financial institutions, government agencies, manufacturers, and large retailers were among the early adopters of data warehouse technology in the late 1980s. Wal-Mart, the world's largest retailer, developed a mastery of supply chain management that provided it with a distinct competitive advantage by the early 1990s. Key to this mastery was its data warehouse that held transaction data collected by its point-of-sales systems. This data provided a deep understanding of the purchasing habits of over 100 million customers at its 6,000 stores sourced by 25,000 suppliers. Wal-Mart's data warehouse was the first commercial data warehouse to reach 1 terabyte of data in 1992. Here are some additional examples of companies using data warehouses.

WHOOP is a wearable device used by professional athletes in Major League Baseball, the National Football League, and the National Basketball Association. There is increasing demand from nonprofessional athletes such as high school and college athletes, cyclists, runners, triathletes, and other fitness enthusiasts. Players wear a WHOOP on their wrist, forearm, or bicep that measures heart rate, motion, skin conductivity, and ambient temperature. What distinguishes WHOOP from other wearables is the massive amount of data it collects and transmits to servers for processing and analysis. Its five sensors collect data 100 times per second. The data is transmitted via Bluetooth to a user's mobile device, and from there to the cloud. WHOOP analytics software converts the data into three scores, assessing strain from exercise, recovery, and sleep. The results help users avoid overtraining, reduce injury, perform at their best, and even enjoy healthier lives after retirement.<sup>3</sup> Some 24,000 American Airlines flight attendants can use software on their mobile devices to tap into a data warehouse of customer information—where and how frequently you fly, if they have delayed you, cancelled you, made you change your seat, or spilled coffee on you. Now attendants can use this information in making decisions to help resolve customer services issues during flight by issuing free frequent flyer miles or travel vouchers.<sup>4</sup>



**FIGURE 6.3**  
**Elements of a data warehouse**

A data warehouse can help managers and executives relate information in innovative ways to make better decisions.

Because data warehouses are used for decision making, maintaining a high quality of data is vital so that organizations avoid wrong conclusions. For instance, duplicated or missing information will produce incorrect or misleading statistics (“garbage in, garbage out”). Due to the wide range of possible data inconsistencies and the sheer data volume, data quality is considered one of the biggest issues in data warehousing.

### **Extract Transform Load (ETL) process:**

A data handling process that takes data from a variety of sources, edits and transforms it into the format used in the data warehouse, and then loads this data into the warehouse.

Data warehouses are continuously refreshed with huge amounts of data from a variety of sources so the probability that some of the sources contain “dirty data” is high. The **Extract Transform Load (ETL) process** takes data from a variety of sources, edits and transforms it into the format used in the data warehouse, and then loads this data into the warehouse, as shown in Figure 6.3. This process is essential in ensuring the quality of the data in the data warehouse.

- **Extract.** Source data for the data warehouse comes from many sources and systems. The goal of this process is to extract the source data from all the various sources and convert it into a single format suitable for processing. During the extract step, data that fails to meet expected patterns or values may be rejected from further processing (e.g., blank or nonnumeric data in net sales field or a product code outside the defined range of valid codes).
- **Transform.** During this stage of the ETL process, a series of rules or algorithms are applied to the extracted data to derive the data that will be stored in the data warehouse. A common type of transformation is to convert a customer’s street address, city, state, and zip code to an organization-assigned sales district or government census tract. Also, data is often aggregated to reduce the processing time required to create anticipated reports. For example, total sales may be accumulated by store or sales district.
- **Load.** During this stage of the ETL process, the extracted and transformed data is loaded into the data warehouse. As the data is being loaded into the data warehouse, new indices are created and the data is checked against the constraints defined in the database schema to ensure its quality. As a result, the data load stage for a large data warehouse can take days.

A large number of software tools are available to support these ETL tasks, including Ab Initio, IBM InfoSphere DataStage, Oracle Data Integrator, and the SAP Data Integrator. Several open-source ETL tools are also available, including Apatar, Clover ETL, Pentaho, and Talend.

### **Data Marts**

**data mart:** A subset of a data warehouse that is used by small- and medium-sized businesses and departments within large companies to support decision making.

A **data mart** is a subset of a data warehouse. Data marts bring the data warehouse concept—lots of data from many sources—to small- and medium-sized businesses and to departments within larger companies. Rather than store all enterprise data in one monolithic database, data marts contain a subset of the data for a single aspect of a company’s business—for example, finance, inventory, or personnel.

### **Data Lakes**

**data lake:** A “store everything” approach to big data that saves all the data in its raw and unaltered form.

A traditional data warehouse is created by extracting (and discarding some data in the process), transforming (modifying), and loading incoming data for predetermined and specific analyses and applications. This process can be lengthy and computer intensive, taking days to complete. A **data lake** takes a “store everything” approach to big data, saving all the data in its raw and unaltered form. The raw data residing in a data lake is available when users decide just how they want to use the data to glean new insights. Only when the data is accessed for a specific analysis is it extracted from the data lake,

classified, organized, edited, or transformed. Thus, a data lake serves as the definitive source of data in its original, unaltered form. Its contents can include business transactions, clickstream data, sensor data, server logs, social media, videos, and more.

Bechtel is a global engineering, construction, and project management company whose accomplishments include building the Hoover Dam, English Channel Tunnel, and other engineering marvels. The company built a 5-petabyte data lake of data that consolidates years of data from hundreds of projects worldwide that provides insights from past and current projects and enables better forecasts of the outcomes of current projects. This analysis provides actionable insights that help the company cut costs, increase its competitiveness, and allow it to win more contracts.<sup>5</sup>

## NoSQL Databases

**NoSQL database:** A way to store and retrieve data that is modeled using some means other than the simple two-dimensional tabular relations used in relational databases.

A NoSQL database differs from a relational database in that it provides a means to store and retrieve data that is modeled using some means other than the simple two-dimensional tabular relations used in relational databases. Such databases are being used to deal with the variety of data found in big data and Web applications. A second difference is that NoSQL databases have the capability to spread data over multiple servers so that each server contains only a subset of the total data. This so-called horizontal scaling capability enables hundreds or even thousands of servers to operate on the data, providing faster response times for queries and updates. Most relational database management systems have problems with such horizontal scaling and instead require large, powerful, and expensive proprietary servers and large storage systems.

A third difference between relational and NoSQL databases is that NOSQL database do not require a predefined schema; data entities can have attributes edited or assigned to them at any time. If a new entity or attribute is discovered, it can be added to the database dynamically, extending what is already modelled in the database.

A fourth difference is that NoSQL databases do not conform to true ACID properties when processing transactions. Instead they provide for “eventual consistency” in which database changes are propagated to all nodes eventually (typically within milliseconds), so it is possible that user queries for data might not return the most current data.

The choice of a relational database management system versus a NoSQL solution depends on the problem that needs to be addressed. Often, the data structures used by NoSQL databases are more flexible than relational database tables and, in many cases, they can provide improved access speed and redundancy.

The four main categories of NoSQL databases and offerings for each category are shown in Table 6.4 and summarized below. Note that some NoSQL database products can meet the needs of more than one category.

- Key-value NoSQL databases are similar to SQL databases, but have only two columns (“key” and “value”), with more complex information sometimes stored within the “value” columns.
- Document NoSQL databases are used to store, retrieve, and manage document-oriented information, such as social media posts and multimedia, also known as semi-structured data.
- Graph NoSQL databases are used to understand the relationships among events, people, transactions, locations, and sensor readings and are well-suited for analyzing interconnections such as when extracting data from social media.
- Column NoSQL databases store data in columns, rather than in rows, and are able to deliver fast response times for large volumes of data.

**TABLE 6.4** Popular NoSQL database products, by category

Key-Value	Document	Graph	Column
Redis	Lotus Notes	Allegro	Accumulo
Couchbase Server	Couchbase Server	Neo4J	Cassandra
Oracle NoSQL Database	Oracle NoSQL Database	InfiniteGraph	Druid
OrientDB	OrientDB	OrientDB	Vertica
HyperDEX	MongoDB	Virtuoso	HBase

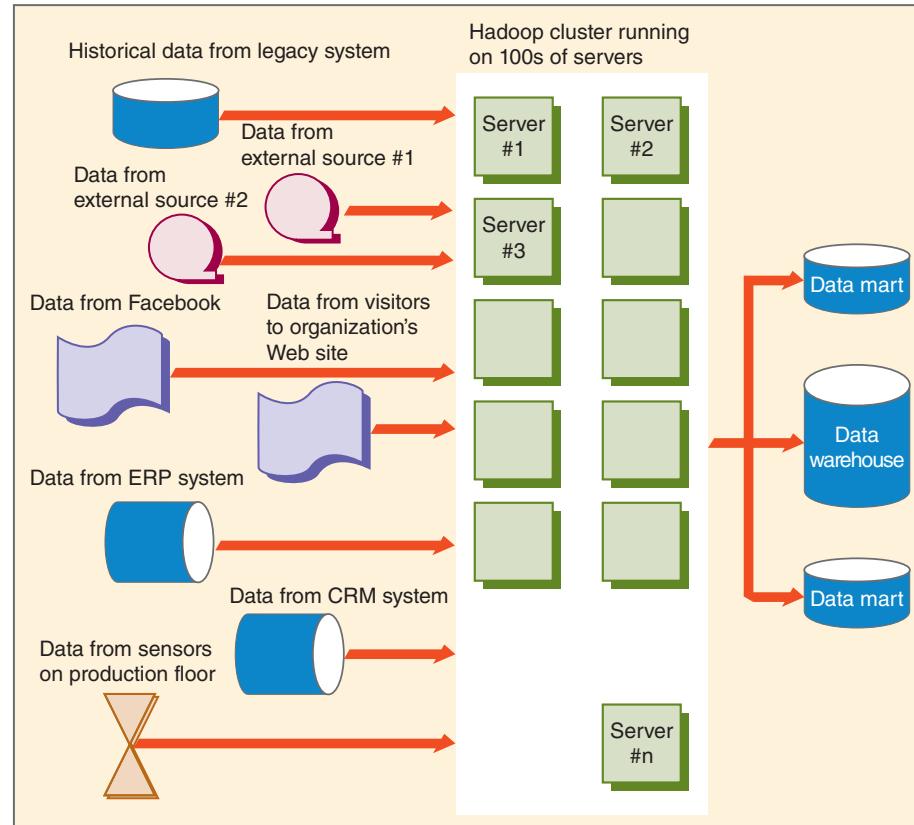
Predix is a software platform created by General Electric for the collection and analysis of large volumes of data from industrial devices. Couchbase Mobile, a NoSQL database, is used to store the data.<sup>6</sup> Qantas built a flight application using Predix to collect data (wind speeds, ambient temperatures, weight of the plane, maximum thrust, fuel consumption, etc.) about each of its aircraft during flight. This data is analyzed to help pilots make decisions to minimize fuel consumption and reduce carbon emissions while still meeting flight schedules.<sup>7</sup>

Amazon DynamoDB is a NoSQL database that supports both document and key-value store models. MLB Advanced Media (MLBAM) used DynamoDB to build its innovative Player Tracking System, which reveals detailed information about the nuances and athleticism of the game. Fans, broadcasters, and teams are finding this new data entertaining and useful. The system takes in data from ballparks across North America and provides enough computing power to support real-time analytics and produce results in seconds.<sup>8</sup>

## Hadoop

**Hadoop:** An open-source software framework including several software modules that provide a means for storing and processing extremely large data sets.

**Hadoop** is an open-source software framework that includes several software modules that provide a means for storing and processing extremely large data sets, as shown in Figure 6.4. Hadoop has two primary components: a data processing component (a Java-based system called MapReduce, which is



**FIGURE 6.4**  
**Hadoop environment**

Hadoop can be used as a staging area for data to be loaded into a data warehouse or data mart.

**Hadoop Distributed File System (HDFS):**

A system used for data storage that divides the data into subsets and distributes the subsets onto different servers for processing.

**MapReduce program:**

A composite program that consists of a Map procedure that performs filtering and sorting and a Reduce method that performs a summary operation.

discussed in the next section) and a distributed file system called the **Hadoop Distributed File System (HDFS)** for data storage. Hadoop divides data into subsets and distributes the subsets onto different servers for processing. A Hadoop cluster may consist of thousands of servers. In a Hadoop cluster, a subset of the data within the HDFS and the MapReduce system are housed on every server in the cluster. This places the data processing software on the same servers where the data is stored, thus speeding up data retrieval. This approach creates a highly redundant computing environment that allows the application to keep running even if individual servers fail.

A **MapReduce program** is composed of a Map procedure that performs filtering and sorting (such as sorting customer orders by product ID into queues, with one queue for each product ID) and a Reduce method that performs a summary operation (such as counting the number of orders in each queue, thus determining product ID frequencies). MapReduce employs a JobTracker that resides on the Hadoop master server as well as TaskTrackers that sit on each server within the Hadoop cluster of servers. The JobTracker divides the computing job up into well-defined tasks and moves those tasks out to the individual TaskTrackers on the servers in the Hadoop cluster where the needed data resides. These servers operate in parallel to complete the necessary computing. Once their work is complete, the resulting subset of data is reduced back to the central node of the Hadoop cluster.

For years, Yahoo! used Hadoop to better personalize the ads and articles that its visitors see. Now Hadoop is used by many popular Web sites and services (such as eBay, Etsy, Twitter, and Yelp). Verizon Wireless uses big data to perform customer churn analysis to get a better sense of when a customer becomes dissatisfied. Hadoop allows Verizon to include more detailed data about each customer, including clickstream data, chats, and even social media searches, to predict when a customer might switch to a new carrier.

Hadoop has a limitation in that it can only perform batch processing; it cannot process real-time streaming data such as stock prices as they flow into the various stock exchanges. However, Apache Storm and Apache Spark are often integrated with Hadoop to provide real-time data processing. Apache Storm is a free and open source distributed real-time computation system. Storm makes it easy to reliably process unbounded streams of data. Apache Spark is a framework for performing general data analytics in a distributed computing cluster environment like Hadoop. It provides in memory computations for increased speed of data processing. Both Storm and Spark run on top of an existing Hadoop cluster and access data in a Hadoop data store (HDFS).

Medscape MedPulse is a medical news app for iPhone and iPad users that enables health care professionals to stay up-to-date on the latest medical news and expert perspectives. The app uses Apache Storm to include an automatic Twitter feed (about 500 million tweets per day are tweeted on Twitter) to help users stay informed about important medical trends being shared in real time by physicians and other leading medical commentators.<sup>9,10</sup>

## In-Memory Databases

**in-memory database (IMDB):** A database management system that stores the entire database in random access memory (RAM).

An **in-memory database (IMDB)** is a database management system that stores the entire database in random access memory (RAM). This approach provides access to data at rates much faster than storing data on some form of secondary storage (e.g., a hard drive or flash drive) as is done with traditional database management systems. IMDBs enable the analysis of big data and other challenging data-processing applications, and they have become feasible because of the increase in RAM capacities and a corresponding decrease in RAM costs. In-memory databases perform best on multiple multicore CPUs that can process parallel requests to the data, further speeding access to and processing of large amounts of data.<sup>11</sup> Furthermore, the advent of 64-bit processors enabled the direct addressing of larger amounts of main memory. Some of the leading providers of IMDBs are shown in Table 6.5.

**TABLE 6.5** IMDB providers

Database Software Manufacturer	Product Name	Major Customers
Altibase	HDB	E*Trade, China Telecom
Oracle	Times Ten	Lockheed Martin, Verizon Wireless
SAP	High-Performance Analytic Appliance (HANA)	eBay, Colgate
Software AG	Terracotta Big Memory	AdJuggler

KDDI Corporation is a Japanese telecommunications company that provides mobile cellular services for some 40 million customers. The company consolidated 40 existing servers into a single Oracle SuperCluster running the Oracle Times Ten in-memory database to make its authentication system that manages subscriber and connectivity data run faster and more efficiently. This move reduced its data center footprint by 83 percent and power consumption by 70 percent while improving the overall performance and availability of the system. As a result, system costs were reduced, and customer service improved.<sup>12</sup>



## Critical Thinking Exercise

### Netflix Uses Analytics to Pick Winners

#### ► ANALYTICAL THINKING

Netflix users generate a large amount of detailed information about their interests, tastes, and viewing habits. It uses this data and analytics to generate viewing recommendations which users appreciate because they are usually right. Netflix also uses data and analytics to predict user demand for the many productions it is considering adding to its lineup. When Netflix cuts a deal with talent like Martin Scorsese, Ryan Reynolds, or the Obamas, it is based on a data model that predicts the probability of success of a certain combination of talent, likely plots, and other factors. Not only can Netflix predict the probability of success, it can predict with a high degree of accuracy which of its subscribers will watch a given series.

#### Review Questions

1. What tools and technologies might Netflix use to store and process all this data?
2. Why may have it been necessary to perform an ETL process on all this data?

#### Critical Thinking Questions

1. Netflix recently eliminated its five-star review system and stopped capturing user-submitted reviews. Instead, it now employs a simpler “thumbs up/thumbs down” feature. Netflix also implemented a personalized match score that aims to pair viewers up with their ideal content based on their viewing habits. Such a change seems almost counterintuitive for an organization that wants to understand its viewers’ interests. Can you offer an explanation for this change?
2. Would there be value to augmenting Netflix sourced data with data from social media networks or Internet searches? What additional value might this data add?

## Analytics and Business Intelligence

The terms business intelligence (BI) and analytics are often used interchangeably; however, there is a difference. BI is used to analyze historical data to tell what happened or is happening right now in your business. BI helps the organization to learn from past mistakes, build on past successes. This knowledge

**business intelligence (BI):** A wide range of applications, practices, and technologies for the extraction, transformation, integration, visualization, analysis, interpretation, and presentation of data to support improved decision making.

**analytics:** The extensive use of data and quantitative analysis to support fact-based decision making within organizations.

can then be fed into the initiative planning process, imitating what works and altering what doesn't. Analytics employs algorithms to determine relationships among data to develop predictions of what will happen in the future. This enables the organization to anticipate new developments and make changes now to improve future outcomes.

**Business intelligence (BI)** includes a wide range of applications, practices, and technologies for the extraction, transformation, integration, visualization, analysis, interpretation, and presentation of data to support improved decision making. The data used in BI is often pulled from multiple sources and may come from sources internal or external to the organization. Many organizations use this data to build data warehouses, data marts, and data lakes, for use in BI applications. Users, including employees, customers, and authorized suppliers and business partners, may access the data and BI applications via the Web or through organizational intranets and extranets—often using mobile devices, such as smartphones and tablets. The goal of business intelligence is to get the most value out of information and present the results of analysis in an easy to understand manner that the layman can understand.

**Analytics** can be defined as the extensive use of data and quantitative analysis to support fact-based decision making within organizations. Business analytics can be used to gain a better understanding of current business performance, reveal new business patterns and relationships, explain why certain results occurred, optimize current operations, and forecast future business results.

Often the data used in BI and analytics must be gathered from a variety of sources. Envoy is a visitor registration product that eliminates the traditional paper and pen sign-in process and replaces it with an efficient iPad sign-in process. Instant notifications triggered at sign-in alert your employees that their visitor has arrived. Visitors can be notified of your specific site policies, right when they sign in. Any forms necessary for the visit (e.g., confidential nondisclosure) can be presented for signature and a record captured for legal purposes.

Envoy had lots of data about how potential customers went through the firm's various sales funnels including Google, Facebook, company Web site, free trial subscription, and salesperson conversation. The problem was this data was stored in five different systems and the data was not easily shareable or able to be combined. As a result, the firm lacked a clear view of how customers went through any of its conversion funnels. The organization moved to a data warehouse solution to store all this data and make it useable by the entire organization. This gave the Envoy team the full picture of how it converted potential customer to customer. The firm learned that its trials to paid customer conversions were a lot lower than originally thought. It became clear that its onboarding process wasn't as effective as it needed to be in getting users fully activated. So, the firm created a new setup guide to take people through the on-boarding steps easier.<sup>13</sup>

## Benefits Achieved from BI and Analytics

BI and analytics are used to achieve a number of benefits as illustrated in the following examples:

- **Detect fraud.** MetLife implemented analytical software to help its special investigations unit (SIU) identify medical provider, attorney, and repair shop fraud. Although an accident claim may not have enough data to be flagged as suspicious when it is first filed, as more claim data is added, a claim is continually rescored by the software. After the first six months of using the software, the number of claims under investigation by the SIU increased 16 percent.<sup>14</sup>

- **Improve forecasting.** Kroger serves customers in 2,422 supermarkets and 1,950 in-store pharmacies. The company found that by better predicting pharmacy customer demand, it could reduce the number of prescriptions that it was unable to fill because a drug is out of stock. To do so, Kroger developed a sophisticated inventory management system that could provide employees with a visualization of inventory levels, adapt to user feedback, and support “what-if” analysis. Out-of-stock prescriptions have been reduced by 1.5 million per year, with a resulting increase in sales of \$80 million per year. In addition, by carrying the right drugs in the right quantities, Kroger was able to reduce its overall inventory costs by \$120 million per year.<sup>15</sup>
- **Increase Sales.** DaimlerChrysler and many other auto manufacturers set their suggested retail and wholesale prices for the year, then adjust pricing through seasonal incentives based on the impact of supply and demand. DaimlerChrysler implemented a price-elasticity model to optimize the company’s pricing decisions. The system enables managers to evaluate many potential incentives for each combination of vehicle model (e.g., Jeep Grand Cherokee), acquisition method (cash, finance, or lease), and incentive program (cash back, promotional APR, and a combination of cash back and promotional APR). The firm estimates that use of the system has generated additional annual sales of \$500 million.<sup>16</sup>
- **Optimize operations.** Chevron is one of the world’s leading integrated energy companies. Its refineries work with crude oil that is used to make a wide range of oil products, including gasoline, jet fuel, diesel fuel, lubricants, and specialty products such as additives. With market prices of crude oil and its various products constantly changing, determining which products to refine at a given time is quite complex. Chevron uses an analytical system called Petro to aid analysts in advising the refineries and oil traders on the mix of products to produce, buy, and sell in order to maximize profit.<sup>17</sup>
- **Reduce costs.** Coca-Cola Enterprises is the world’s largest bottler and distributor of Coca Cola products. Its delivery fleet of 54,000 trucks is second in size to only to the U.S. Postal Service. Using analytics software, the firm implemented a vehicle-routing optimization system that resulted in savings of \$45 million a year from reduced gas consumption and reduction in the number of drivers required.<sup>18</sup>

## The Role of a Data Scientist

**data scientist:** An individual who combines strong business acumen, a deep understanding of analytics, and a healthy appreciation of the limitations of data, tools, and techniques to deliver real improvements in decision making.

A **data scientist** is an individual who combines strong business acumen, a deep understanding of analytics, and a healthy appreciation of the limitations of data, tools, and techniques to deliver real improvements in decision making. Data scientists do not simply collect and report on data; they view a situation from many angles, determine what data and tools can help further an understanding of the situation, and then apply the appropriate data and tools. They often work in a team setting with business managers and specialists from the business area being studied, market research and financial analysts, data stewards, information system resources, and experts highly knowledgeable about the company’s competitors, markets, products, and services. The goal of the data scientist is to uncover valuable insights that will influence organizational decisions and help the organization to achieve competitive advantage.

Data scientists are highly inquisitive, continually asking questions, performing “what-if” analyses, and challenging assumptions and existing processes. Successful data scientists have an ability to communicate their findings to organizational leaders so convincingly that they are able to strongly influence how an organization approaches a business opportunity.

The educational requirements for being a data scientist are quite rigorous—requiring a mastery of statistics, math, and computer programming. Most data scientist positions require an advanced degree, such as a master's degree or a doctorate. Some organizations accept data scientists with undergraduate degrees in an analytical concentration, such as computer science, math and statistics, management information systems, economics, and engineering. American University, Boston University, Colorado Technical University, George Washington University, Syracuse University, University of California-Berkeley, and Villanova University are among the many schools that offer master's degree programs related to BI and analytics.

Many schools also offer career-focused courses, degrees, and certificates in analytical-related disciplines such as database management, predictive analytics, BI, big data analysis, and data mining. Such courses provide a great way for current business and information systems professionals to learn data scientist skills. Most data scientists have computer programming skills and are familiar with languages and tools used to process big data, such as Hadoop, Hive, SQL, Python, R, and Java.

The job outlook for data scientists is extremely bright. The McKinsey Global Institute (the business and economics research arm of the management consulting firm McKinsey & Co.) suggests that demand for data scientists could outpace supply by as many as 250,000 jobs in 2024.<sup>19</sup> The average salary for a data scientist is \$119,000. Highly talented, educated, and experienced data scientists can expect to earn in the neighborhood of \$175,000.<sup>20</sup>

## Components Required for Effective BI and Analytics

Three key components must be in place for an organization to get real value from its BI and analytics efforts. First and foremost is the existence of a solid data management program, including data governance. Recall that data management is an integrated set of functions that defines the processes by which data is obtained, certified fit for use, stored, secured, and processed in such a way as to ensure that the accessibility, reliability, and timeliness of the data meet the needs of the data users within an organization. Data governance is the core component of data management; it defines the roles, responsibilities, and processes for ensuring that data can be trusted and used by the entire organization, with people identified and in place who are responsible for fixing and preventing issues with data.

Another key component that an organization needs is creative data scientists—people who understand the business as well as the business analytics technology, while also recognizing the limitations of their data, tools, and techniques. A data scientist puts all of this together to deliver real improvements in decision making with an organization.

Finally, to ensure the success of a BI and analytics program, the management team within an organization must have a strong commitment to data-driven decision making. Organizations that can put the necessary components in place can act quickly to make superior decisions in uncertain and changing environments to gain a strong competitive advantage.



### Critical Thinking Exercise

#### Location, Location, Location

##### ► ANALYTICAL THINKING

The Marriott name encompasses numerous brands such as Courtyard, Element by Westin, Fairfield Inn and Suites, Residence Inn, Sheraton Four Points, and Starwood Hotels & Resorts. Collectively, these brands will open over 300 hotels each year. Building the right type of hotel in the right location is an essential element of Marriott's success. Marriott employs big data and analytics plus Buxton, a customer

analytics company, to ensure its continuing success. Buxton collects data from 116 million households including household profile; type of jobs held by family members; their salaries; where and how they spend their money; and even the type of jeans they buy. It combines this data with travel information—how often someone travels, is it for business or leisure, where do they live, and to where do they travel. Guest information data from each visit to a Marriott hotel is also gathered—length of stay, type of room, spending details from the hotel's bar or restaurant. Analysis of all this data enables Bruxton to advise Marriott where the unmet demand is for additional hotels. Marriott can then make informed decisions related to future development such as “What type of hotel should we build in South Dakota around an oil field? How many and what type of hotels should we build near the beach in the Caribbean?”<sup>21</sup>

### Review Questions

1. What are the key components that Buxton must put into place to create an environment for a successful BI and analytics program?
2. What complications can arise trying to combine household data, travel information, and hotel guest data from the various Marriott brands?

### Critical Thinking Questions

1. How would you distinguish between BI and analytics? How might Marriott employ BI to monitor what is happening right now in its business?
2. Why would Marriott entrust Bruxton with advising it on such a key decision? Should Marriott develop its own internal resources to take over this role? Why or why not?

## Business Intelligence and Analytics Tools

This section introduces and provides examples of many BI and analytics tools. These tools can be classified into five broad categories: descriptive analysis, predictive analysis, optimization, simulation, and text and video analysis as shown in Table 6.6.

**TABLE 6.6** General categories of BI/analytic techniques

General Categories of BI/Analytic Techniques				
Descriptive Analysis	Predictive Analytics	Optimization	Simulation	Text and Video Analysis
Specific Techniques				
Visual analytics	Time series analysis	Genetic algorithm	Scenario analysis	Text analysis
Regression analysis	Data mining	Linear programming	Monte Carlo simulation	Video analysis

### Descriptive Analysis

**Descriptive analysis:** A preliminary data processing stage used to identify patterns in the data and answer questions about who, what, where, when, and to what extent.

**Descriptive analysis** is a preliminary data processing stage used to identify patterns in the data and answer questions about who, what, where, when, and to what extent. It is used to provide information about what happened and why. You might see, for example, an increase in a stock price following a series of positive tweets on Twitter by popular market analysts. There are many descriptive analysis techniques. We will cover two: visual analytics and regression analysis.

## Visual Analytics

**visual analytics:** The presentation of data in a pictorial or graphical format.

**Visual analytics** is the presentation of data in a pictorial or graphical format. The human brain works such that most people are better able to see significant trends, patterns, and relationships in data that is presented in a graphical format rather than in tabular reports and spreadsheets. As a result, decision makers welcome data visualization software that presents analytical results visually. In addition, representing data in visual form is a recognized technique to bring immediate impact to dull and boring numbers. A wide array of tools and techniques are available for creating visual representations that can immediately reveal otherwise difficult-to-perceive patterns or relationships in the underlying data.

Many companies now troll Facebook, Google Plus, LinkedIn, Pinterest, Tumblr, Twitter, and other social media feeds to monitor any mention of their company or product. Visual analytics tools can take that raw data and immediately provide a rich visual that reveals precisely who is talking about the product and what they are saying. Techniques as simple and intuitive as a word cloud can provide a surprisingly effective visual summary of conversations, reviews, and user feedback about a new product. A **word cloud** is a visual depiction of a set of words that have been grouped together because of the frequency of their occurrence. Word clouds are generated from analyses of text documents or Web pages. Using the text from these sources, a simple count is carried out on the number of times a word or phrase appears. Words or phrases that have been mentioned more often than other words or phrases are shown in a larger font size and/or a darker color, as shown in Figure 6.5. ABCya, Image Chef, TagCloud, ToCloud, Tagul, and Wordle are examples of word cloud generator software.



**FIGURE 6.5**  
**Word cloud**

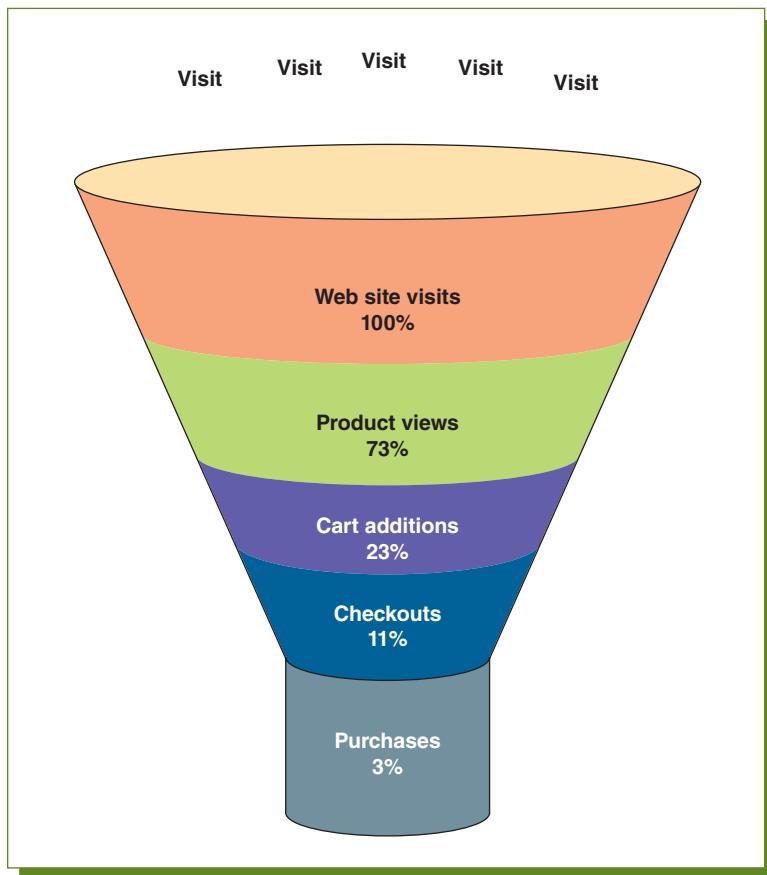
This Word cloud shows the topics covered in this chapter.

**conversion funnel:** A graphical representation that summarizes the steps a consumer takes in making the decision to buy your product and become a customer.

A **conversion funnel** is a graphical representation that summarizes the steps a consumer takes in making the decision to buy your product and become a customer. It provides a visual representation of the conversion data between each step and enables decision makers to see what steps are causing customers confusion or trouble. Figure 6.6 shows a conversion funnel for an online sales organization. It shows where visitors to a Web site are dropping off the successful sales path.

**FIGURE 6.6**  
**The conversion funnel**

The conversion funnel shows the key steps in converting a consumer to a buyer.

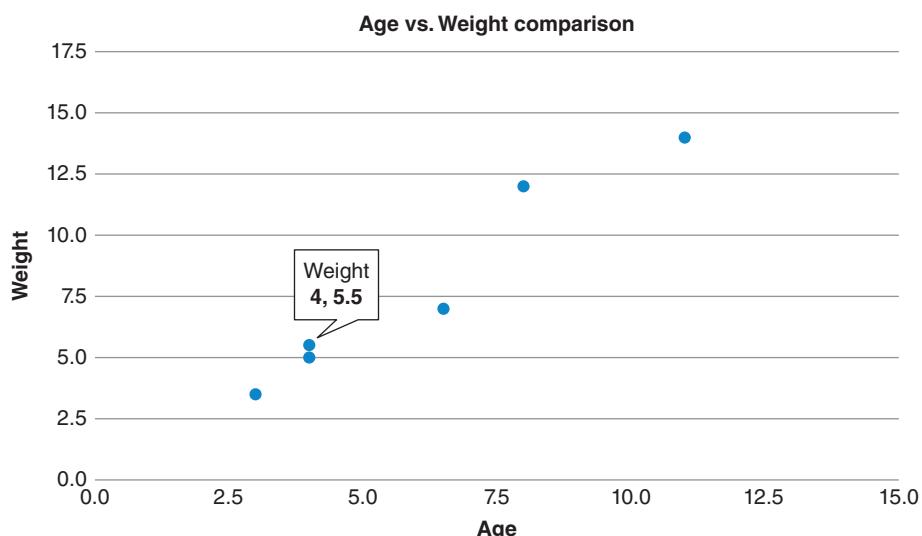


Dozens of data visualization software products are available for creating various charts, graphs, infographics, and data maps (see Figure 6.7). Some of the more common products include Google Charts, iCharts, Infogram, Modest Maps, SAS Visual Statistics, and Tableau. These tools make it easy to visually explore data on the fly, spot patterns, and quickly gain insights.

**FIGURE 6.7**  
**Data visualization**

This scatter diagram shows the relationship between age and weight.

Source: "Visualization: Scatter Chart," Google Charts, <https://developers.google.com/chart/interactive/docs/gallery/scatterchart>, accessed April 10, 2019.



**regression analysis:** A method for determining the relationship between a dependent variable and one or more independent variables.

## Regression Analysis

**Regression analysis** involves determining the relationship between a dependent variable ( $y$ ) and one or more independent variables ( $x_1, x_2, \dots, x_n$ ). It is a proven method for determining which variables have an impact on the dependent variable. It also enables you to determine which factors (independent variables) matter most, which factors can be ignored, and how these factors influence each other. Regression analysis produces a regression equation where the coefficients represent the relationship between each independent variable and the dependent variable. The regression equation can be used to make predictions.

A pharmaceutical company might use regression analysis to predict its shelf life to meet FDA regulations and identify a suitable expiration date for the drug. The dependent variable would be shelf life. The dependent variables could be the average temperature and relative humidity at which the drug will be stored.

$$\text{Estimated shelf life} = a + b \times \text{temperature} + c \times \text{relative humidity}$$

Estimates of the parameter values ( $a$ ,  $b$ , and  $c$ ) are used to develop a tentative regression equation. Various tests are then used to assess if the model is sufficiently accurate. If the model is deemed satisfactory, the regression equation can be used to predict the value of the dependent variable given values for the independent variables.

## Predictive Analytics

**predictive analytics:** A set of techniques used to analyze current data to identify future probabilities and trends, as well make predictions about the future.

**Predictive analytics** is a set of techniques used to analyze current data to identify future probabilities and trends, as well make predictions about the future. Predictive analytics can employ many different techniques. These techniques capture relationships among the many variables in a problem and enable one to assess the risk or potential opportunity associated with a specific set of conditions. This section will discuss two predictive analytics techniques—time series analysis and data mining.

## Time Series Analysis

Time series data is a sequence of well-defined data points measured at uniform time intervals over a long period of time. An example would be the hourly temperature, humidity, and barometric pressure at the end of the pier at Malibu Beach, CA dating back to 1976. Other examples include daily high and low stock prices, daily home energy usage, and your weight at 11 am each day. All are examples of time series data that can be collected at regular intervals.

**Time series analysis** is the use of statistical methods to analyze time series data and extract meaningful statistics and characteristics about the data. Time series analysis can be used to solve such problems such as predicting hour-by-hour the number of patients in a hospital emergency room so staffing levels can be optimized, forecasting future product demand to determine how much production and raw materials are required, and more. Time series analysis helps us understand what the underlying forces leading to a particular trend in the time series data points are. It is used in forecasting and monitoring the data points by fitting appropriate models to it. Time series analysis can be used to understand the past as well as forecast the future.

## Data Mining

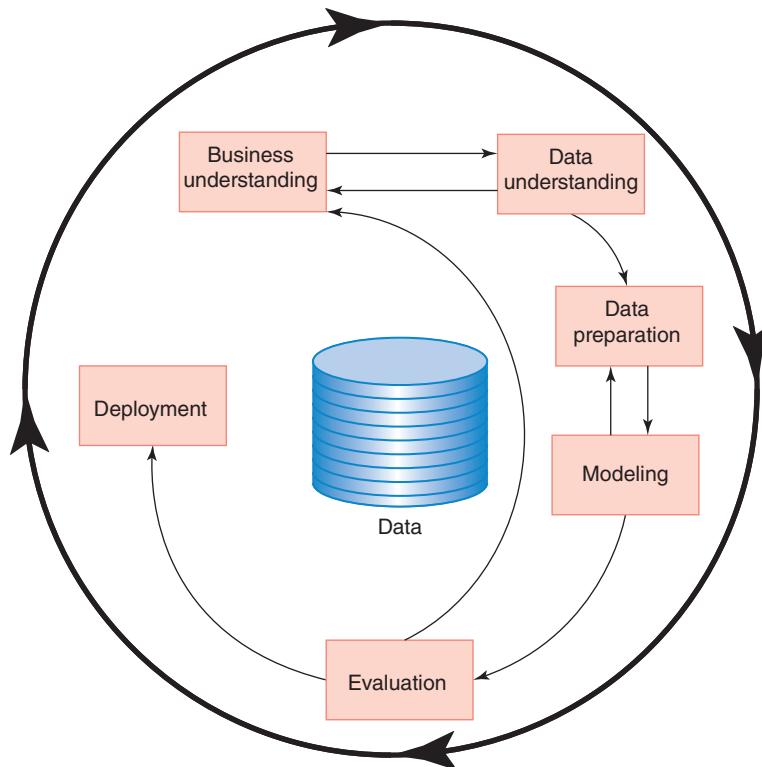
**data mining:** A BI analytics tool used to explore large amounts of data for hidden patterns to predict future trends and behaviors for use in decision making.

**Data mining** is a BI analytics tool used to explore large amounts of data for hidden patterns to predict future trends and behaviors for use in decision making. Used appropriately, data mining tools enable organizations to make predictions about what will happen so that managers can be proactive in capitalizing on opportunities and avoiding potential problems.

**Cross-Industry Process for Data Mining (CRISP-DM):** A six-phase structured approach for the planning and execution of a data mining project.

Among the three most commonly used data mining techniques are association analysis (a specialized set of algorithms sorts through data and forms statistical rules about relationships among the items), neural computing (historical data is examined for patterns that are then used to make predictions), and case-based reasoning (historical if-then-else cases are used to recognize patterns).

The **Cross-Industry Process for Data Mining (CRISP-DM)** is a six-phase structured approach for the planning and execution of a data mining project (see Figure 6.8). It is a robust and well-proven methodology, and although it was first conceived in 1999, it remains the most widely used methodology for data mining projects.<sup>22</sup> The goals for each step of the process are summarized in Table 6.7.



**FIGURE 6.8**  
**The Cross-Industry Process for Data Mining (CRISP-DM)**

CRISP-DM provides a structured approach for planning and executing a data mining project. Source: Piatetsky, Gregory, "CRISP-DM, Still the Top Methodology for Analytics, Data Mining, or Data Science Projects," KDNuggets, October 28, 2014, [www.kdnuggets.com/2014/10/crisp-dm-top-methodology-analytics-data-mining-data-science-projects.html](http://www.kdnuggets.com/2014/10/crisp-dm-top-methodology-analytics-data-mining-data-science-projects.html).

**TABLE 6.7** Goals for each phase of CRISP-DM

Phase	Goal
Business understanding	<ul style="list-style-type: none"> <li>Clarify the business goals for the data mining project, convert the goals into a predictive analysis problem, and design a project plan to accomplish these objectives.</li> </ul>
Data understanding	<ul style="list-style-type: none"> <li>Gather data to be used (may involve multiple sources), become familiar with the data, and identify any data quality problems (lack of data, missing data, data needs adjustment, etc.) that must be addressed.</li> </ul>
Data preparation	<ul style="list-style-type: none"> <li>Select a subset of data to be used, clean data to address quality issues, and transform data into form suitable for analysis.</li> </ul>
Modeling	<ul style="list-style-type: none"> <li>Apply selected modelling techniques.</li> </ul>
Evaluation	<ul style="list-style-type: none"> <li>Assess if the model achieves business goals.</li> </ul>
Deployment	<ul style="list-style-type: none"> <li>Deploy the model into the organization's decision-making process.</li> </ul>

SOURCE: Leaper, Nicole, "A Visual Guide to CRISP-DM Methodology," [https://exde.files.wordpress.com/2009/03/crisp\\_visualguide.pdf](https://exde.files.wordpress.com/2009/03/crisp_visualguide.pdf), accessed September 9, 2018.

Here are a few examples showing how data mining can be used:

- Based on past responses to promotional mailings, identify those consumers most likely to take advantage of future mailings.
- Examine retail sales data to identify seemingly unrelated products that are frequently purchased together.
- Monitor credit card transactions to identify likely fraudulent requests for authorization.
- Use hotel booking data to adjust room rates to maximize revenue.
- Analyze demographic data and behavior data about potential customers to identify those who would be the most profitable customers to recruit.
- Study demographic data and the characteristics of an organization's most valuable employees to help focus future recruiting efforts.
- Recognize how changes in an individual's DNA sequence affect the risk of developing common diseases such as Alzheimer's or cancer.

## Optimization

Optimization techniques are used every day in the organization, often to allocate scarce resources in such a manner as to minimize costs or maximize profits.

### Genetic Algorithm

Darwinism is a theory of biological evolution credited to the English naturalist Charles Darwin. The theory states that all species of organisms arise and develop through the natural selection of small, inherited variations. These variations increase the individual's ability to survive, compete, and reproduce. As random genetic mutations occur within an organism's genetic code, the beneficial mutations are preserved and passed on to the next generation because they aid survival. This process is known as "natural selection."

A **genetic algorithm** is a technique that employs a natural selection-like process to find *approximate* solutions to optimization and search problems. Genetic algorithms are typically implemented as a computer simulation. The simulation starts with a population of abstract representations (called chromosomes) of candidate solutions (called individuals) to an optimization problem. Through computer simulation, this initial population gradually evolves toward better and better solutions. In each generation, the fitness of the whole population is evaluated. Then multiple individuals are selected from the current population (based on their fitness) and modified (mutated or recombined) to form a new population. The new population is then used in the next iteration of the algorithm. This process is depicted in Figure 6.9.

Facebook has many large data centers spread across the United States. These data centers transfer lots of data across its network from site to site. Traffic volume varies based on time of day and day of the month. Facebook used a genetic algorithm to design and build that network. The algorithm determined where to put the various network nodes, how many data routers to use, and where to put them. In just a few minutes the genetic algorithm was able to come up with a solution that was 25 percent cheaper than previous manual solutions.<sup>23</sup>

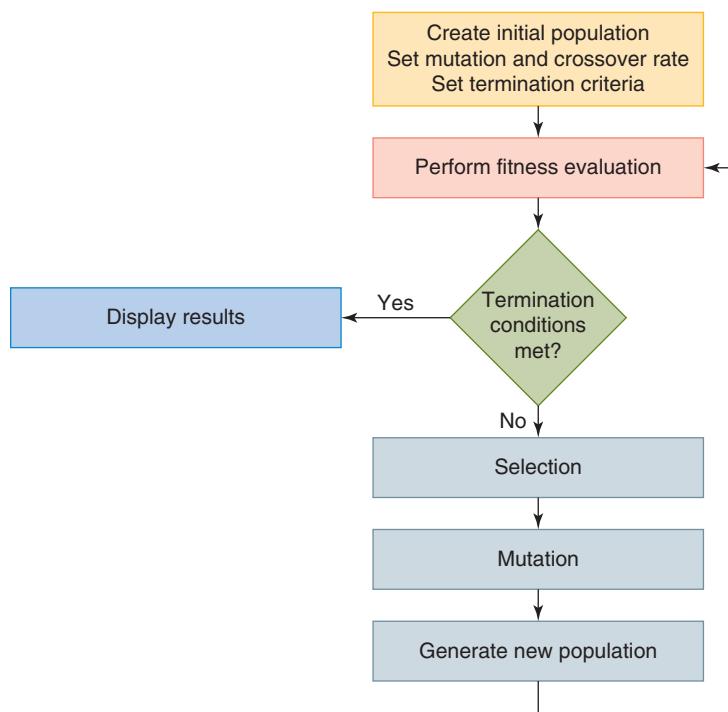
### Linear Programming

**Linear programming:** A technique for finding the optimum value (largest or smallest, depending on the problem) of a linear expression (called the objective function) that is calculated based on the value of a set of decision variables that are subject to a set of constraints.

**Linear programming** is a technique for finding the optimum value (largest or smallest, depending on the problem) of a linear expression (called the objective function) that is calculated based on the value of a set of decision variables that are subject to a set of constraints. For a problem to be a linear programming problem, the decision variables, objective function, decision variables, and constraints all must be linear functions.

Solver is a Microsoft Excel add-in program for solving linear programming problems. It can find an optimal (maximum or minimum) value for a formula

**FIGURE 6.9**  
**Multi-step process of genetic algorithm**



in one cell (the objective cell) subject to constraints, or limits, set on the values of other variables (decision variables) used to compute the formulas in the objective and constraint cells. Solver adjusts the values in the decision variable cells to satisfy the limits set by the constraint cells and produce the optimal value for the objective cell.

## Simulation

Computer simulation involves using a model expressed in the form of a computer program to emulate the dynamic responses of a real-world system to various inputs. The model is composed of equations that duplicate the functional relationships within the real system. Simulation has been used to analyze and understand many systems including the formation of the universe, the behavior of molecules, the operation of complex production processes, the spread of disease, the performance of aircraft and automobiles, and patterns of traffic flow in a highway system—these are just a few examples.

## Scenario Analysis

**Scenario analysis:** A process for predicting future values based on certain potential events.

**Scenario analysis** is a process for predicting future values based on certain potential events. For example, marketing analysts use scenario analysis to predict the results of a new marketing campaign if specific events occur or do not occur. The act of creating scenarios forces the decision makers to examine their assumptions about the future. By shaping their plans and decisions based on the most likely scenarios, they can ensure that their decisions are flexible even if circumstances change. Scenario analysis also helps identify potential problems and enables people to plan and prepare to handle them. It is used to help decide which of several courses of action to take.

The method causes decision makers to define several scenarios that generate different possible outcomes. Each scenario is different—while some are pessimistic, others might be optimistic, but each should be plausible. Most experts recommend the most appropriate number of different scenarios when discussing future strategies is three. Four or more scenarios make the analysis too complicated.

### Monte Carlo Simulation

**Monte Carlo simulation:** A simulation that enables you to see a spectrum of thousands of possible outcomes, considering not only the many variables involved, but also the range of potential values for each of those variables.

A **Monte Carlo simulation** is a simulation that enables you to see a spectrum of thousands of possible outcomes, considering not only the many variables involved, but also the range of potential values for each of those variables. Depending upon the number of variables and their probability distribution (a statistical function that describes all the possible values and likelihoods that a random variable can take within a given range), a Monte Carlo simulation can involve thousands or tens of thousands of individual forecasts or iterations before it is complete. The technique is used by decision makers in many fields, especially finance, project management, manufacturing, engineering, insurance, oil & gas, transportation, and the environment.

Monte Carlo simulation is the primary technique used in financial planning to analyze how long a retiree's nest egg will last based on a given portfolio withdraw rate, current portfolio value, and the percent of the portfolio invested in each asset class (e.g., stocks and bonds). A probability distribution is determined for the return for each asset class based on data going back as far as 1926. The simulation then chooses a value for the return of each asset class based on its probability distribution and calculates the portfolio value at the end of the year using the given withdrawal rate. That completes the year 1 simulation for iteration number 1. The simulation is repeated again for year 2, year 3, . . . year  $n$  with a new value selected for the return on each asset class for each year. This simulation is repeated again and again for iteration 2 (year 2), iteration 3 (year 3) . . . iteration  $n$  (year  $n$ ). Upon completion, the financial planner is presented with a whole distribution of results showing how long the portfolio might last. For example, the results may show that of the 10,000 iterations run, in only 20 percent of the simulations did the portfolio last 20 or more years.

### Text and Video Analysis

Text and video analysis involves various techniques to view text and video to glean insights and data relevant to decision making.

#### Text Analysis

**Text analysis** is a process for extracting value from large quantities of unstructured text data such as consumer comments, social media postings, and customer reviews. It can be used to recognize patterns, perform sentiment analysis, tag and annotate data, and information retrieval. (Sentiment analysis seeks to determine the attitude of an individual or group regarding a particular topic or overall context.)

Oshkosh Corporation is a U.S. industrial company that designs and builds specialty trucks, military vehicles, truck bodies, airport fire apparatus, and access equipment. It uses free-form service call records to systematize technical support operations and prioritize engineering improvements. Unstructured text data from support calls is used to identify common problems and pair sources of malfunction with verified solutions that have proven successful in the past. This has led to a major reduction in incident resolution time thus cutting labor costs and improving customer satisfaction. In addition, understandings gained from data analysis help guide engineering efforts to preempt mechanical problems in products currently under development.<sup>24</sup>

#### Video analysis

**Video analysis** is the process of obtaining information or insights from video footage. It is used to identify trends and patterns. Many airports use visual analysis technology to ease congestion as passengers travel through airport security. The Orlando International Airport is one of the busiest in the country with over 44 million passengers each year. The airport implemented a visual

**text analysis:** A process for extracting value from large quantities of unstructured text data.

**video analysis:** The process of obtaining information or insights from video footage.

analytics system that employs Bluetooth, cameras, and Wi-Fi sensors to calculate passenger throughput. This data is fed into various algorithms that predict passenger wait times at security checkpoints. The airport states that the system has reduced wait times by enabling the Transportation Security Administration (TSA) to shuffle resources.<sup>25</sup>

## Popular BI/Analytics Software

Widely used BI software comes from many different vendors, including Hewlett Packard, IBM, Information Builders, Microsoft, Oracle, and SAP, as shown in Table 6.8. Vendors such as JasperSoft and Pentaho also provide open-source BI software, which is appealing to some organizations.

**TABLE 6.8** Widely used BI software

Vendor	Product	Description
HP	Autonomy IDOL	Enables organizations to process unstructured as well as structured data; the software can examine the intricate relationships between data to answer the crucial question “Why has this happened?”
IBM	Cognos Business Intelligence	Turns data into past, present, and future views of an organization’s operations and performance so decision makers can identify opportunities and minimize risks; snapshots of business performance are provided in reports and independently assembled dashboards.
Microsoft	Power BI for Office 365	Allows users to model and analyze data and query large data sets with powerful natural-language queries; it also allows users to easily visualize data in Excel.
Oracle	Business Intelligence	Offers a collection of enterprise BI technology and applications; tools including an integrated array of query, reporting, analysis, mobile analytics, data integration and management, desktop integration, and financial performance management applications; operational BI applications; and data warehousing.
Oracle	Hyperion	Provides software modules to enable financial management; modules include those for budgeting, planning, and forecasting; financial reporting; database management; financial consolidation; treasury management; and analytics.
SAS	Enterprise BI Server	Provides software modules to support query and analysis, perform OLAP processing, and create customizable dashboards; the software integrates with Microsoft Office.
SAP	Business Objects	Offers a suite of applications that enable users to design and generate reports, create interactive dashboards that contain charts and graphs for visualizing data, and create ad hoc queries and analysis of data; also allows users to search through BI data sources.

## Self-Service Analytics

**self-service analytics:** Training, techniques, and processes that empower end users to work independently to access data from approved sources to perform their own analyses using an endorsed set of tools.

**Self-service analytics** includes training, techniques, and processes that empower end users to perform their own analyses using an endorsed set of tools. Self-service analytics encourages nontechnical end users to make decisions based on facts and analyses rather than intuition. Using a self-service analytics application, end users can gather insights, analyze trends, uncover opportunities and issues, and accelerate decision making by rapidly creating reports, charts, dashboards, and documents from any combination of information assets. Self-service analytics eliminates decision-making delays that can arise if all requests for data analyses must be made through a limited number of data scientists and/or information system resources. It also frees up these resources to do higher-level analytics work. Ideally, self-service analytics will lead to faster and better decision making.

An organization can take several actions to ensure an effective self-service analytics program. First, to mitigate the risks associated with self-service

analytics, data managers should work with business units to determine key metrics, an agreed-upon vocabulary, processes for creating and publishing reports, the privileges required to access confidential data, and how to define and implement security and privacy policies. The information systems organization should help users understand what data is available and recommended for business analytics. One approach to accomplishing this is to provide a data dictionary for use by end users. Training, on both the data and on the use of self-service applications, is critical for getting end workers up to speed on how they can use the information in the BI system. Finally, data privacy and security measures should be in place to ensure that the use of the data meets legal, compliance, and regulatory requirements.

A well-managed self-service analytics program allows technology professionals to retain ultimate data control and governance while limiting information systems staff involvement in routine tasks. Modern data management requires a true balancing act between enabling self-service analysis and protecting sensitive business information.

The advantages of self-service BI and analytics are that it gets valuable data into the hands of end users, it encourages fact-based decision making based on analysis, it accelerates decision making, and it provides a solution to the shortage of data scientists. The disadvantages are that it raises the potential for erroneous analysis, can lead to analyses with inconsistent conclusions, can cause over spending on unapproved data sources and analytics tools, and may remove the necessary checks and balances on data preparation and use. Table 6.9 presents the advantages and disadvantages associated with self-service BI and analytics.

**TABLE 6.9** Advantage and disadvantages associated with self-service BI and analytics

Advantages	Disadvantages
Gets valuable data into the hands of the people who need it the most—end users.	If not well managed, it can create the risk of erroneous analysis and reporting, leading to potentially damaging decisions within an organization.
Encourages nontechnical end users to make decisions based on facts and analyses rather than intuition.	Different analyses can yield inconsistent conclusions, resulting in wasted time trying to explain the differences. Self-service analytics can also result in proliferating “data islands,” with duplications of time and money spent on analyses.
Accelerates and improves decision making.	Can lead to over spending on unapproved data sources and business analytics tools.
Business people can access and use the data they need for decision making, without having to go to technology experts each time they have a new question, thus filling the gap caused by a shortage of trained data scientists.	Can exacerbate problems by removing the checks and balances on data preparation and use. Without strong data governance, organizations can end up with lots of silos of information, bad analysis, and extra costs.

For self-service analytics tools to be effective, they must be intuitive and easy to use. Business users simply don't have the time to learn how to work with complex tools or sophisticated interfaces. A self-service analytics application will only be embraced by end users if it allows them to easily access their own customized information, without extensive training. Microstrategy, Power BI, Qlik, SAS Analytics, Tableau, and TIBCO Software are just a few examples of the dozens of software options available for self-service analytics.

Expert Storybooks, a cloud-based, self-service analytics service from IBM's Watson Analytics line, provides data analysis models that offer connections to a range of data sources, along with secure connections to corporate data. Expert Storybooks are tools for creating sophisticated data visualizations to help users find relevant facts and discover patterns and relationships to make

predictive decisions. There are several Expert Storybooks available, including one that uses baseball statistics from Scoutables to build predictions of player performance, enabling users to gain an edge over their fantasy baseball competitors. A variety of other Storybooks help end users incorporate weather data into revenue analysis; analyze social data to measure reputational risk; analyze marketing campaign data; identify and analyze trends in customer profitability; analyze market trends for investment strategy; and examine relationships among pay, performance, and credit risk.<sup>26</sup>



## Critical Thinking Exercise

### Miami University (Oxford, Ohio)

#### ► ANALYTICAL THINKING

Miami University has an enrollment of nearly 20,000 students on its main campus in Oxford, Ohio. The cost of tuition and fees is around \$15,000 plus another \$13,000 for room and board. Out-of-state students pay almost an additional \$20,000 their first year. U.S. News & World Report has ranked Miami University in the top five schools for undergraduate teaching since 2011. It also described Miami University as having an “astoundingly beautiful” campus.

Faculty and administrators at Miami University are gathering data to improve student success, retention, and graduation rates. This includes data to measure the spectrum of students they recruit in high school, data to show student progress toward graduation, data to show when and how the university can support them during their college career, and data to measure their graduation success and beyond. Predictive analytics is used to analyze much of this data to enable Miami University to better support students and, in many cases, take preemptive action prior to the student leaving the institution.

#### Review Questions

1. How would you define predictive analytics? What predictive analytics techniques might be used at Miami University?
2. What three key organizational components must be in place for Miami University to get real value from its predictive analytics program?

#### Critical Thinking Questions

1. Identify five likely sources of data that would be useful to track and/or improve the academic success, retention, and graduation rate of an individual student.
2. Develop three examples of how predictive analytics might be used to trigger a planned student-faculty or administrator interaction to help a struggling student before the problem became too serious.

## Summary

### Principle:

We have entered an era where organizations are grappling with a tremendous growth in the amount of data available and struggling how to manage and make use of it.

“Big data” is the term used to describe data collections that are so enormous and complex that traditional data management software, hardware, and analysis processes are incapable of dealing with them. Big data has five distinguishing characteristics: volume, velocity, value, variety, and veracity.

Organizations use big data to improve their day-to-day operations, planning, and decision making.

There are many challenges associated with big data, including how to choose what subset of data to store, where and how to store the data, how to find those nuggets of data that are relevant to the decision making at hand, how to derive value from the relevant data, and how to identify which data needs to be protected from unauthorized access.

### Principle:

**A number of available tools and technologies allow organizations to take advantage of the opportunities offered by big data.**

Traditional online transaction processing (OLTP) systems put data into databases very quickly, reliably, and efficiently, but they do not support the types of data analysis that today's businesses and organizations require. To address this need, organizations are building data warehouses specifically designed to support management decision making.

A data warehouse is a large database that holds business information from many sources in the enterprise, covering all aspects of the company's processes, products, and customers.

An extract, transform, load process takes data from a variety of sources, edits and transforms it into the format to be used in the data warehouse, and then loads the data into the warehouse.

Data marts are subdivisions of data warehouses and are commonly devoted to specific purposes or functional business areas.

A data lake takes a "store everything" approach to big data, saving all the data in its raw and unaltered form.

A NoSQL database provides a means to store and retrieve data that is modelled using some means other than the simple two-dimensional tabular relations used in relational databases. Such a database has the capability to spread data over multiple servers so that each server contains only a subset of the total data. The NoSQL does not require a predefined schema, data entities can have attributes edited or assigned to them at any time. NoSQL databases do not conform to true ACID properties when processing transactions.

There are categories of NoSQL databases—key-value, document, graph, and column.

Hadoop is an open-source software framework that includes several software modules that provide a means for storing and processing extremely large data sets. Hadoop has two primary components—a data processing component (MapReduce) and a distributed file system (Hadoop Distributed File System or HDFS) for data storage. Hadoop divides data into subsets and distributes the subsets onto different servers for processing. A Hadoop cluster may consist of thousands of servers. A subset of the data within the HDFS and the MapReduce system are housed on every server in the cluster.

An in-memory database (IMDB) is a database management system that stores the entire database in random access memory to improve storage and retrieval speed.

**There are many business intelligence (BI) and analytics techniques that can be used to support improved decision making.**

Business intelligence includes a wide range of applications, practices, and technologies for the extraction, transformation, integration, visualization, analysis, interpretation, and presentation of data to support improved decision making. It is used to tell what happened and what is happening right now in the organization.

Analytics is the extensive use of data and quantitative analysis to support fact-based decision making within the organization. It is often used to develop predictions of what will happen in the future.

BI and analytics help achieve the following kinds of benefits: detect fraud, improve forecasting, increase sales, optimize operations, and reduce costs.

A data scientist is an individual who combines strong business acumen, a deep understanding of analytics, and a healthy appreciation of the limitations of data, tools, and techniques to deliver real improvements in decision making.

BI/analytics techniques can be divided into five categories: descriptive analysis, predictive analytics, optimization, simulation, and text and video analysis.

Descriptive analysis techniques include visual analytics and regression analysis used to perform preliminary analysis to identify patterns in the data and answer questions about who, what, where, when, and to what extent.

Predictive analytics techniques include time series analysis and data mining used to analyze current data to identify future probabilities and trends, as well as make predictions about the future.

Optimization techniques include genetic algorithms and linear programming used to allocate scarce resources in such a manner as to minimize costs or maximize profits.

Simulation techniques include scenario analysis and Monte Carlo simulation used to emulate the dynamic responses of a real-world system to various inputs.

Text and video analysis techniques include text analysis and video analysis used to glean insights and data relevant to decision making.

Self-service analytics includes training, techniques, and processes that empower end users to work independently to access data from approved sources to perform their own analyses using an endorsed set of tools.

The advantages of self-service BI and analytics are that it gets valuable data into the hands of end users, it encourages fact-based decision making based on analysis, it accelerates decision making, and it provides a solution to the shortage of data scientists.

The disadvantages are that it raises the potential for erroneous analysis, can lead to analyses with inconsistent conclusions, can cause over spending on unapproved data sources and analytics tools, and may remove the necessary checks and balances on data preparation and use.

## Key Terms

analytics	in-memory database (IMDB)
big data	linear programming
business intelligence	MapReduce program
conversion funnel	Monte Carlo simulation
Cross-Industry Process for Data Mining (CRISP-DM)	NoSQL database
data lake	predictive analytics
data mart	regression analysis
data mining	scenario analysis
data scientist	self-service analytics
data warehouse	text analysis
descriptive analysis	time series analysis
Extract Load Transform (ETL) process	video analysis
genetic algorithm	visual analytics
Hadoop	word cloud
Hadoop Distributed File System (HDFS)	

## Self-Assessment Test

We have entered an era where organizations are grappling with a tremendous growth in the amount of data available and struggling to understand how to manage and make use of it.

1. \_\_\_\_\_ is a measure of the quality of big data.
2. The fact that big data comes in many formats and may be structured or unstructured is an indicator of its \_\_\_\_\_.
3. Choosing what data to store and where and how to store the data are two key challenges associated with big data. True or False?
4. \_\_\_\_\_ is not a key challenge associated with big data.
  - a. How to derive value from the relevant data
  - b. Which format the data should be stored in
  - c. How to identify which data needs to be protected from unauthorized access
  - d. How to find those nuggets of data that are relevant to the decision making at hand

A number of available tools and technologies allow organizations to take advantage of the opportunities offered by big data.

5. A \_\_\_\_\_ is a large database that holds business information from many sources in the enterprise, covering all aspects of the company's processes, products, and customers.
  - a. relational database
  - b. data lake
  - c. data warehouse
  - d. data lake
6. The goal of the \_\_\_\_\_ step of the ETL process is to take the source data from all the various sources and convert it into a single format suitable for processing.
7. A \_\_\_\_\_ database enables hundreds or even thousands of servers to operate on the data, providing faster response times for queries and updates.
  - a. NoSQL
  - b. normalized
  - c. SQL
  - d. relational
8. A \_\_\_\_\_ differs from a \_\_\_\_\_ in that it provides a means to store and retrieve data that is modelled using some means other than the simple two-dimensional tabular relations.
  - a. data mart and NoSQL database
  - b. data mart and data warehouse
  - c. NoSQL database and relational database
  - d. data warehouse and data lake

9. The \_\_\_\_\_ component of the Hadoop environment is composed of a procedure that performs filtering and sorting and a method that performs a summary operation.
  - a. ETL
  - b. Map/Reduce program
  - c. JobTracker
  - d. Hadoop Distributed File System
10. The primary advantage associated with the use of an in-memory database to process big data is that \_\_\_\_\_.
  - a. it is much cheaper than secondary storage
  - b. it provides access to data at rates much faster than storing data on some form of secondary storage
  - c. it enables the storage of much larger amounts of data
  - d. it enables the use of Hadoop procedures to process the data

There are many business intelligence (BI) and analytics techniques that can be used to support improved decision making.

11. The primary difference between business intelligence and analytics is that \_\_\_\_\_.
  - a. BI is used to analyze historical data to tell what happened or is happening right now in your business while analytics employs algorithms to determine relationships among data to develop predictions of what will happen in the future.
  - b. analytics employs techniques like optimization, predictive analysis, and simulation while BI employs descriptive analysis and text and visual analysis.
  - c. a data scientist is required to properly employ analytics while an end user working with a database administrator can employ BI.
  - d. organizations used to employ BI but now are moving to greater use of analytics.
12. An individual who combines strong business acumen, a deep understanding of analytics, and a healthy appreciation of the limitations of their data, tools, and techniques to deliver real improvements in decision making is a(n) \_\_\_\_\_.
  - a. systems analyst
  - b. database administrator
  - c. data scientist
  - d. data steward

13. The five broad categories of BI/analytics techniques include \_\_\_\_\_.  
 a. heuristics, predictive analytics, simulation, data mining, and linear programming  
 b. optimization, descriptive analytics, and text and video analysis, simulation, and predictive analytics  
 c. regression analysis, data mining, Monte Carlo simulation, optimization, and time series analysis  
 d. predictive analysis, scenario analysis, image analysis, optimization, and regression analysis
14. Two specific BI/analytics techniques that are in the general category of descriptive analytics are \_\_\_\_\_.  
 a. data mining and linear programming  
 b. scenario analysis and time series analysis  
 c. regression analysis and visual analytics  
 d. Monte Carlo simulation and genetic algorithm
15. Data mining and time series belong in the general category of \_\_\_\_\_ of BI/analytics.  
 a. predictive analytics  
 b. heuristics  
 c. scenario analysis  
 d. optimization
16. Genetic algorithm and linear programming belong in the \_\_\_\_\_ general category of BI/analytics.  
 a. optimization  
 b. scenario analysis  
 c. heuristics  
 d. predictive analytics
17. While there are three key components that must be in place for an organization to get real value from its BI and analytics efforts, the one that is first and foremost is the existence of a solid data management program. True or False?
18. Encouragement of self-service analytics almost assuredly will eliminate the risk of erroneous analysis and reporting and the problem of different analyses yielding inconsistent conclusions. True or False?
19. Which of the following is not a disadvantage of self-service analytics?  
 a. It raises the potential for erroneous analysis.  
 b. It can lead to analyses with inconsistent conclusions.  
 c. It can cause over spending on unapproved data sources and analytics tools.  
 d. It places valuable data in the hands of end users.

## Self-Assessment Test Answers

1. Veracity
2. variety
3. True
4. b
5. c
6. extract
7. a
8. c
9. b
10. b
11. a
12. c
13. b
14. c
15. a
16. a
17. True
18. False
19. d

## Review and Discussion Questions

1. Identify the five primary characteristics associated with big data discussed in this chapter.
2. This chapter presented five key challenges associated with big data. Propose a sixth key challenge. Why do you believe this poses a major challenge?
3. How does a data lake differ from a data warehouse? How does a data mart differ from a data lake, from a data warehouse? Briefly discuss any experience you have working with a data mart, data warehouse, or data lake.
4. Briefly describe the purpose of each step in the ETL process. Would the purchase of high-quality data from a reputable third-party obviate the need for any of the steps in the ETL process? Explain.
5. In what ways is an SQL database different from a NoSQL database?
6. Identify the two primary components of the Hadoop environment and the role that each plays.
7. What is the primary reason an organization might elect to employ an in-memory database to process big data?
8. The terms business intelligence and analytics are often used interchangeably. Are they the same or different? Explain.
9. How would you describe the role of a data scientist? Is such a role of any interest to you? Why or why not?

10. Which broad category of BI/analytics might Walmart employ to analyze the flow of shoppers through its stores? What might be the purpose of such an analysis? What broad category of BI/analytics might Walmart use to analyze consumer comments and questions & comments to capture and quantify customer sentiment data?
11. Which of the specific BI/analytic techniques discussed in this chapter have you employed? Briefly describe the situation in which you used the specific technique(s). Were you satisfied with
- the process required to use this technique and the results it produced? Why or why not? Which specific technique(s) are you interested in learning more about?
12. What two key components in addition to a solid data management program must be in place for an organization to get real value from its BI and analytics efforts?
13. The use of self-service analytics can introduce some new problems for an organization. Can you identify four potential issues?

## Business Driven Decision-Making Exercises

1. Use one of the BI/analytics techniques to find the optimal solution to this problem. You make custom T-shirts with inspirational sayings on them. You just found out about a community flea market sale that is starting tomorrow. You have just 8 hours to prepare product for this sale. You start with a plain white T-shirt. This is your most popular color. But you can dye the white T-shirt blue, yellow, or red—but only one shirt at a time. Your current inventory is 50 white T-shirts

and you have enough dye to make 12 red shirts, 10 yellow shirts, and 15 blue shirts. You take the various color shirts to the sale and then stencil on an inspirational saying—whatever the customer wants up to 35 characters.

Based on experience, you know that at a sale like this, you will be able to sell all 50 shirts. Use the data in the table below to determine how many shirts of each color you should bring to the sale to maximize your profits.

Color	Time Required to Dye (Minutes)	Your Cost of Materials Including Dye and Stencil	You Have Enough Dye to Make This Many Shirts	Selling Price	Profit
White	0	\$5	50	\$12	\$7
Blue	20	\$7	15	\$15	\$8
Yellow	20	\$7	10	\$15	\$8
Red	40	\$10	12	\$16	\$6

2. You and many of your classmates are mourning the loss of one of your college friends. Your friend was highly successful in the business world and was a true humanitarian devoting much of his time and resources to those who needed help. You want to propose to your

classmates that you set up a foundation in his name to provide a \$3,000 grant each year to one deserving student. Identify the data and two analytics techniques you could use to estimate how much money is needed for the foundation.

## Teamwork and Collaboration Activities

1. Imagine that you and your team have been hired by the football coach at the local university to develop a process to predict the academic success of students being considered for athletic scholarship. The school is currently on probation for the poor graduation rates of its football players. The coach needs to make a big improvement or he will likely lose his job. What data might you consider using to develop an estimate of an athlete's academic success? What BI/analytics techniques might you use?
2. Read the article “Why ‘Big Data’ Is a Big Deal” by Jonathan Shaw in the March–April 2014 Harvard Magazine. What does Shaw think is the revolution in big data? Which of the many big data applications that he mentions do you find to be the most interesting? Why? You and your team have been selected to make a 10-minute presentation summarizing the key points of this article.

## Career Exercises

1. You are a certified financial planner working for a large bank that specializes in managing the retirement funds of its customers. One of the most frequently asked questions from your clients is “How long will my retirement funds last?” Which general category of BI/analytics tools would you use to answer this question? What specific tools would be useful?
2. Read the article and comments about “There’s No Such Thing as Big Data in HR” by Peter Cappelli in the June 2017 Harvard Business Review. Do you agree with the views expressed with the author? Why or why not? Can you identify a functional unit of a major organization that has little or no use for analytics?

## Case Study

### ► ANALYTICAL THINKING, APPLICATION

#### **Business Intelligence and Analytics in Major League Baseball**

Early in this century, the Oakland Athletics used readily available traditional player performance statistics in new ways to decide which players to put on the field, and this change led to better play and to several division-winning seasons. Their efforts were memorialized in Michael Lewis's book *Moneyball*, and in the 2011 movie of the same name.

Major league teams are now all using data analysis to improve player selection, player performance, in-game decision making, and player development. The techniques and tools now in use have moved way beyond what was described in *Moneyball*. Now, data on every pitch is captured by a doppler radar system that samples the ball position 2,000 times a second. At the same time, the batter's swing is recorded, capturing data about the ball's speed as it comes off the bat and the ball's launch angle. Cameras behind third base record the position of players on the field 30 times a second. A terabyte of data is captured each game. This is now done at all major and minor league parks, in most Division 1 college parks, and even at some high schools.

This wealth of performance data is used as input to analytical software for a variety of purposes. Here are some examples:

- *In-game decision making:* Teams can see where in the field each batter tends to hit the ball, and they now position fielders accordingly. Therefore you now often see three infielders to the right (or left, as the case may be) of second base, or four fielders in the outfield. These untraditional defensive configurations – rarely seen in baseball's 150-year history – look strange to the average fan, but they are very effective in cutting down on base hits.
- *Player selection:* Teams can acquire players from other teams, or sign players whose contracts with teams have run out. Teams have a rough idea of what pitchers they will face in a year and in what ball parks, which have different dimensions. From the data that is collected each game, a team can simulate how a batter would do against these pitchers in those parks during a full season. In this way a team can project which players would succeed with them and which might not.

- *Improved performance:* Doppler radar-generated data shows in detail how each pitch was delivered – the ball's spin, the way the ball was released by the pitcher, the ball's direction and path taken, and other measures. Analysts are now able to show a pitcher how to change their delivery or motion for certain kinds of pitches. By analyzing data about his pitching, Justin Verlander revived his career after being traded to the Houston Astros.

In 2011 the Houston Astros were one of baseball's worst teams. They hired Jeff Luhnow away from the St. Louis Cardinals, one of the early leaders in the use of data analysis, to establish a program for the Astros. In a two-part *McKinsey Quarterly* interview, Luhnow described this work. Initially, many players were resistant to change, for example to new defensive configurations. But, upper management made it clear to all that the program would continue. A breakthrough occurred when (1) the club showed players how the data was gathered and used, and (2) assigned ex-players with software skills as coaches for the minor league teams to explain the program to players coming up. These moves generated trust and buy-in at all levels. Today, the Astros' program is recognized as one of baseball's best, and the Astros have been one of the most successful teams on the field. Many of Luhnow's staffers have been hired away by other teams.

Luhnow says data analysis in baseball will continue to evolve. In the future, he says, big data and artificial intelligence will be increasingly important. One area of interest is using biometric data to predict, and thus prevent, injuries, particularly to pitchers.

#### Questions:

1. Baseball executives typically call their analysis programs “analytics”. Based on this chapter's BI and Analytics definitions, would you say that their programs are more Business Intelligence or more Analytics? Or, some of both?
2. Excel is a popular and powerful program with a good statistical package. Why do you think baseball teams use tailored software applications for their data analysis, instead of Excel?

3. Baseball teams have used “scouts” to watch young men play at the high school and college levels. Scouts would report the evaluations to the front office, and players were hired based on these reports. Teams still do employ scouts to do this, but increasingly player potential is based on an analysis of doppler and video data. Do you think there will come a day when scouts are no longer needed by major league teams?
4. Most teams have at least a dozen data scientists and other analysts in their programs. Analysts earn high salaries and benefits. Office space, equipment, hardware and software are costly as well. What would you roughly think the data analysis program would cost a major league team each year?

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## Principles

A network has many fundamental components, which—when carefully selected and effectively integrated—enable people to meet personal and organizational objectives.

Together, the Internet and the World Wide Web provide a highly effective infrastructure for delivering and accessing information and services.

## Learning Objectives

- Describe three network topologies and four network types in common use today.
  - State three advantages that 5G wireless communications will provide over 4G communications.
  - Identify three advantages associated with software-defined networking.
- 
- Describe how the Internet works, including the roles of the Internet backbone, TCP/IP protocol, IP address, switches, and routers.
  - Describe how the Web works, including the roles of the client/server architecture, Domain Name System, URL, hyperlinks, Web browser, HTML, XML, and CSS.
  - State the purpose of client-side and server-side programming.
  - Identify three commonly used client-side programming languages and three commonly used server-side programming languages.
  - Outline the process and tools used in developing Web content and applications.
  - Describe five common Internet and Web applications.
  - Explain how intranets and extranets use Internet technologies.

# IS in Action

## Communications in Time of Natural Disaster

### ► GLOBAL

Disasters can occur anywhere and anytime. Several serious natural disasters struck around the world in 2017 and 2018. Powerful hurricanes struck North and South Carolina, Houston, south Florida, Hawaii, Puerto Rico, and the Florida Panhandle. Strong typhoons hit Japan, Australia, Hong Kong, and the Philippines. The fierce winds, driving rain, and storm surge snapped power poles and trees like toothpicks, washed entire neighborhoods into the sea, caused widespread flooding, and resulted in loss of life and hundreds of billions of dollars of damage. China, Indonesia, Iran, Italy, Honduras, Papua New Guinea, Venezuela, Mexico, and Peru were rocked by powerful magnitude 7.0 or greater earthquakes. In some cases, these earthquakes triggered a tsunami whose high, strong waves can travel over 500 mph in the deep ocean waters. When the tsunami hits shore, it washes away everything in its path for miles with death tolls often measured in the thousands.

No matter where the disaster is taking place, rescue and relief operations are needed to find and rescue victims, as well as care for survivors. The first step in coordinating and managing a successful rescue and relief operation is to establish a central base, where all information is gathered and distributed to the first responder teams, including police officers, firefighters, and emergency medical technicians. This central base, or command and control center, is key to ensuring first responders at the disaster sites receive the most up-to-date information and that their efforts are directed to where it is most urgently needed. As you can imagine, reliable communication is key for these operations to be successful.

Unfortunately, natural disasters destroy phone lines and cell towers, rendering useless all landline, wireless, and Wi-Fi communication networks. As a result, first responders increasingly rely on special battery-driven satellite communication telephones which require no local ground-based infrastructure whatsoever. For example, the U.S. company Iridium operates the Iridium satellite constellation, which is a network of 66 Low-Earth Orbit (LEO) satellites used for worldwide voice and data communication from hand-held satellite phones and other transceiver units. These satellites serve as a cell tower in the sky and allow first responders to use satellite phones to transfer voice and live video streams from affected areas back to the center. Surveillance aircraft or drones circling the disaster zone with onboard cameras can also capture and transmit video and images. All this data provides the command post with a more complete picture of what is happening and enables workers there to make decisions based on this information. A complete situation awareness capability such as this, enabled by a wide-area satellite communications network, is vital to the success of any rescue operation.

### As you read this chapter, consider the following:

- How are organizations using networks to support their business strategies and achieve organizational objectives?
- What capabilities do search engines, social networks, and other Internet services provide to make organizations successful?

## Why Learn about Networks?

Today's decision makers need to access data wherever it resides. They must be able to establish fast, reliable connections to exchange messages, upload and download data and software, route business transactions to processors, connect to databases and network services, and send output to wherever it is needed. Regardless of your chosen major or future career field, you will make use of the communications capabilities provided by networks, including the Internet, intranets, and extranets. This is especially true for those whose role is connected to the supply chain and who rely heavily on networks to support cooperation and communication among workers in inbound logistics, warehouse and storage, production, finished product storage, outbound logistics, and, most importantly, with customers, suppliers, and shippers. Many supply chain organizations make use of the Internet to purchase raw materials, parts, and supplies at competitive prices. All members of the supply chain must work together effectively to increase the value perceived by the customer, so partners must communicate well. Other employees in human resources, finance, research and development, marketing, manufacturing, and sales positions must also use communications technology to communicate with people inside and outside the organization. To be a successful member of any organization, you must be able to take advantage of the capabilities that these technologies offer you. This chapter begins by discussing the importance of effective communications.

In today's high-speed global business world, organizations need always-on, always-connected computing for traveling employees and for network connections to their key business partners and customers. Forward-thinking organizations strive to increase revenue, reduce time to market, and enable collaboration with their suppliers, customers, and business partners by using networks. Here are just a few examples of organizations using networks to move ahead:

- Many banks and retail organizations have launched their own mobile payment system, with the hopes of reducing payments to financial services organizations while also increasing customer loyalty. Some of these new systems include Android Pay, Apple Pay, Chase Pay, PayPal, Samsung Pay, Urban Airship, and Walmart Pay.
- Networks make it possible for you to access a wealth of educational material and earn certifications or an online degree. A wide range of courses are available online from such leading educational institutions as Cornell, Carnegie Mellon, Harvard, MIT, and Yale. Many educational organizations such as Coursera, ed2Go, and Kahn Academy offer continuing education, certification programs, and professional development courses. It is possible to earn a degree taking courses online from fully accredited educational institutions including: Arizona State University, Colorado State University, Embry-Riddle Aeronautical University, Ohio State University, Oregon State University, Pennsylvania State University, Temple University, University of Oklahoma, Utah State University, and many others.
- Shrewd operators of major sports venues have discovered that relaying exciting action to friends in real-time on social media has become an important part of the overall fan experience. Such capabilities are proving to be increasingly essential to attracting fans to games. As a result, many venues are installing high-performance cellular and wireless networks to meet this need. They are also providing apps that enable fans to scan their tickets, order food and beverages, download a 360-degree stadium video or even receive real-time updates about lengths of bathroom lines. There is a major potential payoff as it has been estimated that fans would spend an extra \$20 if wait times at concession stands were halved.<sup>1</sup>
- Telemedicine is a means of providing clinical healthcare to a patient from a distance using telecommunications and information technology. During a telemedicine session, patient information is automatically captured using such telemedicine services as sensors and mobile apps. Sensors can track the electrical activity of the patient's heart (ECG) and send the results to doctors. This provides an invaluable tool for

health care professionals to monitor cardiovascular activity. Patient data collection can help identify risk factors for certain illnesses and assist physicians in recommending appropriate treatments. Because telemedicine is one of the fastest growing segments in the health care industry, many organizations are investing in it.<sup>2</sup>

Advances in network technology allow us to communicate in real time with customers, clients, business partners, and coworkers almost anywhere in the world. Networks also reduce the amount of time required to transmit information necessary for driving and concluding business transactions.

## Network Fundamentals

**computer network:** The communications media, devices, and software connecting two or more computer systems or devices.

**communications medium:** Any material substance that carries an electronic signal to support communications between a sending and a receiving device.

**network topology:** The shape or structure of a network, including the arrangement of the communication links and hardware devices on the network.

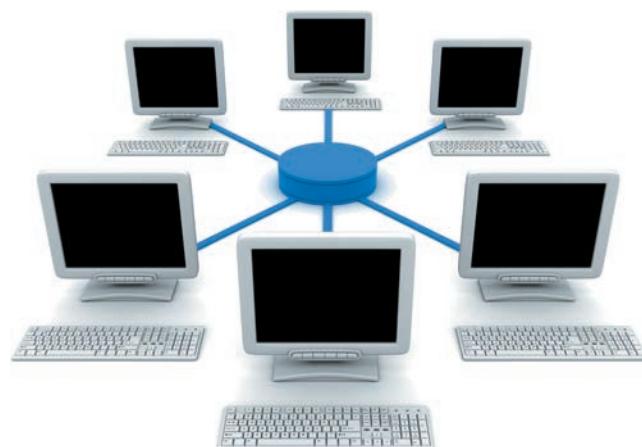
**star network:** A network in which all network devices connect to one another through a single central device called the hub node.

A **computer network** consists of communications media, devices, and software connecting two or more computer systems or devices. **Communications media** are any material substance that carries an electronic signal to support communications between a sending and a receiving device. The computers and devices on the networks are also sometimes called network nodes. Organizations can use networks to share hardware, programs, and databases and to transmit and receive information, allowing for improved organizational effectiveness and efficiency. Networks enable geographically separated workgroups to share documents and opinions, which fosters teamwork, innovative ideas, and new business strategies. Effective use of networks can help a company grow into an agile, powerful, and creative organization, giving it a long-term competitive advantage.

### Network Topology

**Network topology** is the shape or structure of a network, including the arrangement of the communication links and hardware devices on the network. The transmission rates, distances between devices, signal types, and physical interconnection may differ between networks, but they may all have the same topology. The three most common network topologies in use today are the star, bus, and mesh.

In a **star network**, all network devices connect to one another through a single central device called the hub node. See Figure 7.1. Many home networks employ the star topology. A failure in any link of the star network will isolate only the device connected to that link. However, should the hub fail, all devices on the entire network will be unable to communicate.



Vlad Kochelaevsky/Shutterstock.com

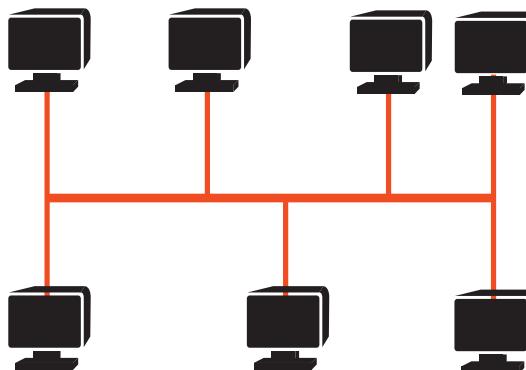
**FIGURE 7.1**

### Star network

In a star network, all network devices connect to one another through a single central hub node.

**bus network:** A network in which all network devices are connected to a common backbone that serves as a shared communications medium.

In a **bus network**, all network devices are connected to a common backbone that serves as a shared communications medium. See Figure 7.2. To communicate with any other device on the network, a device sends a broadcast message onto the communications medium. All devices on the network can “see” the message, but only the intended recipient actually accepts and processes the message.



mamamamsai/Shutterstock.com

**FIGURE 7.2**  
**Bus network**

In a bus network, all network devices are connected to a common backbone that serves as a shared communications medium.

**mesh network:** A network that uses multiple access points to link a series of devices that speak to each other to form a network connection across a large area.

**Mesh networks** use multiple access points to link a series of devices that speak to each other to form a network connection across a large area. See Figure 7.3. Communications are routed among network nodes by allowing for continuous connections and by bypassing blocked paths by “hopping” from node to node until a connection can be established. Mesh networks are very robust: if one node fails, all the other nodes can still communicate with each other, directly or through one or more intermediate nodes.



Vlad Kochelaevsky/Shutterstock.com

**FIGURE 7.3**  
**Mesh network**

Mesh networks use multiple access points to link a series of devices that speak to each other to form a network connection across a large area.

The QLine streetcar spans 20 stations at 12 locations in downtown Detroit. It plays a crucial role in connecting the city and will likely undergo further improvements and expansion. Riders on the QLine can access free Wi-Fi services through a mesh network with network nodes placed about 500 yards apart along the right of way.<sup>3</sup>

## Network Types

A network can be classified as personal area, local area, metropolitan, or wide area network depending on the physical distance between the nodes on the network and the communications and services it provides.

### Personal Area Networks

#### personal area network (PAN)

**(PAN):** A network that supports the interconnection of information technology devices close to one person.

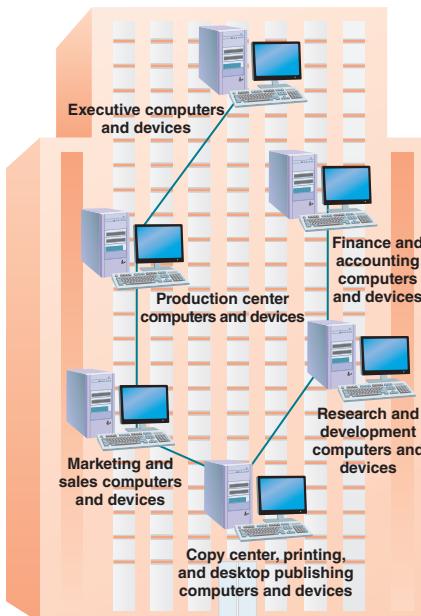
A **personal area network (PAN)** is a wireless network that connects information technology devices close to one person. With a PAN, you can connect a laptop, digital camera, and portable printer without cables. You can download digital image data from the camera to the laptop and then print it on a high-quality printer—all wirelessly. A PAN could also be used to enable data captured by sensors placed on your body to be transmitted to your smartphone as input to applications that can serve as calorie trackers, heart monitors, glucose monitors, and pedometers.

### Local Area Networks

#### local area network (LAN):

A network that connects computer systems and devices within a small area, such as an office, home, or several floors in a building.

A network that connects computer systems and devices within a small area, such as an office, home, or several floors in a building is a **local area network (LAN)**. Typically, LANs are wired into office buildings and factories, as shown in Figure 7.4. Although LANs often use unshielded twisted-pair copper wire, other media—including fiber-optic cable—is also popular. Increasingly, LANs use some form of wireless communications. You can build LANs to connect personal computers, laptop computers, or powerful mainframe computers.



**FIGURE 7.4**  
**Typical LAN**

All network users within an office building can connect to each other's devices for rapid communication. For instance, a user in research and development could send a document from her computer to be printed at a printer located in the desktop publishing center. Most computer labs employ a LAN to enable the users to share the use of high-speed and/or color printers and plotters as well as to download software applications and save files.

A basic type of LAN is a simple peer-to-peer network that a small business might use to share files and hardware devices, such as printers. In a peer-to-peer network, you set up each computer as an independent computer, but you let other computers access specific files on its hard drive or share its printer. These types of networks have no server. Instead, each computer is connected to the next machine. Examples of peer-to-peer networks include ANts, BitTorrent, StealthNet, Tixati, and Windows 10 Homegroup. Performance of the computers on a peer-to-peer network is usually slower because one computer is actually sharing the resources of another computer.

Increasingly, home and small business networks are being set up to connect computers, printers, scanners, and other devices. A person working on

one computer on a home network, for example, can use data and programs stored on another computer's hard disk. In addition, several computers on the network can share a single printer.

### **Metropolitan Area Networks**

#### **metropolitan area network**

**(MAN):** A network that connects users and their computers in a geographical area that spans a campus or city.

A **metropolitan area network (MAN)** is a network that connects users and their computers in a geographical area that spans a campus or city. A MAN might redefine the many networks within a city into a single larger network or connect several LANs into a single campus MAN. Often, the MAN is owned either by a consortium of users or by a single network provider who sells the service to users. Examples of a MAN include a MAN to interconnect police stations or a related group of community colleges spread over a city or county.

### **Wide Area Networks**

#### **wide area network (WAN):**

A network that connects large geographic regions.

A **wide area network (WAN)** is a network that connects large geographic regions. A WAN might be privately owned or rented and includes public (shared-users) networks. When you make a long-distance phone call or access the Internet, you are using a WAN. WANs usually consist of computer equipment owned by the user, together with data communications equipment and network links provided by various carriers and service providers. Bank of America, JP Morgan Chase, and Wells Fargo all rely on a wide area network to connect their thousands of branches across the United States.

WANs often provide communications across national borders, which involves national and international laws regulating the electronic flow of data across international boundaries, often called transborder dataflow. Some countries have strict laws limiting the use of networks and databases, making normal business transactions such as payroll processing costly, slow, or even impossible.

### **Channel Bandwidth**

**channel bandwidth:** The capacity of a communications channel to carry traffic, usually measured in megabits bits per second (Gbps).

Network professionals consider the capacity of the communications path or channel when they recommend transmission media for a network. **Channel bandwidth** refers to the capacity of a communications channel to carry traffic, usually measured in megabits bits per second (one million bits per second, abbreviated Gbps). The higher the bandwidth the more traffic that can be carried (e.g. more simultaneous conversations). Most organizations need high bandwidth to accommodate the transaction volume and transmission speed required to carry out their daily functions. A higher bandwidth means that more traffic can be carried (e.g. more simultaneous conversations). It does not imply how fast that communication will take place (although if you attempt to put more traffic over a network than the available bandwidth, you'll get packets of data being discarded and re-transmitted later, which will degrade your performance).

### **Network Latency**

**network latency:** A measurement of how long it takes for a unit of data to get to its destination and back again.

**Network latency** measures how long it takes for a unit of data to get to its destination and back again. It is typically measured in milliseconds (ms) or thousandths of a second. Network connections in which small delays occur are called low-latency networks (e.g. 4G cellular network with latency of 60 ms) whereas network connections that experience long delays are called high-latency networks (e.g. satellite network with latency of 800 ms). High latency creates bottlenecks in any network communication. Network latency is affected by the distance between the sender and receiver, the transmission medium used, the number and speed of intermediate switches and/or routers through which the communications must pass, and other factors.

## Communications Media

The communications media selected for a network depends on the amount of information to be exchanged, the speed at which data must be exchanged, the level of concern about data privacy, whether the users are stationary or mobile, and a variety of business requirements. Transmission media can be divided into two broad categories guided (also called wired) transmission media, in which communications signals are guided along a solid medium, and wireless, in which the communications signal is broadcast over airwaves as a form of electromagnetic radiation.

### Guided Transmission Media Types

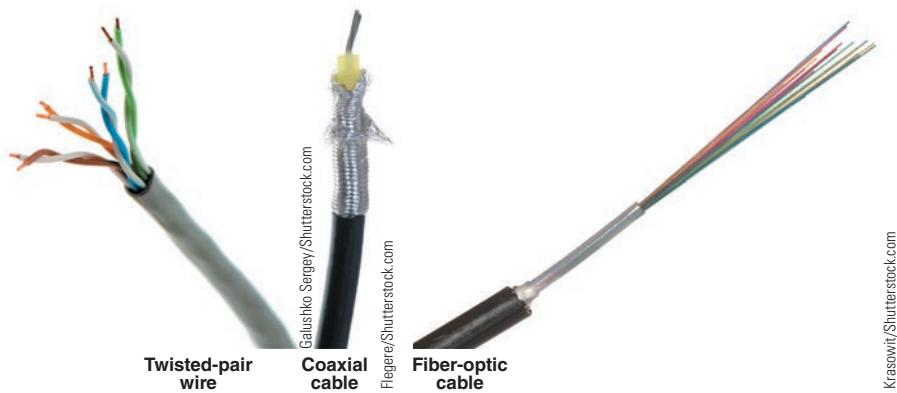
There are many different guided transmission media types. Table 7.1 summarizes the guided media types by physical media form. The three most common guided transmission media types are shown in Figure 7.5.

**TABLE 7.1** Guided transmission media types

Media Form	Description	Advantages	Disadvantages
Twisted-pair wire	Twisted pairs of copper wire, shielded or unshielded; used for telephone service	Widely available	Limitations on transmission speed and distance
Coaxial cable	Inner conductor wire surrounded by insulation	Cleaner and faster data transmission than twisted-pair wire	More expensive than twisted-pair wire
Fiber-optic cable	Many extremely thin strands of glass bound together in a sheathing; uses light beams to transmit signals	Diameter of cable is much smaller than coaxial cable; less distortion of signal; capable of high transmission rates	Expensive to purchase and install

**FIGURE 7.5**  
Types of guided transmission media

Common guided transmission media include twisted-pair wire, coaxial cable, and fiber-optic cable.



10-Gigabit Ethernet is a standard for transmitting data at the speed of 10 billion bps for limited distances over high-quality twisted-pair wire. The 10-Gigabit Ethernet cable can be used for the high-speed links that connect groups of computers or to move data stored in large databases on large computers to stand-alone storage devices.

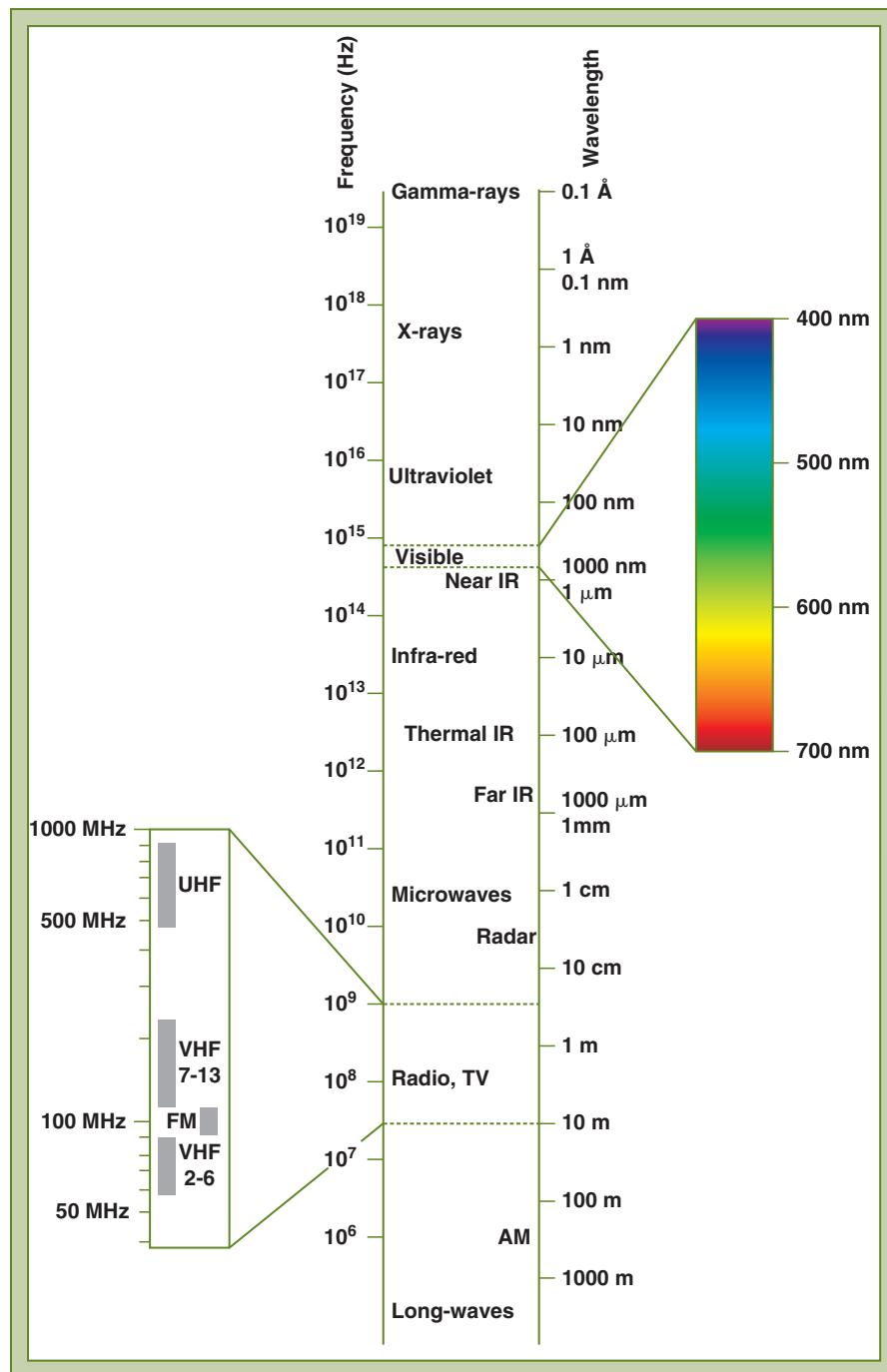
### Wireless Transmission

Wireless communications coupled with the Internet are revolutionizing how and where we gather and share information, collaborate in teams, listen to music or watch video, and stay in touch with our families and coworkers while

on the road. With wireless capability, a coffee shop can become our living room and the bleachers at a ballpark can become our office. The many advantages and freedoms provided by wireless communications are causing many organizations to consider moving to an all-wireless environment.

**wireless communication:** The transfer of information between two or more points that are not connected by an electrical conductor.

**Wireless communication** is the transfer of information between two or more points that are not connected by an electrical conductor. All wireless communications signals are sent within a range of frequencies of the electromagnetic spectrum that represents the entire range of light that exists from long waves to gamma rays as shown in Figure 7.6.



**FIGURE 7.6**  
**The electromagnetic spectrum**

The range of all possible frequencies of electromagnetic radiation.

Source: <https://upload.wikimedia.org/wikipedia/commons/2/25/Electromagnetic-Spectrum.svg>.

The propagation of light is like waves crossing an ocean. Like any other wave, light has two fundamental properties that describe it. One is its frequency, measured in hertz (Hz), which counts the number of waves that pass by a stationary point in one second. The second fundamental property is wavelength, which is the distance from the peak of one wave to the peak of the next. These two attributes are inversely related so the higher the frequency, the shorter the wavelength.

All wireless communication devices operate in a similar way. A transmitter generates a signal, which contains encoded voice, video, or data at a specific frequency, that is broadcast into the environment by an antenna. This signal spreads out in the environment, with only a very small portion being captured by the antenna of the receiving device, which then decodes the information. Depending on the distance involved, the frequency of the transmitted signal, and other conditions, the received signal can be incredibly weak, perhaps one trillionth of the original signal strength.

The signals used in wireless networks are broadcast in one of three frequency ranges: microwave, radio, and infrared, as shown in Table 7.2.

**TABLE 7.2** Frequency ranges used for wireless communications

Technology	Description	Advantages	Disadvantages
Radio frequency range	Operates in the 3 kHz–300 MHz range	Supports mobile users; costs are dropping	Signal is highly susceptible to interception
Microwave—terrestrial and satellite frequency range	High-frequency radio signal (300 MHz–300 GHz) sent through the atmosphere and space (often involves communications satellites)	Avoids cost and effort to lay cable or wires; capable of high-speed transmission	Must have unobstructed line of sight between sender and receiver; signal is highly susceptible to interception
Infrared frequency range	Signals in the 300 GHz–400 THz frequency range	Let's you move, remove, and install devices without expensive wiring	Must have unobstructed line of sight between sender and receiver; transmission is effective only for short distances

Because there are so many competing uses for wireless communication, strict rules are necessary to prevent one type of transmission from interfering with the next. And because the spectrum is limited—there are only so many frequency bands—governments must oversee appropriate licensing of this valuable resource to facilitate use in all bands. In the United States, the Federal Communications Commission (FCC) decides which frequencies of the communications spectrum can be used for which purposes. For example, the portion of the electromagnetic spectrum between 700 MHz and 2.6 GHz has been allocated for use by mobile phones. Most of the spectrum in this range has already been allocated for use. This means that when a wireless company wants to add more spectrum to its service to boost its capacity, it may have problems obtaining the necessary licenses because other companies are already using the available frequencies.

Some of the more widely used wireless communications options are discussed next.

**Near field communication (NFC)** is a very short-range wireless connectivity technology that enables two devices placed within a few inches of each other to exchange data. With NFC, consumers can swipe their credit cards—or

#### near field communication (NFC)

**(NFC):** A very short-range wireless connectivity technology that enables two devices placed within a few inches of each other to exchange data.

even their smartphones—within a few inches of NFC point-of-sale terminals to pay for purchases. Apple Pay, the mobile payment and digital wallet service that lets users make payments using an iPhone, an iPad, or an Apple Watch-compatible device, uses NFC to communicate between the user's device and the point-of-sale terminal.

Many retailers—including Target, Macys, and Walgreens—already have NFC-based contactless pay terminals in place. Shoppers in these stores can also use their smartphones and NFC to gain access to loyalty programs to earn points, view marketing information, and share content and interact with brands via social media.

**Bluetooth:** A wireless communications specification that describes how cell phones, computers, faxes, printers, and other electronic devices can be interconnected over distances of 10 to 30 feet at a rate of about 2 Mbps.

**Wi-Fi:** A medium-range wireless communications technology brand owned by the Wi-Fi Alliance.

**Bluetooth** is a wireless communications specification that describes how cell phones, computers, printers, and other electronic devices can be interconnected over distances of 10 to 30 feet at a transmission rate of about 2 Mbps. Using Bluetooth technology, users of multifunctional devices can synchronize data on their device with information stored in a desktop computer, send or receive faxes, and print. The Bluetooth G-Shock watch enables you to make a connection between your watch and your smartphone. With a G-shock watch, you can control your phone's music player from the watch and the watch's timekeeping functions from your phone.

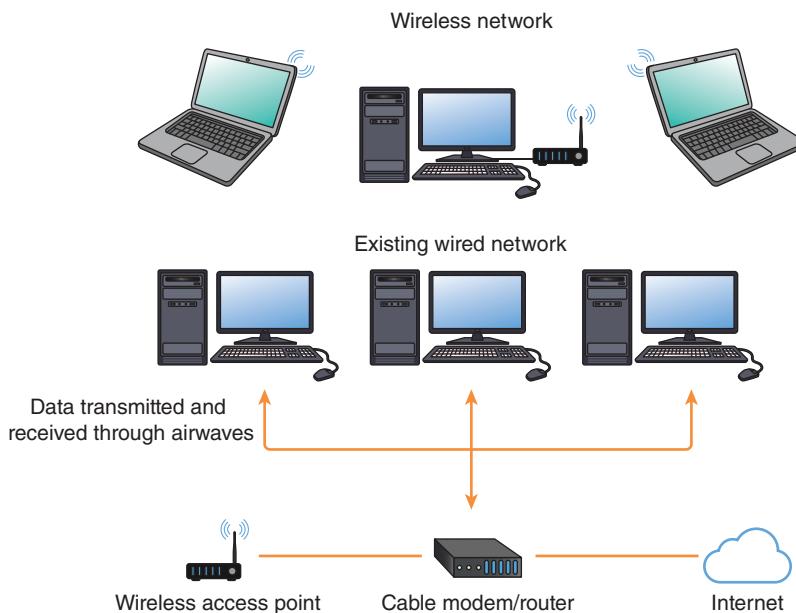
**Wi-Fi** is a wireless network brand owned by the Wi-Fi Alliance, which consists of about 300 technology companies, including AT&T, Dell, Microsoft, Nokia, and Qualcomm. The alliance exists to improve the interoperability of wireless local area network products based on the IEEE 802.11 series of communications standards. IEEE stands for the Institute of Electrical and Electronics Engineers, a nonprofit organization and one of the leading standards-setting organizations. Table 7.3 summarizes several variations of the IEEE 802.11 standard.

**TABLE 7.3** IEEE 802.11 wireless local area networking standards

Wireless Networking Protocol	Maximum Data Rate per Data Stream	Comments
IEEE 802.11a	54 Mbps	Transmits at 5 GHz, which means it is incompatible with 802.11b and 802.11g
IEEE 802.11b	11 Mbps	First widely accepted wireless network standard and transmits at 2.4 GHz; equipment using this protocol may occasionally suffer from interference from microwave ovens, cordless telephones, and Bluetooth devices
IEEE 802.11g	54 Mbps	Equipment using this protocol transmits at 2.4 GHz and may occasionally suffer from interference from microwave ovens, cordless telephones, and Bluetooth devices
IEEE 802.11n	300 Mbps	Employs multiple input, multiple output (MIMO) technology, which allows multiple data streams to be transmitted over the same channel using the same bandwidth that is used for only a single data stream in 802.11a/b/g
IEEE 802.11ac	400 Mbps–1.3 Gbps	An 802.11 standard that provides higher data transmission speeds and more stable connections; it can transmit at either 2.4 GHz or 5 GHz

In a Wi-Fi wireless network, the user's computer, smartphone, or other mobile device has a wireless adapter that translates data into a radio signal and transmits it using an antenna. A wireless access point, which consists of a transmitter with an antenna, receives the signal and decodes it. The access point then sends the information to the Internet over a wired connection.

See Figure 7.7. When receiving data, the wireless access point takes the information from the Internet, translates it into a radio signal, and sends it to the device's wireless adapter. These devices typically come with built-in wireless transmitters and software to enable them to alert the user to the existence of a Wi-Fi network. The area covered by one or more interconnected wireless access points is called a “hot spot.” Wi-Fi has proven so popular that hot spots are popping up in places such as airports, coffee shops, college campuses, libraries, and restaurants. The availability of free Wi-Fi within a hotel's premises has become very popular with business travelers. Meanwhile, hundreds of cities in the United States have implemented municipal Wi-Fi networks for use by meter readers and other municipal workers and to provide Internet access to their citizens and visitors.



**FIGURE 7.7**  
**Wi-Fi network**

In a Wi-Fi network, the user's computer, smartphone, or cell phone has a wireless adapter that translates data into a radio signal and transmits it using an antenna.

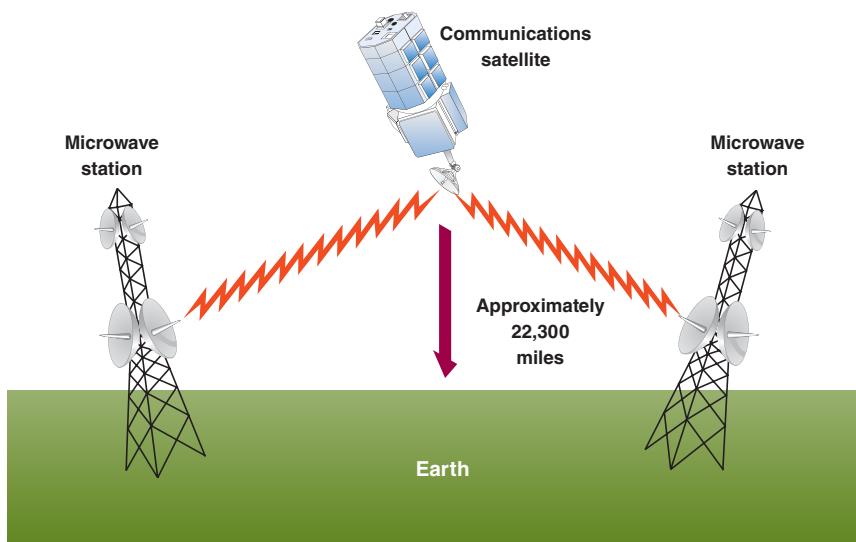
### Microwave Transmission

Microwave is a high-frequency (300 MHz to 300 GHz) signal sent through the air. Terrestrial (Earth-bound) microwaves are transmitted by line-of-sight devices, so the line of sight between the transmitter and receiver must be unobstructed. Typically, microwave stations are placed in a series—one station receives a signal, amplifies it, and retransmits it to the next microwave transmission tower. Such stations can be located roughly 30 miles apart before the curvature of the Earth makes it impossible for the towers to “see” one another. Because they are line-of-sight transmission devices, microwave dishes are frequently placed in relatively high locations, such as mountains, towers, or tall buildings.

A communications satellite also operates in the microwave frequency range. See Figure 7.8. The satellite receives the signal from the Earth station, amplifies the relatively weak signal, and then rebroadcasts it at a different frequency. The advantage of satellite communications is that satellites can receive and broadcast over large geographic regions. Problems such as the curvature of the Earth, mountains, and other structures that block the line-of-sight microwave transmission make satellites an attractive alternative. Geostationary, low earth orbit, and small mobile satellite stations are the most common forms of satellite communications.

**FIGURE 7.8**  
**Satellite transmission**

Communications satellites are relay stations that receive signals from one Earth station and rebroadcast them to another.



A geostationary satellite orbits the Earth directly over the equator, approximately 22,300 miles above the Earth, so that it appears stationary. The U.S. National Weather Service relies on the Geostationary Operational Environmental Satellite program for weather imagery and quantitative data to support weather forecasting, severe storm tracking, and meteorological research.

Google's Project Loon plans to launch a series of hot air balloons into the upper atmosphere about 12 miles above the Earth's surface. From there, they'll beam down a signal to network stations on the Earth's surface. The primary goal is to provide world-wide Internet access to everyone, everywhere. But the project will also enable cell phone service and Internet access to relief workers and inhabitants in disaster areas until local sources are available again. This approach is like launching geostationary satellites, but much cheaper.<sup>4</sup>

#### 4G Wireless Communications

Wireless communications have evolved through four generations of technology and services and is now entering a fifth generation. The first generation (1G) of wireless communications standards originated in the 1980s and was based on analog communications. The second-generation (2G) networks were fully digital, superseding 1G networks in the early 1990s. With 2G networks, phone conversations were encrypted, mobile phone usage was expanded, and short message services (SMS)—or texting—was introduced. 3G wireless communications supports wireless voice and broadband speed data communications in a mobile environment at speeds of 2 to 4 Mbps. Additional capabilities include mobile video, mobile e-commerce, location-based services, mobile gaming, and the downloading and playing of music.

4G broadband mobile wireless delivers more advanced versions of enhanced multimedia, smooth streaming video, universal access, and portability across all types of devices; eventually 4G will also make possible worldwide roaming. 4G can deliver 3 to 20 times the speed of 3G networks for mobile devices such as smartphones, tablets, and laptops.

Each of the four major U.S. wireless network operators (AT&T, Verizon, Sprint, and T-Mobile) is rapidly expanded its 4G networks based on the Long Term Evolution (LTE) standard. **Long Term Evolution (LTE)** is a standard for wireless communications for mobile phones based on packet switching, which is an entirely different approach from the circuit-switching approach employed in 3G communications networks. To convert to the LTE standard, carriers had to reengineer their voice call networks.

The biggest benefit of LTE is how quickly a mobile device can connect to the Internet and how much data it can download or upload in a given amount of time. LTE makes it reasonable to stream video to your phone, using services

#### Long Term Evolution (LTE):

A standard for wireless communications for mobile phones based on packet switching.

such as Amazon Prime Instant Video, Hulu Plus, Netflix, or YouTube. It also speeds up Web browsing, with most pages loading in seconds. LTE enables video calling using services such as Skype or Google Hangouts. LTE's faster speed also makes sharing photos and videos from your phone quick and easy.

### **5G Wireless Communications**

A new mobile communications generation has come on the scene about every 10 years since the first 1G system. 5G is a term used to identify the next major phase of mobile communications standards beyond 4G. AT&T and Verizon have plans to launch 5G networks in multiple cities by late 2018. T-Mobile plans to build a nationwide 5G network starting in 2019 with full national coverage by 2020. 5G networks will have three advantages over the current 4G networks. First, they will have the bandwidth to transmit more data (on the order of 20 Gbps). At this bandwidth, a two-hour movie can be streamed in less than 3 seconds. Second, they will have lower latency—less than 1 ms compared to 10 ms. This means that data will zip through the network much faster. Third, 5G networks will have the ability to support many more devices (thousands) at one time.

5G networks will enable several exciting new applications. The current generation of autonomous cars are self-contained and make driving decisions based on their knowledge of current traffic and road conditions. Next generation autonomous cars will interact with other vehicles and “smart roads” exchanging information directly with other cars and/or smart devices strategically positioned along the highways. They will use this data to further improve driver safety and overall traffic flow. The sub-millisecond latency of 5G networks will be required to support these brief bursts of data.

Augmented reality (AR) adds a virtual layer over the real world opening the door to a wide range of potential applications. AR can be used to see how it might look if you lost twenty pounds, tried on new clothes, or redecorated your home; help you find friends in a crowd, or get a description of the shops along a street or in a mall without even entering them. The bandwidth, latency, and lack of uniformity (the consistency of mobile connection) of 4G networks greatly limits what can be done with AR and VR. However, 5G networks with a latency of less than 1 ms will greatly improve the AR/VR experience. AR/VR enthusiasts will be able to pair a 5G smartphone with a AR/VR headset complete with a controller that tracks the position and location of your hands to stream VR content and play online VR games wherever they are.

**FIGURE 7.9**  
**New 5g smartphones paired with 5G networks will be able to offer VR experience**

Source: JFCfotografic/Shutterstock.com



5G networks will have some initial drawbacks that must be overcome. More cell towers will be required because 5G cells are not able to broadcast as great a distance as a 3G or 4G cell. Because more cells will need to be installed, 5G users can expect that their coverage may not be as widespread at first. At least initially, 5G devices must be designed to work on both the slower 4G networks and 5G networks. 5G equipment is costly, so deployment and maintenance will be expensive.

## Communications Software

### **network operating system (NOS)**

**(NOS):** Systems software that controls the computer systems and devices on a network and allows them to communicate with each other.

A **network operating system (NOS)** is systems software that controls the computer systems and devices on a network and allows them to communicate with each other. The NOS performs similar functions for the network as operating system software does for a computer, such as memory and task management, and coordination of hardware. When network equipment (such as printers, plotters, and disk drives) is required, the NOS makes sure that these resources are used correctly. Linux (used on workstations), OS X (used on Apple MACs), UNIX (used on servers), and Windows Server (used on workstations and servers) are common network operating systems.

Because companies use networks to communicate with customers, business partners, and employees, network outages or slow performance can mean a loss of business. Network management includes a wide range of technologies and processes that monitor the network and help identify and address problems before they can create a serious impact.

Software tools and utilities are available for managing networks. With **network-management software**, a manager on a networked personal computer can monitor the use of individual computers and shared hardware (such as printers), scan for viruses, and ensure compliance with software licenses. Network-management software also simplifies the process of updating files and programs on computers on the network—a manager can make changes through a communications server instead of having to visit each individual computer. In addition, network-management software protects software from being copied, modified, or downloaded illegally. It can also locate communications errors and potential network problems. Some of the many benefits of network-management software include fewer hours spent on routine tasks (such as installing new software), faster response to problems, and greater overall network control.

Banks use a special form of network-management software to monitor the performance of their automated teller machines (ATMs). Status messages can be sent over the network to a central monitoring location to inform support people about situations such as low cash or receipt paper levels, card reader problems, and printer paper jams. Once a status message is received, a service provider or branch location employee can be dispatched to fix the ATM problem.

Today, most IS organizations use network-management software to ensure that their network remains up and running and that every network component and application is performing acceptably. The software enables IS staff to identify and resolve fault and performance issues before they affect end users. The latest network-management technology even incorporates automatic fixes: The network-management system identifies a problem, notifies the IS manager, and automatically corrects the problem before anyone outside the IS department notices it.

The Covell Group is a small IT consulting group in San Diego that provides server and Web site monitoring for small- and medium-sized companies. The firm uses network-monitoring software to watch sensors and remote probes that track CPU, disk space, and Windows services. Constant monitoring enables the firm to detect if a communications line is down or if there is a power failure overnight so that everything is up and ready by the start of the next work day.<sup>5</sup>

**Mobile device management (MDM) software** manages and troubleshoots mobile devices remotely, pushing out applications, data, patches, and settings. With the software, a central control group can maintain group policies for security, control system settings, ensure malware protection is in place for mobile devices used across the network, and make it mandatory to use passwords to access the network. In addition to smartphones and tablets, laptops and desktops are sometimes supported using MDM software as mobile device management becomes more about basic device management and less about a specific mobile platform.

Jet Story is a Polish private jet airline that offers private jet rental services and professional aircraft purchasing consultancy services, as well as aircraft

### **mobile device management**

**(MDM) software:** Software that manages and troubleshoots mobile devices remotely, pushing out applications, data, patches, and settings while enforcing group policies for security.

maintenance and management. The firm employs around 120 people including 50 pilots and 20 flight attendants.<sup>6</sup> The firm needed to manage and control the iPads that its pilots use on board the aircraft in the cockpits. The specially outfitted iPads, called Electronic Flight Bags, provide pilots access to all necessary documentation and manuals. Jet Story employed mobile device monitoring software to ensure that every device was properly managed, for example, protected with a passcode. The MDM software makes it easy to check the available memory on each device and list all installed applications. This fulfills European Aviation Safety Agent (EASA) regulations by ensuring that pilots always have fully functioning iPads with all the necessary documentation available.<sup>7</sup>

### **Software-Defined Networking (SDN)**

A typical network is comprised of hundreds or thousands of network devices that perform such tasks as routing and switching of data through the network, providing network access and control, and enabling access to a variety of applications and services. In today's current network environment, each network device must be configured individually, usually via manual keyboard input. For a network of any size, this becomes a labor-intensive and error-prone effort, making it difficult to change the network so it can meet the changing needs of the organization.

**Software-defined networking (SDN)** is an emerging approach to networking that allows network administrators to manage a network via a controller that does not require physical access to all the network devices. This approach automates tasks such as configuration and policy management and enables the network to dynamically respond to application requirements. As a result, new applications can be made available sooner, the risk of human error (a major contributor to network downtime) is reduced, and overall network support and operations costs are reduced.

ProMedica is a 13-hospital nonprofit health care organization serving the residents of Indiana, Kentucky, Michigan, Ohio, Pennsylvania, and West Virginia. The organization made a major decision to implement the Epic Electronic Health Record (EHR) system and replace many legacy systems. Since Epic supports almost every health care activity, ProMedica needed to ensure its continuous availability. To achieve this goal, both of ProMedica's data centers, roughly 20 miles apart, were networked together and managed as one to create a fully redundant computing environment. This required a major overhaul of its data center network environment consisting of some 3,500 servers and numerous hubs, switches, and routers. The only practical solution was to convert to an SDN network architecture. Network and data center changes are faster, easier, and less risky with SDN. There is no longer a concern that when one thing is upgraded that something else may be negatively affected. No need to physically go to a network device to make a change thus greatly reducing change management and repair efforts.<sup>8</sup>



### **Critical Thinking Exercise**

#### **Local Hospital Upgrades Network**

##### **► APPLICATION**

Smallville, Kansas is a small farming community of just under 50,000. The community is building an emergency care facility to treat patients with injuries or illnesses requiring immediate care, but not serious enough to require an emergency department visit. The facility will be staffed with enough physicians and nurses to handle a maximum of four patients per hour and 50 patients per day. It will also have a small administrative staff to handle patient record keeping and billing. A local IT consultant was hired to define how to meet the computing and networking needs of the facility. The consultants recommend that a small star local area network be used to connect all six laptop computers, two faxes, and two printers. The devices will connect to the central node of the network using fiber-optic cable. They further

recommend that network-management software be installed so that they can monitor the operation of the network from their offices located across town. Mobile device management software will be installed on all portable computing devices.

### Review Questions

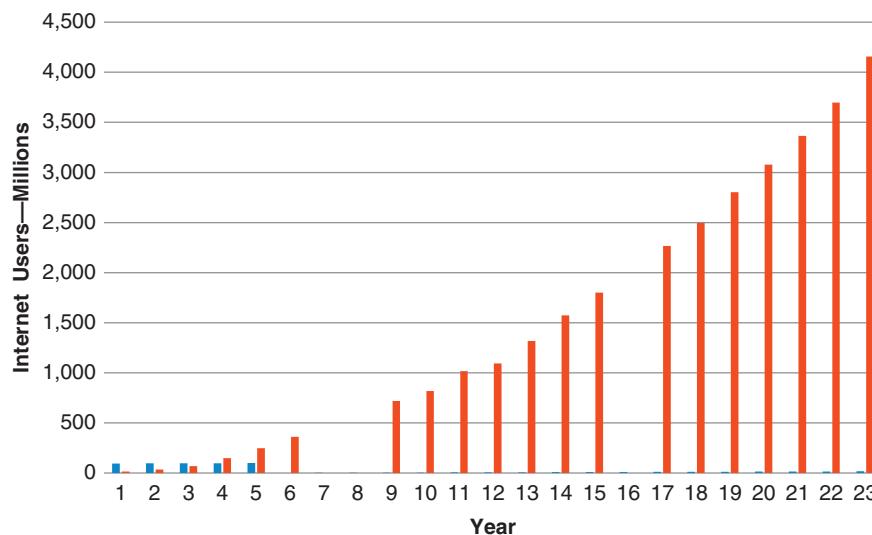
1. What advantages/disadvantages are there in installing a wired, star network to connect all the devices? Would you agree with the IT consultant's recommendation in this regard? Why or why not?
2. What specific benefits would be gained by installing network-management software?

### Critical Thinking Questions

1. Are there any elements of the IT consultant's recommendation that you do not support? If so, which ones and why?
2. What specific suggestions do you have to improve upon the IT consultant's recommendation?

## The Internet and World Wide Web

The Internet has grown rapidly (see Figure 7.10) and is truly international in scope, with users on every continent—including Antarctica. As of November 2015, citizens of Asian countries make up about 49 percent, Europeans about 17 percent, Latin America/Caribbean about 10 percent, and North Americans about 8 percent of all Internet users. China is the country with the most Internet users, with 772 million—which is more users than the next two countries combined (India 462 million and United States 312 million).<sup>9</sup> Being connected to the Internet provides global economic opportunity to individuals, businesses, and countries.



**FIGURE 7.10**  
**Number of Internet users worldwide**

Source: "Internet Growth Statistics," <https://www.internetworldstats.com/emarketing.htm>, accessed September 27, 2018.

The ancestor of the Internet was the ARPANET, a project started by the U.S. Department of Defense (DoD) in 1969. The ARPANET was both an experiment in reliable networking and a means to link DoD and military research contractors, including many universities doing military-funded research. (ARPA stands for the Advanced Research Projects Agency, the branch of the DoD in charge of awarding grant money. The agency is now known as DARPA—the added D is for Defense.) The ARPANET was highly successful, and every university in the country wanted to use it. This wildfire growth made it difficult to manage the

ARPANET, particularly the rapidly growing number of university sites. So, the ARPANET was broken into two networks: MILNET, which included all military sites, and a new, smaller ARPANET, which included all the nonmilitary sites. The two networks remained connected, however, through use of the Internet protocol (IP) which enables traffic to be routed from one network to another as needed. All the networks connected to the Internet use IP, so they all can exchange messages.

## How the Internet Works

In the early days of the Internet, the major communications companies around the world agreed to connect their networks so that users on all the networks could share information over the Internet. The communications media, routers, switches, communication towers, and satellites that make up these networks are the hardware over which Internet traffic flows. The combined hardware of the network service providers form the high-speed communications links that span the globe over land and under sea and make up the **Internet backbone**.

The Internet works by breaking messages into packets of data that are routed through the network until they reach their desired destination as shown in Figure 7.11. The **Transmission Control Protocol/Internet Protocol (TCP/IP)** is a collection of communication protocols used to interconnect network devices on a packet switching network such as the Internet. TCP defines how applications can create channels of communication across a network. TCP also manages how a message is assembled into smaller packets before they are then transmitted over the Internet and reassembled in the proper sequence at the destination address. IP specifies how to address and route each packet to make sure it reaches the desired destination. A network following these standards can link to the Internet's backbone and become part of the worldwide Internet community.

## IP Address and MAC Address

Because the Internet is a global network of computers, each computer connected to the Internet must have a unique address called its IP address. An **IP address** is a 64-bit number that uniquely identifies a computer on the Internet. The IP stands for Internet Protocol. The IP address gets linked to all online activity you do. The 64-bit number is typically divided into four bytes and translated to decimal; for example, 69.32.133.79. The Internet is migrating to Internet Protocol version 6 (IPv6), which uses 128-bit addresses to provide for many more devices.

A network interface card (NIC) is a circuit board or card that is installed into a hardware device so that it can be connected to a network. During the manufacturing process, the manufacturer “burns” a specific MAC address into the read only memory (ROM) of each network card.

## Network Hardware

The terms switch and router are often used interchangeably, but these devices each perform different functions as will now be discussed.

The **switch** is a network device that keeps a record of the MAC (Media Access Control) address of all the devices connected to it and uses this information to determine to which port a frame of data should be directed. When a switch receives a packet, it knows exactly which port to send it to, with no significant increase in network response times. Networks today use switches to connect computers, printers, phones, cameras, lights, and servers in a building or campus.

The **router** is a network device that directs data packets to other networks until each packet reaches its destination. One of the key features of a data packet is that it not only contains data, but also the destination address of where it's going. The information needed to get data packets to their

**Internet backbone:** One of the Internet's high-speed, long-distance communications links.

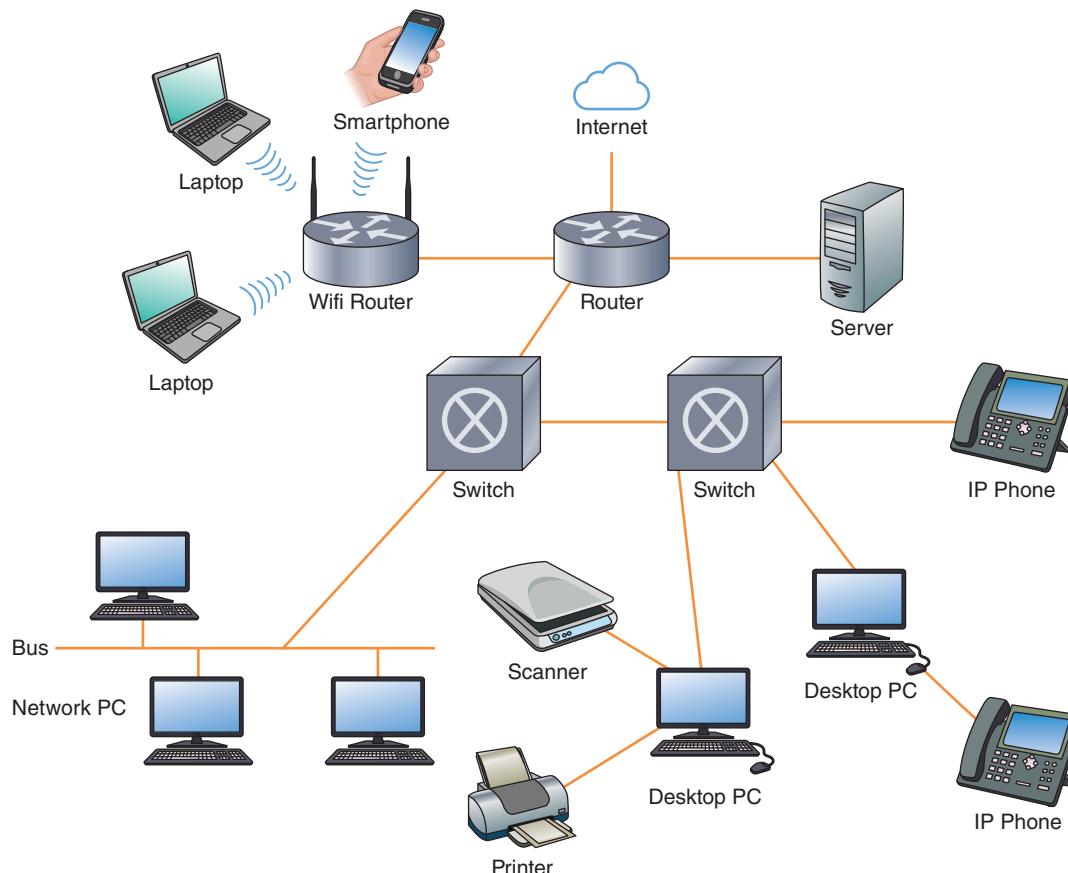
**Transmission Control Protocol/Internet Protocol (TCP/IP):** A collection of communication protocols used to interconnect network devices on packet switching networks such as the Internet.

**IP address:** A 64-bit number that identifies a computer on the Internet.

**switch:** is a network device that keeps a record of the MAC (Media Access Control) address of all the devices connected to it and uses this information to determine to which port a frame of data should be directed.

**router:** A network device that directs data packets to other networks until each packet reaches its destination.

destinations is stored in routing tables maintained by each router connected to the Internet. A router usually connects two different networks and routes data packets between them. Each router knows about its subnetworks and which IP addresses they use. The largest and most powerful network routers form the Internet backbone.



**FIGURE 7.11**  
**How the Internet works**

Data is transmitted from one host computer to another on the Internet.

### Routing

Routers in the network obtain the destination address from each data packet header and find it in their lookup table. The lookup table specifies the next router to which to send the packet to move it one step closer to its destination. However, the routers are programmed to “look ahead” and balance the data transmission load across the various network devices on a millisecond-by-millisecond basis. If there are too many packets of data following a given path, the router will choose an alternate path. The routers are even able to detect if there is a problem with one piece of equipment in the network and re-route the data packets around the problem. This will ensure the eventual delivery of the entire message. It is entirely possible that because of this dynamic routing, packets may arrive at the destination device out of order. So once the packets arrive at their destination, that device strips off the header and trailer information and reassembles the entire message based on the numbered sequence of the packets.

## Accessing the Internet

You can connect to the Internet in numerous ways. Which access method you choose is determined by where you are located and the equipment and services available to you.

### Connecting via Internet Service Providers

#### **Internet service provider (ISP):**

Any organization that provides Internet access to people.

Users in organizations or at home access the Internet through an **Internet service provider**, an organization that provides Internet access to people. Thousands of organizations serve as ISPs, ranging from universities that make the Internet available to students and faculty to small Internet businesses to major communications giants such as AT&T and Comcast. To connect to the Internet through an ISP, you must have an account with the service provider (for which you usually pay) along with software (such as a browser) and devices (such as a computer or smartphone) that support a connection via TCP/IP.

Several high-speed Internet services are available for home and business. They include cable modem connections from cable television companies, DSL connections from phone companies, and satellite connections from satellite television companies.

### Wireless Connection

In addition to connecting to the Internet through wired systems such as phone lines and fiber optic cables, wireless Internet service over cellular and Wi-Fi networks has become common. Thousands of public Wi-Fi services are available in coffee shops, airports, hotels, and elsewhere, where Internet access is provided free, for an hourly rate, or for a monthly subscription fee. Wi-Fi has even made its way into aircraft, allowing business travelers to be productive during air travel by accessing email and corporate networks.

Cell phone carriers also provide Internet access for smartphones, notebooks, and tablets. The 4G mobile phone services rival wired high-speed connections used at home and work. The major wireless communications companies including AT&T, Sprint, T-Mobile, and Verizon have brought nearly total 4G service to subscribers in populated areas of the U.S.

## How The World Wide Web Works

The World Wide Web was developed by Tim Berners-Lee at CERN, the European Organization for Nuclear Research in Geneva. He originally conceived of it as an internal document-management system. From this modest beginning, the Web has grown to become a primary source of news and information, an indispensable conduit for commerce, and a popular hub for social interaction, entertainment, and communication.

While the terms Internet and Web are often used interchangeably, technically, the two are different technologies. The Internet is the infrastructure on which the Web exists. The Internet is made up of computers, network hardware such as switches, routers, communications media, software, and the TCP/IP protocols. The World Wide Web (Web), on the other hand, consists of server and client software, the hypertext transfer protocol (http), standards, and markup languages that combine to deliver information and services over the Internet.

## Client/Server Architecture

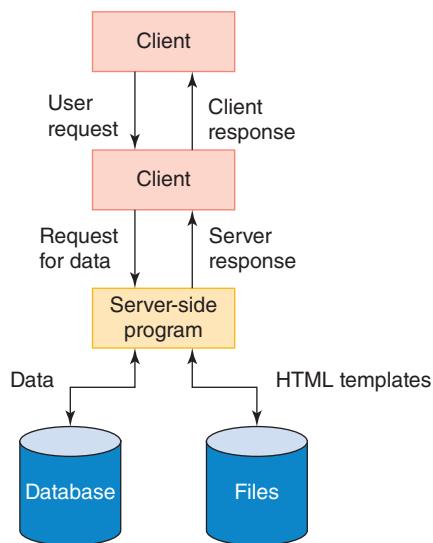
**client/server architecture:** This is a networking approach wherein many clients (end-user computing devices) request and receive services from servers (host computers) on the network.

**Client/server architecture**, is a networking approach wherein many clients (end-user computing devices) request and receive services from servers (host computers) on the network. Servers receive client user requests, process them, and obtain the requested data. This may require queries to a database and encoding

the data into the HTML format. This is the computing model that is employed to support the Web. Figure 7.12 illustrates this client/server architecture.

The client computers provide an interface to allow the client computer user to request services of the server computers. The client computers also display the results (Web pages) that the servers return. JavaScript, VBA Script, HTML, CSS, and Ajax are among other widely used client-side programming languages.

Server-side programming creates a program that runs on the server and deals with generation of the content of a Web page to satisfy the client's request. The Web site uses server-side programming to dynamically display different data as needed. The data is pulled from a database stored on the server and sent to the client to be displayed by client-side code. Server-side programming enables Web site designers to customize Web site content for individual users. Online shopping Web sites such as Amazon use server-side programming to make customer recommendations based on customer preferences and previous purchases. Social media Web sites like Facebook use server-side programming to highlight, share, and control access to content deemed interesting to the user. PHP, C++, Java, Python, and Ruby on Rails are among the most widely used server-side programming languages.



**FIGURE 7.12**  
**Client/Server Architecture**

**domain name system:** A system that maps the name people use to locate a website to the IP address that a computer uses to locate a website.

**Uniform Resource Locator (URL):** A Web address that specifies the exact location of a Web page using letters and words that map to an IP address and a location on the host.

### Domain Name System (DNS)

The **domain name system** maps the name people use to locate a Web site to the IP address that a computer uses to locate a Web site. For example, if you type *TechTarget.com* into a Web browser, a server behind the scenes will map that name to the IP address 206.19.49.149.

A **Uniform Resource Locator (URL)** is a Web address that specifies the exact location of a Web page using letters and words that map to an IP address and a location on the host. The URL gives those who provide information over the Internet a standard way to designate where Internet resources such as servers and documents are located. Consider the URL for Cengage Learning, <http://www.cengage.com/us>.

The “http” specifies the access method and tells your software to access a file using the Hypertext Transport Protocol. This is the primary method for interacting with the Internet. In many cases, you don’t need to include http:// in a URL because it is the default protocol. The “www” part of the address

sometimes signifies that the address is associated with the World Wide Web service. The URL *www.cengage.com* is the domain name that identifies the Internet host site. The part of the address following the domain name—/us—specifies an exact location on the host site.

Domain names must adhere to strict rules. They always have at least two parts, with each part separated by a dot (period). For some Internet addresses, the far-right part of the domain name is the country code, such as au for Australia, ca for Canada, dk for Denmark, fr for France, de (Deutschland) for Germany, and jp for Japan. Many Internet addresses have a code denoting affiliation categories, such as com for business sites and edu for education sites. Table 7.4 contains a few popular domain affiliation categories. The far-left part of the domain name identifies the host network or host provider, which might be the name of a university or business. Other countries use different top-level domain affiliations from the U.S. ones described in the table.

**TABLE 7.4** Number of domains in U.S. top-level domain affiliations

Affiliation ID	Affiliation
Biz	Business sites
Com	All types of entities including nonprofits, schools, and private individuals
Edu	Post-secondary educational sites
Gov	Government sites
Net	Networking sites
Org	Nonprofit organization sites

SOURCE: Domain Count Statistics for TLDs, <http://research.domaintools.com/statistics/tld-counts>.

The Internet Corporation for Assigned Names and Numbers (ICANN) is responsible for managing IP addresses and Internet domain names. One of ICANN's primary concerns is to make sure that each domain name represents only one individual or entity—the one that legally registers it. For example, if your teacher wanted to use *www.cengage.com* for a course Web site, he or she would discover that domain name has already been registered by Cengage Learning and is not available. ICANN uses companies called accredited domain name registrars to handle the business of registering domain names. For example, you can visit *www.namecheap.com*, an accredited registrar, to find out if a particular name has already been registered. If not, you can register the name for around \$9 per year. Once you do so, ICANN will not allow anyone else to use that domain name as long as you pay the yearly fee.

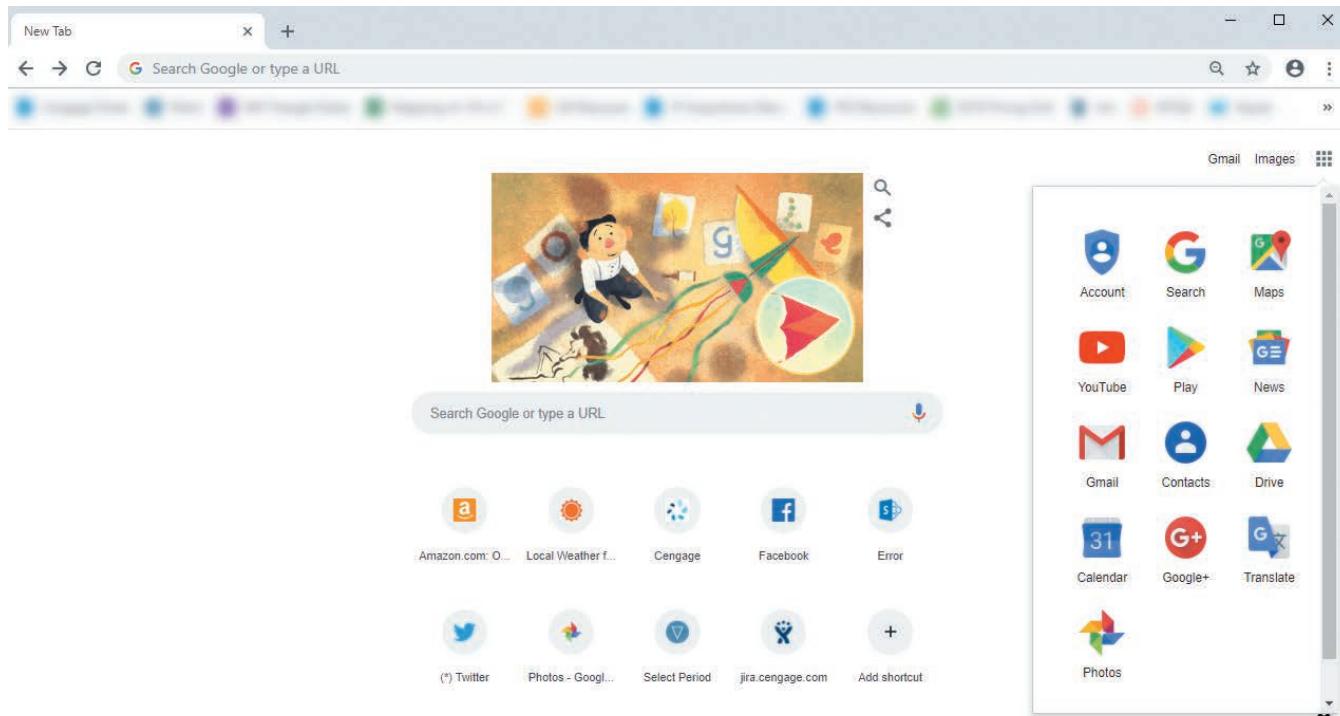
### Hyperlinks

The Web was designed to make information easy to find and organize. It connects billions of documents, called Web pages, stored on millions of servers around the world. Web pages are connected to each other using **hyperlinks**, specially denoted text or graphics on a Web page, that, when clicked, open a new Web page containing related content. Using hyperlinks, users can jump between Web pages stored on various Web servers—creating the illusion of interacting with one big computer. Because of the vast amount of information available on the Web and the wide variety of media, the Web has become the most popular means of accessing information in the world today.

**hyperlink:** Highlighted text or graphics in a Web document that, when clicked, opens a new Web page containing related content.

**Web browser:** Web client software—such as Chrome, Edge, Firefox, Internet Explorer, and Safari—used to view Web pages.

In short, the Web is a hyperlink-based system that uses the client/server model. It organizes Internet resources throughout the world into a series of linked files, called pages, which are accessed and viewed using Web client software called a **Web browser** or just browser. Google Chrome, Mozilla Firefox, Microsoft Edge, Internet Explorer, Apple Safari, and Opera are popular Web browsers. See Figure 7.13. A collection of pages on one particular topic, accessed under one Web domain, is called a Web site. The Web was originally designed to support formatted text and pictures on a page. It has evolved to support many more types of information and communication including animation, games, social media, and video. Web plug-ins help provide additional features to standard Web sites. Adobe Flash and Real Player are examples of Web plug-ins.



**FIGURE 7.13**  
**Google Chrome**

Web browsers such as Google Chrome let you access Internet resources such as email and other online applications.  
Source: Google, Inc.

**Hypertext Markup Language (HTML)**  
**(HTML):** The standard page description language for Web pages.

**HTML tag:** A code that tells the Web browser how to format text—as a heading, as a list, or as body text—and whether images, sound, and other elements should be inserted.

### Hypertext Markup Language (HTML)

**Hypertext Markup Language (HTML)** is the standard page description language for Web pages. HTML is defined by the World Wide Web Consortium (referred to as “W3C”) and has developed through numerous revisions. It is currently in its fifth revision—HTML5. HTML tells the browser how to display font characteristics, paragraph formatting, page layout, image placement, hyperlinks, and the content of a Web page. HTML uses **HTML tags**, also called tags, which are codes that tell the browser how to format the text or graphics as a heading, list, or body text, for example.

Web site creators “mark up” a page by placing HTML tags before and after one or more words. For example, to have the browser display a sentence as a heading, you place the `<h1>` tag at the start of the sentence and an `</h1>` tag at the end of the sentence. When that page is viewed in a browser,

the sentence is displayed as a heading. HTML also provides tags to import objects stored in files—such as photos, graphics, audio, and movies—into a Web page. In short, a Web page is made up of three components: text, tags, and references to files. The text is your Web page content, the tags are codes that mark the way words will be displayed, and the references to files insert photos and media into the Web page at specific locations. All HTML tags are enclosed in a set of angle brackets (< and >), such as <h2>. The closing tag has a forward slash in it, such as </b> for closing bold. Consider the following text and tags.

**Extensible Markup Language (XML):** The markup language designed to transport and store data on the Web.

### **Extensible Markup Language (XML)**

**Extensible Markup Language (XML)** is a markup language for Web documents containing structured information, including words and pictures. XML does not have a predefined tag set. With HTML, for example, the tag always means a first-level heading. The content and formatting are contained in the same HTML document. XML Web documents contain the content of a Web page. The formatting of the content is contained in a style sheet. A few typical instructions in XML follow:

```
<book>
<chapter>Hardware</chapter>
<topic>Input Devices</topic>
<topic>Processing and Storage Devices</topic>
<topic>Output Devices</topic>
</book>
```

### **Cascading Style Sheet (CSS)**

**Cascading Style Sheet (CSS):** A markup language for defining the visual design of a Web page or group of pages.

A **Cascading Style Sheet (CSS)** is a file or portion of an HTML file that defines the visual appearance of content in a Web page. Using CSS is convenient because you only need to define the technical details of the page's appearance once, rather than in each HTML tag. CSS uses special HTML tags to globally define characteristics for a variety of page elements as well as how those elements are laid out on the Web page. Rather than having to specify a font for each occurrence of an element throughout a document, formatting can be specified once and applied to all occurrences. CSS styles are often defined in a separate file and then can be applied to many pages on a Web site.

For example, the visual appearance of the preceding XML content could be contained in the following style sheet:

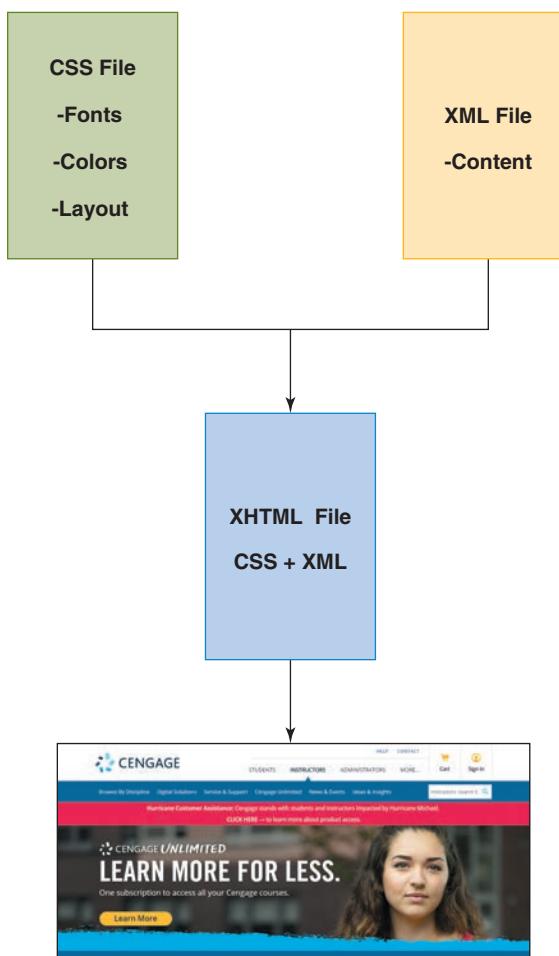
```
chapter (font-size 18pt; color blue; font-weight bold;
display block; font-family Arial;
margin-top 10pt; margin-left 5pt)
topic (font-size 12pt; color red; font-style italic;
display block; font-family Arial;
margin-left 12pt)
```

This style sheet specifies that the chapter title “Hardware” is displayed on the Web page in a large Arial font (18 points). “Hardware” will also appear in bold blue text. The “Input Devices” title will appear in a smaller Arial font (12 points) and italic red text.

XML is extremely useful for organizing Web content and making data easy to find. Many Web sites use CSS to define the design and layout of Web pages, XML to define the content, and HTML to join the design (CSS) with the content (XML). See Figure 7.14. This modular approach to Web design allows Web site developers to change the visual design without affecting the content and to change the content without affecting the visual design.

**FIGURE 7.14**  
**XML, CSS, and HTML**

Today's Web sites are created using XML to define content, CSS to define the visual style, and HTML to put it all together.



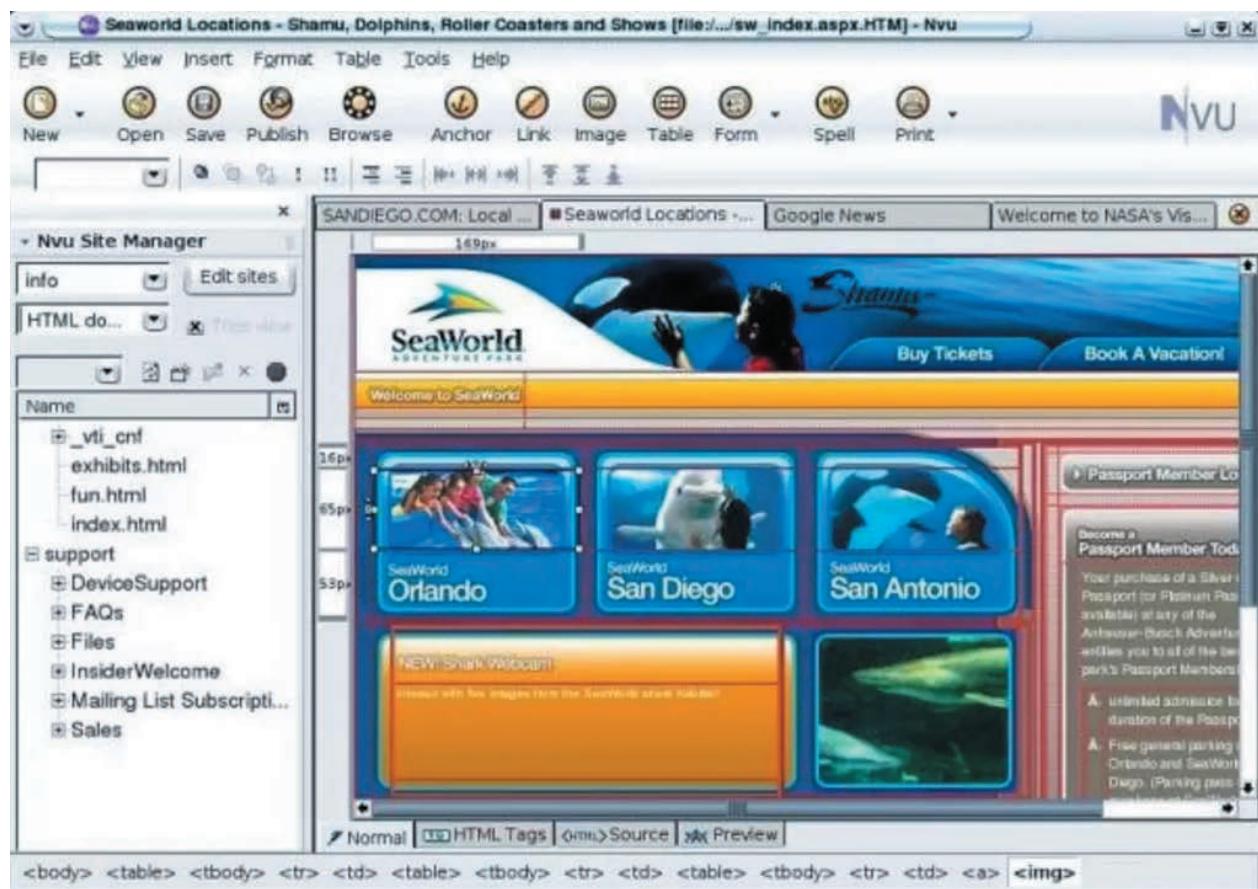
## Developing Web Content and Applications

If you need to create a Web site, you have many options. You can hire someone to design and build it, or you can do it yourself. If you do it yourself, you can use an online service to create the Web pages, use a Web page creation software tool, or use a plain text editor to create the site.

Popular tools for creating Web pages and managing Web sites include Adobe Dreamweaver, RapidWeaver (for Mac developers), and Nvu (pronounced n-view). See Figure 7.15. Today's Web development applications allow developers to create Web sites using software that resembles a word processor. The software includes features that allow the developer to work directly with the HTML code or to use auto-generated code. Web development software also helps the designer keep track of all files in a Web site and the hyperlinks that connect them.

Many products make it easy to develop Web content and interconnect Web services, as discussed in the next section. Microsoft, for example, provides a development and Web services platform called .NET, which allows developers to use various programming languages to create and run programs, including those for the Web. The .NET platform also includes a rich library of programming code to help build XML Web applications. Other popular Web development platforms include JavaServer Pages, Microsoft ASP.NET, and Adobe ColdFusion.

After you create Web pages, your next step is to place or publish the content on a Web server. Popular publishing options include using ISPs, free sites, and Web hosting services. Web hosting services provide space on their Web servers for people and businesses that don't have the financial resources, time, or skills to host their own Web sites. A Web host can charge \$15 or more per



**FIGURE 7.15**  
**Creating Web pages**

Nvu makes Web design nearly as easy as using a word processor.  
Source: SOFTONIC INTERNATIONAL S.A.

month, depending on services. Some Web hosting sites include domain name registration, Web authoring software, activity reporting, and Web site monitoring. Some ISPs also provide limited storage space, typically 1 to 6 megabytes, as part of their monthly fee. If more disk space is needed, additional fees are charged. Free sites offer limited space for a Web site. In return, free sites often require the user to view advertising or agree to other terms and conditions.

Some Web developers are creating programs and procedures to combine two or more Web applications into a new service, called a mashup—named after the process of mixing two or more hip-hop songs into one song. Map applications such as Google Maps provide tool kits that allow them to be combined with other Web applications. For example, Google Maps can be used with Twitter to display the location where various tweets were posted. Likewise, Google Maps combined with Flickr can overlay photos of specific geographic locations.

## Internet and Web Applications

The variety of Internet and Web applications available to individuals and organizations around the world is vast and ever expanding.

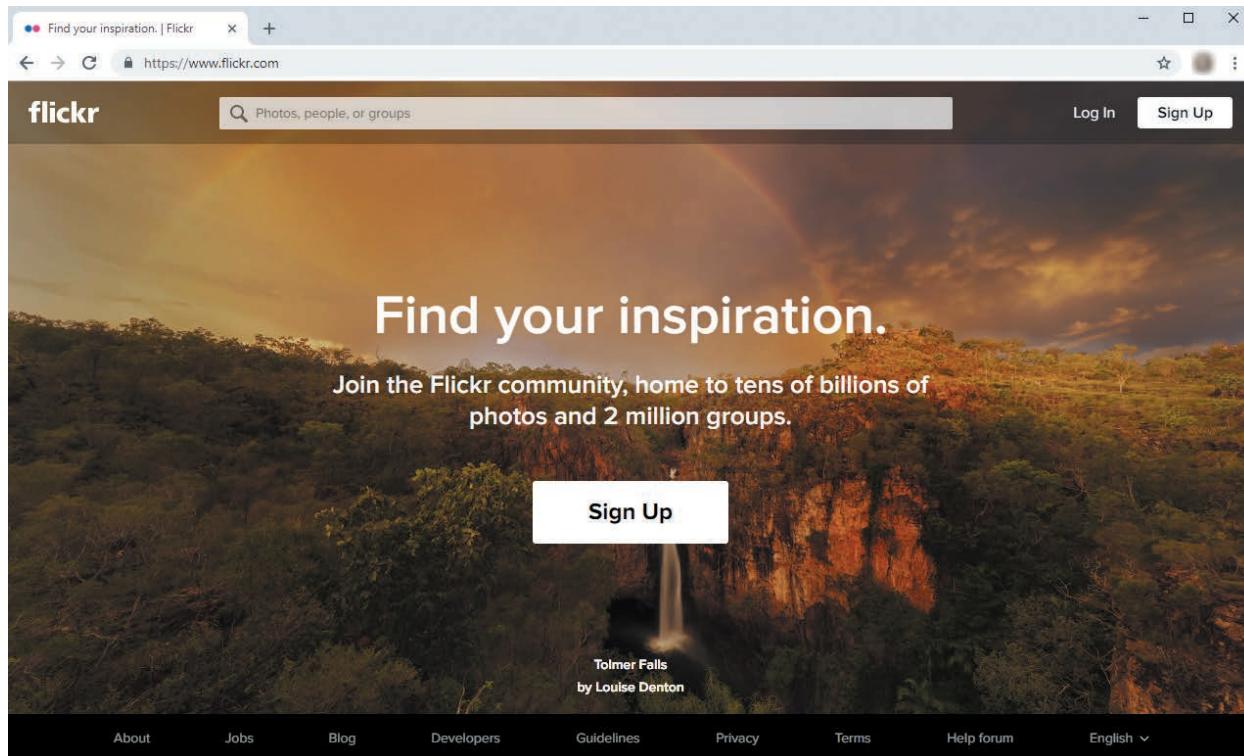
### Web 2.0 and the Social Web

Over the years, the Web has evolved from a one-directional resource where users only obtain information to a two-directional resource where users obtain and contribute information. Consider Web sites such as YouTube, Wikipedia,

**Web 2.0:** The Web as a computing platform that supports software applications and the sharing of information among users.

and Facebook as just a few examples. The Web has also grown in power to support full-blown software applications such as Google Docs and is becoming a computing platform itself. These two major trends in how the Web is used and perceived have created dramatic changes in how people, businesses, and organizations use the Web, creating a paradigm shift to **Web 2.0**.

The original Web—Web 1.0—provided a platform for technology-savvy developers and the businesses and organizations that hired them to publish information for the general public to view. Web sites such as YouTube and Flickr allow users to share video and photos with other people, groups, and the world. Microblogging sites such as Twitter allow people to post thoughts and ideas throughout the day for friends to read. See Figure 7.16.



**FIGURE 7.16**

## Flickr

Flickr allows users to share photos with other people around the world.  
Source: Flickr

Social networking Web sites provide Web-based tools for users to share information about themselves and to find, meet, and converse with other members. Instagram is a popular social networking service through which users can share photos and videos—either publicly or with a set group of friends. Another social network, LinkedIn, is designed for professional use to assist its members with creating and maintaining valuable professional connections. Ning provides tools for Web users to create their own social networks dedicated to a topic or interest.

Social networks have become very popular for finding old friends, staying in touch with current friends and family, and making new friends. Besides their personal value, these networks provide a wealth of consumer information and opportunities for businesses as well. Some businesses are including social networking features in their workplaces.

The use of social media in business is called Enterprise 2.0. Enterprise 2.0 applications, such as Salesforce's Chatter, Jive Software's Engage Dialog, and Yammer, enable employees to create business wikis, support social networking, perform blogging, and create social bookmarks to quickly find information. Tyco, a fire protection and security company, recently went through a major restructuring, changing from a conglomerate of holding companies to a united global enterprise with more than 69,000 employees in 50 countries. Throughout its transition, Tyco relied on Yammer rather than email to educate its workforce on the differences between the old Tyco and the new Tyco and to increase employee engagement across the company.<sup>10</sup>

Not everyone is happy with social networking sites, however. Employers might use social networking sites to get personal information about you. Some people worry that their privacy will be invaded or their personal information used without their knowledge or consent.

### **News**

The Web is a powerful tool for keeping informed about local, state, national, and global news. It has an abundance of special-interest coverage and provides the capacity to deliver deeper analysis of the subject matter. Text and photos are supported by the HTML standard. Video (sometimes called a Webcast) and audio are provided in a browser through plug-in technology and in podcasts.

As traditional news sources migrate to the Web, new sources are emerging from online companies. News Web sites from Google, Yahoo!, Digg, and News-vine provide popular or interesting stories from a variety of news sources. In a trend some refer to as social journalism or citizen journalism, ordinary citizens are more involved in reporting the news than ever before. Although social journalism provides important news not available elsewhere, its sources may not be as reliable as mainstream media sources. It is also sometimes difficult to discern news from opinion.

### **Education and Training**

Today, institutions and organizations at all levels provide online education and training, which can be accessed via PCs, tablets, and smartphones. Kahn Academy, for example, provides free online training and learning in economics, math, banking and money, biology, chemistry, history, and many other subjects.<sup>11</sup> NPower helps nonprofit organizations, schools, and individuals develop information system skills. The nonprofit organization provides training to hundreds of disadvantaged young adults through a 22-week training program that can result in certification from companies such as Microsoft and Cisco.<sup>12</sup>

High school and college students are also using mobile devices to read electronic textbooks instead of carrying heavy printed textbooks to class. And educational support products, such as Blackboard, provide an integrated Web environment that includes virtual chat for class members; a discussion group for posting questions and comments; access to the class syllabus and agenda, student grades, and class announcements; and links to class-related material. Conducting classes over the Web with no physical class meetings is called distance learning.

### **Job Information**

The Web is also an excellent source of job-related information. People looking for their first jobs or seeking information about new job opportunities can find a wealth of information online. Search engines, such as Google or Bing (discussed next), can be a good starting point for searching for specific companies or industries. You can use a directory on Yahoo's home page, for example, to explore industries and careers. Most medium and large companies have Web sites that list open positions, salaries, benefits, and people to contact for further

information. The IBM Web site, [www.ibm.com](http://www.ibm.com), has a link to “Careers.” When you click this link, you can find information on jobs with IBM around the world. In addition, several sites specialize in helping you find job information and even apply for jobs online, including [www.linkedin.com](http://www.linkedin.com) (see Figure 7.17), [www.monster.com](http://www.monster.com), and [www.careerbuilder.com](http://www.careerbuilder.com).

The screenshot shows the LinkedIn jobs search interface. At the top, there's a search bar with 'information systems', a location filter set to 'United States', and a 'Search' button. Below the search bar are filters for 'Jobs', 'Date Posted', 'LinkedIn Features', 'Company', and 'Experience Level'. The main area displays search results for 'Information systems in United States' with 259,737 results. Each result includes a company logo, job title, company name, location, a brief description, and application options like 'Be an early applicant' and 'Easy Apply'. One specific job listing for Spotify is expanded, showing a detailed description, application status ('3 days ago'), and a 'Save' or 'Apply' button. To the right of the job listing, there's a sidebar with 'Job description' and 'Industry' (Computer Software), 'Employment Type' (Full-time), 'Job Functions' (Product Management, Marketing, Messaging), and a 'See how you compare to 13 applicants' section.

**FIGURE 7.17**  
**LinkedIn jobs listing**

LinkedIn and many other Web sites specialize in helping people get information about jobs and apply for jobs online.  
Source: LinkedIn Corporation

### Search Engines and Web Research

A **search engine** is a valuable tool that enables you to find information on the Web by specifying words or phrases known as keywords, which are related to a topic of interest. You can also use operators such as AND, OR, and NOT for more precise search results.

The search engine market is dominated by Google. Other popular search engines include Yahoo! Search, Bing, Ask, Dogpile, and China’s Baidu. Google has taken advantage of its market dominance to expand into other Web-based services, most notably email, scheduling, maps, social networking, Web-based applications, and mobile device software. Search engines like Google often have to modify how they display search results, depending on pending litigation from other Internet companies and government scrutiny, such as antitrust investigations.

The Bing search engine has attempted to innovate with its design. Bing refers to itself as a decision engine because it attempts to minimize the amount of information that it returns in its searches that is not useful or pertinent. Bing also includes media—music, videos, and games—in its search results.

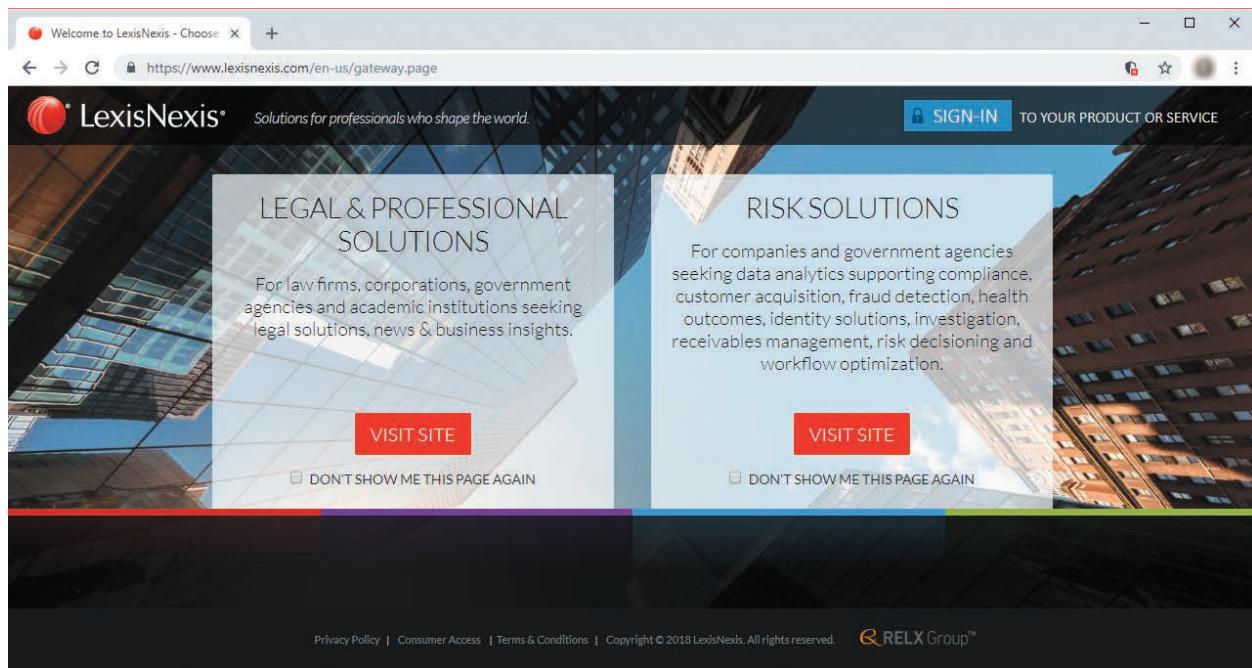
Savvy Web site operators know that the search engine results are tools that can draw visitors to certain Web sites. Many businesses invest in **search engine optimization (SEO)**—a process for driving traffic to a Web site by using techniques that improve the site’s ranking in search results. Normally,

#### search engine optimization

**(SEO):** A process for driving traffic to a Web site by using techniques that improve the site’s ranking in search results.

when a user gets a list of results from a Web search, the links listed highest on the first page of search results have a far greater chance of being clicked. SEO professionals, therefore, try to get the Web sites of their businesses to be listed with as many appropriate keywords as possible. They study the algorithms that search engines use, and then they alter the contents of their Web pages to improve the page's chance of being ranked number one. SEO professionals use Web analytics software to study detailed statistics about visitors to their sites.

Search engines offer just one option for performing research on the Web. Libraries typically provide access to online catalogs as well as links to public and sometimes private research databases on the Web. Online research databases allow visitors to search for information in thousands of journal, magazine, and newspaper articles. Information database services are valuable because they offer the best in quality and convenience. They conveniently provide full-text articles from reputable sources over the Web. College and public libraries typically subscribe to many databases to support research. One of the most popular private databases is LexisNexis Academic Universe. See Figure 7.18.



**FIGURE 7.18**

### LexisNexis

At LexisNexis Academic Universe, you can search the news, legal cases, company information, people, or a combination of categories.

Source: LexisNexis

**instant messaging:** The online, real-time communication between two or more people who are connected via the Internet.

### Instant Messaging

**Instant messaging** is online, real-time communication between two or more people who are connected via the Internet. With instant messaging, participants build contact lists of people they want to chat with. Some applications allow you to see which of your contacts are currently logged on to the Internet and available to chat. If you send messages to one of your contacts, that message appears within the messaging app on a smartphone or other mobile device, or, for those working on PCs, the message opens in a small dialog box on the recipient's computer. Although chat typically involves exchanging text

messages with one other person, many messaging apps allow for group chats. And today's instant messaging software supports not only text messages but also the sharing of images, videos, files, and voice communications. Popular instant messaging services include Facebook Messenger, KIK Messenger, Instagram, Skype, Snapchat, WhatsApp, and WeChat. It is estimated that mobile operators lost \$23 billion in 2012 alone as teens shifted away from texting over cellular networks in favor of communicating with their friends over the Internet using instant messaging apps.<sup>13</sup>

### **Microblogging, Status Updates, and News Feeds**

Referred to as a microblogging service, Twitter is a Web application that allows users to send short text updates (up to 280 characters) from a smartphone or a Web browser to their Twitter followers. While Twitter has been hugely successful for personal use, many businesses are finding value in the service as well. Business people use Twitter to stay in touch with associates by sharing their location and activities throughout the day. Businesses also find Twitter to be a rich source of consumer sentiment that can be tapped to improve marketing, customer relations, and product development. Many businesses have a presence on Twitter, dedicating personnel to communicate with customers by posting announcements and reaching out to individual users. Village Books, an independent bookstore in Bellingham, Washington, uses Twitter to build relationships with its customers and to make them feel part of their community.

The popularity of Twitter has caused social networks, such as Facebook, LinkedIn, and Tumblr, to include Twitter-like news or blog post feeds. Previously referred to as Status Updates, Facebook users share their thoughts and activities with their friends by posting messages to Facebook's News Feed.

### **Conferencing**

Some Internet technologies support real-time online conferencing. Participants dial into a common phone number to share a multiparty phone conversation and, in many cases, live video of the participants. The Internet has made it possible for those involved in teleconferences to share computer desktops. Using services such as WebEx or GoToMeeting, conference participants log on to common software that allows them to broadcast their computer display to the group. This ability is quite useful for presenting with PowerPoint, demonstrating software, training, or collaborating on documents. Participants verbally communicate by phone or PC microphone.

Athena Software is the developer of Penelope, case management software that enables its users to track all of a client's information in one place. This includes appointments, billing, case notes, client communication, and scheduling. Athena made a major product sale that required it to train 11,000 new users on their product in just 30 days. Athena employed GoToMeeting to record, publish, and distribute many brief, focused training sessions that the new users could view anytime to become effective users of the software.<sup>14</sup>

You don't need to be a big business to enjoy the benefits of video conversations. Free software is available to make video chat easy to use for anyone with a computer, a Webcam, and a high-speed Internet connection. Online applications such as Google Voice support video connections between Web users. For spontaneous, random video chat with strangers, you can go to the Chatroulette Web site. Software, such as FaceTime and Skype, provide computer-to-computer video chat so users can speak to each other face-to-face. In addition to offering text, audio, and video chat on computers and mobile devices, FaceTime and Skype offer video phone service over Internet-connected TVs. Recent Internet-connected sets from Panasonic and Samsung ship with the Skype software preloaded. You attach a Webcam to your TV to have a video chat from your sofa.

## Blogging and Podcasting

**blog:** A Web site that people and businesses use to share their observations, experiences, and opinions on a wide range of topics.

**podcast:** An audio broadcast you can listen to over the Internet.

A **blog** is a Web site that people and businesses use to share their observations, experiences, and opinions on a wide range of topics. The community of blogs and bloggers is often called the blogosphere. A blogger is a person who creates a blog, whereas blogging refers to the process of placing entries on a blog site. A blog is like a journal. When people post information to a blog, it is placed at the top of the blog page. Blogs can include links to external information and an area for comments submitted by visitors. Many organizations launch blogs as a way to communicate with customers and generate new business. Video content can also be placed on the Internet using the same approach as a blog. This is often called a *video log* or *vlog*.

A **podcast** is an audio broadcast you can listen to over the Internet. The name podcast originated from Apple's *iPod* combined with the word *broadcast*. A podcast is like an audio blog. Using PCs, recording software, and microphones, you can record podcast programs and place them on the Internet. Apple's iTunes provides free access to tens of thousands of podcasts, which are sorted by topic and searchable by keyword. After you find a podcast, you can download it to your PC (Windows or Mac), to an MP3 player such as an iPod, or to any smartphone or tablet. You can also subscribe to podcasts using RSS software included in iTunes and other digital audio software.

## Online Media and Entertainment

Like news and information, all forms of media and entertainment have followed their audiences online. Music, movies, television program episodes, user-generated videos, e-books, and audio books are all available online to download and purchase or stream.

**Content streaming** is a method of transferring large media files over the Internet so that the data stream of voice and pictures plays more or less continuously as the file is being downloaded. For example, rather than wait for an entire 5 MB video clip to download before they can play it, users can begin viewing a streamed video as it is being received. Content streaming works best when the transmission of a file can keep up with the playback of the file.

### Music

The Internet and the Web have made music more accessible than ever, with artists distributing their songs through online radio, subscription services, and download services. Spotify, Pandora, Napster, and Google Play Music are just a few examples of Internet music sites. Internet music has even helped sales of classical music by Mozart, Beethoven, and others. Internet companies, including Facebook, are starting to make music, movies, and other digital content available on their Web sites. Facebook, for example, allows online music companies, such as Spotify and Radio, to post music-related news on its Web site.

Apple's iTunes was one of the first online music services to find success. Microsoft, Amazon, Walmart, and other retailers also sell music online. Downloaded music may include digital rights management (DRM) technology that prevents or limits the user's ability to make copies or to play the music on multiple players.

Podcasts are yet another way to access music on the Web. Many independent artists provide samples of their music through podcasts. Podcast Alley includes podcasts from unsigned artists.

### Movies, Video, and Television

Television and movies are expanding to the Web in leaps and bounds. Online services such as Amazon Prime Video, Hulu, and Netflix provide television programming from hundreds of providers, including most mainstream television networks. Walmart's acquisition of Vudu has allowed the big discount

retailer to successfully get into the Internet movie business. Increasingly, TV networks offer apps for streaming TV content to tablets and other mobile devices. Some TV networks charge viewers to watch episodes of their favorite shows online. The Roku LT Streaming Media Box connects wirelessly to your TV and streams TV shows and movies from online sources such as Amazon Prime, Sony Crackle, Disney, Hulu, Netflix, and Xfinity TV.

No discussion of Internet video would be complete without mentioning YouTube. YouTube supports the online sharing of user-created videos. YouTube videos tend to be relatively short and cover a wide range of categories from the nonsensical to college lectures. It is estimated that 400 hours of video are uploaded to YouTube every minute and that over 1 billion hours of video are watched each day on YouTube.<sup>15</sup> Other video-streaming sites include Veoh, Metacafe, Internet Archive, Sony Crackle, and Vimeo. As more companies create and post videos to Web sites like YouTube, some IS departments are creating a new position—video content manager.

### **Online Games and Entertainment**

Video games have become a huge industry with worldwide annual revenue projected to exceed \$138 billion by the end of 2018.<sup>16</sup> The market for online gaming is very competitive and constantly changing. After Google included online games on its Web site, Facebook updated its online gaming offerings. Many video games are available online. They include single-user, multiuser, and massively multiuser games. The Web offers a multitude of games for all ages, including role-playing games, strategy games, and simulation games. Among the most popular online games of 2018 are Fortnite Battle Royale, Player Unknown's Battlegrounds, League of Legends, Splatoon 2, and Hearthstone.

Game consoles such as the PlayStation, Wii, and Xbox provide multiplayer options for online gaming over the Internet. Subscribers can play with or against other subscribers in 3D virtual environments. They can even talk to each other using a microphone headset.

### **Shopping Online**

Shopping on the Web can be convenient, easy, and cost effective. You can buy almost anything online, from books and clothing, to cars and sports equipment. Groupon, for example, offers discounts at restaurants, spas, auto repair shops, music performances, and almost any other product or service offered in your area or city. Revenues for Groupon were nearly \$3 billion in 2017.<sup>17</sup>

Other online companies offer different services. Dell and many other computer retailers provide tools that allow shoppers to specify every aspect and component of a computer system to purchase. *ResumePlanet.com* would be happy to create your professional résumé. AmazonFresh, Costco, Kroger, Safeway, Trader Joe's, Walmart, and Whole Foods all have at least some stores in some states willing to deliver groceries to your doorstep. Products and services abound online.

Amazon acquired Whole Foods in 2017 for \$13.7 billion in a move that shook up the entire grocery industry. Amazon soon began to sell its devices like Echo in stores and reserved lockers for delivery in certain Whole Foods locations. In some Whole Foods stores, there are now signs for special discounts for Amazon Prime members. Those discounts will likely become national. Whole Foods has also begun to offer free delivery for Prime members.

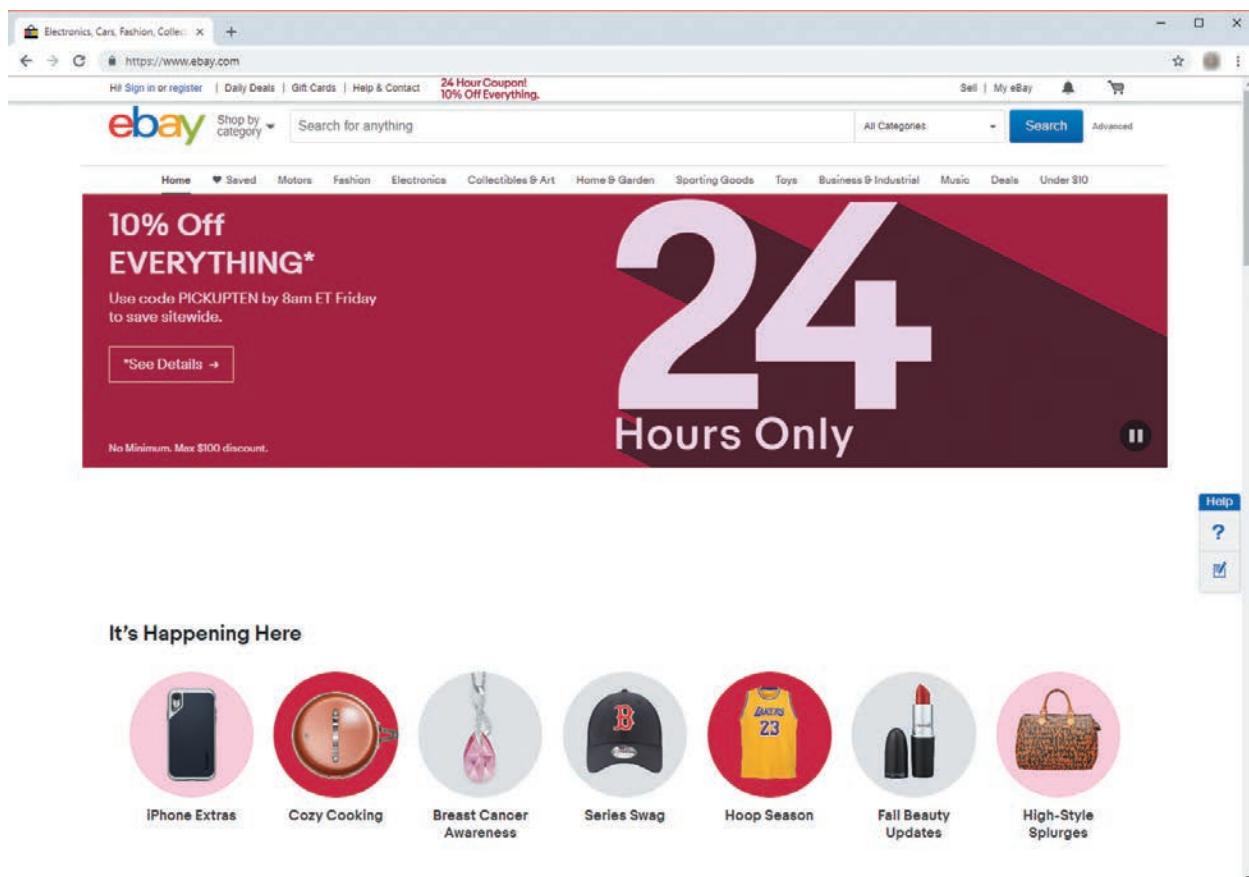
Many online shopping options are available to Web users. Online versions of retail stores often provide access to products that may be unavailable in local stores. BestBuy, Target, Walmart, and many others carry only a percentage of their inventory in their retail stores; the other inventory is available online. To add to their other conveniences, many Web sites offer free shipping and pickup for returned items that don't fit or otherwise meet a customer's needs.

Web sites such as [www.mySimon.com](http://www.mySimon.com), [www.DealTime.com](http://www.DealTime.com), [www.PriceSCAN.com](http://www.PriceSCAN.com), [www.PriceGrabber.com](http://www.PriceGrabber.com), and [www.NexTag.com](http://www.NexTag.com) provide product price

quotations from numerous online retailers to help you to find the best deal. Apps such as BuyVia, Purchx, RedLaser, and Shop Savvy enable users to compare prices at national and local outlets and lets you set up alerts (including location-based) for products. At a store and unsure if the price on the shelf is the lowest you can find? Use the UPC barcode scanner to get an answer on the spot.

Online clearinghouses, Web auctions, and marketplaces offer a platform for businesses and individuals to sell their products and belongings. Online clearinghouses, such as *www.uBid.com*, provide a method for manufacturers to liquidate stock and for consumers to find a good deal. Outdated or overstocked items are put on the virtual auction block and users bid on the items. The highest bidder when the auction closes gets the merchandise—often for less than 50 percent of the advertised retail price.

The most popular online auction is eBay, shown in Figure 7.19. The site provides a public platform for global trading where anyone can buy, sell, or trade practically anything. It offers a wide variety of features and services that enable members to buy and sell on the site quickly and conveniently. Buyers have the option to purchase items at a fixed price or in an auction-style format, where the highest bid wins the product.



**FIGURE 7.19**

## eBay

eBay provides an online marketplace where anyone can buy, sell, or trade practically anything.  
Source: eBay, Inc.

Auction houses such as eBay accept limited liability for problems that buyers or sellers may experience in their transactions. Transactions that make use of the PayPal service are protected on eBay. Others, however, may be more risky. Participants should be aware that auction fraud is the most prevalent type of fraud on the Internet.

Craigslist is a network of online communities that provides free online classified advertisements. It is a popular online marketplace for purchasing items from local individuals. Many shoppers turn to Craigslist rather than going to the classifieds in the local paper.

Businesses benefit from shopping online as well. Global supply management online services provide methods for businesses to find the best deals on the global market for raw materials and supplies needed to manufacture their products. Electronic exchanges provide an industry-specific Web resource created to deliver a convenient centralized platform for B2B e-commerce among manufacturers, suppliers, and customers.

### **Travel, Geolocation, and Navigation**

The Web has had a profound effect on the travel industry and the way people plan and prepare for trips. From getting assistance with short trips across town to planning long holidays abroad, travelers are turning to the Web to save time and money and to overcome much of the risk involved in visiting unknown places.

Travel Web sites such as Travelocity, Expedia, Kayak, and Priceline help travelers find the best deals on flights, hotels, car rentals, vacation packages, and cruises. Priceline offers a slightly different approach from the other Web sites. It allows shoppers to name a price they're willing to pay for an airline ticket or a hotel room and then works to find an airline or hotel that can meet that price.

Mapping and geolocation tools are among the most popular and successful Web applications. MapQuest, Google Maps, and Bing Maps are examples. See Figure 7.20. By offering free street maps for locations around the world, these tools help travelers find their way. Provide your departure location and destination, and these online applications produce a map that displays the fastest route. Using GPS technologies, these tools can detect your current location and provide directions from where you are.



**FIGURE 7.20**  
**Google Maps**

Mapping software, such as Google Maps, provide view of Camelback Mountain in Phoenix.  
Source: Google, Inc.

Google Maps also provides extensive location-specific business information, satellite imagery, up-to-the-minute traffic reports, and Street View. The latter is the result of Google employees driving the streets of the world's cities in vehicles with high-tech camera gear, taking 360-degree images. These images are integrated into Google Maps to allow users to get a "street view" of an area that can be manipulated as if the viewer were actually walking down the street looking around. Bing Maps and Google Maps both offer high-resolution aerial photos and street-level 3D photographs.

A geographic information system (GIS) provides geographic information layered over a map. For example, Google Earth provides options for viewing traffic, weather, local photos and videos, underwater features such as shipwrecks and marine life, local attractions, businesses, and places of interest. Software such as Connect, Find My Friends, Phone Tracker, and Tracker allow you to find your friends on a map—with their permission—and will automatically notify you if a friend is near.

Geotagging is a technology that allows for tagging information with an associated location. For example, Flickr and other photo software and services allow photos to be tagged with the location they were taken. Once tagged, it becomes easy to search for photos taken, for example, in Florida. Geotagging also makes it easy to overlay photos on a map, as Google Maps and Bing Maps have done. Facebook, Instagram, Snapchat, Twitter, and many other social networks have also made it possible for users to geotag photos, comments, tweets, and posts.

Geolocation information does pose a risk to privacy and security. Many people prefer that their location remain unknown, at least to strangers and often to acquaintances and even friends. Recently, criminals have made use of location information to determine when people are away from their residences so that they can burglarize without fear of interruption.

## Intranets and Extranets

**intranet:** An internal corporate network built using Internet and World Wide Web standards and products.

An **intranet** is an internal corporate network built using Internet and World Wide Web standards and products. Employees of an organization can use an intranet to gain access to corporate information. After getting their feet wet with public Web sites that promote company products and services, corporations are seizing the Web as a swift way to streamline—even transform—their organizations. These private networks use the infrastructure and standards of the Internet and the World Wide Web. Using an intranet offers one considerable advantage: many people are already familiar with Internet technology, so they need little training to make effective use of their corporate intranet.

An intranet is an inexpensive yet powerful alternative to other forms of internal communication, including conventional computer setups. One of intranet's most obvious virtues is its ability to reduce the need for paper. Because Web browsers run on all types of computers, the same electronic information can be viewed by any employee. That means that all sorts of documents (such as internal phone books, procedure manuals, training manuals, and requisition forms) can be inexpensively converted to electronic form, posted online, and easily updated. An intranet provides employees with an easy and intuitive approach to accessing information that was previously difficult to obtain. For example, it is an ideal solution to providing information to a mobile salesforce that needs access to rapidly changing information.

A growing number of companies offer limited network access to selected customers and suppliers. Such networks are referred to as extranets, which connect people who are external to the company. An **extranet** is a network built using Web technologies that links selected resources of the intranet of a company with its customers, suppliers, or other business partners.

Corporate executives at a well-known global fast food chain wanted to improve their understanding of what was happening at each restaurant location

**extranet:** A network built using Web technologies that links selected resources of the intranet of a company with its customers, suppliers, or other business partners.

and needed to communicate with franchisees to better serve their customers. The firm implemented an extranet, enabling individual franchisees to fine-tune their location-specific advertising and get it approved quickly by corporate-level staff. In addition, with the extranet, corporate employees now have a much better understanding of customers, both by location and in aggregate, based on information they are receiving from franchisees.

Security and performance concerns are different for an extranet than for a Web site or network-based intranet. User authentication and privacy are critical on an extranet so that information is protected. Obviously, the network must also be reliable and provide quick response to customers and suppliers. Table 7.5 summarizes the differences between users of the Internet, intranets, and extranets.

**TABLE 7.5** Summary of Internet, intranet, and extranet users

Type	User	Need User ID and Password?
Internet	Anyone	No
Intranet	Employees	Yes
Extranet	Business partners	Yes

**virtual private network (VPN):** A secure connection between two points on the Internet; VPNs transfer information by encapsulating traffic in IP packets and sending the packets over the Internet.

Secure intranet and extranet access applications usually require the use of a **virtual private network (VPN)**, a secure connection between two points on the Internet. VPNs transfer information by encapsulating traffic in IP packets and sending the packets over the Internet, a practice called tunneling. Most VPNs are built and run by ISPs. Companies that use a VPN from an ISP have essentially outsourced their networks to save money on wide area network equipment and personnel. To limit access to the VPN to just individuals authorized to use it, authorized users may be issued a logon ID and a security token assigned to that logon ID. The security token displays a 10- to 12-digit password that changes every 30 seconds or so. A user must enter their logon ID and the security password valid for that logon ID at that moment in time.



## Critical Thinking Exercise

### Web Site to Support Car Part Salvage

#### ► APPLICATION

You work part time for a relative who owns four auto part salvage yards in the surrounding tri-state area. Each salvage yard has hundreds of wrecked autos and tens of thousands of parts. Today, when a customer is seeking a part, the customer and a sales clerk go out and walk the salvage yard until they find the desired part or give up because they cannot find it. Although each salvage yard is somewhat organized by year, make, and model of car, it can take as much as an hour to find the desired part.

You have an idea to create a database that includes a description of the parts available at the four junk yards. The description will include the year, make, and model of car, part name, and condition of the part as well as identification of the location of the part in the salvage yard. There may be a photo for some parts (e.g. side panels, doors, auto hood, grill, etc.). When a customer calls or comes to the salvage yard, a clerk would query the database to find the availability, condition, and location of the desired parts. If the part is in inventory but at another salvage yard, a clerk can send an instant message to the employees at that salvage yard to ship the part. The database will be continually updated as parts are added or sold at each junk yard. Your current thinking is that the database will only be accessible over an intranet used by just the employees of the four salvage yards.

### Review Questions

1. What advantages does use of a centralized database accessed by an intranet provide versus the current approach?
2. What measures can you take to control access to the database so that only authorized employees may enter their data? Can you identify measures that need to be taken to ensure the accuracy, completeness, and consistency of description of parts in the database?

### Critical Thinking Questions

1. What potential start-up issues may be involved in preparing the employees to use this new system? How will you overcome these issues?
2. If this idea proves successful, can you outline an approach to sell your system to other owners of salvage yards? What additional measures would you need to put into place to make this work?

## Summary

### Principle:

**A network has many fundamental components, which—when carefully selected and effectively integrated—enable people to meet personal and organizational objectives.**

A computer network consists of communications media, devices, and software connecting two or more computer systems or devices. Communications media are any material substance that carries an electronic signal to support communications between a sending and a receiving device.

The effective use of networks can help a company grow into an agile, powerful, and creative organization, giving it a long-term competitive advantage. Networks let users share hardware, programs, and databases across the organization. They can transmit and receive information to improve organizational effectiveness and efficiency. They enable geographically separated workgroups to share documents and opinions, which fosters teamwork, innovative ideas, and new business strategies.

Network topology indicates how the communications links and hardware devices of the network are arranged. The three most common network topologies are the star, bus, and mesh.

A network can be classified as personal area, local area, metropolitan, or wide area network depending on the physical distance between nodes on the network and the communications and services it provides.

Channel bandwidth refers to the capacity of a com, usually measured in megabits per second (Gbps).

Network latency measures how long it takes for a unit of data to get to its destination and back and is measured in milliseconds (ms).

Communications media can be divided into two broad categories: guided transmission media, in which a communications signal travels along a solid medium, and wireless media, in which the communications signal is sent over airwaves. Guided transmission media include twisted-pair wire, coaxial, and fiber-optic cable.

Wireless communication is the transfer of information between two or more points that are not connected by an electrical conductor. Wireless communications involves the broadcast of communications in one of three frequency ranges: microwave, radio, and infrared. Wireless communications options include near-field communications, Bluetooth, Wi-Fi, microwave, and a variety of 3G, 4G, and 5G communications options.

Long-Term Evolution (LTE) is a standard for wireless communications for mobile phones based on packet switching.

A network operating system (NOS) controls the computer systems and devices on a network, allowing them to communicate with one another. Network-management software enables a manager to monitor the use of individual computers and shared hardware, scan for viruses, and ensure compliance with software licenses.

Mobile device management (MDM) software manages and troubleshoots mobile devices remotely, pushing out applications, data, patches, and settings.

Software-defined networking (SDN) is an emerging approach to networking that allows network administrators to manage a network via a controller that does not require physical access to all the network devices.

### Principle:

**Together, the Internet and the World Wide Web provide a highly effective infrastructure for delivering and accessing information and services.**

The Internet is truly international in scope, with users on every continent. It is the world's largest computer network. It is a collection of interconnected networks, all freely exchanging information.

The Internet transmits data from one computer (called a host) to another. The set of conventions used to pass packets from one host to another is known as the Internet Protocol (IP). Many other protocols are used with IP. The best known is the Transmission Control Protocol (TCP) which defines how applications can create channels of communication across the network. TCP is so widely used that many people refer to the Internet protocol as TCP/IP, the combination of TCP and IP used by most Internet applications.

Each computer on the Internet has an assigned IP address for easy identification.

A switch is a network hardware device that keeps a record of the MAC of all the devices connected to it so it can determine to which port a packet of data should be sent.

The router is a network hardware device that directs data packets to other networks until each packet reaches its destination.

A client/server system is a networking approach wherein many clients request and receive services from servers on the network. Servers receive client user requests, process them, and obtain the requested data.

Client-side programming languages such as JavaScript, VBA Script, HTML, CSS, and Ajax are used to provide an interface to enable the client computer to request the services of the server computers and to display the results.

Server-side programming languages such as PHP, C++, Java, Python, and Ruby on Rails are used to create programs that run on the server and deals with the generation of the content of a Web page to satisfy a client's request.

The domain name system maps the name people use to locate a website to the IP address that a computer users to locate a Web site.

A Uniform Resource Locator (URL) is a Web address that specifies the exact location of a Web page using letters and words that map to an IP address and a location on the host.

An Internet service provider is any company that provides access to the Internet. To connect to the Internet through an ISP, you must have an account with the service provider and software that allows a direct link via TCP/IP.

The Web was designed to make information easy to find and organize. It connects billions of documents, which are now called Web pages, stored on millions of servers around the world. Web pages are connected to each

other using hyperlinks, specially denoted text or graphics on a Web page, that, when clicked, open a new Web page containing related content. The pages are accessed and viewed using Web client software called a Web browser.

Many Web sites use cascading style sheets (CSS) to define the design and layout of Web pages, extensible mark-up language (XML) to define the content, and hypertext mark-up language (HTML) to join the content (XML) with the design (CSS).

Popular tools for creating Web pages and managing Web sites include .NET platform, JavaServer Pages, Microsoft ASP.NET, and Adobe Cold Fusion.

Internet companies, including Amazon, eBay, and Google, use Web services to streamline and simplify communication among Web sites.

XML is also used within a Web page to describe and transfer data between Web service applications.

Today's Web development applications allow developers to create Web sites using software that resembles a word processor. The software includes features that allow the developer to work directly with the HTML code or to use auto-generated code.

The use of social media in business is called Enterprise 2.0. Enterprise 2.0 applications, such as Salesforce's Chatter, Jive Software's Engage Dialog, and Yammer, enable employees to create business wikis, support social networking, perform blogging, and create social bookmarks to quickly find information.

Social journalism provides important news not available elsewhere; however, its sources may not be as reliable as mainstream media sources.

Today, schools at all levels provide online education and training. The Web is also an excellent source of job-related information.

A search engine is a valuable tool that enables you to find information on the Web by specifying words or phrases known as keywords, which are related to a topic of interest. Search engine optimization (SEO) is a process for driving traffic to a Web site by using techniques that improve the site's ranking in search results.

Instant messaging is online, real-time communication between two or more people who are connected via the Internet.

Twitter is a Web application that allows users to send short text updates (up to 280 characters) from a smartphone or a Web browser to their Twitter followers.

Internet technologies support real-time online conferencing where participants dial into a common phone number to share a multiparty phone conversation and, in many cases, live video of the participants.

A Web log, typically called a blog, is a Web site that people and businesses use to share their observations, experiences, and opinions on a wide range of topics.

A podcast is an audio broadcast you can listen to over the Internet.

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An intranet is an internal corporate network built using Internet and World Wide Web standards and products. Employees of an organization can use an intranet to access corporate information.

A growing number of companies offer limited network access to selected customers and suppliers. Such networks are referred to as extranets, which connect people who are external to the company.

Secure intranet and extranet access applications usually require the use of a virtual private network, a secure connection between two points on the Internet.

## Key Terms

- |                                  |  |
|----------------------------------|--|
| blog                             | mobile device management (MDM) software                  |
| Bluetooth                        | near-field communication (NFC)                           |
| bus network                      | network latency  |
| Cascading Style Sheet (CSS)      | network operating system (NOS)                           |
| channel bandwidth                | network-management software                              |
| client/server architecture       | network topology   |
| communications media             | personal area network (PAN)                              |
| computer network                 | podcast  |
| content streaming                | router   |
| domain name system               | search engine  |
| Extensible Markup Language (XML) | search engine optimization (SEO)                         |
| extranet                         | software-defined networking (SDN)                        |
| HTML tag                         | star network   |
| hyperlink                        | switch   |
| Hypertext Markup Language (HTML) | Transmission Control Protocol/Internet Protocol (TCP/IP) |
| instant messaging                | Uniform Resource Locator (URL)                           |
| Internet backbone                | virtual private network (VPN)                            |
| Internet service provider (ISP)  | Web 2.0  |
| intranet                         | Web browser  |
| IP address                       | Wi-Fi  |
| local area network (LAN)         | wide area network (WAN)                                  |
| Long-Term Evolution (LTE)        | wireless communication                                   |
| mesh network                     |  |
| metropolitan area network (MAN)  |  |

## Self-Assessment Test

**A network has many fundamental components—which, when carefully selected and effectively integrated—enable people to meet personal and organizational objectives.**

1. A network topology in which all network devices connect to one another through a single central device called the hub node is a \_\_\_\_\_.
  - a. bus network
  - b. mesh network
  - c. packet switching network
  - d. star network
2. \_\_\_\_\_ is a wireless network that connects information technology devices close to one person.
  - a. Mesh network
  - b. Personal area network
  - c. Local area network
  - d. Packet switching
3. A network that connects large geographic regions is a \_\_\_\_\_.
  - a. MAN
  - b. bus network
  - c. client/server network
  - d. WAN
4. A 5G network will have the following advantages over a 4G network:
  - a. Overall network support and operations costs are reduced, new applications can be made available sooner, and the risk of human error is reduced.
  - b. Ability to support more concurrent devices, minimal infrastructure changes, and lower latency.
  - c. Lower latency, greater bandwidth, and ability to support more devices.
  - d. Ability to support exciting new applications, greater bandwidth, and improved security.
5. Three advantages associated with a software-defined network include \_\_\_\_\_.
  - a. the risk of human error is reduced, overall network support and operations costs are reduced, and new applications can be made available sooner
  - b. The ability to support more concurrent devices, minimal infrastructure changes, and lower latency
  - c. the ability to support exciting new applications, greater bandwidth, and improved security
  - d. lower latency, greater bandwidth, and the ability to support more devices

**Together, the Internet and the World Wide Web provide a highly effective infrastructure for delivering and accessing information and services.**

6. \_\_\_\_\_ specifies how to address and route each packet to make sure it reaches the desired destination.
  - a. TCP/IP
  - b. TCP
  - c. IP
  - d. MAC
7. A 64-bit number that uniquely identifies a computer on the Internet is a(n) \_\_\_\_\_.
  - a. URL
  - b. MAC address
  - c. IP address
  - d. TCP address
8. A network device that directs data packets to other networks until each packet reaches its destination is a \_\_\_\_\_.
  - a. router
  - b. hub
  - c. switch
  - d. client/server
9. A networking approach wherein many clients (end user computing devices) request and receive services from servers (host computers) on the network is \_\_\_\_\_.
  - a. peer-to-peer
  - b. client/server
  - c. mesh
  - d. distributed
10. The \_\_\_\_\_ maps the name people use to locate a Web site to the IP address that a computer uses to locate a Web site.
  - a. URL
  - b. MAC address
  - c. domain name system
  - d. IPL
11. The \_\_\_\_\_ is a Web address that specifies the exact location of a Web page using letters and words that map to an IP address and a location on the host.
  - a. URL
  - b. MAC address
  - c. hyperlink
  - d. CSS
12. \_\_\_\_\_ are specially denoted text or graphics on a Web page, that, when clicked, open a new Web page containing related content.
  - a. URLs
  - b. Hyperlinks
  - c. XMLs
  - d. MAC addresses

13. Web client software used to view Web pages is called \_\_\_\_\_.  
 a. HTML  
 b. CSS  
 c. XML  
 d. browser
14. \_\_\_\_\_ is a standard page description language for Web pages that tells the browser how to display font characteristics, paragraph formatting, page layout, image placement, hyperlinks, and the content of a Web page. It uses tags, which are codes that tell the browser how to format the text or graphics as a heading, list, or body text.  
 a. XML  
 b. CSS  
 c. HTML  
 d. URL
15. Many Web sites use Cascading Style Sheets (CSS) to define the design and layout of Web pages, and Extensible Markup Language (XML) to define the content, and hypertext mark-up language to join the content with the design. True/False
16. The purpose of client-side programming is to \_\_\_\_\_.  
 a. deal with the generation of a web page to satisfy the client's request  
 b. pull data from a database stored on the server  
 c. customize website content for individual users  
 d. provide an interface to allow the client computer to request services of the server computer
17. JavaScript, VBA Script, HTML, CSS, and Ajax are server-side programming languages, while PHP, C++, Java, Python, and Ruby on Rails are client-side programming languages. True or False?
18. A(n) \_\_\_\_\_ is an internal corporate network built using Internet and World Wide Web standards and products, while a(n) \_\_\_\_\_ is a means to offer limited network access to people external to the organization such as selected customers and suppliers.

## Self-Assessment Test Answers

1. d  
 2. b  
 3. d  
 4. c  
 5. a  
 6. c  
 7. c  
 8. c  
 9. b
10. c  
 11. a  
 12. b  
 13. d  
 14. c  
 15. True  
 16. d  
 17. False  
 18. intranet, extranet

## Review and Discussion Questions

1. Describe three common network topologies and four network types in common use today.
2. What advantages will 5G wireless communications have over 4G?
3. What is software-defined networking (SDN), and what advantages does it offer?
4. Describe how the Internet works by identifying and explaining the role of its key components.
5. Describe how the Web works by identifying and explaining the role of its key components.
6. Briefly outline the process used in developing Web content and applications. Outline half a dozen tools used to develop Web content and applications.
7. What is the purpose of client-side computing? What is the purpose of server-side programming?
8. Identify three commonly used server-side programming languages and three commonly used client-side programming languages.
9. Describe five common Internet and Web applications.
10. Define the terms intranet and extranet. How are they alike? How are they different?
11. Develop a spreadsheet to track the amount of time you spend each day on Twitter, Instagram, Facebook, and other social networks. Record your times on each network for a two-week period. What percent of this time would you consider informative and worthwhile? How much time is just socializing or entertainment?

## Business-Driven Decision-Making Exercises

1. You are a member of the IS support group for your organization. The manager of sales is very tech savvy and a rapid adopter of new technology. Today, she texted you that she would like to upgrade from 4G phones to 5G phones for the 45 members of the sales organization as soon as possible. What are some of the advantages and disadvantages of such an approach? Would it be wiser to wait until the new 5G technology has been more fully developed? Why or why not? How do you respond to this manager?
2. Think of a business that you might like to establish. Use a word processor to define the business in terms of what product(s) or service(s) it provides, where it is located, and its name. Go to [www.godaddy.com](http://www.godaddy.com), and find an appropriate domain name for your business that is not yet taken. Shop around online for the best deal on Web site hosting. Write a paragraph about your experience finding a name, why you chose the name that you did, and how much it would cost you to register the name and host a site.

## Teamwork and Collaboration Activities

1. Plan, set up, and execute a meeting with another team wherein you meet via the use of a Web service such as GoToMeeting or WebEx. Develop an agenda, goals, and a time limit for this meeting and share it with members of each team in advance. What are some of the problems you encountered in setting up and executing the meeting? How would you evaluate the effectiveness of the meeting? What could have been done to make the meeting more effective?
2. Net neutrality is the principle that Internet service providers should be required to treat

all Internet traffic running over their wired and wireless networks the same—without favoring content from some sources and/or blocking or slowing (also known as throttling) content from others. The debate over net neutrality raises questions about how best to keep the Internet open and impartial while still offering Internet service providers incentive to expand their networks to serve more customers and to support new services. Have you and your team do research to find out the status of net neutrality in the United States. Prepare a brief report summarizing your findings.

## Career Exercises

1. Explore LinkedIn, a social media network for professional networking. Use some of its features to find former peers or coworkers. What are some of the advantages of using such a Web site? What are some of the potential problems? Would you consider joining LinkedIn? Why or why not?
2. Do research on Mark Zuckerberg and Jeff Bezos. (You might elect to read the book *The Boy Billionaire*, or *Jeff Bezos, The Force Behind the*

*Man*. The first book offers insights into Mark Zuckerberg, the founder of Facebook. The second book is about Jeff Bezos, founder of Amazon and the richest man in the world). How did Zuckerberg recognize the potential of social networking? How did Bezos recognize the potential of online shopping? What is it about these two individuals that made them super achievers? In what ways are you like them, in what ways are you unlike them? What can you learn from them?

## Case Study

### ► TEAMWORK

#### T-Mobile Employs Enterprise 2.0

Wireless telephone service providers are ranked #5 from the bottom in terms of the most hated industries in the U.S. Surveys show there are three major areas for where improvement is needed. First, customers feel call center

staff members can be rude and unhelpful. Second, customers are not happy with the speed of store service or center transactions. Third, customers are not satisfied with the range of wireless voice and/or data plans available.

T-Mobile with 51,000 employees, 73 million customers, and over \$40 billion in annual revenue is the third largest wireless provider in the U.S. It recognizes that it must take strong action to eliminate customer pain points. Some recent changes include elimination of two-year service contracts, doing away with data buckets, abolishing unpredictable international roaming charges, and including taxes and fees in the rates quoted customers. These are all part of T-Mobile's "un-carrier strategy" aimed at putting people first and improving the overall customer experience.

Customers' biggest complaint about their wireless telephone service provider is the poor service they receive when contacting the service center—long wait times on hold, curt and impatient service reps, and ambiguous answers to their questions. T-Mobile is making use of a commercial Enterprise 2.0 collaboration and knowledge management tool to improve the overall customer experience when customers contact the call center. The Enterprise 2.0 solution helps T-Mobile customers and enables the organization to achieve major increases in productivity, employee teamwork, and customer satisfaction. T-Mobile used Enterprise 2.0 software as the basis to build its "T-Community" which serves as the central knowledge source for customer service and support. The new platform has been well received by customers and has also dramatically improved productivity. The effort required to publish content compared to previous means was cut by 70 percent thus saving \$8 million over a three-year period. T-Mobile saves an additional \$3 million each year in call handling costs by providing call center reps with easy access to current and more complete information. This cuts down the time spent searching for answers and reduces customer call time.

T-Mobile also used Enterprise 2.0 technology to create a company intranet to enable employees to connect, communicate, and work together as a team. This collaboration platform provides a central place for people to collaborate securely and openly across organizations, geographies,

systems, and devices. It brings together all the people, information, and tools needed to move the business forward. The intranet provides a single platform for company communications, team collaboration, employee engagement and onboarding, knowledge sharing, enterprise search, and organizational analytics. It enables employees to create business wikis, support social networking, perform blogging, and create social bookmarks to quickly find information. The intranet is accessible via browsers and a mobile intranet app that enables employees to work from anywhere. With the Enterprise 2.0 intranet, getting work done across departments—or time zones—is easier, more efficient, and more transparent. Decisions are made quickly, and projects are finished faster.

### Critical Thinking Questions:

1. What complaints do you have in dealing with your wireless service provider? How might Enterprise 2.0 help improve this relationship?
2. Can you identify any innovative ideas to enable T-Mobile to improve the speed and/or quality of in-store service? Briefly outline your thoughts.
3. Should T-Mobile consider allowing access to its intranet to customers, suppliers, or other parties? What might be the value in doing this? What potential issues does this raise?

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## Principles

- Cloud computing provides access to state-of-the-art technology at a fraction of the cost of ownership and without the lengthy delays that can occur when an organization tries to acquire its own resources.
- Organizations are using the Internet of Things (IoT) to capture and analyze streams of sensor data to detect patterns and anomalies—not after the fact, but while they are occurring—in order to have a considerable impact on the event outcome.

## Learning Objectives

- Identify three commonly used approaches to cloud computing.
- Identify three key benefits associated with cloud computing.
- Summarize four common issues organizations encounter when moving to public cloud computing.
- Discuss the pros and cons of public, private, and hybrid cloud computing.
- Define what is meant by the Internet of Things (IoT).
- Discuss four applications of IoT and associated connected devices.
- Describe how 5G networks will transform developments with IoT.
- Identify four benefits associated with the IoT.
- State the degree of sensing and the degree of action associated with four types of IoT applications.
- Identify two potential issues associated with the expansion of the IoT.

# IS in Action

## Enterprise Considerations When Moving to the Cloud

### ► SYSTEMS AND PROCESSES

As businesses migrate their email, productivity, and collaboration tools to the cloud, Microsoft Office 365 and Google's G Suite are two leading online solutions often under consideration. Microsoft's Office 365 suite includes Outlook for email and shared calendars; OneDrive for cloud storage; and Word, Excel, PowerPoint, and OneNote for productivity. Enterprise users often make use of additional apps, including Teams, a collaboration platform; Skype for Business, an audio and video conferencing app; Yammer, a corporate social network; and Planner, a work and project management app.

Google's G Suite includes Gmail and Calendar for email and shared calendars; Google Drive for cloud storage; Google Docs, Sheets, and Slides for productivity; and Hangouts for online meetings and chat. Some enterprise users also use Currents for company-wide discussions. Network administrators can use G Suite's Admin app to add users, manage devices, and configure security settings, such as two-step verification—across an entire organization. Administrators can also specify which Google data centers around the world can be used to store their organization's data.

Cloud service providers such as Microsoft and Google deliver applications and operating system updates directly to users' devices over the Internet using a SaaS (software as a service) subscription model. Typically, users access cloud applications through a browser. In today's workplace, employees access corporate data stored in the cloud on mobile devices, tablets, and laptops running Windows, Mac, iOS, Android, and other operating systems. Because apps and services are hosted in the cloud, employees can work wherever they are able to get online.

A migration to the cloud enables employees to focus on the core tasks of their jobs rather than setting up and maintaining servers or installing software updates on their devices. Before the launch of cloud-based services, organizations had to undertake significant testing when upgrading an operating system. New major versions were typically released once every two or three years and contained many more changes, requiring significant testing to ensure ongoing compatibility with existing hardware and software resources. Although SaaS applications such as Office 365 and G Suite change frequently—requiring organizations to develop strategies for evaluating and testing these updates prior to pushing them out to user's computers and devices—the process for rolling out updates across the enterprise is much faster with cloud-based services. Cloud service providers provide software and operating systems updates as they become available, and analytics tools track when these upgrades take place.

Moving resources that have been traditionally hosted and managed in-house to the cloud requires an organization to consider many factors, including network infrastructure, security, and training. Although information and applications may be hosted in the cloud, an organization's technology infrastructure must still be robust enough to handle the additional traffic when the entire organization works online. Organizations must determine whether data will be stored in the cloud only, or in a hybrid cloud configuration, with some data stored on premises and some data stored in the cloud. This also involved establishing security settings, including specifying which files and data can be accessed in-house and remotely, and by whom.

Because data and the servers storing it are no longer on premises, enterprises must consider possible delays in performance, or latency, when using cloud applications over the Internet and accept and possible loss of control over managing a computing environment virtually. In a recent survey, more than 80 percent of enterprises reported moderate to high levels of concern about being locked into a single public cloud platform. Some companies choose multiple cloud providers to keep their applications portable and switch between them as necessary; others choose to take advantage of specific features of a vendor's platform to save development time.<sup>1</sup>

Security of a company's data is one of the biggest challenges when moving to the cloud. Many users believe their data is safer on their own servers, where they have more control over it. However, cloud providers must comply with strict regulations when storing sensitive information such as patient medical records or credit card numbers. In addition, BYOD (bring your own device) policies that permit, and in some cases encourage, the use of personal mobile devices at work require organizations to detail how employees can access corporate files and services securely on their own devices. If a user's mobile device is lost or stolen, management tools can be used to wipe confidential data remotely from a user's mobile device to keep company data secure. Finally, data stored on servers located in other countries are subject to local data privacy and security rules, which may be different from a company's home country.

Enterprise office cloud services also include capabilities to identify and provide electronic information that can be used as evidence in legal cases. This process, known as **e-discovery (electronic discovery)**, involves identifying, collecting, and producing information from archived email, files and documents in cloud storage, collaboration apps, and other cloud services. Electronic information often has metadata, such as time stamps, location data, sender and recipient information, and properties of files, which are not evident in printed materials, but may provide relevant evidence in legal matters.

**Virtualization tools** allow users to access their desktop operating system hosted in the cloud on a centralized server—meaning users can interact with files and applications as if they were stored on a local device. This approach saves money because applications, data, and operating systems are stored in the cloud. Organizations no longer need to maintain physical servers, or facilities to house them, or spend on electricity to power and cool them.

As of March 2018, cloud email services from Microsoft and Google had been adopted by more than 40 percent of public companies. Google's popularity has increased among smaller businesses, while larger organizations tend to use Microsoft products and services. The 2018 Cloud Adoption report from BitGlass, a cloud security company, shows that Office 365 usage has increased from 34.3 to 56.3 percent in 2018, while G Suite usage has remained steady at about 25 percent since 2018. Gartner predicts that by 2021 more than 70 percent of businesses will have completed a transition to providing cloud-based office services to their employees.

#### As you read this chapter, consider the following:

- What factors must organizations consider when implementing and deploying cloud computing solutions to support their business strategies and achieve organizational objectives?
- What challenges and opportunities does the Internet of Things (IoT) present for individuals and organizations?

## Why Learn about Cloud Computing and the Internet of Things (IoT)?

Workers in many organizations operate in a cloud-computing environment in which software, data storage, and other services are accessed over the Internet ("the cloud"). The services are run on another organization's computer hardware, and both software and data are easily accessed. Examples of public cloud service providers, which make their services available to the general public, include Amazon Elastic Compute Cloud (EC2), IBM's Blue Cloud, DigitalOcean, Google Cloud Platform, Rackspace's Managed Cloud, and Microsoft Azure. Public cloud users can realize a considerable cost savings because the very high initial hardware, application, and communications costs are paid for by the service provider and passed along to users as a relatively small monthly or per-use fee. Furthermore, companies can easily scale up or down the amount of services used, depending on user demand for services. Cloud computing also provides the benefit of making it easy for workers to collaborate by sharing documents on the Internet.

**e-discovery (electronic discovery):** The process of identifying, collecting, and producing electronically stored information for use in legal cases.

**virtualization tools:** A set of tools that allow users to access their desktop operating system hosted in the cloud on a centralized server—meaning users can interact with files and applications as if they were stored on a local device.

## Cloud Computing

**cloud computing:** A computing environment where software and storage are provided as an Internet service and are accessed with a Web browser.

**Cloud computing** refers to a computing environment in which software and storage are provided as an Internet service and accessed by users with their Web browser (see Figure 8.1). Many organizations are turning to cloud computing as an approach to outsource some or all their IT operations. This section defines cloud computing and its variations and points out some of its advantages as well as some potential issues, including problems associated with cost, scalability, security, and regulatory compliance.

**FIGURE 8.1**  
**Cloud computing**

Cloud computing enables applications such as file sharing, data storage and backup, media streaming, Web site hosting, information security, and communication services to be delivered via the Web.


iStock.com/photecho

Cloud computing can be deployed in several different ways, including public cloud computing, private cloud computing, and hybrid cloud computing. Public cloud computing refers to a deployment in which a cloud service provider offers its cloud-based services to the public. Examples of public cloud computing include an individual using Google Calendar and a corporation using the Salesforce.com application. In a private cloud deployment, cloud technology is used within the confines of a private network. Hybrid cloud computing combines elements of both public and private cloud computing, accessed through a private network.

### Public Cloud Computing

In a **public cloud computing environment**, a service provider organization owns and manages the infrastructure (including computing, networking, storage devices, and support personnel) with cloud user organizations (called tenants) accessing slices of shared resources via the Internet. The service provider can deliver increasing amounts of computing, network, and storage capacity on demand, without requiring any capital investment on the part of the cloud users. Thus, public cloud computing is a great solution for organizations whose computing needs vary greatly depending on changes in demand. Amazon, Google, and Microsoft are among the largest public cloud computing service providers. These firms typically offer a monthly or annual subscription service model; they may also provide training, support, and data integration services.

**public cloud computing environment:** A computing environment in which a service provider organization owns and manages the infrastructure (including computing, networking, storage devices, and support personnel) with cloud user organizations (called tenants) accessing slices of shared resources via the Internet.

### **Benefits of Public Cloud Computing**

Public cloud computing offers three key benefits to organizations—reduced costs, flexible computing capacity, and increased redundancy in the event of disaster. With public cloud computing, organizations avoid large, up-front investments in hardware. Public cloud computing can also lower the ongoing investment in the people and other resources required to manage that hardware. Organizations can request just the right type and capacity of information system resources from their cloud computing provider, pay for it on an ongoing basis, and let the service provider handle the system support and maintenance.

Should an organization's computing needs change, it can request its cloud computing service provider to deliver more or less capacity, with a corresponding increase or decrease in monthly charges. This avoids lengthy delays (possibly months) that can occur when an organization tries to acquire its own resources. Such flexibility can increase the speed and reduce the costs of new product and service launches. An organization can quickly acquire the increased computing capacity required to test a new product or service offering literally overnight. If the test proves successful, even more computing capacity can be requested to support the rollout of the new product or service. On the other hand, should the test prove unsuccessful, the organization can simply request the cloud computing service provider to turn off the additional capacity.

Public cloud service providers operate multiple data centers distributed geographically. They also save multiple copies of tenants' data on different machines. This redundancy ensures that the tenants' information and the service provider's processing power remain available with minimal interruption. Continuity of operations can be guaranteed even in the event a natural disaster strikes a certain region (e.g., a hurricane), a local hardware or software failure occurs at one of the data centers, or a software or hardware component needs to be updated or replaced.

Seattle-based Zulily is an online retailer that sells clothing, toys, and home products. In 2018, the retailer moved several of its core business processes to Amazon's public cloud service platform to enhance the online shopping experience of its more than six million active customers. Machine learning helps Zulily present customers with a customized experience, and data is at the center of the company's operations. By moving several of its production databases to the cloud, Zulily gained higher fault tolerance and improved performance—both of which are critical to the company's ongoing success. The company is also saving thousands of dollars per month through cloud computing. In addition, the move to the cloud resulted in a 30–40 percent performance improvement for each request for data from the company's online databases made through its Web site and mobile app.<sup>2</sup>

### **Cloud Computing Services**

Public cloud computing can be divided into three main types of services (see Figure 8.2):

- **Infrastructure as a service (IaaS):** An information systems model in which an organization outsources the equipment used to support its data processing operations, including servers, storage devices, and networking components.
- **Platform as a service (PaaS):** An information systems model in which users are provided with a computing platform, typically including operating system, programming language execution environment, database services, and a Web server. The user can create an application or service using tools and/or libraries from the provider. The user also controls

#### **infrastructure as a service (IaaS):**

An information systems model in which an organization outsources the equipment used to support its data processing operations, including servers, storage devices, and networking components.

#### **platform as a service (PaaS):**

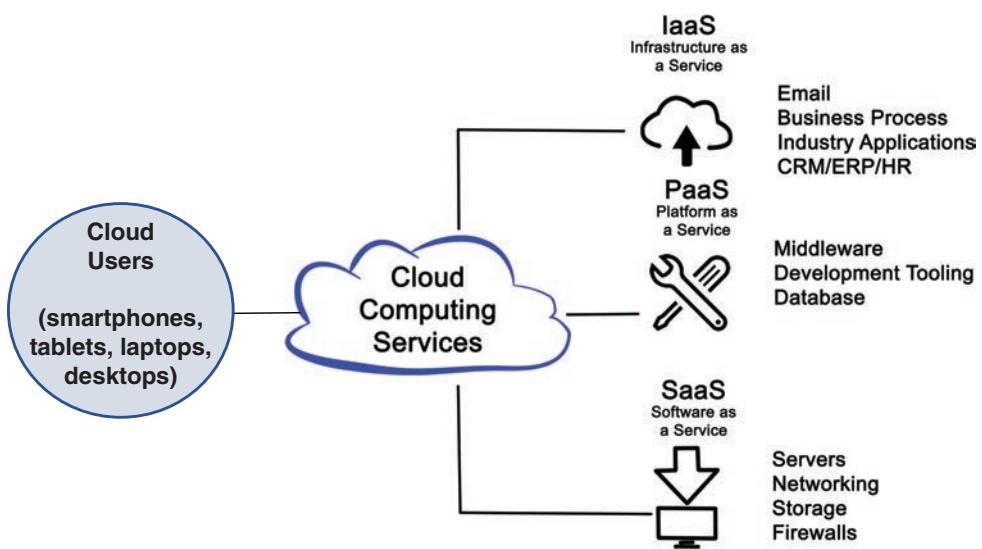
An information systems model in which users are provided with a computing platform, typically including operating system, programming language execution environment, database services, and a Web server.

### software as a service (SaaS):

A software delivery approach that provides users with access to software remotely as a Web-based service.

software deployment and configuration settings. The PaaS provider provides the networks, servers, storage, and other services required to host the consumer's application. PaaS enables application developers to develop, test, and run their software solutions on a cloud platform without the cost and complexity of buying and managing the underlying hardware and software.

- **Software as a service (SaaS)** is a software delivery approach that provides users with access to software remotely as a Web-based service. SaaS pricing is based on a monthly fee per user and typically results in lower costs than a licensed application. Another advantage of SaaS is that because the software is hosted remotely, users do not need to purchase and install additional hardware to provide increased capacity. Furthermore, the service provider handles necessary software maintenance and upgrades.



**FIGURE 8.2**  
**The cloud computing environment**

Cloud computing can be divided into three main types of services: infrastructure as a service (IaaS), platform as a service (PaaS), and software as a service (SaaS).

### Issues with Public Cloud Computing

Although public cloud computing offers the benefits of reduced costs, flexible computing capacity, and increased redundancy in the event of disaster, companies contemplating moving to the cloud are advised to proceed carefully, as organizations frequently encounter major challenges during the transition. Common problems include complex pricing arrangements, wide variations in performance over time, inadequate data security, and vendor lock-in.

Cloud computing arrangements can be lengthy and complex, and they are often subject to more than one interpretation. Organizations are advised to use experienced legal, purchasing, and IS resources to review and modify, where necessary, a cloud service provider's standard contract. Failure to do so may result in unexpected costs that reduce the expected cost savings.

Cloud service provider performance issues can result in wide variations in performance over time and greater than expected downtime for tenants. Tenants rely on the service provider to provide the valuable capability of quickly ramping up or down the amount of computing capacity made available to them. Failure to respond quickly to a capacity change request can greatly reduce the value of cloud computing. In addition, the service provider's

disaster recovery capabilities must be adequate to meet each tenant's needs. A loss of capability for anything longer than a few minutes may be disastrous to tenants who are running mission-critical applications in the cloud, and it may quickly impact their revenue-generation and customer service capabilities.

Data security is another key concern when using a public cloud computing service because you are relying on someone else to safeguard your data, which may even reside on the same storage device as data from another organization (perhaps even a competitor). All these potential issues must be investigated fully before entering into a public cloud computing arrangement. Organizations subject to complex regulatory requirements (e.g., financial, health care, and public utility organizations) must ensure that their own processes and applications—as well as those of the cloud provider—are compliant with those regulations.

A major start-up issue that organizations should also consider is the amount of effort involved in moving to the cloud in the first place. This introduces the issue of vendor lock-in—meaning once an organization has gone through the effort required to transition its infrastructure and/or data to a public cloud provider, it will likely be very reluctant to go through the time-consuming migration process a second time, even if concerns arise with the vendor they are working with. Because of this, organizations must choose their cloud provider wisely, as it is a business relationship that the organization will likely need to live with for the foreseeable future.

## Private Cloud Computing

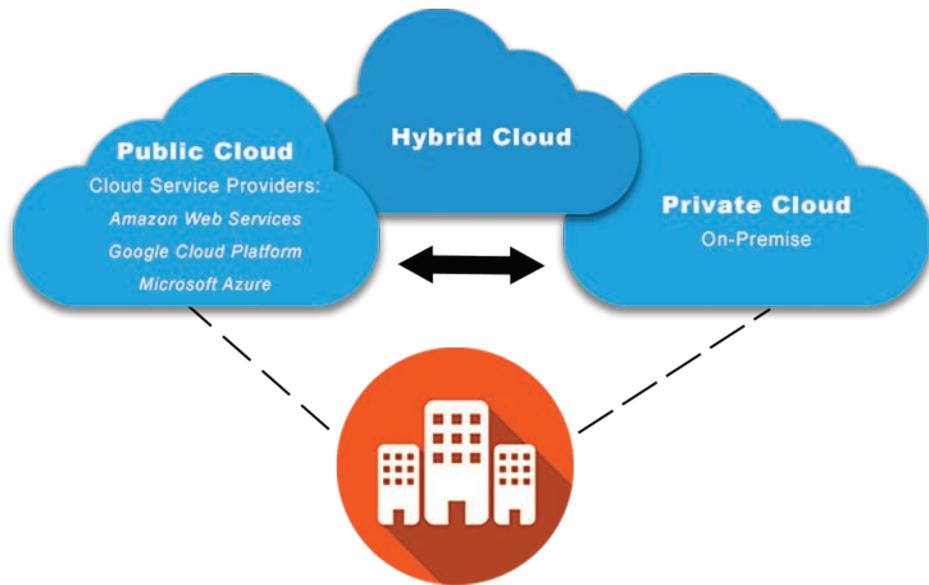
**private cloud computing environment:** A single-tenant cloud.

A **private cloud computing environment** is a single-tenant cloud. Organizations that implement a private cloud often do so because they are concerned that their data will not be secure in a public cloud. An organization might establish several private clouds with one for finance, another one for product development, and a third for sales, for example. Each private cloud has a defined set of available resources and users, with predefined quotas that limit how much capacity users of that cloud can consume. Private clouds can be divided into two distinct types. Some organizations build their own on-premise private cloud, and others elect to have a service provider build and manage their private cloud (sometimes called a virtual private cloud). When considering the total cost of ownership, which includes the IT platform, applications, and services, many organizations have found that a private cloud is comparable or less than the total cost of an on-premises environment, while also providing benefits, such as being able to work anywhere and on any device. Some companies have found that they can save over 70 percent on computing expenses over the course of five years by switching to the cloud.<sup>3</sup> However, many complications must be overcome—and deep technical skills and sophisticated software are needed—to successfully build and manage a private cloud.

Pfizer, a global leader in the pharmaceutical industry, wanted to address the way it handled computing needs at peak times. The company found a solution in Amazon's VPC (Virtual Private Cloud), which was set up to enhance Pfizer's high-performance computing systems and improve performance during peak demand.<sup>4</sup> The Amazon VPC offered Pfizer additional levels of security and an ability to integrate with the company's existing technology infrastructure. Pfizer now uses the VPC to provide a secure environment in which to carry out complex research calculations. The VPC's job scheduler function manages workload, and adds additional instances as needed to address demand. As a result, Pfizer avoided the need for some additional hardware and software investments, which freed up more money for investing in the company's research and development activities.<sup>5</sup>

## Hybrid Cloud Computing

**hybrid cloud computing environment:** A cloud computing environment is composed of both private and public clouds integrated through networking.



**FIGURE 8.3**  
**Hybrid Cloud Environment**

Source: [https://www.google.com/search?q=diagram+of+hybrid+cloud&rlz=1C1SQJL\\_enUS795US795&tbo=isch&source=iu&ictx=1&fir=gkwwFN7GW0Y22M%253A%252CggnWtMh4MoSaRbM%252C\\_&usg=AI4\\_-kSDF\\_skSpA-ZIJQ8Lh699ApjtYlqw&sa=X&ved=2ahUKEwjzguSB26veAhXRz1MKHRjyCkgQ9QEwAXoECAQQBg#imgrc=4OQqHNyZ-p\\_t\\_M](https://www.google.com/search?q=diagram+of+hybrid+cloud&rlz=1C1SQJL_enUS795US795&tbo=isch&source=iu&ictx=1&fir=gkwwFN7GW0Y22M%253A%252CggnWtMh4MoSaRbM%252C_&usg=AI4_-kSDF_skSpA-ZIJQ8Lh699ApjtYlqw&sa=X&ved=2ahUKEwjzguSB26veAhXRz1MKHRjyCkgQ9QEwAXoECAQQBg#imgrc=4OQqHNyZ-p_t_M)

Integrating data across applications, including data from different vendors, or located in different data centers is common in cloud computing environments. Organizations typically use the public cloud to run applications with less sensitive security requirements and highly fluctuating capacity needs, but run more critical applications, such as those with significant compliance requirements, on the private portion of their hybrid cloud. So, a hospital may run its Web conferencing and email applications on a public cloud while running its applications that access patient records on a private cloud to meet Health Insurance Portability and Accountability Act (HIPAA) and other compliance requirements. The network used with a hybrid cloud must provide a secure, reliable, low latency private connection between the user's private and public cloud environments and any business location. Security is a critical responsibility that is shared between the network providers, the cloud provider, and the user. As computing and processing demands rise and fall, a hybrid environment allows businesses to scale their in-house computing infrastructure to the public cloud to handle any additional demand for resources. Data and applications can be shared between the two clouds, as organizations use the public cloud for basic tasks while keeping sensitive data and applications on premises behind a firewall. Companies pay only for the additional resources they use during peak times rather than having to purchase, configure, and maintain additional servers needed to handle temporary computing demands. Hybrid cloud computing provides flexibility, scalability, and cost efficiency with low security risks.<sup>6</sup>

Public cloud, on-premise private cloud, virtual private cloud, and hybrid cloud are four major forms of cloud computing. According to Flexera's 2019 State of the Cloud Report, an estimated 84 percent of enterprises now use multicloud solutions, and enterprises with a hybrid strategy combining public and private clouds grew to 58 percent in 2019. An estimated 91 percent use public cloud, 72 percent use hosted private cloud, and 69 percent using at least one public and one private cloud. Fewer than 10 percent of large organizations employ just a single public cloud, and only about 4 percent employ a single private cloud.<sup>7, 8</sup>

When moving to a multicloud environment, organizations must consider the expected performance of its applications, security concerns, regulatory compliance, availability requirements, and total cost savings.

## Autonomic Computing

**autonomic computing:** The ability of IT systems to manage themselves and adapt to changes in the computing environment, business policies, and operating objectives.

An enabling technology for cloud computing is **autonomic computing** or the ability of IT systems to manage themselves and adapt to changes in the computing environment, business policies, and operating objectives. The goal of autonomic computing is to create complex systems that run themselves, while keeping the system's complexity invisible to the end user. Autonomic computing addresses four key functions: self-configuring, self-healing, self-optimizing, and self-protecting. As cloud computing environments become increasingly complex, the number of skilled people required to manage these environments also increases. Software and hardware that implement autonomic computing are needed to reduce the overall cost of operating and managing complex cloud computing environments. While this is an emerging area, software products such as Tivoli from IBM are partially filling the need.



## Critical Thinking Exercise

### DoD Implements JEDI Solution

#### ► APPLICATION

The Department of Defense (DoD) is responsible for coordinating and supervising all agencies and functions of the government concerned directly with national security and the U.S. Armed Forces. It has an annual budget of \$716 billion and employs 287 million service employees and 732 thousand civilian employees.<sup>9</sup>

The DoD currently relies on a largely fragmented and on-premises computing and storage solution, with data centers and computing facilities located at hundreds of locations around the world. Tedious data and application management processes are required to add computing and storage capacity, forcing the DoD to forego new computing and storage capacity to meet the needs of new DoD programs or plod through a lengthy acquisition, rollout, and provisioning process.

The DoD has proposed a 10-year, \$10 billion Joint Enterprise Defense Infrastructure (JEDI) program to move its computing and storage capacity to the cloud. The contract is designed to establish the cloud technology strategy for the military over the next 10 years as it begins to take advantage of the latest innovation such as the Internet of Things (IoT), artificial intelligence, and big data. The JEDI project will account for 20 percent of the DOD's spending on cloud services and infrastructure.<sup>10</sup>

The DoD would like a single cloud vendor to build out its enterprise cloud because it believes that is the best way to maintain focus and control of its cloud strategy. The DOD also believes that such an approach increases security, improves data accessibility, and simplifies the DoD's ability to adopt and use cloud services. However, such an approach is counter to the approach of many large organizations around the world that are adopting multicloud solutions.

In 2019, the DoD's move to the cloud became more complicated after Oracle filed a protest alleging that the bid review process unfairly favors Amazon because the DoD has an existing contract with Amazon Web Services (AWS) to provide classified cloud services and infrastructure, giving one vendor dominance in the government sector. Both the DoD and the U.S. Government Accountability Office have rejected this argument.<sup>11</sup>

### Review Questions

1. What benefits are the DoD likely to achieve from moving from a fragmented and on-premises computing and storage solution to a cloud-based computing environment?
2. What are some of the issues that the DoD faces in making this move to the cloud?

### Critical Thinking Questions

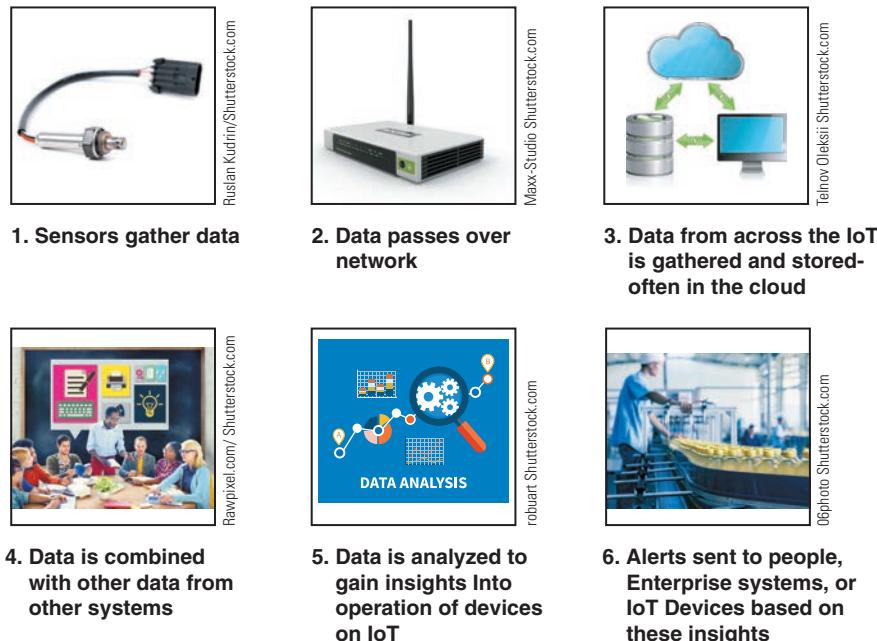
1. What are the pros and cons of adopting a single cloud vendor solution as compared with engaging multiple cloud providers to meet the needs of the DoD?
2. Research recent developments in the DoD JEDI project. What lessons can organizations learn from the DoD JEDI project when selecting cloud service providers?

## The Internet of Things (IoT)

The Internet of Things (IoT) is a network of physical objects or “things” embedded with sensors, processors, software, and network connectivity capability to enable them to exchange data with the manufacturer of the device, device operators, and other connected devices (see Figure 8.4).

**FIGURE 8.4**  
**The Internet of Things**

The IoT is a network of physical objects or “things” embedded with sensors, processors, software, and network connectivity capability to enable them to exchange data with the manufacturer of the device, device operators, and other connected devices.



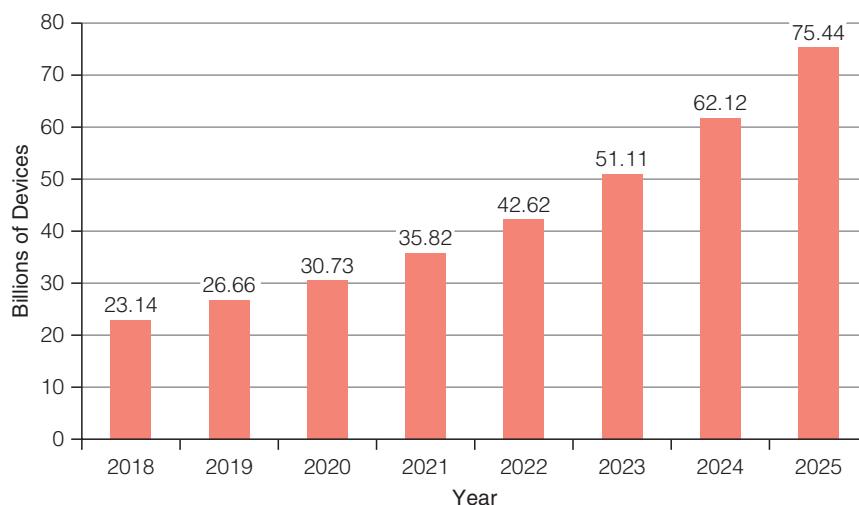
A sensor is a device that is capable of sensing something about its surroundings, such as pressure, temperature, humidity, pH level, motion, vibration, or level of light. The sensor detects an event, such as a change in temperature or humidity, and produces a corresponding output, usually an electrical or optical signal. Sensors are being installed in a variety of machines and products, ranging from home appliances and parking garages to clothing and grocery products. To be truly part of the IoT, these networked devices need IP

addresses and a connection to the public Internet, which allows the data to be transmitted to an operational historical database containing data from many sensors. The database may be on a data storage device in a local control room, in an enterprise data center in another state, or hundreds of miles away in the cloud. The operational data can be accessed via the Internet and analyzed by users with personal computers or mobile devices. Updates, alerts, or even automatic adjustments may be sent to the devices on the IoT based on this analysis. The IoT takes automation to a deep, broad level—one where interconnectivity between various devices exists in a way it never did before.

The number of connected devices worldwide is expected to continue to increase, as shown in Figure 8.5.

**FIGURE 8.5**  
**Estimated number of devices connected to the IoT worldwide**

Source: "Internet of Things (IoT) connected devices installed base worldwide from 2015 to 2025 (in billions), Statista, <https://www.statista.com/statistics/471264/iot-number-of-connected-devices-worldwide/>, accessed October 26, 2018.



### **Examples of IoT**

IoT technology is finding its way into automated homes, wearable devices, smart cities, and autonomous vehicles, as described in the following paragraphs:

- **Home automation.** Smart homes are becoming more popular as the enabling technologies have become more affordable and easier to configure. Smart speakers, such as Google Home and Amazon Alexa, connect to the Internet and respond to your voice commands to perform functions such as reviewing calendar appointments, performing search queries, streaming music, and turning on or off lights connected to smart outlets. Networked home automation also enables users to adjust the thermostat, monitor a home security system, turn on or off a television or other appliances, and adjust windows or blinds using apps on their smartphones.
- **Wearable devices.** Wearable devices include sensors that can collect information such as your location and vital signs. Smartwatches track your location and allow you to check email, read text messages, and make phone calls. Fitness trackers, such as Fitbit, can track your heart rate and communicate that data to your mobile device for biofeedback therapy and exercise monitoring. Medical services providers, including hospitals, insurance companies, and medical device companies, often have access to this data, making accuracy and privacy important considerations for users of wearable devices.
- **Smart cities.** The IoT is also influencing city planning. A **smart city** uses data from sensors combined with artificial intelligence to improve its infrastructure and efficiently manage traffic lights, power plants, water supplies, networks, energy usage, and other resources. Automation systems monitor and improve lighting and air conditioning in office buildings, and these enhancements can increase workplace productivity. Smart transportation

**smart city:** Cities that make use of data from sensors combined with artificial intelligence to improve infrastructure and efficiently manage traffic lights, power plants, water supplies, networks, energy usage, and other resources.

systems monitor traffic patterns and provide up-to-the-minute information to drivers, making it easier to navigate the city. Smart garbage dumpsters placed on city streets are equipped with sensors that send a notification to the city's public works department when they are full, streamlining operations and saving labor and vehicle wear, as bins need only be emptied when they are full. Barcelona, Spain, was named the first "Smart City" in Europe because of its efficient public transportation, use of data to monitor traffic and parking patterns, and innovative use of solar energy.

- **Autonomous vehicles.** Smart cars have sensors that capture data such as vehicle location and gas mileage, and report this information back to their owner's mobile device or a service provider. Other sensors monitor objects in the car's blind spots and at the front and rear of the car to aid in driving or parking. Self-driving vehicles rely on maps, traffic information, and weather data stored in the cloud along with cameras and sensors that collect data that the vehicle's systems can quickly analyze to determine when it should speed up, slow down, change lanes, or turn. Tesla and Google have been pioneers in developing autonomous vehicles.

## Enabling Connectivity with 5G

**5G (5<sup>th</sup> generation):** The latest generation of mobile communications, featuring high data transfer speeds over high frequencies with minimal latency and requiring low energy.

Advances in 5G technology are changing the way consumers and large enterprises use the IoT. **5G (5<sup>th</sup> generation)** is the latest generation of mobile communications, featuring high data transfer speeds over high frequencies with minimal latency (delays in response time) and requiring low energy. 5G uses millimeter wave, a higher frequency band of the wireless spectrum, which allows data to be transferred at faster rates than the lower frequency bands used by 4G networks. However, because millimeter wave signals do not travel as far as 4G signals, carriers must place 5G antennas closer together than was required for prior generations of wireless networks.

5G enables many devices to transmit data quickly to the cloud where it can be stored or analyzed, and the technology will make possible new services that can transform industries such as performing remote surgery, streaming high definition movies, operating drones to deliver medical supplies, and conducting security and surveillance operations.<sup>12</sup> Self-driving cars will rely on 5G for their sensors, which interact with other cars on the road and process traffic and mapping information in real time. Smartphones operating on 5G networks will support enhanced immersive experiences with augmented and virtual reality.

Major mobile carriers in the United States are investing billions of dollars to upgrade their networks to be able to support 5G connectivity. Controlled rollouts began in major cities in 2019, and availability is expected to quickly increase in subsequent years.<sup>13</sup>

Table 8.1 provides some historical background showing the developments in networking technology leading up to 5G networks.<sup>14</sup>

**TABLE 8.1** Developments leading up to 5G networking capabilities

Generation	Year introduced	Capabilities	Speed
1G	1986	Analog voice calls on mobile phones	2.4 kb/sec
2G	1991	Digital voice, text messaging	64 kb/sec
3G	2001	Mobile data, Internet connectivity	2 mb/sec
4G / LTE	2011	Enhanced speeds capable of broadband video streaming	100 mb/sec
5G	2020	Fast data transfer, with minimal latency and ability to connect many IoT devices	1–10 Gbps

## Business Benefits of IoT

Application of the IoT can bring four key benefits to an organization:

1. **Reduce costs to achieve a competitive advantage.** Manufacturers can use IoT devices to monitor production equipment and minimize downtime by predicting failures and scheduling necessary preventative maintenance. IoT-enabled sensors on equipment, such as a conveyor line, can alert plant floor personnel to problems in real time. The data can also be analyzed to uncover patterns that allow technicians to predict potential failures or redeploy resources in a more optimal fashion. Organizations can also reduce energy costs by using IoT and smart building systems to monitor and control unnecessary usage of electrical systems. IoT devices can help manufacturers sectors accurately assess demand and efficiently manage various stages of production through real-time tracking of parts and raw materials.
2. **Deepen the organization's understanding of consumer preferences and behaviors.** The key to the success of any business, especially in the consumer goods and retail sector, is understanding customer preferences and behavior. IoT devices can collect, monitor, and analyze data from video surveillance, social media, mobile, and Internet usage. With this data, marketing analysts can predict preferences and forecast trends so that the business can design products and offer personalized value-added services for better customer engagement, with the goal of retaining target consumers and fostering brand loyalty.
3. **Improve customer service and experience.** Superior customer service is a key factor in ensuring the success of any service. Mobile card readers that can connect to smartphones to process transactions and smart trackers that enable consumers to keep track of their shipped products can improve customer experience and overall satisfaction. For example, IoT sensors are used extensively in the utilities industry to capture operational data to achieve 24/7 uptime. Sensor data is carefully analyzed to predict when critical pieces of equipment or power lines are about to fail so that quick, anticipatory corrective action can take place before any failure.
4. **Improve workplace safety.** IoT devices can help employers ensure worker safety and enhance overall workplace security. With sensors embedded in safety helmets and wristbands, workers in high-risk environments such as mining, heavy industries, and construction can be continuously monitored to guard against potential injuries and exhaustion. Organizations can employ video surveillance cameras and smart locks to monitor office premises and ensure the protection of important assets.

## Types of IoT Applications

IoT applications can be classified into one of four types, as shown in Table 8.2. Consider the following examples of the four basic types of IoT applications:

- **Connect and monitor.** Food and drug manufacturers can monitor shipping containers for changes in temperatures that could affect product quality and safety using inexpensive battery-powered sensors and 4G LTE or 5G connectivity.
- **Control and react.** Retailers use sensors to detect the in-store behavior of customers, allowing them to optimize the shopping experience to increase revenue and market share. Streaming data from sensors is analyzed along with other information, including inventory data, social media chatter, and online-shop user profiles, to send customized offers to shoppers while they are in the process of making a purchase decision.

**TABLE 8.2** Types of IoT applications

Type of IoT application	Degree of sensing	Degree of action
Connect and monitor	Individual devices each gather a small amount of data	Enables manual monitoring using simple threshold-based exception alerting
Control and react	Individual devices each gather a small amount of data	Automatic monitoring combined with remote control with trend analysis and reporting
Predict and adapt	External data is used to augment sensor data	Data used to perform predictive analysis and initiate preemptive action
Transform and explore	Sensor data combined with external data is used to provide new insights	New business models, products, and services are created

- **Predict and adapt.** Compology is a company that provides dumpster-monitoring software for waste haulers to streamline their operations and improve customer service. The software is powered by camera-based sensors and GPS devices that track garbage container fullness, location, and motion. Drivers are equipped with tablets with customized apps that provide real-time data on trash containers in need of service, as well as the fastest routes to do it.<sup>15</sup>
- **Transform and explore.** Enlightened organizations apply analytics to the streams of data gathered by IoT devices—even before the data is stored for post-event analysis. This enables workers to detect patterns and potential problems as they are occurring and to make appropriate adjustments in the operation of the devices being measured. For example, sensors embedded in General Electric (GE) aircraft engines collect some 5,000 individual data points per second. This data is analyzed while the aircraft is in flight to adjust the way the aircraft performs, thereby reducing fuel consumption. The data is also used to plan predictive maintenance on the engines based on engine component wear and tear. This technology helped GE earn \$1 billion in incremental income by delivering performance improvements, less downtime, and more flying miles.<sup>16</sup>

## Potential Issues with IoT Applications

Unfortunately, there can be many issues with the receipt and usability of sensor data. Sometimes a faulty sensor or bad network connection results in missing data or sensor data that lacks a time stamp indicating when the reading occurred. As a result, sensor data can be incomplete or contain inconsistent values, indicating a potential sensor failure or a drop in a network. Developers of IoT systems must be prepared for and be able to detect faulty sensor data.

Security is a very major issue with IoT applications. In today's manufacturing environment, the factory network is a closed environment designed to communicate with plant sensors and devices but not typically with the outside world. So, there is a key decision that organizations must make when considering implementation of an IoT: Are the benefits of doing so sufficient to overcome the risk of making detailed company information accessible through the Internet and exposing internal systems to hacking, viruses, and destructive malware? Hackers who gain access to an organization's IoT can steal data, transfer money out of accounts, and shut down Web sites. They can also wreak physical havoc by tampering with critical infrastructure such as air traffic control systems, health care devices, power grids, and supervisory control and data acquisition (SCADA) systems. One of the first things developers of IoT application should focus on is building in security from the start. This needs to include ways of updating the system in a secure manner.



## Critical Thinking Exercise

### Manufacturer Weighs Converting to Internet of Things (IoT)

#### ► REFLECTIVE THINKING

Traditionally, car insurance premiums are set based on the type of vehicle and the demographics of the driver. As a result, young drivers are charged much higher premiums. Several auto insurance companies are now employing low-cost in-car sensors with the ability to provide real-time data and advancements in mathematical modeling techniques to improve their risk assessment models. The sensors can record immense amounts of data related to the vehicle and driver. Insurers and underwriters can use this data to judge risk based on a much more individual basis than ever before.

Your insurance company has offered you the option of installing a small telematics device into your car's diagnostics port. This device records data such as the vehicle's speed, distance traveled, time of day, and the rate of acceleration and braking. By analyzing this data, the insurer can determine the driver's style and adjust the premium as necessary. While no guarantee was made, your agent says that there is potential that your premium could be reduced.

#### Review Questions

1. Which of the four types of IoT application does this device represent?
2. What security concerns might using this device raise?

#### Critical Thinking Questions

1. What additional benefits might be gained from use of this device?
2. If you had access to a telematics device, would you use it in your car in exchange for potentially smaller insurance premiums? How does using this device impact your privacy?

## Summary

### Principle:

**Cloud computing provides access to state-of-the-art technology at a fraction of the cost of ownership and without the lengthy delays that can occur when an organization tries to acquire its own resources.**

Cloud computing refers to a computing environment in which software and storage are provided as an Internet service and can be accessed by users with their Web browser. Computing activities are increasingly being delivered over the Internet rather than from software installed on PCs.

Cloud computing offers three key benefits—reduced costs, flexible computing capacity, and increased redundancy in case of a disaster.

A cloud service provider can deliver increasing amounts of computing, network, and storage capacity on demand, without requiring any capital investment on the part of the cloud users. Cloud computing can also lower the ongoing investment in people and other resources required to manage the hardware. Cloud service providers operate multiple data centers spread out geographically, and they save multiple copies of tenants' data on different machines.

Cloud computing can be deployed in several different ways, including public cloud computing, private cloud computing, and hybrid cloud computing.

In a public cloud computing environment, a service provider organization owns and manages the infrastructure (including computing network, storage devices, and support personnel) with cloud user organizations (called tenants) accessing slices of shared resources via the Internet. In a private cloud

deployment, cloud technology is used within the confines of a private network. Organizations that implement a private cloud often do so because they are concerned that their data will not be secure in a public cloud.

A hybrid cloud is composed of both private and public clouds integrated through networking. Organizations typically use the public cloud to run applications with less sensitive security requirements and highly fluctuating capacity needs, while running more critical applications, such as those with significant compliance requirements, on the private portion of their hybrid cloud.

Most organizations implement a multicloud strategy to balance high application performance, security concerns, regulatory compliance, availability requirements, and total costs. Autonomic computing is an enabling technology for cloud computing that enables systems to manage themselves and adapt to changes in the computing environment, business policies, and operating objectives.

Cloud computing can be divided into three main types of services: infrastructure as a service (IaaS), software as a service (SaaS), and platform as a service (PaaS).

Organizations contemplating moving to the cloud are advised to proceed carefully, as almost one in three organizations encounter major challenges as they transition to the cloud. Common problems include complex pricing arrangements and hidden costs that reduce expected cost savings, issues that cause wide variations in performance over time, inadequate data security, poor user support, and greater than expected downtime.

### Principle:

**Organizations are using the Internet of Things (IoT) to capture and analyze streams of sensor data to detect patterns and anomalies—not after the fact, but while they are occurring—in order to have a considerable impact on the event outcome.**

The Internet of Things (IoT) is a network of physical objects or “things” embedded with sensors, processors, software, and network connectivity capability to enable them to exchange data with the manufacturer of the device, device operators, and other connected devices.

Organizations that have implemented IoT solutions have found four key benefits: reduced costs, a deeper understanding of consumer preferences and behaviors, improved customer service and experiences, and improved workplace safety.

As 5G networks continue to evolve, they will enable fast data transfer and increased ability to connect many IoT devices that have the potential to transform industries through new services that previously were not possible.

IoT application types include connect and monitor and control and react, where individual devices each gather a small amount of data; predict and adapt, where external data augments sensor data; and transform and explore, where sensor data combined with external data is used to provide new insights, enabling the creation of new business models, products, and services.

## Key Terms

5G (5<sup>th</sup> generation)  
autonomic computing  
cloud computing  
e-discovery (electronic discovery)  
hybrid cloud computing environment  
infrastructure as a service (IaaS)

platform as a service (PaaS)  
private cloud computing environment  
public cloud computing environment  
smart city  
software as a service (SaaS)  
virtualization tools

## Self-Assessment Test

**Cloud computing provides access to state-of-the-art technology at a fraction of the cost of ownership and without the lengthy delays that can occur when an organization tries to acquire its own resources.**

1. Three commonly used approaches to cloud computing are public cloud computing, private cloud computing, and \_\_\_\_\_ cloud computing.
2. Public cloud computing offers three key benefits to organizations including \_\_\_\_\_.
  - a. reduced costs, increased data privacy and security, and vendor lock-in
  - b. flexible computing capacity, freedom from performance issues, and increased redundancy in the event of disaster
  - c. freedom from performance issues, reduced costs, and vendor lock-in
  - d. increased redundancy in the event of disaster, reduced costs, and flexible computing capacity
3. Common issues encountered when moving to public cloud computing include complex pricing arrangements, performance issues, inadequate data security, and \_\_\_\_\_.

4. A private cloud computing environment can provide more data security than a public cloud computing environment. True or False?

**Organizations are using the Internet of Things (IoT) to capture and analyze streams of sensor data to detect patterns and anomalies—not after the fact, but while they are occurring—in order to have a considerable impact on the event outcome.**

5. Network connectivity is not required for objects with sensors to exchange data with other connected devices. True or False?
6. A faulty sensor or a bad network connection can result in \_\_\_\_\_ or IoT sensor data that lacks a time stamp indicating when the reading occurred or.
7. One of the first things developers of IoT applications should focus on is building in \_\_\_\_\_ from the start.
  - a. redundancy and backup
  - b. cost controls
  - c. security
  - d. disaster recovery

## Self-Assessment Test Answers

1. hybrid
2. d
3. vendor lock-in
4. True
5. False
6. missing data
7. c

## Review and Discussion Questions

1. What is cloud computing? Identify three approaches to deploying cloud computing.
2. Cloud-based office solutions, including productivity, collaboration, and communication tools, have been widely used since they were first introduced to consumers. Identify several factors that organizations must consider when implementing these tools across the enterprise.
3. What is autonomic computing, and how does it benefit cloud computing? What is the Internet of Things (IoT), and how is it used?
4. Identify some of the issues and concerns associated with connecting devices to the Internet of Things (IoT).
5. Identify and briefly discuss four problems frequently encountered by organizations moving to the cloud.
6. Identify several benefits companies can experience when moving to the cloud.
7. Identify the four types of IoT applications and give an example of each.
8. Summarize and discuss the pros and cons of different cloud computing models.

## Business-Driven Decision-Making Exercises

1. You work for a mid-sized law firm, and your boss has asked you to research Amazon Web Services (AWS), Google Compute Engine, and Windows Azure cloud computing services. Write a paragraph summarizing each service. Prepare a spreadsheet to compare the three services based on ease of use, cost, and other key criteria of your choosing. Based on your findings, which service provider would you recommend for your firm?
2. You have been hired to develop a plan for improving traffic flow, waste management, security, and other municipal services in a large urban area. Describe the approaches, IoT technologies, or networking solutions you might propose to create a “smart city” that will allow government entities to use the data that is collected to make better, more informed decisions.

## Teamwork and Collaboration Activities

1. Form a team to identify IoT sensors in high demand in the medical device/pharma/bio-med industry. How are these sensors being used? What companies manufacture them? What do they cost if purchased in large quantities? Write a summary of your team’s findings.
2. Form a team to plan a visit to a city that has been designated as a smart city. Each team member should research one initiative that the city has taken in areas such as sustainability, public safety, transportation, and other factors influenced by IoT developments. Prepare a digital presentation using a cloud-based tool such as Pinterest, PowerPoint Online, or Google Slides to share your findings with your team.
3. You are the Chief Information Officer for a startup “FinTech” (financial services/technology) company that currently has 12 employees and expects to grow to 50 employees by the end of the year. Form a team to research and recommend a cloud-based office service such as Office 365 or G Suite for the company. Prepare your report with your team using a cloud-based tool, such as Google Docs or Word Online, and if you have access to G Suite or Microsoft Teams, use one of these tools to facilitate your collaboration.

## Career Exercises

1. You are working for a small real estate firm that is considering a migration from an on-premise technology infrastructure to one hosted in the cloud. What benefits might you identify when a real estate company moves to the cloud? Which cloud technologies and platforms might you research? What information might you want to know before recommending whether a public, hybrid, or private cloud architecture is appropriate? What trainings, certifications, or prior work experiences might you seek if you need additional training to guide the company’s move to the cloud?
2. TechWatch is an IoT company creating new consumer solutions for home automation and wearable devices. Write job descriptions for an entry-level position as well as a more senior position that the company might post on monster.com or another job-listing Web site to recruit candidates. Describe the job responsibilities, experience and education required, and possible salary ranges in your area.

## Case Study



### Coca-Cola Benefits from IoT

The Coca-Cola Company leads a worldwide franchise system built on the foundation of local bottlers. Its many flavors of Coke—plus Fanta, Powerade, Dr. Pepper, and Sprite—are worldwide favorites. Collectively, Coca-Cola has more than 100,000 employees in the United States, nearly 70 independent Coca-Cola bottlers across the United States,

and another 225 bottling partners worldwide. Coca-Cola manufactures and sells concentrates, beverage bases, and syrups to the bottlers. It also owns the brands and is responsible for consumer brand marketing initiatives.

Coca-Cola bottling partners work closely with local businesses, including amusement parks, convenience stores, grocery stores, movies, restaurants, and street vendors, to

execute localized strategies developed in partnership with Coca-Cola. These outlets sell Coca-Cola brand soft drinks to consumers at a rate of more than 1.9 billion servings a day. This approach has enabled Coca-Cola to create a global reach with a local focus.

In recent years, Coca-Cola has been developing intelligent IoT-connected coolers that provide data that the company hopes will improve productivity and boost sales at local outlets. These refrigerator units, which vend and dispense Coca-Cola products, establish secure network connections to a cloud-based IoT platform over which the data can be processed and analyzed. The coolers, which Coca-Cola first tested in Bulgaria in 2015, are currently being tested in smaller retail chains in Chicago and Dallas, and they are expected to provide the company, bottlers, and retailers several benefits.

An IoT-connected cooler captures and reports data such as product temperature, compressor cycles, and power consumption that can be used to trigger preventative maintenance and avoid cooler outages. For example, retailers can identify a compressor that is running continuously and work to quickly resolve the issue. Data from the IoT-enabled coolers will also identify the busiest locations and most popular drinks, helping retailers to accurately set inventory levels and calculate machine profitability. Cameras and sensors can monitor cooler door openings and product movement to optimize sales. For example, retailers may discover that two large single-door coolers had less combined activity than one small single-door cooler. Connected coolers will also allow retailers to detect changes in shopper patterns that can be linked to daily sales figures, promotions, and changes in cooler location or temperature.

The Coca-Cola Company has partnered with technology firms AirWatch, SAP, and Salesforce to pilot the use of these coolers in select markets. Coca-Cola is purposefully starting slowly, rolling out parts of the program, including training sales teams, to ensure it gets the right data flowing before expanding more broadly. Pilot success will be determined by the ability of the connected coolers to help with preemptive equipment maintenance, stock optimization, and personalized customer communication.

Coca-Cola Hellenic Bottling Company (Coca-Cola HBC) is one of the world's largest bottlers for The Coca-Cola Company. It has operations in Russia, Nigeria, and 26 countries in Europe, serving roughly 595 million consumers. Coca-Cola HBC is taking a much more aggressive approach to rolling out connected coolers by partnering with Atos Codex

(a European IT services company), eBest IoT, and Microsoft. By the end of 2018, Coca-Cola HBC had deployed more than 300,000 refrigeration units. By adding IoT sensors and cameras to coolers, artificial intelligence software can process the data received from the sensors and cameras in real time and then recommend processes to streamline stocking, identify failing coolers, improve asset optimization, and predict inventory levels. Coca-Cola HBC's sales increased by 10 percent as a result of the pilot project.

Smart coolers also enable proximity interaction with the use of mobile apps, enabling Coca-Cola HBC to engage with customers in real time, such as offering customized offers and near-me promotions. In the long term, Atos predicts, the technology will connect Coca-Cola HBC's entire fleet of 1.6 million coolers.

### Critical Thinking Questions

- How might The Coca-Cola Company and/or its bottlers use connected coolers to engage with customers in real time? What advantages might this capability provide?
- The many Coca-Cola bottlers worldwide may employ different technology partners and different technology solutions to implement the connected coolers. They are likely to rollout the technology over different timeframes. Will this lack of standardization hinder the success of this initiative?
- Is there a need to share the data collected from the various bottlers? What issues might arise in attempting to share this data?

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# PART 3

# Business Information Systems

**Chapter 9**  
**E-Commerce**

**Chapter 10**  
**Enterprise Systems**

**Chapter 11**  
**Artificial Intelligence (AI) and  
Automation**



## Principles

- Organizations must define and execute an effective strategy to be successful in e-commerce.
- E-commerce is evolving, providing new ways of conducting business that present both potential benefits and potential problems.
- E-commerce can be used in many innovative ways to improve the operations of an organization.
- E-commerce requires the careful planning and integration of many technology infrastructure components.

## Learning Objectives

- Describe the underlying concepts of e-commerce.
- Outline a multistage purchasing model that describes how e-commerce works.
- Outline the key components of a successful e-commerce business strategy.
- Discuss common types of e-commerce applications.
- Discuss key features of electronic payment systems needed to support e-commerce.
- Identify the key components of technology infrastructure that must be in place for e-commerce to work.

# IS in Action

## E-Commerce is on Your Campus Now

### ► ANALYTICAL THINKING, APPLICATION

So many university students have reached a level of technological agility that universities may find it difficult to develop information systems that meet their expectations. Many would agree that today's students have lived with smartphones and the Web their entire life, and they may have a better understanding of the role of technology in society and business than the older generations that are creating the current e-commerce applications. Universities are organizations and understand that students are the consumers of their products—not only academics but also food service, housing, textbooks, school apparel, and a host of other products/services.

We will focus on one school for its e-commerce solution to selling school apparel and then focus on a small group of schools that are addressing food delivery to their students. The University of Oregon has students, alumni, and friends that strongly support their athletic teams. When they reached the NCAA Tournament Sweet Sixteen in March 2017 the demand for T-shirts, sweat shirts, and other memorabilia surged. The Duck Store—formerly the University of Oregon Bookstore—has 11 locations across Oregon as well as online sales. The online sales are one facet of the total sales effort that ties into the same enterprise resource planning system, point-of-sale-system, inventory system, and marketing system used for all sales.

Online sales are subject to intense and sudden surges in activity, such as the Oregon win over Kansas that propelled the Ducks into the Final Four of the tournament. Order volume rose 350 percent for the Duck Store during this period compared to orders for the same time period the year before. Web page views rose 127 percent. How does an online system for a bookstore handle such large, sudden increases in activity? By planning ahead.

In 2014, The Duck Store migrated to Oracle's NetSuite as an e-commerce provider that integrates online sales with all other sales channels. This let The Duck Shop migrate from a collection of older legacy systems that often did not digitally communicate with each other. The integration allows for rapid response to online sales, such as pulling inventory from physical retail stores to meet the sudden surge of sales online. Sales that would have been backordered if online sales were a standalone system.

Student purchases of T-shirts swell as their teams win, but meals are purchased every day. Students bring the same expectations of food service choices to their university as they had before arriving at college. They expect an app that takes their order, and they expect the order to be delivered. The trend to have major food chains on campus is ancient history. Pre-ordering food for pick-up has improved the experience at campus dining outlets but has not really changed the process of ordering a meal. The kiosk has moved from the entryway of the outlet to your phone.

Instead of “going to” a place for a meal, the process is now trending towards “bringing a meal” *to* the student. This e-commerce is smartphone driven, where the app and payment systems are loaded to the student’s phone, and a meal delivered to the student is only a few clicks away. But is it?

Universities are more security conscious now than they were even five years ago. Getting a meal delivered to a dorm frequently meant having the student meet the delivery person in the dorm lobby. But not at Boston University. Stoovy Snacks is a school-sanctioned startup that uses Boston University students to deliver food in the dorms. Because the delivery students have BU student IDs, they can deliver right to the dorm room door. The service currently delivers only evening meals from 5 pm until midnight. Boston University benchmark their operations against local restaurants, not other universities.

Emory University in Atlanta focuses on delivering orders from dining halls to students. The app was used for only a couple of hundred mobile orders per day during its first year, but its use is expected to quickly increase this year. As revenues for universities decline, it is important that profits from food services stay on campus instead of flowing to local restaurants.

The University of Massachusetts, Amherst, uses the ordering technology to manage food preparation by their kitchen staff. Better management of kitchen staff turns into higher profits.

Convenience in the selection and delivery of meals has been the major emphasis so far, but there is a new concern on the horizon. Vegan, locally sourced, international foods, holiday meals, and sustainable food sources are only a few of the new concerns driving students' meal choices today. Meals to students are largely driven by student demand, and students want to use their phone for interacting with food service. All of this and more will soon be an app on your phone.

**As you read about e-commerce in this chapter consider the questions below:**

- Some e-commerce focuses not only on a known set of products but also on an unknown amount of demand for those products. How does e-commerce impact the processes within the organization to effectively deal with uncertain levels of demand?
- Some e-commerce is shaped by the changing demands of consumers of the online products. How do organizations become agile and restructure their e-commerce to quickly adapt to changing customer demands?

**As you read this chapter, consider the following:**

- What are the advantages of e-commerce?
- How do innovations in technology and infrastructure affect regions across the globe?
- How do you build e-commerce that accounts for the availability and cost of technology across developed markets, developing markets, and under-developed markets?

## Why Learn About E-commerce?

Over the last several decades, e-commerce has transformed many areas of our lives and careers. One fundamental change has been the manner in which organizations interact with their suppliers, customers, government agencies, and other business partners. As a result, most organizations today have set up business on the Internet. To be successful, all members of the organization need to plan and participate in that effort. As a sales or marketing manager, you will be expected to help define your firm's e-commerce business model. As a customer service employee, you can expect to participate in the development and operation of your firm's Web site. As a human resource or public relations manager, you will likely be asked to provide Web site content for use by potential employees and shareholders. As an analyst in finance, you will need to know how to measure the business impact of your firm's Web operations and how to compare that to competitors' efforts. Clearly, as an employee in today's organization, you must understand what the potential role of e-commerce is, how to capitalize on its many opportunities, and how to avoid its pitfalls. Many customers, potential employees, and shareholders will be accessing your firm's Web site via desktops, smartphones, tablets, and laptops. This chapter begins by providing a brief overview of the dynamic world of e-commerce.

## An Introduction to E-Commerce

E-commerce involves conducting business activities (e.g., distribution, buying, selling, marketing, and servicing of products or services) electronically over computer networks. Some people think of the network as roads that connect the Web sites together, while the Web sites are collections of content located along that network of roads. E-commerce includes any business transaction executed electronically between companies (business-to-business), companies and consumers (business-to-consumer), consumers and other consumers (consumer-to-consumer), public sector and business (government-to-business), the public sector to citizens (government-to-citizen), and public sector to public sector (government-to-government).

Business activities that have proven to be strong candidates for conversion to e-commerce include ones that were paper based, time consuming, and inconvenient for customers. Since the mid-2000s, customers have also developed a huge appetite for digital commerce, which refers to e-commerce that involves a digital transmission—such as a film, a TV episode, music, an e-book, video games, or an event or airline e-ticket—rather than a physical product. This form of e-commerce is growing each year and presents its own set of opportunities and dangers. Sony spent approximately \$44 million to produce the movie *The Interview*. Hackers believed to be working from North Korea hacked the movie in 2014 and threatened Sony if the movie was released and therefore putting the \$44 million investment in jeopardy.<sup>1</sup>

## Categories of E-Commerce

E-commerce, which is enabled by networks and other information technology elements has developed into many distinct categories. Three of the first recognized categories were business-to-business (B2B), business-to-consumer (B2C), and consumer-to-consumer (C2C). Later, with the launch of e-government, the efficiencies of e-commerce were applied to improve the way that governments interacted with citizens and other government entities.

Mobile commerce (m-commerce) has many benefits for convenience but also for more mundane, practical reasons. Smartphones can access the Internet either by the normal radio frequencies for phone conversations or by connecting to a Wi-Fi connection. In most developed countries the adoption of smartphones is already high, and in developing countries the adoption is rising quickly. Moore's Law is again at work making it constantly less expensive for users in developing countries to have access to mobile computing even though the users may not be able to afford a laptop or desktop computer.

But mobile computing has some inherent limitations, most notable is the small amount of space where the e-commerce application can display information. Another limitation is that it is much easier to lose or misplace a smartphone than a desktop or laptop. What happens if someone other than the owner starts using the smartphone for e-commerce? These issues require e-commerce developers to wrestle with questions such as where sensitive information may reside? On the phone or in the cloud to be accessed via the phone?

As you read the rest of this chapter keep in mind that e-commerce addresses the entire commerce model from identifying customers to service after the sale. Your organization actively searches for new customers but also the customer may find you. Once found, the customer makes a selection of a product or service—sometimes the price will be negotiated. When both parties to the purchase agree to the terms and costs a purchase is made. Delivery can be a traditional, physical delivery, a digital delivery, or a combination of both. Don't forget that service after the sale is made is a critical step of the transaction.

## Business-to-Business (B2B) E-Commerce

**Business-to-business (B2B) e-commerce** is a subset of e-commerce in which all the participants are organizations. B2B e-commerce is a useful tool for connecting business partners in a virtual supply chain to cut resupply times and reduce costs. Although the business-to-consumer market grabs more of the news headlines, the B2B market is considerably larger and is growing more rapidly. B2B sales within the United States are estimated to reach \$1.8 trillion by 2023.<sup>2</sup>

In 2018, almost half of all B2B buyers were millennials and their percentage is rapidly growing.<sup>3</sup> Popular B2C Web sites have helped raise expectations as to how an e-commerce site must operate, and many B2B companies are responding to those heightened expectations by investing heavily in their B2B platforms. Spending on e-commerce technologies by large U.S. manufacturers, wholesalers, and distributors is expected to top \$2 billion in 2019.<sup>4</sup>

### business-to-business (B2B) e-commerce

A subset of e-commerce in which all the participants are organizations.

Moving more customers online is key to B2B commerce success, so in addition to investing in new technologies, B2B companies are focusing on new ways of engaging their customer across multiple channels—both online and offline. The average B2B buyer uses six different channels in the decision to purchase. Unfortunately, only 36 percent of organizations have even started to support multiple channels for B2B.<sup>5</sup>

**omnichannel:** An integrated strategy for engaging customers (and potential customers) across multiple platforms and channels of communication to provide a seamless experience.

Beginning in 2010, organizations began adopting a new strategy for interacting with customers across multiple channels. **Omnichannel** refers to an integrated strategy for engaging customers (and potential customers) across multiple platforms and channels of communication to provide a seamless experience. Organizations aspire to have the multiple channels of communication happen at the same time, but this is difficult to achieve. Think of a purchasing agent speaking with an organization's salesperson while reading customer review's on the Twitter feed for the product. Later, that agent may go to the company's Web site, where a virtual assistant helps guide her purchase. Omnichannel engagement provides multiple ways for that purchasing agent to evaluate the terms of the B2B transaction.

Many organizations use both *buy-side e-commerce* to purchase goods and services from their suppliers and *sell-side e-commerce* to sell products to their customers. Buy-side e-commerce activities include identifying and comparing competitive suppliers and products, negotiating and establishing prices and terms, ordering and tracking shipments, and steering organizational buyers to preferred suppliers and products. Sell-side e-commerce activities include enabling the purchase of products online, providing information for customers to evaluate the organization's goods and services, encouraging sales and generating leads from potential customers, providing a portal of information of interest to the customer, and enabling interactions among a community of consumers. Thus, buy-side and sell-side e-commerce activities support the organization's value chain and help the organization provide lower prices, better service, higher quality, or uniqueness of product and service.

Grainger is a B2B distributor of products for facilities maintenance, repair, and operations (a category called MRO) with more than 1.5 million different items offered online. See Figure 9.1. In 2018, the company's online sales exceeded \$11 billion.<sup>6</sup> A key part of Grainger's e-commerce success is its suite of mobile apps, which make it possible for customers to access products online and quickly find and order products via a smartphone or other mobile device. Over 60 percent of Grainger's revenue comes from online transactions.<sup>7</sup>

**FIGURE 9.1**  
**Grainger e-commerce**  
Grainger offers more than 1.5 million items online.

The screenshot shows the Grainger website interface. At the top, there is a dark header bar with the 'GRAINGER' logo, a search bar containing 'Enter keyword, item, model or replacement part number.', and several navigation links: General Catalog, Find A Branch, Services, Solutions, Sign up for Email, Feedback, Help, and Worldwide. Below the header is a navigation bar with links for All Products, Search, Bulk Order Pad, Cart, and Print. The main content area features a 'Product Categories' grid divided into three rows of seven categories each. The categories are represented by icons and labels: Row 1: Abrasives, Adhesives, Sealants and Tape, Cleaning and Janitorial, Electrical, Electronics, Appliances, and Batteries, Fasteners, Fleet and Vehicle Maintenance. Row 2: Furniture, Hospitality and Food Service, HVAC and Refrigeration, Hardware, Hydraulics, Lab Supplies, Lighting, Lubrication. Row 3: Tools, Forklifts, Pumps, Storage Equipment, Power Equipment, Boxes, and a Paint Roller icon.

## Business-to-Consumer (B2C) E-Commerce

### business-to-consumer (B2C) e-commerce

**(B2C) e-commerce:** A form of e-commerce in which customers deal directly with an organization and avoid intermediaries.

**Business-to-consumer (B2C) e-commerce** is a form of e-commerce in which customers deal directly with an organization and avoid intermediaries. Early B2C pioneers competed with the traditional “brick-and-mortar” retailers, selling their products directly to consumers. For example, in 1995, upstart *Amazon.com* challenged well-established booksellers Waldenbooks and Barnes & Noble. Amazon did not become profitable until 2003, but since then, it has become a retail giant, selling a wide variety of products through 14 international Web sites (called marketplaces) to customers in more than 180 countries.<sup>8</sup> According to the U.S. Department of Commerce, B2C commerce accounted for more than 14 percent of total retail sales in 2018. Amazon dominates the U.S. B2C market with 40 percent of U.S. B2C sales.<sup>9</sup> As with B2B sales, B2C revenue is increasingly being driven by customers using mobile devices. A 2018 survey found that 79 percent of customers ordered online within the last six months.<sup>10</sup>

By using B2C e-commerce to sell directly to consumers, producers and providers of consumer products can eliminate the middlemen, or intermediaries, between them and the consumer. In many cases, this squeezes costs and inefficiencies out of the supply chain and can lead to higher profits for businesses and lower prices for consumers. The elimination of intermediate organizations between the producer and the consumer is called disintermediation.

More than just a tool for placing orders, the Internet enables shoppers to compare prices, features, and value, and to check other customers’ opinions. Consumers can, for example, easily and quickly compare information about automobiles, cruises, loans, insurance, and home prices to find better values. The user may use multiple channels of Web sites and social media in the search for information. Internet shoppers can unleash shopping bots or access sites such as Google Shopping, Shopzilla, PriceGrabber, and Yahoo! Shopping to browse the Internet and obtain lists of items, prices, and merchants. Increasingly, B2C retailers look to encourage customers to write reviews based on confirmed purchases because reviews by verified shoppers are often more influential than anonymous reviews in terms of generating additional sales.

Worldwide, B2C e-commerce sales continue to grow rapidly, reaching \$3.5 trillion in 2019.<sup>11</sup> China is expected to reach almost \$2 trillion in 2019, which means more than half of B2C e-commerce will occur in China during 2019.<sup>12</sup> Table 9.1 shows the top ten countries ranked by e-commerce sales.

**TABLE 9.1** Countries ranked by retail e-commerce sales

Top 10 Countries, Ranked by Retail Ecommerce Sales, 2018 & 2019 Billions and % change			
	2018	2019	% change
1. China*	\$1,520.10	\$1,934.78	27.3%
2. US	\$514.84	\$586.92	14.0%
3. UK	\$127.98	\$141.93	10.9%
4. Japan	\$110.96	\$115.40	4.0%
5. South Korea	\$87.60	\$103.48	18.1%
6. Germany	\$75.93	\$81.85	7.8%
7. France	\$62.27	\$69.43	11.5%
8. Canada	\$41.12	\$49.80	21.1%
9. India	\$34.91	\$46.05	31.9%
10. Russia	\$22.68	\$26.92	18.7%

Note: Includes products or services ordered using the Internet via any device, regardless of the method of payment or fulfillment; excludes travel and event tickets, payments such as bill pay, taxes or money transfers, food services and drinking place sales, gambling and other vice good sales.

\*excludes Hong Kong

Source: eMarketer, May 2019

**SOURCES:** “Global Ecommerce 2019,” eMarketer, June 27, 2019, <https://www.emarketer.com/content/global-ecommerce-2019>

One reason for the steady growth in B2C e-commerce is that shoppers find that many goods and services are cheaper when purchased online, including stocks, books, newspapers, airline tickets, and hotel rooms.

Another reason for the growth in B2C e-commerce is that online B2C shoppers have the ability to design a personalized product. Nike, Inc. provides a successful example of this approach to personalization. The company's online Nike By You service (formerly NIKEiD) enables purchasers to customize a pair of shoes by selecting from different material, features, and fit options—including the level of insole cushioning, sole material, and the fabric color and design of everything from the lining of the shoe to the laces. Nike also allows you to create your own text or logo to further individualize their shoes by adding a personal message to their shoes—whether that be a personal mantra, a sports team affiliation, or a personal record.<sup>13,14</sup>

Yet a third reason for the continued growth of B2C e-commerce is the effective use of social media networks by many companies looking to reach consumers, promote their products and generate online sales. Vera Bradley is a luggage design company that produces a variety of products, including quilted cotton luggage, handbags, and accessories. The firm has more than 1.8 million Facebook followers and is one of the most followed Internet retailers on Pinterest. Indeed, Vera Bradley has been extremely conscientious in cross-posting items on social media sites, including Facebook, YouTube, and Pinterest. When you visit the Vera Bradley Web site, Pinterest and other social buttons appear on the product pages so that shoppers can share their likes with friends. Vera Bradley is an example of a B2C retailer that makes social media channels work together effectively to reach more potential customers.

Facebook, Instagram, Pinterest, and Twitter are just a few social media sites that are continuing to add “paid social” features designed to help e-commerce companies generate sales by reaching a targeted audience. In 2018, Pinterest introduced “Product Pins,” allowing more of the social network’s 265 million active users to purchase products without ever leaving the site.<sup>15,16</sup>

Many B2C merchants have also added social commerce or social shopping tools to their own sites. The number of retailers doing this is small now but promises to grow soon. Snapchat has a feature that allows users to take a photo of a product or of its barcode, find that item or a similar item on a Web site, and then purchase the item.<sup>17</sup>

Another important trend is that of consumers researching products online but then purchasing those products at a local brick-and-mortar store. Sales in local stores that are stimulated through online marketing and research are called Web-influenced sales. In 2018, 87 percent of shoppers searched for product information online, in fact, 71 percent of shoppers used their mobile device in the stores to find information while shopping.<sup>18</sup>

As noted earlier in the chapter, Amazon is the dominant B2C retailer in the United States. B2C competitor Alibaba is a Chinese-based company with larger B2C sales than any U.S. company except Amazon. To understand just how much larger Amazon is than Alibaba see Table 9.2, which compares the two giants.

**TABLE 9.2** Comparing the world’s two largest B2C retailers

	Comparing Alibaba and Amazon	
	Alibaba	Amazon
<b>Annual Sales</b>	\$39.8 billion	\$232.8 billion
<b>Annual net profit</b>	\$10.2 billion	\$10.0 billion
<b>Domestic e-commerce as percentage of total e-commerce</b>	about 80%	about 60%

SOURCE: Naoki Matsuda and Mariko Hirano, “Alibaba Struggles to Follow Amazon Beyond E-Commerce,” *Nikkei Asian Review*, February 5, 2019, <https://asia.nikkei.com/Business/Companies/Alibaba-struggles-to-follow-Amazon-beyond-e-commerce>.

As a result of a 1992 Supreme Court ruling, online retailers did not have to collect sales taxes in states where they lacked a physical presence. Consumers who lived in states that had such a physical presence with sales tax were supposed to keep track of their out-of-state purchases and report those “use taxes” on their state income tax returns. However, few tax filers reported such purchases. Thus, despite having a legal basis to do so, states found it very difficult to collect sales taxes on Internet purchases. This avoidance of sales tax creates a price advantage for online retailers over brick-and-mortar stores, where sales taxes must be collected. It also resulted in the loss of about \$23 billion in tax revenue that would have gone to state and local governments to provide services for their citizens. In 2013, and again in 2015, the United States Supreme Court declined to get involved in state efforts to force Web retailers, such as Overstock and eBay, to collect sales tax from customers.

The court’s failure to act put pressure on Congress to devise a national solution, as both online and traditional retailers complain about a patchwork of state laws and conflicting lower-court decisions. Many states devised ways to sidestep the Supreme Court’s rulings or initiate new challenges in the courts. Louisiana, Nebraska, and Utah are all considering measures that would expand the definition of “physical presence” to include a company’s use of a third-party shipping company to deliver products to customers’ homes.<sup>19</sup> Another way to infer a nexus occurs is by defining an annual sales amount per year and/or number of sales a year in that state. In the meantime, several other states are simply moving forward with efforts to collect tax from online purchases, and many merchants are already complying. In 2018, the Supreme Court ruled that a company did not need a physical presence in the state or even a nexus in order to be compelled to collect state tax for online purchases, and many of the large e-commerce retailers have complied.<sup>20</sup>

## Consumer-to-Consumer (C2C) E-Commerce

**consumer-to-consumer (C2C) e-commerce:** A subset of e-commerce that involves electronic transactions between consumers using a third party to facilitate the process.

**Consumer-to-consumer (C2C) e-commerce** is a subset of e-commerce that involves electronic transactions between consumers using a third party to facilitate the process. eBay is an example of a C2C e-commerce site; customers buy and sell items to each other through the site. Founded in 1995, eBay has become one of the most popular Web sites in the world, with 2018 net revenue of \$10.8 billion.<sup>21</sup>

Other popular C2C sites include Craigslist, eBid, Etsy, Fiverr, Ibidfree, Kijiji, Ubid, Facebook Marketplace, and Taobao. The growth of C2C is responsible for a drastic reduction in the use of the classified pages of newspapers to advertise and sell personal items and services, so it has had a negative impact on that industry. On the other hand, C2C has created an opportunity for many people to make a living out of selling items on auction sites. According to eBay, the gross merchandise volume for items sold on its site was expected to exceed \$88 billion in 2019.<sup>22</sup>

Companies and individuals engaging in e-commerce must be careful that their sales do not violate the rules of various county, state, or country legal jurisdictions. More than 4,000 Web sites offer guns for sale, and on the Armslist Web site alone, over 20,000 gun ads are posted each week. Extending background checks to the flourishing world of online gun sales has become a highly controversial issue in the United States. Under current law, the question of when a background check must occur depends on who is selling the gun. Federal regulations require licensed dealers to perform checks, but the legal definition of who must be licensed has not been clear.<sup>23</sup> An executive action signed by President Barack Obama on January 4, 2016, was designed to extend background check requirements to more types of online gun sellers, including more private sellers who had previously been exempted.<sup>24</sup>

Table 9.3 summarizes the key factors that differentiate B2B, B2C, and C2C e-commerce.

**TABLE 9.3** Differences among B2B, B2C, and C2C

Factors	B2B	B2C	C2C
Typical value of sale	Thousands or millions of dollars	Tens or hundreds of dollars	Tens of dollars
Length of sales process	Days to months	Days to weeks	Hours to days
Number of decision makers involved	Several people to a dozen or more	One or two	One or two
Uniformity of offer	Typically a uniform product offering	More customized product offering	Single product offering, one of a kind
Complexity of buying process	Extremely complex; much room for negotiation on quantity, quality, options and features, price, payment, and delivery options	Relatively simple; limited negotiation on price, payment, and delivery options	Relatively simple; limited negotiation on payment and delivery options; negotiations focus on price
Motivation for sale	Driven by a business decision or need	Driven by an individual consumer's need or emotion	Driven by an individual consumer's need or emotion

## E-Government

**e-government:** The use of information and communications technology to simplify the sharing of information, speed formerly paper-based processes, and improve the relationship between citizens and government.

**E-government** is the use of information and communications technology to simplify the sharing of information, speed formerly paper-based processes, and improve the relationship between citizens and government. Government-to-citizen (G2C), government-to-business (G2B), and government-to-government (G2G) are all forms of e-government, each with different applications.

U.S. citizens can use G2C applications to submit their state and federal tax returns online, renew auto licenses, purchase postage, and apply for student loans. Citizens can also purchase items from the U.S. government through its GSA Auctions Web site, which offers the general public the opportunity to bid online for a wide range of government assets. *HealthCare.gov* is a healthcare exchange Web site created by and operated under the U.S. federal government as specified in the Patient Protection and Affordable Care Act. It is designed for use by residents in the 34 U.S. states that do not operate their own state exchanges. By accessing this Web site, users can view healthcare options, determine if they are eligible for healthcare subsidiaries, and enroll in a plan.<sup>25</sup>

G2B applications support the purchase of materials and services from private industry by government procurement offices, enable firms to bid on government contracts, and help businesses identify government contracts on which they may bid. The Web site *USA.gov/business* allows small businesses to access information about laws and regulations and to download the relevant forms needed to comply with federal requirements for their businesses. Federal agencies post procurement notices on the FedBizOpps Web site to provide an easy point of contact for businesses that want to bid on government contracts with a value of \$25,000 or more.

G2G applications support transactions between government entities, such as between the federal government and state or local governments. Government to Government Services Online (GSO) is a suite of Web applications that enables government organizations to report information—such as birth and death data, arrest warrant information, and information about the amount of state aid being received—to the Social Security Administration. This information can affect the payment of benefits to individuals. Many state governments provide a range of e-government services to various state and local agencies. For example, the state of Oregon's transaction payment engine (TPE) option enables agencies to

use an efficient Internet payment solution while adhering to statewide policies and procedures. This service is just one aspect of Oregon's E-Government program, which has the goals of creating a uniform online identity for the state of Oregon, promoting digital government, and saving Oregon taxpayers money.<sup>26,27</sup>



## Critical Thinking Exercise

### Building a Successful B2B Web Site

#### ► APPLICATION

Two years ago, you started a business, Wilmington Powell Brewing, selling home-brewing supplies. Since then, you have developed and expanded the business to include a small brewery that has a bar area where customers can buy glasses of the beer you brew. You have a strong local following, and you regularly brew a dozen standard brews along with seasonal brews for holidays and other occasions. The brewery is located in a tourist town with a local population of about 250,000 that swells by an additional 100,000 during the summer months.

Through the local chamber of commerce, you have connected with a number of restaurants in your area, and a few have become customers. You have been servicing those customers with phone calls and visits, but that is time consuming for both you and the restaurants' management. Your area has approximately 100 restaurants that could serve your beer, and with your brewing capabilities, you could reasonably handle 15 to 20 restaurants as regular customers—if you could attract the business and find a way to work with your customers more efficiently. You have decided the best way to do that is to develop a Web site, which you hope to launch in the next several months.

#### Review Questions

1. What features should be included on your new Web site?
2. What benefits will your customers likely expect from using a Web site to purchase product from you?

#### Critical Thinking Questions

1. Should you design the Web site yourself, or should you hire a professional with experience in designing Web sites for similar businesses?
2. What might a omnichannel strategy look like for the brewery after the launch of your Web site?

## Introduction to M-Commerce

The types of e-commerce discussed earlier in this chapter—in particular, B2B and B2C—are frequently associated with the technology available when these e-commerce solutions became available. Desktops and laptops were the most commonly used devices to conduct e-commerce. As technology became more powerful and less expensive, users began accessing e-commerce via tablets and smartphones. The concepts and strategies stayed the same, but the tactics of e-commerce had to change. Why? Because the size of the users' interface was so much smaller. Companies needed to reengineer their e-commerce Web sites to ensure that users could still effectively interact with their sites.

Mobile commerce (m-commerce) relies on the use of mobile devices, such as smartphones and tablets, to place orders and conduct business. Smartphone manufacturers such as Apple, Huawei, Lenovo, LG, Samsung, and Xiaomi have worked with communications carriers such as AT&T, Sprint/Nextel, T-Mobile, and Verizon to develop wireless devices, related technology, and services to support m-commerce.

## M-Commerce in Perspective

M-commerce is a rapidly growing segment of e-commerce. In 2017, m-commerce accounted for approximately 35 percent of all e-commerce, and by 2021, its portion of e-commerce sales is expected to reach 54 percent.<sup>28</sup> In the United States, m-commerce sales totaled \$207 billion in 2018.<sup>29</sup>

The market for m-commerce in North America is maturing much later than in other countries, such as Japan, South Korea, and the United Kingdom, for several reasons. In North America, responsibility for network infrastructure is fragmented among many providers, and consumer payments are usually made by credit card. In most Western European countries, consumers are much more willing to use m-commerce. Japanese consumers are generally enthusiastic about new technology and therefore have been much more likely to use mobile technologies to make purchases.

The number of mobile Web sites worldwide has grown rapidly because of advances in wireless broadband technologies, the development of new and useful applications, and the availability of less costly but more powerful smartphones. Experts point out, however, that the relative clumsiness of mobile browsers and security concerns still must be overcome to speed the growth of m-commerce.

## M-Commerce Sites

A number of retailers have established special Web sites for mobile devices users. Table 9.4 provides a list of some of the top-ranked mobile Web sites according to a recent survey of more than 400,000 people by OC&C Strategy Consultants.

**TABLE 9.4** Highly rated m-commerce retail Web sites

Rank	Company
1	eBay
2	Amazon
3	Apple
4	Burberry
5	John Lewis
6	Lush

**SOURCE:** Goldfingle, Gemma, "The Top 10 M-Commerce Sites, According To OC&C's Proposition Index," *Retail Week*, January 25, 2016, [www.retail-week.com/technology/online-retail/the-top-10-m-commerce-sites-according-to-occ-proposition-index/7004140.fullarticle](http://www.retail-week.com/technology/online-retail/the-top-10-m-commerce-sites-according-to-occs-proposition-index/7004140.fullarticle).

Consumers often place high value on different criteria, depending on the type of mobile site. In the OC&C survey, eBay and Amazon ranked highly due to their convenience, effective search tools, and transaction speed. The mobile site for natural cosmetics company Lush was rated highly because it created a strong emotional connection with consumers.

## Advantages of E-Commerce

Conversion to an e-commerce or m-commerce system enables organizations to reach new customers, reduce the cost of doing business, speed the flow of goods and information, increase the accuracy of order-processing and order fulfillment, and improve the level of customer service. These increased efficiencies are important, but they do not tell the entire story. E-commerce—and

m-commerce, in particular—can lead to a more effective experience for the organization and the customer. The convenience of anytime/anywhere m-commerce leads to higher levels of interaction and more purchases. A reduction in costs as a result of moving more transactions to e-commerce is an important benefit, but the greater benefit comes from the fact that more transactions are initiated and processed.

### Reach New Customers

The establishment of an e-commerce Web site enables a firm to reach new customers in new markets. Indeed, this is one of the primary reasons organizations give for establishing a Web site.

Founded in 1978, Shoe Carnival is a chain of more than 400 footwear stores located in 33 states.<sup>30</sup> Shoe Carnival's unique concept involves creating a high-energy atmosphere within each store through features such as a "spinning wheel of savings" and a team member on a microphone interacting with shoppers. According to Ken Zimmerman, vice president of digital at Shoe Carnival, the chain's goal is "to entertain our customers. We create a fun place with music and excitement." Initially, the Shoe Carnival Web site served only as a source of information for customers; however, the company now has a full e-commerce site—which includes social shopping tools such as customer-generated reviews of individual items—that has allowed the company to expand its reach to customers in areas where it does not have physical stores. The company's national advertising campaign is focused on driving more traffic to the company's e-commerce site, and the company's future online efforts will be focused on re-creating its "surprise and delight" concept online to differentiate it from other online shoe stores.<sup>31</sup>

More recent applications of m-commerce reflect that more and more people are likely to use their phones as the primary interface for e-commerce. Mobile banking and mobile stock trading have become steadily more important to this group of consumers. Charles Schwab and Capital One have both become very active in this area, although they are hardly alone. Nerdwallet has become a favorite site for consumers to learn about the benefits of digital finance.

### Reduce Costs

By eliminating or reducing time-consuming and labor-intensive steps throughout the order and delivery process, more sales can be completed in the same period and with increased accuracy. With increased speed and accuracy of customer order information, companies can reduce the need for inventory—from raw materials to safety stocks and finished goods—at all the intermediate manufacturing, storage, and transportation points.

BloomNation bills itself as a "trusted community marketplace for people to list, discover, and send unique bouquets handcrafted by local florists across the country."<sup>32</sup> Launched as a response to the rising commissions being charged by the dominant floral wire services; including FTD, 1-800-Flowers, and Teleflora; the BloomNation site offers floral arrangements from over 1,500 florists around the country who take and post their own photos on the site. The florists are able to take advantage of the increased exposure and stability that BloomNation's site offers, without some of the staffing and other costs associated with processing individual customer orders and payments. The florists also pay lower per-order fees—just 10 percent per order rather than the 27 percent charged by the large wire services.<sup>33</sup>

### Speed the Flow of Goods and Information

When organizations and their customers are connected via e-commerce, the flow of information is accelerated because electronic connections and communications are already established. As a result, information can flow from buyer to seller easily, directly, and rapidly.

Shutterfly, an online provider of photographic products and services to both businesses and consumers, generated nearly \$2 billion in revenue in 2018. While the vast majority of Shutterfly's e-commerce revenue comes from B2C transactions, the company also offers B2B marketing products and services through its Web site, where business customers can order customized, four-color marketing materials. The company's e-commerce capabilities, automated workflow, and large-scale production centers allow business customers to quickly customize and place their orders—cutting the project completion time from weeks to days for many clients.<sup>34,35</sup>

### Increase Accuracy

By enabling buyers to enter their own product specifications and order information directly, human data-entry error on the part of the supplier is eliminated. And order accuracy is important—no matter what the product. Domino's, the largest pizza chain in the world, was one of the first chain restaurants to offer an e-commerce site where customers could enter and pay for their orders. More than half of Domino's sales now comes through its e-commerce site. Using the site's Easy Order feature, customers can enter their orders and address information directly—improving order and delivery accuracy. And for customers who create a "Pizza Profile" online, ordering can be as simple as sending a tweet or a text (customers can initiate an order using just a pizza emoji) or just clicking a button on the Domino's smartphone app.<sup>36</sup>

### Improve Customer Service

Increased and more detailed information about delivery dates and current status can increase customer loyalty. In addition, the ability to consistently meet customers' desired delivery dates with high-quality goods and services eliminates any incentive for customers to seek other sources of supply.

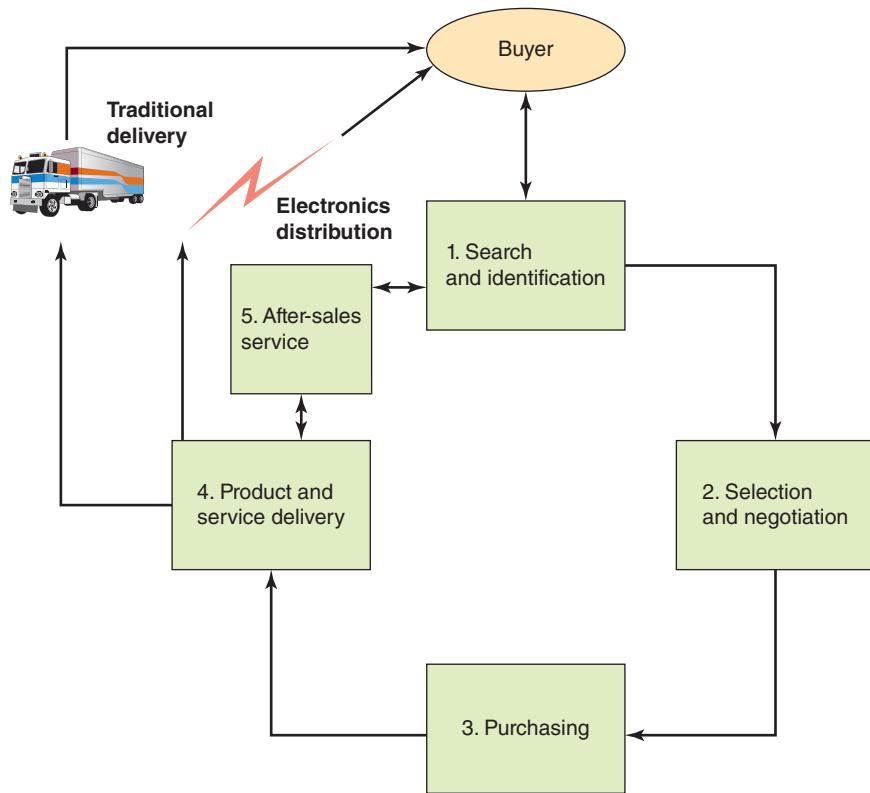
Customers come to Sticker Mule's e-commerce site to order customized stickers for a wide range of projects, whether that be to market a business, label products, drive traffic to a Web site, or raise money for a crowdfunding project. When developing its e-commerce site, Sticker Mule placed a high priority on ease of use. Customers using the site can place their orders within a matter of minutes and then view and approve order proofs online, further reducing the time it takes to complete orders. Sticker Mule's Web infrastructure allows its customer service team to consolidate support inquiries from a variety of channels—including email, Web, and phone—into one place, making it easier and faster for team members to respond to customer queries. And because customer service is a top priority for Sticker Mule, its site also includes a sophisticated help center with more than 200 articles (in multiple languages) that customers can research on their own. The site also allows customers to post reviews.<sup>37</sup>

## Multistage Model for E-Commerce

A successful e-commerce system must address the many stages that consumers experience in the sales life cycle. At the heart of any e-commerce system is the user's ability to search for and identify items for sale; select those items and negotiate prices, terms of payment, and delivery date; send an order to the vendor to purchase the items; pay for the product or service; obtain product delivery; and receive after-sales support. Figure 9.2 shows how e-commerce can support each of these stages. Product delivery can involve tangible goods delivered in a traditional form (e.g., clothing delivered via a shipping company) or goods and services delivered electronically (e.g., software or a movie downloaded over the Internet).

**FIGURE 9.2****Multistage model for e-commerce (B2B and B2C)**

A successful e-commerce system addresses the stages that consumers experience in the sales life cycle.



### Search and Identification

An employee ordering parts for a storeroom at a manufacturing plant would follow the steps shown in Figure 9.2. Assume the storeroom stocks a wide range of office supplies, spare parts, and maintenance supplies. The employee prepares a list of needed items—for example, fasteners, piping, and plastic tubing. Typically, for each item carried in the storeroom, a corporate buyer has already identified a preferred supplier based on the vendor's price competitiveness, level of service, quality of products, and speed of delivery. The employee then logs on to the Internet and goes to the Web site of the preferred supplier.

How does your organization become a preferred supplier? First, design the organization's Web page to be intuitive from the user's point of view. That view may be quite different from the way someone within your organization would navigate the site. Second, multichannel to enhance the user's experience. Provide a chat or a phone feature that allows someone in your organization to follow the user as they navigate through the site, providing help and suggestions as the customer shops.

From the supplier's home page, the employee can access a product catalog and browse until he or she finds the items that meet the storeroom's specifications. The employee fills out a request-for-quotation form by entering the item codes and quantities needed or by simply dragging them to a shopping cart. When the employee completes the quotation form, the supplier's Web application calculates the total charge of the order with the most current prices and shows the additional cost for various forms of delivery—overnight, within two working days, or the next week. The employee might elect to visit other suppliers' sites and repeat this process to search for additional items or obtain competing prices for the same items.

## Select and Negotiate

After price quotations have been received from each supplier, the employee examines them and indicates by clicking the request-for-quotation form which items to order from a given supplier. The employee also specifies the desired delivery date. In addition to price, an item's quality and the supplier's service and speed of delivery can be important in the selection and negotiation process.

B2B e-commerce systems need to support negotiation between a buyer and the selected seller over the final price, delivery date, delivery costs, and any extra charges. However, these features are not fundamental requirements of most B2C systems, which typically offer their products for sale on a "take-it-or-leave-it" basis.

## Purchase Products and Services Electronically

The employee completes the purchase order specifying the final agreed-upon terms and prices by sending a completed electronic form to the supplier. Complications can arise in paying for the products. Typically, a corporate buyer who makes several purchases from a supplier each year has established credit with the supplier in advance, and all purchases are billed to a corporate account. But when individual consumers make their first, and perhaps only, purchase from the supplier, additional safeguards and measures are required. Part of the purchase transaction can involve the customer providing a credit card number. Another approach to paying for goods and services purchased over the Internet is using electronic money, which can be exchanged for hard cash, as discussed later in the chapter.

## Deliver Products and Services

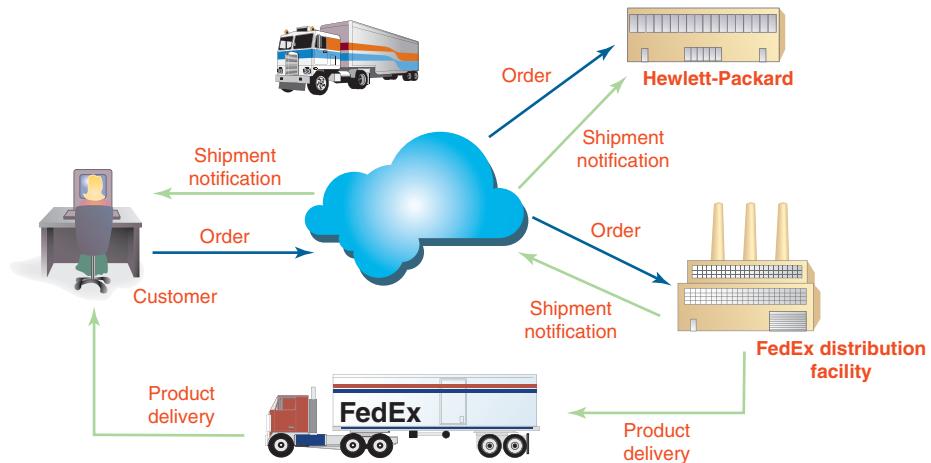
Digital distribution can be used to deliver software, music, pictures, videos, and written material through the Internet faster and less expensively than shipping the items via a package delivery service. Most non-digital products cannot be delivered over the Internet, so they are delivered in a variety of other ways: overnight carrier, regular mail service, truck, or rail. In some cases, the customer might elect to drive to the supplier and pick up the product.

Many manufacturers and retailers have outsourced the physical logistics of delivering merchandise to other companies that take care of the storing, packing, shipping, and tracking of products. To provide this service, DHL, Federal Express, United Parcel Service, the U.S. Postal Service, and other delivery firms have developed software tools and interfaces that directly link customer ordering, manufacturing, and inventory systems with their own systems of highly automated warehouses, call centers, and worldwide shipping networks. The goal is to make the transfer of all information and inventory, from the manufacturer to the delivery firm to the consumer, fast and simple.

For example, when a customer orders a printer on the Hewlett-Packard (HP) Web site, that order actually goes to FedEx, which stocks the products that HP sells online to U.S. buyers at a dedicated e-distribution facility in Memphis, Tennessee, a major FedEx shipping hub. FedEx ships the order, which triggers an email notification to the customer that the printer is on its way and an inventory notice is sent to HP that the FedEx warehouse now has one less printer in stock. See Figure 9.3.

**FIGURE 9.3****Product and Information flow**

When a customer orders an HP printer online, the order goes first to FedEx, which ships the order, triggering an email notification to the customer and an inventory notice to HP.



For product returns, HP enters return information into its own system, which is linked to FedEx's systems. This information signals a FedEx courier to pick up the unwanted item at the customer's house or business. Customers don't need to fill out shipping labels or package the item. Instead, the FedEx courier uses information transmitted over the Internet to a computer in his truck to print a label from a portable printer attached to his belt. FedEx has control of the return, and HP can monitor its progress from start to finish.

### After-Sales Service

In addition to the information required to complete an order, comprehensive customer information is also captured from each order and stored in the supplier's customer database. This information can include the customer name, address, telephone numbers, contact person, credit history, and other details. For example, if a customer later contacts the supplier to complain that not all items were received or that some arrived damaged, any customer service representative will be able to retrieve the order information from the database. Organizations provide multiple ways to locate customer orders in their systems—using a customer's name or phone number or even the date or the order and the zip code where the customer is located. Many companies also provide extensive after-sale information on their Web sites, such as how to maintain a piece of equipment, how to effectively use a product, and how to receive repairs under warranty.

## E-Commerce Challenges

A company must overcome many challenges to convert its business processes from the traditional form to e-commerce processes, especially for B2C e-commerce. As a result, not all e-commerce ventures are successful. For example, Borders began an online Web site in the late 1990s, but after three years of operating in the red, the bookseller outsourced its e-commerce operations to Amazon in 2001. Borders reversed course and decided to relaunch its own *Borders.com* Web site in May 2008, but continued to generate disappointing sales figures. As a result of the substandard results, many top executives were replaced, including the CIO and senior vice president of sales. Borders tried to keep both a physical presence (with coffee shops and chairs in their stores) and a strong digital presence, but in early 2011, Borders applied for bankruptcy protection and began closing its stores.<sup>38</sup>

You may wonder if Borders, a bookseller, was wise to outsource its Web site to Amazon because Amazon started as a bookselling Web site and is known to aggressively buy out its competitors and startups. There are both opportunities and dangers in the e-commerce world.

The following are three key challenges to e-commerce: (1) dealing with consumer privacy concerns, (2) overcoming consumers' lack of trust, and (3) overcoming global issues. We'll examine these in the following sections.

## Dealing with Consumer Privacy Concerns

While two-thirds of U.S. Internet users have purchased an item online and most Internet users say online shopping saves them time, about one-third of all adult Internet users will not buy anything online primarily because they have privacy concerns or lack trust in online merchants. In addition to having an effective e-commerce model and strategy, companies must carefully address consumer privacy concerns and overcome consumers' lack of trust.

The following are a few examples of recent security breaches in which personal data was compromised:

- Close to 50 million Facebook users had their personal information stolen in 2018 when hackers exploited bugs in the one of the site's features that was actually intended to provide users more control over their privacy settings. Some members of Congress have called for more Congressional oversight of companies such as Facebook that have a large number of users, store private information, and have been hacked.<sup>39</sup>
- Patreon, a crowdfunding platform that allows users to make ongoing donations to a Web site, artist, or project sustained a security breach that resulted in their entire cache of data—including names, email addresses, and donation records—being published online.<sup>40,41</sup>
- The names, addresses, and passport numbers of more than 500 million guests of Starwood Hotels (owned by Marriott) was stolen in 2018.<sup>42</sup>
- In 2018, Under Armour disclosed a breach of 150 million records of users of its MyFitnessPal app. While the hackers did not gain access to users' social security number, payment information, or driver's license numbers, they were able to access usernames, email addresses, and hashed (or encrypted) passwords.<sup>43</sup>

**identity theft:** The use of someone's personal identification information without his or her permission, often to commit fraud or other crimes.

In some cases, the compromise of personal data can lead to identity theft. According to the Federal Trade Commission (FTC), “**Identity theft** occurs when someone steals your personal information and uses it without your permission.”<sup>44</sup> Often stolen personal identification information (PII), such as your name, Social Security number, or credit card number, is used to commit fraud or other crimes. Thieves may use a consumer's credit card numbers to charge items to that person's accounts, use identification information to apply for a new credit card or a loan in a consumer's name, or use a consumer's name and Social Security number to receive government benefits.

Companies must be prepared to make a substantial investment to safeguard their customers' privacy or run the risk of losing customers and generating potential class action lawsuits should the data be compromised. It is not uncommon for customers to initiate a class action lawsuit for millions of dollars in damages for emotional distress and loss of privacy. In addition to potential damages, companies must frequently pay for customer credit monitoring and identity theft insurance to ensure that their customers' data is secure.

Facebook faced a lawsuit stemming from the 2018 data breach within days of announcing it. What made the breach so threatening was that Facebook users who connected to their accounts through Instagram, and possibly other social media platforms, were at risk of having those platform accounts hacked as well.<sup>45</sup>

In order to address customers' privacy concerns, companies looking to do business online must invest in the latest security technology and employ highly trained security experts to protect their consumers' data. For large companies, that can mean a sizable in-house staff that monitors security issues 24/7. Smaller companies often rely on security services provided by companies such as Symantec, whose Norton Secured Seal is intended to provide customers with the confidence they need to transact e-commerce business.

Akimbo Financial is a financial services company based in San Antonio, Texas. Even though Akimbo is a small player in the financial services industry, it is still obligated to comply with Payment Card Industry (PCI) and other regulations requiring encryption for online transactions and communication. And because Akimbo collects social security numbers and other confidential data, it must assure users that their data is secure. The company employs Symantec's Secure Site with EV (Extended Validation) SSL Certificate to secure its site, and it prominently displays the Norton Secured Seal. The EV certificate used to present online visitors with a green bar in their browser address bar, intended to highlight the secure nature of the site. That green bar has been replaced with an icon of a locked padlock. According Akimbo CEO and founder, Houston Frost, the green bar (now replaced with a locked padlock icon) gives consumers a "warm and fuzzy" feeling.<sup>46</sup>

## Overcoming Consumers' Lack of Trust

Lack of trust in online sellers is one of the most frequently cited reasons that some consumers give to explain why they are unwilling to purchase online. Can they be sure that the company or person with which they are dealing is legitimate and will send the item(s) they purchase? What if there is a problem with the product or service when it is received: for example, if it does not match the description on the Web site, is the wrong size or wrong color, is damaged during the delivery process, or does not work as advertised?

Online marketers must create specific trust-building strategies for their Web sites by analyzing their customers, products, and services. A perception of trustworthiness can be created by implementing one or more of the following strategies:

- Demonstrate a strong desire to build an ongoing relationship with customers by giving first-time price incentives, offering loyalty programs, or eliciting and sharing customer feedback.
- Demonstrate that the company has been in business for a long time.
- Make it clear that considerable investment has been made in the Web site.
- Provide brand endorsements from well-known experts or well-respected individuals.
- Demonstrate participation in appropriate regulatory programs or industry associations.
- Display Web site accreditation by the Better Business Bureau Online or TRUSTe programs.

Here are some tips to help online shoppers avoid problems:

- Only buy from a well-known Web site you trust—one that advertises on national media, is recommended by a friend, or receives strong ratings in the media.
- Look for a seal of approval from organizations such as the Better Business Bureau Online or TRUSTe. See Figure 9.4.

**FIGURE 9.4****Seals of approval**

To avoid problems when shopping online, look on the Web site for a seal of approval from organizations such as the Better Business Bureau Online or TRUSTe.



Courtesy Better Business Bureau and TRUSTe

- Review the Web site's privacy policy to be sure that you are comfortable with its conditions before you provide personal information.
- Determine what the Web site policy is for return of products purchased.
- Be wary if you must enter any personal information other than what's required to complete the purchase (name, credit card number, address, and telephone number).
- Do not, under any conditions, ever provide information such as your Social Security number, bank account numbers, or your mother's maiden name.
- When you open the Web page where you enter credit card information or other personal data, make sure that the Web address begins with "https," and check to see if a locked padlock icon appears in the Address bar or status bar, as shown in Figure 9.5.

**FIGURE 9.5****Web site security**

Web site that uses "https" in the address and a secure site lock icon.

- Consider using virtual credit cards, which expire after one use, when making purchases online. These cards are essentially one-time-use credit card numbers that your credit card vendor sends you for a specific purpose. Even if a hacker obtains that number through a security breach it will have no value.
- Before downloading music, change your browser's advanced settings to disable access to all computer areas that contain personal information.

## Overcoming Global Issues

E-commerce and m-commerce offer enormous opportunities by allowing manufacturers to buy supplies at a low cost worldwide. They also offer enterprises the chance to sell to a global market right from the start. Moreover, they offer great promise for developing countries, helping them to enter the prosperous global marketplace, which can help to reduce the gap between rich and poor countries. People and companies can get products and services from around the world, instead of around the corner or across town. These opportunities,

however, come with numerous obstacles and issues associated with all global systems:

- **Cultural challenges.** Great care must be taken to ensure that a Web site is appealing, easy to use, and not offensive to potential customers around the world. For example, consumption of alcohol or marijuana may be legal in some places but not others. Do images on the Web site depict people consuming alcohol or using marijuana?
- **Language challenges.** Language differences can make it difficult to understand the information and directions posted on a Web site.
- **Time and distance challenges.** Significant time differences make it difficult for some people to be able to speak to customer services representatives or to get technical support during regular waking hours.
- **Infrastructure challenges.** The site must support access by customers using a wide variety of hardware and software devices.
- **Currency challenges.** The Web site must be able to state prices and accept payment in a variety of currencies.
- **State, regional, and national law challenges.** The site must operate in conformance to a wide variety of laws that cover a variety of issues, including the protection of trademarks and patents, the sale of copyrighted material, the collection and safeguarding of personal or financial data, the payment of sales taxes and fees, and much more.



### Critical Thinking Exercise

#### Museum Tours Web Site

##### ► APPLICATION, GLOBAL

You recently inherited your aunt's tourist business, which creates custom tours of museums and other sites of interest in Washington, D.C. Your aunt had no employees; rather, she would contact an organization, such as a local historical society, and work directly with her contact at the organization to propose and arrange a tour. After the tour details were finalized, your aunt would open the tour to other people who might wish to take the same tour. This strategy allowed your aunt to have a confirmed number of people for the tour, and additional people made the tour more profitable.

Your aunt's tour business has an excellent reputation and was regularly recognized as a high-quality experience in tourist magazines and AARP publications. But almost all the people taking tours with your aunt's business are from the United States. You feel that you can substantially build the business if you also cater to foreign tourist groups. You will begin by seeking tourist groups from other English-speaking countries because you are not fluent in any language other than English.

You have decided that you must establish a Web presence if you are going to contact customers from other countries. Your aunt's business has no Web presence because it was mainly promoted by "word of mouth" endorsements from people who had taken tours with your aunt. You view this as an opportunity because you are now able to create the Web presence without having to worry about how it will interact with any existing Web presence for the business.

#### Review Questions

1. What challenges do you expect to encounter as you try to attract tour groups from other countries?
2. How will customers from other countries pay for the tours? Will you accept payment in currencies other than the U.S. dollar?

### Critical Thinking Questions

1. What will your strategy be to blend the “word of mouth” customer base created by your aunt with the Web presence you intend to create?
2. You do not have the expertise to host the Web presence. Will you use a generic host, will you try to be a sub-site of an established organization, such as AARP, or will you find some other way?

## E-Commerce and M-Commerce Applications

E-commerce and m-commerce are being used in innovative and exciting ways. This section examines a few of the many B2B, B2C, C2C, and m-commerce applications in retail and wholesale, manufacturing, marketing, advertising, bartering, retargeting, price comparison, couponing, investment and finance, and banking. As with any new technology, m-commerce will succeed only if it provides users with real benefits. Companies involved in e-commerce and m-commerce must think through their strategies carefully and ensure that they provide services that truly meet customers’ needs.

### Wholesale E-Commerce

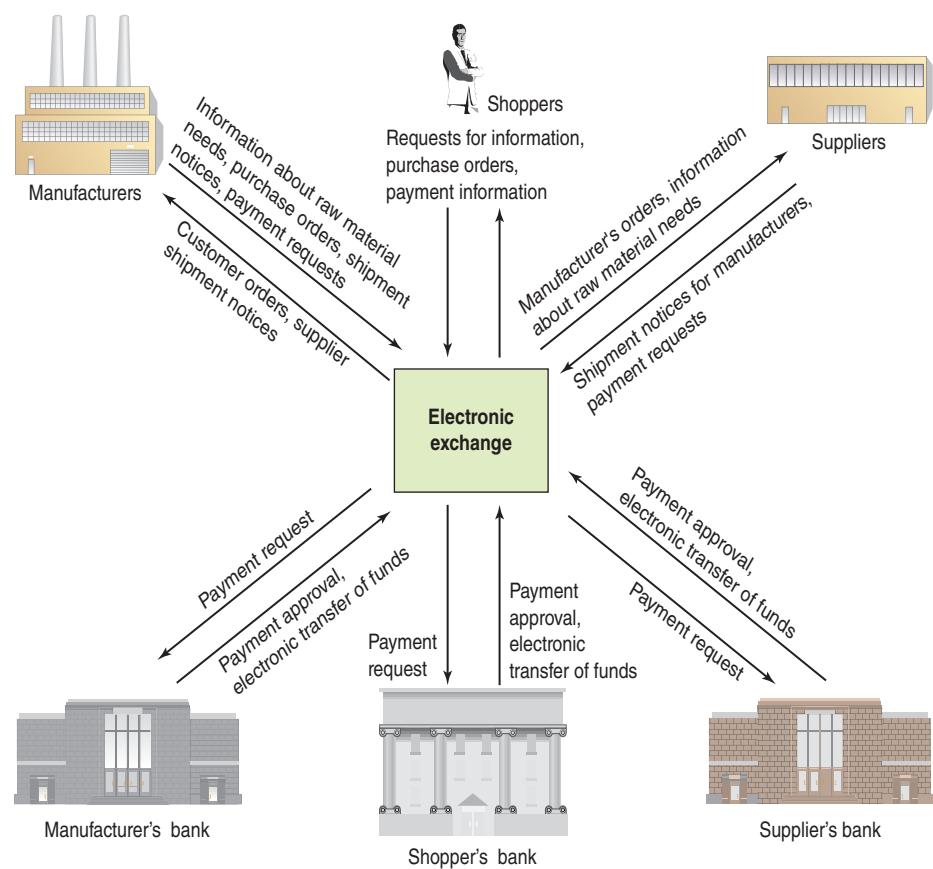
In the United States, wholesale e-commerce is expected to surpass \$1 trillion by 2021.<sup>47</sup> A key sector of wholesale e-commerce is spending on manufacturing, repair, and operations (MRO) goods and services—from simple office supplies to mission-critical equipment, such as the motors, pumps, compressors, and instruments that keep manufacturing facilities running smoothly. MRO purchases often approach 40 percent of a manufacturing company’s total revenue, but the purchasing systems within many companies are haphazard, without automated controls. Companies face significant internal costs resulting from outdated and cumbersome MRO management processes. Manufacturing downtime can be caused by not having the right part at the right time in the right place. The result is lost productivity and capacity. E-commerce software for plant operations provides powerful comparative searching capabilities to enable managers to identify functionally equivalent items, helping them spot opportunities to combine purchases for cost savings. Comparing various suppliers, coupled with consolidating more spending with fewer suppliers, leads to decreased costs. In addition, automated workflows are typically based on industry best practices, which can streamline processes.

Grainger, a leader in the MRO market, had over \$11 billion in sales for 2018. Its CEO, D. G. Macpherson, expects growth to continue.<sup>48,49</sup>

### Manufacturing

**electronic exchange:** An electronic forum where manufacturers, suppliers, and competitors buy and sell goods, trade market information, and run back-office operations.

One approach taken by many manufacturers to raise profitability and improve customer service is to move their supply chain operations onto the Internet. Here, they can form an **electronic exchange**, an electronic forum where manufacturers, suppliers, and competitors buy and sell goods, trade market information, and run back-office operations, such as inventory control, as shown in Figure 9.6. This approach speeds up the movement of raw materials and finished products and reduces the amount of inventory that must be maintained. It also leads to a much more competitive marketplace and lower prices. The increased competition can have a positive or negative effect on an organization depending upon whether it wins or loses. Overall, the purchaser tends to have more of an advantage with these electronic exchanges.



**FIGURE 9.6**  
**Model of an electronic exchange**

An electronic exchange is an electronic forum where manufacturers, suppliers, and competitors buy and sell goods, trade market information, and run back-office operations.

Companies can join one of three types of exchanges based on who operates the exchange. Private exchanges are owned and operated by a single company. The owner uses the exchange to trade exclusively with established business partners. Walmart's Retail Link is such an exchange. Consortium-operated exchanges are run by a group of traditionally competing companies with common procurement needs. For example, Covisint was developed as an exchange to serve the needs of the big three auto makers. Independent exchanges are open to any set of buyers and sellers within a given market. In 2017, Covisint was purchased by OpenText, and it widened its focus to include healthcare, governmental, and financial service providers. Independent exchanges provide services and a common technology platform to their members and are open, usually for a fee, to any company that wants to use them. For example, Tinypass is a flexible e-commerce platform that enables content publishers to choose from a variety of payment models to sell access to their media. Publishers can offer limited previews to readers before they subscribe, ask for payment to view each video or article, or allow the audience to pay what they believe the content is worth. Content is defined by the publisher and can be any sort of digital media: an article, a movie, a song, a blog post, a PDF, access to a forum, or access to an entire Web site. Tinypass exchange members can use the platform to crowdfund projects from within their own Web sites, rather than working through third party sites, such as GoFundMe or Kickstarter.<sup>50,51</sup>

Several strategic and competitive issues are associated with the use of exchanges. Many companies distrust their corporate rivals and fear they might lose trade secrets through participation in such exchanges. Suppliers worry that

online marketplaces will drive down the prices of goods and favor buyers. Suppliers also can spend a great deal of money configuring their systems and work processes to participate in multiple exchanges. For example, more than a dozen new exchanges have appeared in the oil industry, and the printing industry has more than 20 online marketplaces. Until a clear winner emerges in particular industries, suppliers may feel compelled to sign on to several or all of them. Yet another issue is potential government scrutiny of exchange participants: When competitors get together to share information, it raises questions of collusion or antitrust behavior.

Many companies that already use the Internet for their private exchanges have no desire to share their expertise with competitors. At Walmart, the world's largest retail chain, executives turned down several invitations to join exchanges in the retail and consumer goods industries before building its own in-house exchange, Retail Link, which connects the company to 7,000 worldwide suppliers that sell everything from toothpaste to furniture. Through Retail Link, Walmart has created a supplier-managed inventory system where it lets each supplier decide where to put SKUs (stock keeping units) and how to ship through to stores. It empowers suppliers to make these decisions by providing them with inventory and sales data by SKU by hour, by store. This in turn makes Walmart more profitable, because it can hold each supplier accountable to maximize margin, with the lowest inventory possible, to produce the greatest return on investment in inventory.<sup>52</sup>

Always consider the issues of trust, privacy, and multinational e-commerce when considering electronic exchanges. Participants must trust that others in the exchange are honestly portraying their goods, their intentions to purchase, and the quality of products and services being offered. Privacy is lost when entering into the electronic exchange and is replaced by confidentiality for information shared among exchange members. Privacy is a secret only you know, while confidentiality pertains to things such as your health records, which may be shared among many people you may not know but who are participating in your care.

Consider the implications of confidentiality in the context of how your data is handled. The more people who are authorized to see your confidential data, the greater the chance that the data might be misused. Consider the final grade you receive for a course. You may have taken the course once but received a poor grade. If you retake the course and do better the second time, your original poor grade will be replaced with the second grade. You and the instructor know your original grade, but so do staff in the registrar's office. The teaching assistant may also have known you were taking the course for a second time. The instructor may also have had a staff person enter the grade into the school's information system. All of these people have a valid reason to know your grade, so they all have access to this confidential data.

Don't forget that multinational e-commerce can be complicated when the laws and customs of sovereign countries differ. The European Union (EU) implemented the General Data Protection Regulation in 2018. Essentially, the EU believes that privacy and data protection are fundamental freedoms. Companies that disregard the data protection regulations are subject to very high fines. Consent to have data about a user shared with another company requires the user's specific, informed, and unambiguous consent from the user. The user "owns" the data, not the company.

In the United States, companies own the data they collect about you from any business transaction you make with the company. They can sell it to other companies—with or without your consent. While many companies promise that they will not share your information with other companies, it is just that, a promise. It is not a legally binding commitment, and the company can change its mind at any time and sell your data to others.

## Marketing

The nature of the Web enables firms to gather more information about customer behavior and preferences as customers and potential customers gather their own information and make their purchase decisions. Analysis of this data

**market segmentation:** The identification of specific markets to target them with tailored advertising messages.

is complicated because of the Web's interactivity and because each visitor voluntarily provides or refuses to provide personal data such as name, address, email address, telephone number, and demographic data. Indeed, customers may intentionally lie about this information. Internet advertisers use the data to identify specific markets and target them with tailored advertising messages. This practice, called **market segmentation**, divides the pool of potential customers into subgroups usually defined in terms of demographic characteristics, such as age, gender, marital status, income level, and geographic location.

In the past, market segmentation has been difficult for B2B marketers because firmographic data (addresses, financials, number of employees, and industry classification code) was difficult to obtain. Now, however, eXelate, a subsidiary of Nielsen, the marketing and media information company, has joined forces with Dun & Bradstreet to provide a data as a service solution that customers can use to access a database of more than 250 million business records, including critical company information such as contact names, job titles and seniority levels, locations, addresses, number of employees, annual sales, and Standard Industry Code (SIC) and North America Industry Classification System (NAICS) classification codes. Using this data, analysts can identify, access, and segment their potential B2B audience; estimate potential sales for each business; and rank the business against other prospects and customers.<sup>53</sup>

## Advertising

Mobile ad networks distribute mobile ads to publishers such as mobile Web sites, application developers, and mobile operators. Because most people carry their smartphones (which are connected to the Web in many different ways) with them at all times, organizations have an incentive to make extensive use of mobile ads to reach consumers. Mobile ad impressions are generally bought at a cost per thousand (CPM), cost per click (CPC), or cost per action (CPA), in which the advertiser pays only if the customer clicks through and then buys the product or service. The main measures of success are the number of users reached, click through rate (CTR), and the number of actions users take, such as the number of downloads prompted by the ad. Advertisers are keenly interested in this data to measure the effectiveness of their advertising spending, and many organizations are willing to pay extra to purchase the data from a mobile ad network or a third party. Generally, there are three types of mobile ad networks—blind, premium blind, and premium networks—though no clear lines separate them. The characteristics of these mobile advertising networks are summarized in Table 9.5.

**TABLE 9.5** Characteristics of three types of mobile advertising networks

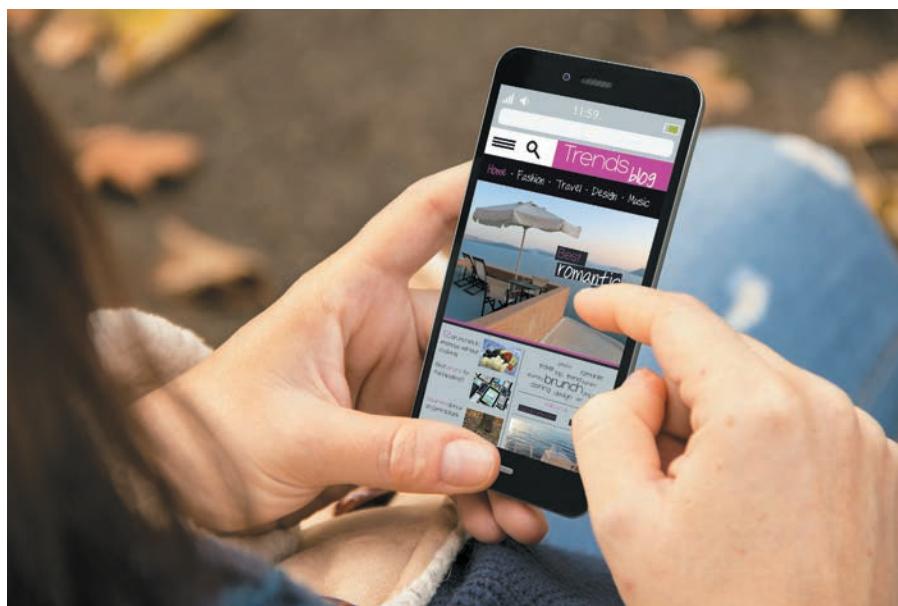
Characteristic	Blind Networks	Premium Blind Networks	Premium Networks
<b>Degree to which advertisers can specify where ads are run</b>	An advertiser can specify country and content channel (e.g., news, sports, or entertainment) on which the ad will run but not a specific Web site.	Most advertising is blind, but for an additional charge, the advertiser can buy a specific spot on a Web site of its choice.	Big brand advertisers can secure elite locations on top-tier destinations.
<b>Predominant pricing model and typical rate</b>	CPC (e.g., \$0.01 per click)	CPM (e.g., \$20 per thousand impressions)	CPM (e.g., \$40 per thousand impressions)
<b>Examples</b>	<ul style="list-style-type: none"> <li>• Admoda/Adultmoda</li> <li>• AdMob</li> <li>• BuzzCity</li> <li>• InMobi</li> </ul>	<ul style="list-style-type: none"> <li>• Jumptap</li> <li>• Madhouse</li> <li>• Millennial Media</li> <li>• Quattro Wireless</li> </ul>	<ul style="list-style-type: none"> <li>• Hands</li> <li>• Microsoft Mobile Advertising—App Samurai</li> <li>• Nokia Interactive Advertising</li> <li>• Pudding Media</li> <li>• YOC Group</li> </ul>

InMobi is a global provider of cloud-based resources aimed at companies that have significant m-commerce clients. The company, which is a recognized leader in its field, uses a technique it calls “appropriate targeting” to increase the chance that users of a type of media or app will engage with advertisers using its services. In 2019, InMobi launched a new independent business unit called TruFactor, which allows telecommunications companies to “transform their digital assets into strategic knowledge.” In other words, the companies can use the individual records of the phone location, Web site being viewed, length of time at the Web site, and other facts into a collection of broad trends that are useful for planning future advertising strategies. This can only further increase the effectiveness of providing a more integrated approach to interaction with customers via all of their interconnected devices for m-commerce.<sup>54,55</sup>

Because m-commerce devices usually have a single user, they are ideal for accessing personal information and receiving targeted messages for a particular consumer. Through m-commerce, companies can reach individual consumers to establish one-to-one marketing relationships and communicate whenever it is convenient—in short, anytime and anywhere. M-commerce is also often an important component of an omnichannel strategy. For instance, a mobile device can broadcast a user’s current location so that m-commerce can be seamlessly integrated to other e-commerce experiences at the user’s current location—your location can tell what store you are in and provide coupons pertinent to your shopping experience. See Figure 9.7.

### FIGURE 9.7 M-commerce is convenient and personal

Consumers are increasingly using mobile phones to purchase goods and perform other transactions online.



McLittle Stock/Shutterstock.com

### Bartering

During the economic downturn between 2007 and 2009, many people and businesses turned to bartering as a means of gaining goods and services. Even as the economy slowly recovered, bartering and a “gig economy” helped many people through difficult economic times. A number of Web sites have been created to support this activity, as shown in Table 9.6. Some businesses are willing to barter to reduce excess inventory, gain new customers, or avoid paying cash for necessary raw materials or services. Cash-strapped customers may find bartering to be an attractive alternative to paying scarce dollars. Generally, bartering transactions have tax-reporting, accounting, and other record-keeping responsibilities associated with them. Indeed, the IRS hosts a Bartering Tax Center Web site that provides details about the tax laws and responsibilities for bartering transactions.

**TABLE 9.6** Popular bartering Web sites

Web site	Purpose
Craiglist.org	Includes a section where users can request an item in exchange for services or exchange services for services
Swapagift.com	Enables users to buy, sell, or swap merchant gift cards
Swapstyle.com	Allows users to swap, sell, or buy direct women's accessories, clothes, cosmetics, and shoes
Game Trading Zone	Forum for trading games, movies, and music
TradeAway.com	Enables users to exchange a wide variety of new or used items, services, or real estate

### Retargeting

Cart abandonment is an ongoing challenge for e-commerce companies. Close to 73 percent of shopping carts accessed via desktop computers are abandoned before purchase, while that rate rises to 86 percent for carts created on smartphones.<sup>56</sup> “Retargeting” is a technique used by advertisers to recapture these shoppers by using targeted and personalized ads to direct shoppers back to a retailer’s site. For example, a visitor who viewed the men’s clothing portion of a retailer’s Web site and then left the site would be targeted with banner ads showing various men’s clothing items from that retailer. The banner ads might even display the exact items the visitor viewed, such as men’s casual slacks. The retargeting could be further enhanced to include comments and recommendations from other consumers who purchased the same items. Retargeting ensures that potential consumers see relevant, targeted ads for products they’ve already expressed interest in.

### Price Comparison

An increasing number of companies provide mobile phone apps that enable shoppers to compare prices and products online. Wirecutter (owned by the *New York Times*) has product reviews on appliances and tech gadgets. Amazon’s Price Check app also let you search for pricing by taking a picture of a book, DVD, CD, or video game cover. The Barcode Scanner app allows shoppers to scan UPC or Quick Response codes to perform a price comparison and read the latest product reviews.<sup>57,58</sup>

### Couponing

In 2017, almost \$300 billion worth of free-standing insert (FSI) coupons were distributed, amounting to almost \$575 billion in potential savings. In 2017, over \$3 billion of saving occurred through coupon use (a small fraction of possible savings), and digital coupons represented around 12 percent of that \$3 billion.<sup>59</sup>

Many businesses now offer a variety of digital coupons—which tend to be redeemed at higher rates than FSI coupons—including printable coupons available on a company’s Web site or delivered to customers via email. Shoppers at some retail chains can go to the store’s Web site and load digital coupons onto their store loyalty card. Other retailers have programs that allow a person to enter their mobile number and a PIN at checkout to redeem coupons they selected online. Honey ([www.joinhoney.com](http://www.joinhoney.com)) allows users to click its app while checking out at the grocery store to find coupons and savings. Many consumer product good manufacturers and retailers and other businesses now send mobile coupons directly to consumers’ smartphones via SMS technology.

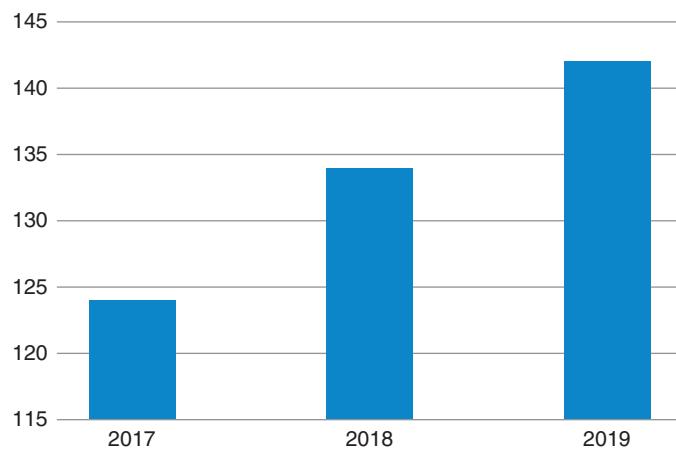
Google has quietly emerged as a platform leader for proximity marketing, which makes use of in-store beacons that emit wireless communications up to about 10 feet away to target shoppers with individual advertisements and coupons based on the customer’s known profile. Proximity marketing is expected to see a large growth increase throughout 2019. A recent study suggests 1.5 billion mobile coupons will be delivered by proximity beacons in 2020.<sup>60,61</sup>

The estimated number of mobile coupon redeemers is expected to increase due to the integration of couponing into social networks, along with an increase in smartphone and tablet users, new mobile apps, and location-based deals.<sup>62</sup> See Figure 9.8.

**FIGURE 9.8**  
**Millions of mobile coupon users in the U.S.**

The number of mobile coupon redeemers is increasing significantly.

Source: Caroline Cakebread, "Who's Using Mobile Coupons in the US?," eMarketer, December 3, 2018, <https://www.emarketer.com/content/the-mobile-series-mobile-coupons-infographic>.



Online marketplaces such as Groupon and LivingSocial offer an updated approach to digital couponing. Discount coupons for consumers are valid only if a predetermined minimum number of people sign up for them. Merchants do not pay any money up front to participate in Groupon or LivingSocial but must pay the companies a fee (up to 50 percent for Groupon) whenever a customer purchases a coupon.

## Investment and Finance

The Internet has revolutionized the world of investment and finance. Perhaps the changes have been so significant because this industry had so many built-in inefficiencies and so much opportunity for improvement.

The brokerage business adapted to the Internet faster than any other arm of finance. See Figure 9.9. The allure of online trading that enables investors to do quick, thorough research and then buy shares in any company in a few seconds and at a fraction of the cost of a full-commission firm has brought many investors to the Web. Fidelity offers mobile trading apps for tablets, smartphones, and even Apple Watch. The apps allow investors a secure platform to monitor their portfolios, view real-time stock quotes, track preferred stocks, and execute trades.<sup>63</sup>

**FIGURE 9.9**  
**Mobile investment and finance**

Investment firms provide mobile trading apps to support clients on the go.



## Banking

Online banking customers can check balances of their savings, checking, and loan accounts; transfer money among accounts; deposit checks; and pay bills. These customers enjoy the convenience of not writing checks by hand, tracking their current balances, and reducing expenditures on envelopes and stamps. In addition, online banking customers have the satisfaction of knowing that paying bills online is good for the environment because it reduces the amount of paper used, thus saving trees and reducing greenhouse gases.

All of the major banks and many of the smaller banks in the United States enable their customers to pay bills online, and most support bill payment via mobile devices. Banks are eager to gain more customers who pay bills online because such customers tend to stay with the bank longer, have higher cash balances, and use more of the bank's products and services. To encourage the use of this service, many banks have eliminated all fees associated with online bill payment.

Consumers who have enrolled in mobile banking and downloaded the mobile application to their cell phones can check credit card balances before making major purchases to avoid credit rejections. They can also transfer funds from savings to checking accounts to avoid an overdraft.

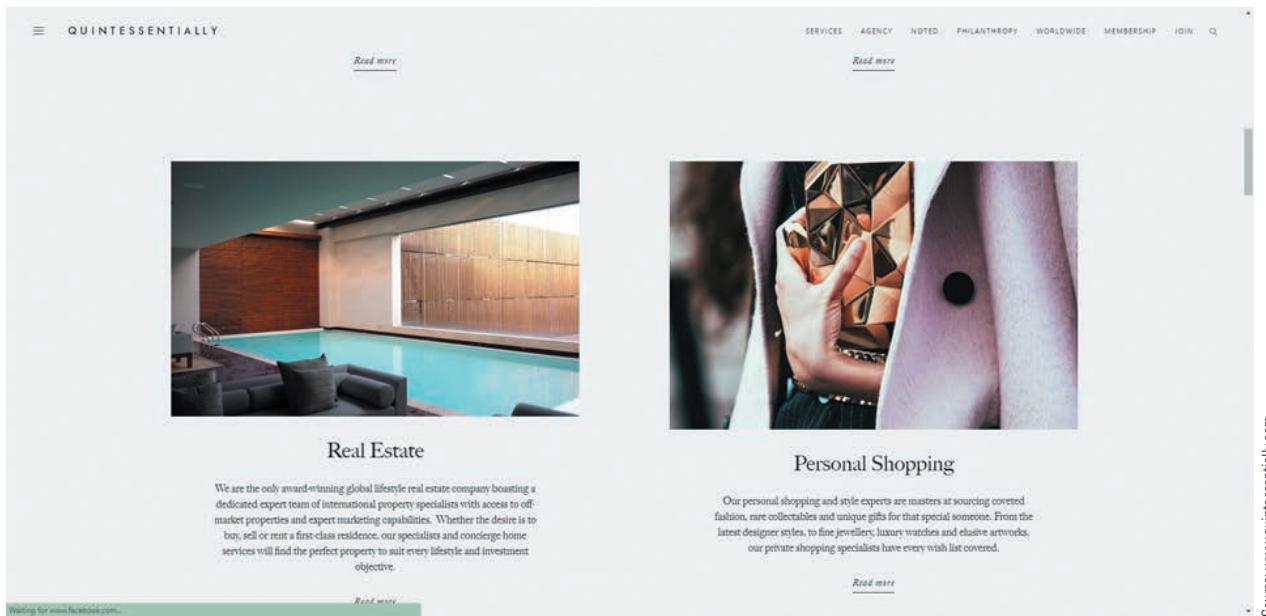
M-Pesa (M for mobile, Pesa for money in Swahili) with some 30 million users worldwide is considered by many to be the most developed mobile payment system in the world. The service is operated by Safaricom and Vodacom, the largest mobile network operators in Kenya and Tanzania. M-Pesa enables users with a national ID card or passport to deposit, withdraw, and transfer money easily with a mobile device. Its services have expanded from a basic mobile money transfer scheme to include loans and savings products, bill pay, and salary disbursements. It is estimated that two percent of Kenyan households have been lifted out of poverty by access to mobile money services such as M-Pesa.<sup>64,65</sup>

## Online Personalized Shopping

An increasing number of Web sites offer personalized shopping consultations for shoppers interested in upscale, contemporary clothing—dresses, sportswear, denim clothing, handbags, jewelry, shoes, and luxury gifts. Key to the success of companies such as MyTheresa and Net-a-Porter is a philosophy of excellent customer service and strong, personal client relationships. Net-a-Porter offers same-day delivery in Hong Kong, New York, and London, and a team of personal shoppers stock the virtual carts of women around the globe who are looking for high fashion and luxury items.<sup>66</sup>

Rent the Runway specializes in designer clothing for people that want access to high fashion for both everyday wear and special occasions. A fee of less than \$100 is required for a short time access to the site and higher fees for longer access. Users can rent four pieces for up to eight days. This can greatly expand the customer's choice of formal clothes at a price that young professionals can afford.

Quintessentially is a luxury shopping and concierge service whose private shopping specialists can find the rarest and most exquisite items for the affluent shopper. See Figure 9.10. T team at Quintessentially can get that Hermes Birkin handbag without the long delay many shoppers experience.<sup>67</sup>



Source: www.quintessentially.com

**FIGURE 9.10**  
**Luxury goods online**

Quintessentially is an online luxury concierge service that features unusual and exclusive goods.



### Critical Thinking Exercise

### Banding Together

#### ► APPLICATION

More than 20 universities and colleges are located in Atlanta, and students at these schools have many things in common. You believe there is a market for an app that addresses the consumer demand of Atlanta students in three areas: housing, food, and clothes. Many shoppers—including college students—are overwhelmed by the number of apps for individual products and businesses. And new students coming to campus have to spend effort in just trying to find out what is offered near their campus and where it's located.

It would greatly help the use of the app if the universities and colleges would make students aware of it as they go through orientation at their school. Because universities have rules in place to protect student information, they may have questions about how data will be collected, stored, and used. You may find that some schools would prefer to create their own app and not be part of a consortium.

Your goal is to create a single app that acts similar to a consortium, that is, an electronic exchange. On any given evening at dinner time, for instance, hundreds of students in the Atlanta area may want pizza for dinner. Instead of each student finding a single vendor and making a separate order, why not assemble all the student orders over a 30-minute time and then have pizza vendors bid on the entire order. This would allow students to use the buying power of the consortium to get the best price and product.

The same concept could be applied to housing and to buying “gently used” clothing. As individuals, students do not have much power in the purchasing action. With your app, students would benefit by being part of a consortium that has greater power to negotiate better purchase terms.

#### Review Questions

1. It sounds easy to say that 20 universities and colleges will cooperate in the consortium, but in reality, it can be complicated. What type of technology infrastructure would need to be in place to make this consortium (electronic

exchange) work? Can universities in the consortium provide some of the resources? Make sure you consider the technology needed by the user as well as the consortium technology.

2. Students will benefit from lower prices on what they purchase but how might the consortium itself make a profit?

#### Critical Thinking Questions

1. How will you get businesses to bid to provide products/services on the electronic exchange?
2. Who would likely take the lead on the development of the app for the electronic exchange? One of the universities, a private business, a student government, or something else?

## Strategies for Successful E-Commerce and M-Commerce

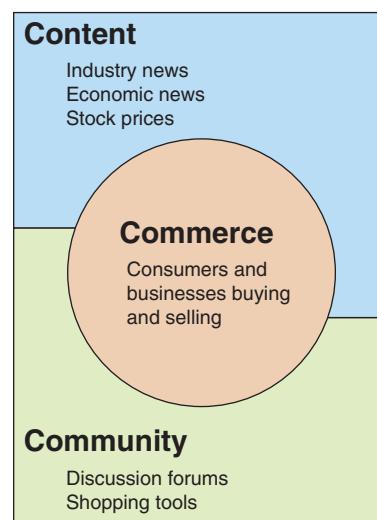
With all the constraints to e-commerce already discussed in this chapter, it's clear that a company must develop an effective Web site, one that is easy to use and accomplishes the goals of the company yet is safe, secure, and affordable to set up and maintain. However, before building a Web site, a company must first define an effective e-commerce model and strategy. The next sections examine several issues for a successful e-commerce site.

### Defining an Effective E-Commerce Model and Strategy

The first major challenge is for the company to decide on the e-commerce model it wants to use and formulate an effective e-commerce strategy. Although companies can select from a number of approaches, the most successful e-commerce models include three basic components: community, content, and commerce, as shown in Figure 9.11. Discussion forums and other social shopping tools can build a loyal community of people who are interested in and enthusiastic about the company and its products and services. Providing useful, accurate, and timely content, such as industry and economic news and stock quotes, is a sound approach to encourage people to return to your Web site time and again. Commerce involves consumers and businesses paying to purchase physical goods, information, or services that are posted or advertised online.

**FIGURE 9.11**  
**Content, commerce, and community**

A successful e-commerce model includes three basic components.



## Defining the Functions of a Web Site

When building a Web site, you should first decide which tasks the site must accomplish. Most people agree that an effective Web site is one that creates an attractive presence and that meets the needs of its visitors, which might include the following:

- Obtaining general information about the organization
- Obtaining financial information for making an investment decision in the organization
- Learning the organization's position on social issues
- Learning about the products or services that the organization sells
- Buying the products or services that the company offers
- Checking the status of an order
- Getting advice or help on effective use of the products
- Registering a complaint about the organization's products
- Registering a complaint concerning the organization's position on social issues
- Providing a product testimonial or an idea for product improvement or a new product
- Obtaining information about warranties or service and repair policies for products
- Obtaining contact information for a person or department in the organization

After a company determines which objectives its site should accomplish, it can move on planning and developing the site, keeping in mind that the priorities and objectives of customers may change over time. The site must also be easy and intuitive to use by the targeted customers. As the number of e-commerce shoppers increases and they become more comfortable—and more selective—making online purchases, a company might need to redefine the basic business model of its site to capture new business opportunities. For example, consider the major travel sites such as Expedia, Travelocity, CheapTickets, Orbitz, and Priceline. These sites used to specialize in one area of travel—inexpensive airline tickets. Now they offer a full range of travel products, including airline tickets, auto rentals, hotel rooms, tours, and last-minute trip packages. Expedia provides in-depth hotel descriptions to help comparison shoppers and even offers 360-degree virtual tours and expanded photo displays. It also entices flexible travelers to search for rates, compare airfares, and configure hotel and air prices at the same time. Expedia has also developed numerous hotel partnerships to reduce costs and help secure great values for consumers. Meanwhile, Orbitz has a special full-service program for corporate business travelers.

## Establishing a Web Site

Companies large and small can establish Web sites. Some companies elect to develop their sites in-house, but this decision requires a Web development staff that is experienced with network security, online payments, and Web design software. Many firms, especially those with few or no experienced Web developers, outsource the building of their Web sites in order to get their sites up and running faster and cheaper—and to develop a more professional Web site—than they could by doing the job themselves. Web development firms can provide organizations with prebuilt templates and Web site builder tools to enable customers to construct their own Web sites.

Businesses can custom design a new Web site or redesign an existing Web site. Many of these firms have worked with thousands of customers to help them get their Web sites up and running. When the Web site is being configured, it should be inclusive of apps and other marketing and commerce channels used by the organization. Developing a Web site that stands alone is a waste of money.

Web site hosting companies such as DreamHost, InMotion, HostWay, and BroadSpire make it possible to set up a Web page and conduct e-commerce within a matter of days, with little up-front cost. However, to allow visitors to pay for merchandise with credit cards, a company needs a merchant account with a bank. If your company doesn't already have one, it must establish one.

**storefront broker:** A company that acts as an intermediary between your Web site and online merchants who have the products and retail expertise.

Another model for setting up a Web site is the use of a **storefront broker**, a business that serves as an intermediary between your Web site and online merchants who have the actual products and retail expertise. The storefront broker deals with the details of the transactions, including who gets paid for what, and is responsible for bringing together merchants and reseller sites. The storefront broker is similar to a distributor in standard retail operations, but in this case, no product moves—only electronic data flows back and forth. Products are ordered by a customer at your site, orders are processed through a user interface provided by the storefront broker, and the product is shipped by the merchant.

Shopify is a Canadian firm that helps retailers create their own online store without all the technical work involved in developing their own Web site or the huge expense of contracting someone else to build it. Clients can select a stylish e-commerce Web site template, customize it to meet their unique needs, upload product information, and then start taking orders and accepting payments. Thousands of online retailers, including General Electric, CrossFit, Tesla Motors, Red Bull, Foo Fighters, and GitHub built their Web sites using the Shopify platform. In 2018, Shopify had revenue of over \$1 billion.<sup>68</sup>

Don't forget that the Web site is a key to your e-commerce strategy. Consider a "how to reach us" section that includes any account you have on Twitter, Facebook, WhatsApp, WeChat, or other social media. When a Web site is reached the site can determine the type of device is accessing the page and present different formats of the page optimized for that type of device. This is especially true for users accessing your Web page via their phones. Make sure you have your Web page developed so that users across a variety of devices can use it equally well.

If you have developed an app for your business, it is important to make sure your Web page alerts users to the app and how it can be downloaded to their phones. Do you have coupons for products or services you sell? Make sure that those coupons are available on one or more of the couponing sites mentioned earlier in the chapter. In short, the Web page is an important entrance to your business that should tie into all of your e-commerce efforts.

## Building Traffic to Your Web site

The Internet includes hundreds of thousands of e-commerce Web sites. With all those potential competitors, a company must take strong measures to ensure that the customers it wants to attract can find its Web site. The first step is to obtain and register a domain name, which should say something about your business. For instance, stuff4u might seem to be a good catchall, but it doesn't describe the nature of the business—it could be anything. If you want to sell soccer uniforms and equipment, then you'd try to get a domain name such as *www.soccerstuff4u.com*, *www.soccerequipment.com*, or *www.stuff4soccercoaches.com*. The more specific the Web address, the better.

The next step to attracting customers is to make your site search-engine friendly by improving its rankings. The following are several ideas on how to accomplish this goal:

- Search engines work by constantly visiting Web sites and using algorithms to decide the best way to categorize the site's contents. The search engine company send out robots (sometimes called "spiders" or "crawlers") to sites linked to the Internet. Companies can ensure their site appears in search engine results by listing links and other resources (listed by a uniform resource locator [URL]) in a file named Robots.txt. That file is searched by spiders and crawlers.

- Use Web site traffic data analysis software to turn the data captured in the Web log file into useful information. This data can tell you the URLs from which your site is being accessed, the search engines and keywords that find your site, and other useful information. Using this data can help you identify search engines to which you need to market your site, allowing you to submit your Web pages to them for inclusion in the search engine's index.

**search engine optimization:**

The process of maximizing the number of visitors to your Web site using the quality and quantity of terms/links on your Web page that match common Internet searches.

You want your Web site built for **search engine optimization**. Search engines like Bing, Google, and Yahoo! have algorithms that rate a Web page based on a number of attributes: traffic to the page, reliability of information on the page, comments on social media about the page, and many other characteristics. Search engines guard exactly how their algorithms score each Web page so that organizations cannot unfairly manipulate their scores. You may find it useful to hire a consultant or firm that specializes in optimizing an organization's Web page for search engine optimization.

- Provide quality, keyword-rich content. Be careful not to use too many keywords, as search engines often ban sites that do this. Judiciously place keywords throughout your site, ensuring that the Web content is sensible and easy to read by humans as well as search engines.
- Consider paying the search engine companies to include you as a "sponsored" ad.
- Add new content to your site on a regular basis. The time frame should be short enough so that customers notice new products or features as they return to the Web site. Again, this makes the site attractive to humans as well as search engines.
- Acquire links to your site from other reputable Web sites that are popular and related to your site.

The use of the Internet is growing rapidly in markets throughout Europe, Asia, and Latin America. Obviously, companies that want to succeed on the Web cannot ignore this global shift. A company must be aware that consumers outside the United States will access sites with a variety of devices. A Web site's design should reflect that diversity if the company wants to be successful in other markets. In Europe, for example, closed-system iDTVs (integrated digital televisions) are becoming popular for accessing online content, with more than 50 percent of the population now using them. Because such devices have better resolution and more screen space than the PC monitors that many U.S. consumers use to access the Internet, iDTV users expect more ambitious graphics. Successful global firms operate with a portfolio of sites designed for each market, with shared sourcing and infrastructure to support the network of stores and with local marketing and business development teams to take advantage of local opportunities. Service providers continue to emerge to solve the cross-border logistics, payments, and customer service needs of these global retailers.

## Maintaining and Improving Your Web Site

Web site operators must constantly monitor the traffic to their sites and the response times experienced by visitors. AMR Research, a Boston-based independent research analysis firm, reports that Internet shoppers expect service to be better than or equal to their in-store experience. Nothing will drive potential customers away faster than experiencing unreasonable delays while trying to view or order products or services. To keep pace with technology and increasing traffic, companies might need to modify the software, databases, or hardware on which their sites run to ensure acceptable response times.

Retailing giant Walmart invested over \$2 billion as part of a multiyear project designed to improve its Web site and strengthen its e-commerce infrastructure.

Walmart's technology team overhauled the company's e-commerce capabilities from the ground up—with changes to the look of the Web site, the launch of an improved, proprietary site search engine, and upgrades to the underlying transaction software and supporting databases and Web servers. In addition to revamping its Web site to make it easier for customers to shop, Walmart continues to look for innovative ways to interact with online shoppers, such as a three-dimensional virtual tours of home furnishings in order to compete with Wayfair, Amazon, and others.<sup>69,70</sup>

Web site operators must also continually be alert to new trends and developments in the area of e-commerce and be prepared to take advantage of new opportunities. For example, recent studies show that customers more frequently visit Web sites they can customize. **Personalization** is the process of tailoring Web pages to specifically target individual consumers. The goal is to meet the customer's needs more effectively, make interactions faster and easier, and consequently, increase customer satisfaction and the likelihood of repeat visits. Building a better understanding of customer preferences can also aid in cross-selling related products and more expensive products. The most basic form of personalization involves using the consumer's name in an email campaign or in a greeting on the Web page. Amazon uses a more advanced form of personalization in which the Web site greets each repeat customer by name and recommends a list of new products based on the customer's previous purchases.

Businesses use two types of personalization techniques to capture data and build customer profiles. Implicit personalization techniques capture data from actual customer Web sessions—primarily based on which pages were viewed and which weren't. Explicit personalization techniques capture user-provided information, such as information from warranties, surveys, user registrations, and contest-entry forms completed online. Data can also be gathered through access to other data sources such as the Bureau of Motor Vehicles, Bureau of Vital Statistics, and marketing affiliates (firms that share marketing data). Marketing firms aggregate this information to build databases containing a huge amount of consumer behavioral data. During each customer interaction, powerful algorithms analyze both types of data instantly to predict the consumer's needs and interests. This analysis makes it possible to deliver new, targeted information while the customer is at the site. Because personalization depends on gathering and using personal user information, privacy issues are a major concern.

Salesforce Marketing Cloud is a provider of digital marketing automation and analytics software and services that its customers use to personalize email marketing, target mobile messaging campaigns, and make personalized, predictive recommendations to online customers. Room & Board, a Minnesota-based national furniture chain specializing in modern furniture and home accessories, uses Salesforce to create a digital experience that reflects the ways their customers use the Web as well as one that extends the company's personalized sales approach to its Web site. The Salesforce system, which ties into customers' sales histories as well as years' worth of data about what styles and individual pieces of furniture work well together and what products customers tend to view and purchase in groups, allows the company to make increasingly effective personal recommendations to its online customers. Customers who engage with Room & Board's recommendations place online orders with 40 percent higher average values than those who don't.<sup>71</sup>

The tips and real-world examples presented in this section represent just a few ideas that can help a company set up and maintain an effective e-commerce site. With technology and competition changing constantly, managers should read articles in print and online to keep up to date on ever-evolving issues.

**personalization:** The process of tailoring Web pages to specifically target individual consumers.



## Critical Thinking Exercise

### Move-In Ready

#### ► APPLICATION

You have been the senior housing staff member at your university for several years. One of your biggest challenges is managing the move-in process at the beginning of each school year. All students who will live in campus housing are required to move into their residences over a three-day period, which requires an extensive and complex effort to pull off. You have organized volunteers that help students unload all their belongings from their cars and into their dorm rooms efficiently. But there is still a problem. Now students and their families go out to stores all around the university looking for fans, extension cords, laundry supplies, sheets and pillowcases, along with a million other “must-have” items.

You have an idea that would require a lot of cooperation from people within and outside of your university. “Move-In Ready” would allow students to buy all of the stuff they need (from soap and paper towels to mini-refrigerators and even furniture and grocery items) through a page on the university’s Web site. Everything ordered would be delivered to the student’s room before he or she arrives.

The concept seems simple enough, but several issues need to be resolved. First, your university is a public university and is not allowed to sell or advocate for a particular business. Also, how will the purchases for a student that may come from several different businesses be assembled into one order and delivered to the correct residence before students move in? Maybe one object, such as a sweatshirt with the university logo, is likely to be ordered by hundreds of students. Does the vendor of that sweatshirt look at its inventory and then have its supplier begin delivery of the sweatshirt? The B2C Web site just impacted a B2B Web site.

#### Review Questions

1. Assume the Web site will be built before students arrive on campus next fall. How will you build traffic to the Web site?
2. Universities are dynamic places. What kind of processes would you develop to make sure the Web site is maintained and grows to meet the changing needs of students?

#### Critical Thinking Questions

1. Web sites like the one described here are often accessed by people using laptops or desktop computers because there is so much visual information to be displayed. But college students are known to be very m-commerce aware so how would you design a Web site that will be mobile friendly?
2. How would you measure the Web site’s success or lack of success?

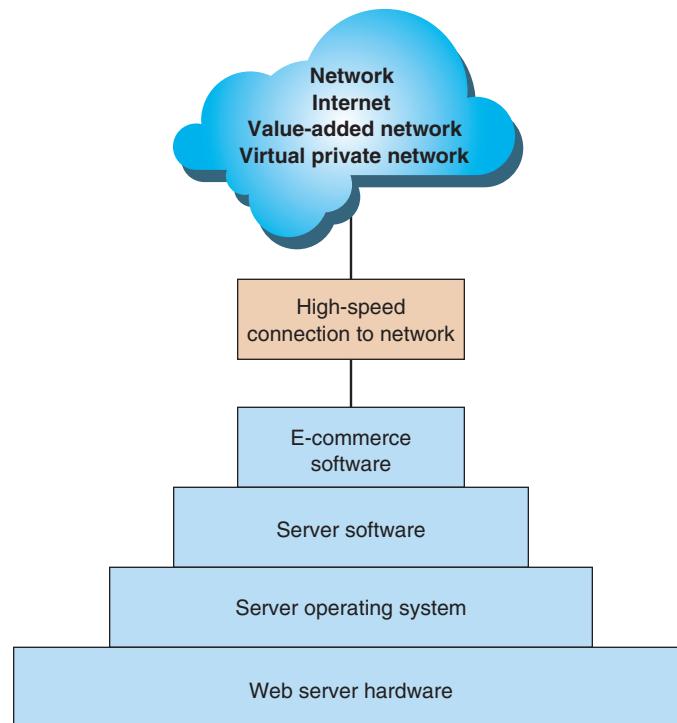
## Technology Infrastructure Required to Support E-Commerce and M-Commerce

Now that we’ve examined some key factors in establishing an effective e-commerce initiative, let’s look at some of the technical issues related to e-commerce systems and the technology that makes it possible. Successful implementation of e-commerce requires significant changes to existing business processes and substantial investment in IS technology. These technology components must be chosen carefully and integrated to support a large volume of transactions with customers, suppliers, and other business partners.

worldwide. In surveys, online consumers frequently note that poor Web site performance (e.g., slow response time, inadequate customer support, and lost orders) drives them to abandon some e-commerce sites in favor of those with better, more reliable performance. This section provides a brief overview of the key technology infrastructure components. See Figure 9.12.

**FIGURE 9.12**  
**Key technology infrastructure components**

E-commerce systems require specific kinds of hardware and software to be successful.



## Hardware

A Web server platform complete with the appropriate hardware and software is a key ingredient to e-commerce infrastructure. The amount of storage capacity and computing power required of the Web server depends primarily on two things: the software that must run on the server and the volume of e-commerce transactions that must be processed. The most successful e-commerce solutions are designed to be highly scalable so that they can be upgraded to meet unexpected user traffic.

Computing hardware is getting more powerful even while the prices of hardware fall. When you consider the cost of hardware for e-commerce you must take this into account. It is important to understand the role of Moore's Law when you consider the hardware used to support e-commerce. Gordon Moore, a co-founder of Intel, made a prediction in 1965 concerning the rate at which the number of transistors on a microchip would increase. In the years that followed, researchers have modified his observation to a general prediction about the power of computers: Computer power doubles about every 18 months—for the same price. Based on that prediction, in six years, a computer will be 16 times more powerful for the same cost. In nine years, a computer will be 64 times as powerful for the same cost, but in 15 years, a computer will be 1,024 times as powerful for the same cost.

Even as you consider the constantly increasing power of computing technology, do not overlook that you can use existing technologies in new and creative ways. Apple's iPhones have touted their ability to take images using infrared light, and many Android phones can take infrared images as well. It's simply a feature of many digital cameras. You may have seen news accounts of people who had a medical issue detected from a simple infrared image. Maybe someone can take this existing technology and repurpose it to look for skin cancer or other medical issues.

Even when you have the right hardware in place you can have a Web site outage if visitors cannot access the Web page. There were several high-profile Web site outages in 2019 that impacted millions of users. Table 9.7 shows six outages affecting some of the largest Web sites in the world.

**TABLE 9.7** Some 2019 major Web site outages

Site	When	Cause
Facebook	March 13	Server configuration change
Google Cloud Platform	June 2	Server configuration change
Verizon	June 24	Volume of network traffic routed to networks with insufficient capacity
Cloudflare	July 2	Bad software deployment
Facebook, Twitter, Apple	July 3–4	Bad maintenance check
Twitter	July 11	Internal system change

**SOURCE:** Twain Taylor, "Biggest 2019 Website Outages and What Caused Them," August 23, 2019, <http://techgenix.com/2019-website-outages>.

A key decision facing a new e-commerce company is whether to host its own Web site or to let someone else do it. Many companies decide that using a third-party Web service provider is the best way to meet initial e-commerce needs. The third-party company rents space on its computer system and provides a high-speed connection to the Internet, thus minimizing the initial out-of-pocket costs for e-commerce start-up. The third party can also provide personnel trained to operate, troubleshoot, and manage the Web server.

## Web Server Software

In addition to the Web server operating system, each e-commerce site must have Web server software to perform fundamental services, including security and identification, retrieval and sending of Web pages, Web site tracking, Web site development. Many personnel who manage Web sites first learn how to measure site performance using Google Analytics (*Analytics.Google.com*). The two most widely used Web server software packages are Apache HTTP Server and Microsoft's Internet Information Services.

## E-Commerce Software

After you have located or built a host server, including the hardware, operating system, and Web server software, you can begin to investigate and install e-commerce software to support five core tasks: catalog management to create and update the product catalog, product configuration to help customers select the necessary components and options, shopping cart facilities to track the items selected for purchase (see Figure 9.13), e-commerce transaction processing, and Web traffic data analysis to provide details to adjust the operations of the Web site.

**FIGURE 9.13**  
**Electronic shopping cart**

An electronic shopping cart allows online shoppers to view their selections and add or remove items.

## M-Commerce Hardware and Software

For m-commerce to work effectively, the interface between the mobile device and its user must improve to the point that it is nearly as easy to purchase an item on a mobile device as it is to purchase it on a PC. In addition, network speeds must continue to improve so that users do not become frustrated. Security is also a major concern, particularly in two areas: the security of the transmission itself and the trust that the transaction is being made with the intended party. Encryption can provide secure transmission. Digital certificates can ensure that transactions are made between the intended parties.

Mobile devices used for m-commerce have several limitations that complicate their use. Their screens are small, perhaps no more than several square inches, and might be able to display only small portions of a Web site. In addition, entering data on a mobile device can be tedious and error prone. Mobile devices also have less processing power and less bandwidth than desktop or laptop computers, which are usually connected to a high-speed network. They also operate on limited-life batteries. For these reasons, Web developers must often rewrite Web applications so that users with mobile devices can access them more efficiently.

## Electronic Payment Systems

Electronic payment systems are a key component of e-commerce infrastructure. Current e-commerce technology relies on user identification and encryption to safeguard business transactions. Actual payments are made in a variety of ways, including electronic cash, electronic wallets, and smart, credit, charge, and debit cards. Web sites that accept multiple payment types convert more visitors to purchasing customers than merchants who offer only a single payment method.

**digital certificate:** An attachment to an email message or data embedded in a Web site that verifies the identity of a sender or Web site.

**certificate authority (CA):** A trusted third-party organization or company that issues digital certificates.

Authentication technologies are used by many organizations to confirm the identity of a user requesting access to information or assets. A **digital certificate** is an attachment to an email message or data embedded in a Web site that verifies the identity of a sender or Web site. A **certificate authority (CA)** is a trusted third-party organization or company that issues digital certificates. The CA is responsible for guaranteeing that the people or organizations granted these unique certificates are in fact who they claim to be. Digital certificates thus create a trust chain throughout the transaction, verifying both purchaser and supplier identities.

Many organizations that accept credit cards to pay for items purchased via e-commerce have adopted the Payment Card Industry (PCI) security standard ([www.pcisecuritystandards.org](http://www.pcisecuritystandards.org)). This standard spells out measures and security procedures to safeguard the card issuer, the cardholder, and the merchant. Some of the measures include installing and maintaining a firewall configuration to control access to computers and data, never using software or hardware vendor-supplier defaults for system passwords, and requiring merchants to protect stored data, encrypt transmission of cardholder information across public networks, use and regularly update antivirus software, and restrict access to sensitive data on a need-to-know basis.

Various measures are being implemented to increase the security associated with the use of credit cards at the time of purchase. The Address Verification System is a check built into the payment authorization request that compares the address on file with the card issuer to the billing address provided by the cardholder. The Card Verification Number technique is a check of the additional digits typically printed on the back of the card (or on the front, in the case of American Express cards). Visa has Advanced Authorization, a Visa-patented process that provides an instantaneous rating of that transaction's potential for fraud—using factors such as the value of the transaction, type of merchant, time of day the purchase is being made, and whether the site is one where the card owner has previously shopped. The card issuer can then send an immediate response to the merchant regarding whether to accept or decline the transaction. The technology is applied to every Visa credit and check card purchase today, and it has contributed to a two-thirds reduction in system-wide fraud for Visa over the past two decades. Visa has continued to add other features and data inputs to its fraud-detection systems, such as extended cardholder transaction data and even mobile location confirmation.<sup>72</sup>

The Federal Financial Institutions Examination Council has developed a set of guidelines called “Authentication in an Internet Banking Environment,” which recommend two-factor authorization. This approach adds another identity check along with the password system. A number of multifactor authentication schemes can be used, such as biometrics, one-time passwords, or hardware tokens that plug into a USB port on the computer and generate a password that matches the ones used by a bank’s security system.

The use of biometric technology to secure digital transactions has been slow to develop due to cost and privacy concerns. However, the Mastercard Identity Check service allows users to take an ID photo that will be used to create a digital map of their face, which will be stored on Mastercard’s servers. When the user wants to make a payment using their smartphone, the Mastercard app will capture their image, which, along with a user-entered password, will be authenticated before the transaction is approved. Mastercard’s system also offers a fingerprint sensor that can be used to verify purchases.<sup>73</sup> The Apple Pay system makes use of the fingerprint sensors on newer iPhones. Consumers paying with Apple Pay, which is tied to a credit or debit card, just hold their iPhone close to the contactless reader with their finger on the Touch ID button (if their iPhone has the button) or the Face ID feature.<sup>74</sup>

## Transport Layer Security

### Transport Layer Security (TLS):

A communications protocol or system of rules that ensures privacy between communicating applications and their users on the Internet.

All online shoppers fear the theft of credit card numbers and banking information. To help prevent this type of identity theft, the Transport Layer Security communications protocol is used to secure sensitive data. **Transport Layer Security (TLS)** is a communications protocol or system of rules that ensures privacy between communicating applications and their users on the Internet. TLS enables a client (such as a Web browser) to initiate a temporary, private conversation with a server (such as a shopping site on the Web or an online bank). Before the client and server start communicating, they perform an automated process called a “handshake” where they exchange information about who they are, and which secret codes and algorithms they’ll use to encode their messages to each other. Then for the duration of the conversation, all the data that passes between the client and server is encrypted so that even if somebody does listen in, they won’t be able to determine what’s being communicated. TLS is the successor to the Secure Sockets Layer (SSL).

In addition to TLS handling the encryption part of a secure e-commerce transaction, a digital certificate is assigned to the Web site to provide positive server identification so shoppers can be assured of with whom that are dealing.

## Electronic Cash

**electronic cash:** An amount of money that is computerized, stored, and used as cash for e-commerce transactions.

**Electronic cash** is an amount of money that is computerized, stored, and used as cash for e-commerce transactions. Typically, consumers must open an account with an electronic cash service provider by providing identification information. When the consumers want to withdraw electronic cash to make a purchase, they access the service provider via the Internet and present proof of identity—a digital certificate issued by a certification authority or a user-name and password. After verifying a consumer’s identity, the system debits the consumer’s account and credits the seller’s account with the amount of the purchase. PayPal, Venmo, Apple Pay Cash, Square Cash, Stripe, and WePay are some popular online payment service providers that facilitate the use of electronic cash.

PayPal and Venmo enable any person or business with an email address to securely, easily, and quickly send and receive payments online. To send money, you enter the recipient’s email address and the amount you want to send. You can pay with a credit card, debit card, or funds from a checking account. The recipient gets an email message and accepts the transfer. Recipients can then collect their money by clicking a link in the email message that takes them to [www.paypal.com](http://www.paypal.com). To receive the money, the user also must have a credit card or checking account to accept fund transfers. To request money for an auction, invoice a customer, or send a personal bill, you enter the recipient’s email address and the amount you are requesting. Venmo is a subsidiary of PayPal.<sup>75</sup>

PayPal and Venmo have some important differences. First, PayPal is geared to transactions from a PC or tablet, not from a mobile device, which is the platform of Venmo. Second, PayPal was designed for secure transactions between people that may not know each other while Venmo was designed for people who know and trust each other. PayPal became popular when eBay bought it as a way to facilitate the payments between buyers and sellers using the eBay site. (PayPal spun off from eBay in 2015.) Venmo is a mobile app, and when a vendor accepts a Venmo payment, such as Uber, you can make the payment right from your phone. Another popular feature of Venmo allows you to share the cost of a purchase among other Venmo users. Once the other Venmo users accept their share of the cost, your account is adjusted.<sup>76</sup>

The use of smartphones to make purchases and transfer funds between consumers and business has become commonplace. The goal is to make the payment process as simple and secure as possible and for it to work on many

different phones and through many different mobile network providers—not simple tasks. Fortunately, the intelligence built into the iPhone and other smartphones can make this all possible.

You can use several services (e.g., Square, PayPal Here, Intuit GoPayment, and PayAnywhere) to plug a credit card reader device into the headphone jack on a cell phone to accept credit card payments. Intuit's GoPayment service does not require a credit card reader but rather provides software that lets you enter the credit card number.

A free Starbucks mobile app that runs on iPhones and Android smartphones enables customers to order and pay for their java using their smartphones—without ever having to wait in line. App users, whose mobile purchases are tied to a credit card, can even tip their barista digitally.<sup>77</sup>

### Credit, Charge, Debit, and Smart Cards

Many online shoppers use credit and charge cards for most of their Internet purchases. A credit card, such as Visa or Mastercard, has a preset spending limit based on the user's credit history, and each month the user can pay all or part of the amount owed. Interest is charged on the unpaid amount. A charge card, such as American Express, carries no preset spending limit, and the entire amount charged to the card is due at the end of the billing period. There may be a limit to your spending, but it is dynamically determined and not preset as a fixed amount. You can't carry a balance from month to month with a charge card like you can with a credit card. Charge cards require customers to pay in full every month or face a fee. Debit cards look like credit cards, but they operate like cash or a personal check. The debit card is linked directly to your savings or checking account. Each time you use the card, money is automatically taken from your checking or savings account to cover the purchase. Credit, charge, and debit cards currently store limited information about you on a magnetic strip. This information is read each time the card is swiped to make a purchase. All credit card customers are protected by law from paying more than \$50 for fraudulent transactions, but the same is not true for debit cards. Banks can hold you liable for up to \$500 in the case of a fraudulent use of your debit card.

The smart card is a credit card-sized device with an embedded microchip to provide electronic memory and processing capability. Smart cards can be used for a variety of purposes, including storing a user's financial facts, health insurance data, credit card numbers, and network identification codes and passwords. They can also store monetary values for spending.

Smart cards are better protected from misuse than conventional credit, charge, and debit cards because the smart-card information is encrypted. Conventional credit, charge, and debit cards clearly show your account number on the face of the card. The card number, along with a forged signature, is all that a thief needs to purchase items and charge them against your card. A smart card makes credit theft practically impossible because a key to unlock the encrypted information is required, and there is no external number that a thief can identify and no physical signature a thief can forge. Table 9.8 compares various types of payment systems.

Here in the United States, credit cards with only magnetic stripes are being replaced by cards with chips that employ the EMV (Europay, Mastercard, and Visa) global standard for working with point-of-sale systems. Each time the EMV card is used for inserted into a point-of-sale device for payment, it creates a unique transaction code that can never be reused. Unlike the European version of the card, which requires the user to enter a PIN number to complete the transaction, the U.S. card user simply signs the receipt. Technically, if a chip is used to verify the transaction, the card owner may or may not be required to sign the receipt, but if the transaction uses the magnetic strip to verify the information, the receipt should be signed. While cards with chips are nearly impossible to counterfeit, the account number of these cards is clearly visible and can be used by fraudsters for online purchases.

If your credit card has both a chip and a magnetic stripe, you may not be as safe as you think. Even though the chip creates very secure transactions the magnetic stripe is a significant security risk. A magnetic stripe reader can be purchased for about \$30 and can read all of the sensitive personal information the chip is designed to protect. Your best option is to have a credit card with a chip and no magnetic stripe.

The U.S. financial institutions elected to implement the chip-and-sign EMV card rather than the chip-and-PIN card. Mastercard and Visa are supporters of EMV, and their cards all have chips, but in the United States there are still many credit cards backed by other institutions that do not have chips and only have a magnetic strip. The later card requires the user to enter their personal PIN number for each transaction. Counterfeit credit card fraud dropped 75 percent between the end of 2015 and early 2018 thanks to the introduction of chip embedded credit cards.<sup>78</sup>

**TABLE 9.8** Comparison of payment systems

Payment System	Description	Advantages	Disadvantages
Credit card	Carries preset spending limit based on the user's credit history	Each month the user can pay all or part of the amount owed.	The unpaid balance accumulates interest charges—often at a high rate of interest.
Charge card	Looks like a credit card but carries no preset spending limit	Does not involve lines of credit and does not accumulate interest charges	The entire amount charged to the card is due at the end of the billing period or the user must pay a fee.
Debit card	Looks like a credit card or automated teller machine (ATM) card	Operates like cash or a personal check	Money is immediately deducted from user's account balance.
Smart card	Is a credit card device with embedded microchip capable of storing facts about cardholder	Better protected from misuse than conventional credit, charge, and debit cards because the smart card information is encrypted	Slowly becoming more widely used in the United States.



### Critical Thinking Exercise

### Don't Do It Yourself

#### ► ANALYTICAL THINKING, APPLICATION

For years, your construction materials business has had a B2B Web site that is used extensively by contractors in your area. Recently, you have decided to launch a B2C site to sell home repair materials to do-it-yourself (DIY) homeowners as well. Moving into the B2C market requires you to adapt your B2B business practices to better meet the needs of a B2C Web site. For instance, you had an established way to get payments from your B2B customers involving credit lines, invoicing, and installment plans, but you have never dealt with collecting online payments for relatively small orders from individuals.

As you have begun planning for the launch of your B2C site, you have made two key decisions: (1) you will learn more about electronic payment systems and (2) you will hire a knowledgeable professional to construct the site. In order for your B2C site to thrive, you will need to accept credit cards, debit cards, PayPal, WePay, Venmo, and other forms of electronic payments. You are planning to research their terms of use—such as how much they charge you when they are used to make a payment—before making a final decision on what types of electronic payments you will accept. You will trust the professional B2B Web site developer to gather all the necessary information to support electronic payments and to ensure that your site will interface with the systems of the electronic payment providers.

### Review Questions

1. What should the Web site developer do to ensure security of the information used by your site?
2. Is it better to limit payment at the B2C Web site to only credit cards and debit cards, or is it better to have a wide variety of electronic payment types?

### Critical Thinking Questions

1. Why should your business have separate B2B and B2C Web sites?
2. Many DIY customers are young and use their phones to make most of their online purchases. How will you assure your B2C Web site is m-commerce friendly?

## Summary

### Principle:

**Organizations must define and execute an effective strategy to be successful in e-commerce.**

E-commerce is simply the conducting of business activities electronically over computer networks. Business-to-business (B2B) e-commerce allows manufacturers to buy at a low cost worldwide, and it offers enterprises the chance to sell to a global market. By far the greatest dollar volume of e-commerce sales falls under the category of B2B e-commerce. However, business-to-consumer (B2C) e-commerce occurs far more frequently, but the dollar amounts for the transactions are only a fraction of the B2B transactions. B2C enables organizations to sell directly to the final consumers of the product. The direct approach eliminates intermediaries and limits costs. In many cases, this practice squeezes costs and inefficiencies out of the supply chain that can lead to both higher profits for the business and lower prices for consumers. Consumer-to-consumer (C2C) e-commerce involves consumers selling directly to other consumers. Online auctions are the chief method by which C2C e-commerce is currently conducted. E-government involves the use of information and communications technology to simplify the sharing of information, speed formerly paper-based processes, and improve the relationship between citizens and government.

M-commerce is the use of mobile devices such as cell phones and smartphones to facilitate the sale of goods or services—anytime and anywhere. It is *just another form of e-commerce* and at the same time *a brand-new way to do e-commerce*. It has the disadvantage of limited space to display information (on a smartphone), but it allows e-commerce to take place anytime/anywhere and all the time/everywhere. M-commerce is a rapidly growing segment of e-commerce, with countries in Asia and Europe leading much of the growth. The market for m-commerce in North America is maturing much later than in other countries for several reasons.

Conversion to an e-commerce or m-commerce system enables organizations to reach new customers, reduce the cost of doing business, speed the flow of goods and information, increase the accuracy of order-processing and order fulfillment, and improve the level of customer service. Many smartphone users always have their devices with them, and this fact allows them to constantly be engaged in e-commerce.

A successful e-commerce system must address the many stages consumers experience in the sales life cycle. At the heart of any e-commerce system is the ability of the user to search for and identify items for sale; select those items; negotiate prices, terms of payment, and delivery date; send an order to the vendor to purchase the items; pay for the product or service; obtain product delivery; and receive after-sales support.

From the perspective of the provider of goods or services, an effective e-commerce system must be able to support the activities associated with supply chain management and customer relationship management. Many manufacturers and retailers have outsourced the physical delivery of goods to organizations specializing in product delivery.

A firm faces three key challenges when converting its business processes from the traditional form to e-commerce processes: (1) dealing effectively with consumer privacy concerns, (2) successfully overcoming consumers' lack of trust, and (3) overcoming global issues. Of these three challenges, privacy is currently the most prominent. The number of security breaches and their wide impact must be addressed by businesses involved with e-commerce.

### Principle:

**E-commerce is evolving, providing new ways of conducting business that present both potential benefits and potential problems.**

Many manufacturers are joining electronic exchanges; wholesale e-commerce is set to pass \$1 trillion per year. That's \$1,000 billion. They are also using e-commerce to improve the efficiency of the selling process by moving customer queries about product availability and prices online where customers can instantly seek answers from the manufacturer's database.

The Web allows firms to gather much more information about customer behavior and preferences than they could using other marketing approaches. This new technology relies heavily on Web site analytics and has greatly enhanced the practice of market segmentation. This enables many companies to establish closer relationships with their customers.

The Internet has revolutionized the world of investment and finance, especially online stock trading and online banking. The Internet has also created many options for electronic auctions, where geographically dispersed buyers and sellers can come together. Don't forget that multinational stock trading and online banking can be complicated by conflicting laws in the different countries.

The numerous m-commerce applications include advertising, bartering, retargeting, price comparison, couponing, investment and finance, and banking. But the main characteristics to consider are that (a) your device is with you so businesses know your location, (b) you have a customer profile that the business can use to target you, and (c) the m-commerce message can be delivered to your smartphone.

### Principle:

**E-commerce can be used in many innovative ways to improve the operations of an organization.**

Businesses and people use e-commerce and m-commerce to reduce transaction costs, speed the flow of goods and information, improve the level of customer service, and enable the close coordination of actions among manufacturers, suppliers, and customers. The capabilities of e-commerce grow as the power of computers and speed of networks increase—you could say that Moore's Law applies to e-commerce.

E-commerce and m-commerce also enable consumers and companies to gain access to worldwide markets. Organizations are making great strides in China, Japan, South Korea, and other Asian countries. There is also great promise for developing countries, enabling them to enter the prosperous global marketplace and hence helping to reduce the gap between rich and poor countries.

Because e-commerce and m-commerce are global systems they face cultural, language, time and distance, infrastructure, currency, product and service, and state, regional, and national law challenges.

Most people agree that an effective Web site is one that creates an attractive presence and meets the needs of its visitors. E-commerce start-ups must decide whether they will build and operate the Web site themselves or outsource this function. Web site hosting services and storefront brokers provide alternatives to building your own Web site.

To increase traffic to your Web site, you should register a domain name that is relevant to your business, make your site search-engine friendly by making it easily searchable by Web robots (“spiders”) that crawl the entire World Wide Web looking for content. Businesses also use Web site traffic data analysis software to attract additional customers and customize the user’s experience on the Web site so that it supports the user’s personal experience. Web site operators must constantly monitor the traffic and response times associated with their sites and adjust Web site content, software, databases, and hardware to ensure that visitors have a good experience when they visit.

Web site operators must also continually be alert to new trends and developments in the area of e-commerce and be prepared to take advantage of new opportunities, including personalization—the process of tailoring Web pages to specifically target individual consumers.

### Principle:

**E-commerce requires the careful planning and integration of many technology infrastructure components.**

A number of infrastructure components must be chosen and integrated to support a large volume of transactions with customers, suppliers, and other business partners worldwide. These components include hardware, Web server software, and e-commerce software.

M-commerce presents additional infrastructure challenges, including improving the ease of use of wireless devices, addressing the security of wireless transactions, and improving network speed. The Wireless Application Protocol (WAP) is a standard set of specifications to enable development of m-commerce software for wireless devices. The development of WAP and its derivatives addresses many m-commerce issues.

Electronic payment systems are a key component of the e-commerce infrastructure. A digital certificate is an attachment to an email message or data embedded in a Web page that verifies the identity of a sender or a Web site. To help prevent the theft of credit card numbers and banking information, the Transport Layer Security (TLS) communications protocol is used to secure all sensitive data. Several electronic cash alternatives require the purchaser to open an account with an electronic cash service provider and to present proof of identity whenever payments are to be made. Payments can also be made by credit, charge, debit, and smart cards, and p-cards. Retail and banking industries are developing means to enable payments using a cell phone like a credit card.

## Key Terms

business-to-business (B2B) e-commerce  
business-to-consumer (B2C) e-commerce  
certificate authority (CA)  
consumer-to-consumer (C2C) e-commerce  
digital certificate  
e-government  
electronic cash  
electronic exchange

identity theft  
market segmentation  
omnichannel  
personalization  
search engine optimization  
storefront broker  
Transport Layer Security (TLS)

## Self-Assessment Test

**Organizations must define and execute an effective strategy to be successful in e-commerce and m-commerce.**

1. Businesses should use Web sites as standalone items for e-commerce and not connect them to other commerce efforts by the business. True or False?
2. Businesses may use multiple, coordinated e-commerce applications that engage you in a purchase decision (such as allowing a customer in a physical store to scan a product UPC code to see social media comments, price comparisons for nearby stores, or a coupon for a discounted purchase). What is this marketing plan called?
  - a. Spam
  - b. Millennial marketing
  - c. Omnichannel marketing
  - d. B2B
3. The most important issue to be considered when an organization embarks on e-commerce is \_\_\_\_\_.
  - a. choosing the right technology
  - b. choosing the right professional to design the Web site
  - c. making the business strategy paramount
  - d. the amount spent on technology
4. Implementation of a B2C e-commerce application can lead to B2B opportunities. True or False?

**E-commerce is evolving, providing new ways of conducting business that present both potential benefits and problems.**

5. Which of the following is not a main characteristic to consider with m-commerce application?
  - a. M-commerce messages can be delivered to your phone.
  - b. M-commerce only works when an app on your phone makes the payment.
  - c. Your customer profile allows business to target you.
  - d. Your mobile device lets a business know your location.
6. According to Moore's Law, how long does it take for the power of computing technology to double for the same cost?
  - a. 1½ years
  - b. 5 years
  - c. 10 years
  - d. 100 years
7. The evolution of e-commerce \_\_\_\_\_.
  - a. is a normal business occurrence that makes business processes more efficient
  - b. is a disruption to business processes that makes businesses rethink how they achieve their objectives

- c. cannot be determined because e-commerce is less than 10 years old
- d. means that m-commerce will be the only form of e-commerce within five years

**E-commerce can be used in many innovative ways to improve the operations of an organization.**

8. Organizations cannot use existing technologies in innovative ways, they must wait for new technology to emerge before they innovate. True or False?
9. Improving an organization's performance with e-commerce most often means \_\_\_\_\_.
  - a. replacing current, older employees with new, younger employees who are more adept at using technology
  - b. changing the organization's processes to achieve goals
  - c. using artificial intelligence
  - d. keeping the same processes but performing them faster
10. Which of the following is NOT considered to be a key challenge of e-commerce?
  - a. Dealing with consumer privacy issues
  - b. Overcoming users' lack of trust
  - c. Overcoming global cultural challenges, language, time, distance, infrastructure, and currency challenges
  - d. Low user interest in accessing global markets and competitive pricing

**E-commerce requires the careful planning and integration of many technology infrastructure components.**

11. E-commerce is dependent upon electronic payments. True or False?
12. Which of the following is a key technology infrastructure component?
  - a. User profile privacy
  - b. Translation features on Web sites
  - c. Multinational banking
  - d. A high-speed connection to the network
13. Which of the following is not a Payment Card Industry security safeguard?
  - a. Using cash in transactions
  - b. Using a firewall to control access to computers and data
  - c. Never allowing the use of default passwords for systems
  - d. The use of antivirus software that is updated regularly

## Self-Assessment Test Answers

1. False
2. c.
3. c.
4. True
5. b.
6. a.
7. b.
8. False
9. b.
10. d.
11. True
12. d.
13. a.

## Review and Discussion Questions

1. Briefly explain the differences between B2B, B2C, and C2C.
2. What challenges does m-commerce present?
3. How does social media impact B2C e-commerce?
4. Explain some of the ways e-government, especially G2C, is different from B2C.
5. Describe the multistage model for e-commerce.
6. Explain the difference between “privacy” and “confidentiality.”
7. Explain some of the security issues around electronic payments.
8. Identify and briefly discuss the five stages consumers experience in the sales life cycle that must be supported by a successful e-commerce system.
9. Identify and briefly discuss several challenges that an organization faces in creating a successful e-commerce operation.
10. Outline the key steps in developing a corporate global e-commerce strategy.

## Business-Driven Decision-Making Exercises

1. Two of the electronic cash options discussed in this chapter are Venmo and Square Cash. Do a comparison between these two based upon (1) type of phone the app can run on, (2) bank transfer fee, (3) credit card fee, (4) debit card fee, (5) transfer limit, and other factors you believe are significant. Explain which features are most important to you and how you would rate these apps overall.
2. Assume you are in an organization that only does business in the United States but that is considering doing business in the European Union. How would you change your data acquisition and storage policies in order to satisfy data privacy concerns in the European Union?
3. The air conditioning in your car just went out. Use what you have learned in this chapter to find and compare several auto repair shops that can fix air conditioning. Your comparison should include cost, ratings by customers that have used the repair shops, and how soon the work can be completed. Write a brief summary of your experience, and identify the Web sites you found most useful.

## Teamwork and Collaboration Activities

1. As a team, develop a plan for a B2C Web site to suggest additional items a customer might purchase as well as higher value items. For example, if the customer purchased a new phone you could suggest also purchasing a “lost or stolen” insurance plan or a case for the phone that keeps it safe as dropped. You might suggest that for just a little more money per month you could get a larger data plan. Be creative.
2. Have your team choose three countries and develop a plan that will make your university’s Web site culturally acceptable to all three countries. Describe several possible cultural issues and describe how your plan addresses the issues.

## Career Exercises

- Do research and write a brief report on three Web sites that show job openings or internships related to your major. *CareerBuilder.com* and even Facebook have sites but try to find a site that focuses on your major. Describe the key features of each of these sites, and explain why you would use the Web sites, or why not. Some of the key features might include (1) keeping your information confidential (remember that confidential is not the same as private), (2) the ability to apply for multiple jobs/internships, and (3) listings for part-time jobs. Be sure to include your university's career center Web site in your research.
- Determine an organization you might wish to work for and examine its Web site. How could the B2C features of the Web site be improved? Provide at least three examples.

## Case Study

### ► ANALYTICAL THINKING, GLOBAL, APPLICATION

#### **Alibaba, the Giant Chinese E-Commerce Site**

Alibaba (Alibaba Group Holdings), which was founded in Hangzhou, China, in 1999 has a B2B e-commerce site (*Alibaba.com*) and two large B2C e-commerce sites (*Taobao.com* and *Tmall.com*). The company employs over 100,000 people across many countries. Their mission is “To Make It Easy to Do Business Anywhere,” and judging by the company’s success in only 20 years, it is achieving its mission.

“Singles Day” in China is a response to traditional Valentine’s Day celebrations, which take place in August in that country. On Single’s Day, which falls on November 11th each year, many Chinese treat themselves to an online purchase. **In just 90 seconds** on November 11, 2018, Alibaba took in over \$1 billion in sales, and its Web sites pulled in more than \$31 billion in sales by the end of the day on November 11. To put Alibaba sales in perspective, consider that the U.S. Cyber Monday sales for 2018 were a little over \$6 billion. Online Valentine’s Day sales in the United States were less than \$20 billion in 2018.

Alibaba’s online travel platform, Fliggy, now offers an e-commerce market aimed at Chinese travelers traveling to other countries. There were 131 million overseas trips made by Chinese travelers in 2017. Fliggy is trying to improve the travel experience by offering Chinese tourists access to merchants and other businesses in the country they are visiting so they can purchase food and other products duty free and make arrangements for accommodations, sightseeing, and entertainment, all before reaching their destination. The platform allows merchants and other businesses in foreign countries to reach the large Chinese market. The reputation of Alibaba assures Chinese tourists of the quality and high standards of foreign businesses using the Fliggy site.

Like any other e-commerce giant, Alibaba has been the target of hackers looking to steal customer information. In 2018, 21 suspects were arrested on suspicion of stealing information from one of Alibaba’s affiliates. No private information was obtained, but the thieves stole usernames and phone numbers from 10 million parcel shipments.

The thieves were arrested before they were able to sell the stolen information to a third party, so police believe minimal damage was done to Alibaba customers.

A constant theme at Alibaba is to expand, expand again, and then expand some more. In 20 years it grew from less than 20 employees to over 100,000. It had \$31 billion in sales in a single day. E-commerce is dependent upon electronic payments so how do all the customers pay? Alipay is the electronic payment system most Alibaba customers use in China. Over one billion people have an Alipay account, and over 500 million of those are active users.

There are an estimated 100 million daily transactions on Alipay. By comparison, Visa has approximately 150 million transactions daily for their world wide operations. To use Alipay you must have a Chinese bank account or credit card account with a state-run bank in China. Alipay is used at restaurants, retail shops, hotels, and most businesses in China. Considering Alipay’s requirement for a Chinese bank account, its transaction numbers are staggering. The *Taobao.com* and *TMall.com* sites have recently added Visa and Mastercard as acceptable payment method, but many Chinese do not have these credit cards.

Alipay has expanded beyond China and southeast Asia—it has come to the United States as well as 70 other countries. Alipay focuses heavily on Chinese traveling to or living in the other countries and does not actively market to non-Chinese. Remember, Alipay is tied to state-run banks operating in China. Alipay promotes e-commerce of Chinese tourists traveling in the United States or other countries who do not have bank accounts or credit cards in that foreign country. That means the Chinese tourist may be in the United States, but all transactions with *Taobao.com*, *TMall.com*, and Fliggy can still be made using Alipay. B2C e-commerce is closely tied to how customers can pay for their purchases, and Alibaba wants to retain their customers’ loyalty even as they travel. As China’s economy grows and more of its citizens travel abroad, Alibaba wants to be their e-commerce site of choice as they travel.

## Critical Thinking Questions

1. Alipay is the electronic cash system developed by Alibaba for *Taobao.com* and *TMall.com*, but it can generate revenues for Alibaba when Alipay is used for other purchases such as at restaurants, grocery stores, etc. Mastercard and Visa have recently passed the Chinese government's regulations to be used in China, but those credit cards are mainly accepted at larger restaurants, hotels, and other travel industry establishments in larger areas. Small businesses and businesses in rural areas are unlikely to accept Mastercard and/or Visa. Would the increased use of Mastercard and/or Visa at *Taobao.com* and *TMall.com* help or hurt Alibaba? Explain your answer.
2. Chinese citizens made over 130 million trips overseas in 2017, and the numbers increase each year. How does Alibaba leverage its Fliggy e-commerce site to get profits from using Fliggy instead of an e-commerce Web site in the country being visited by the Chinese tourist?

3. Review the "Overcoming Global Issues" section of this chapter and then visit the *TMall.com* e-commerce Web site. How does TMall deal with the six challenges listed in that section?

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## Principles

- An organization must have information systems that support routine, day-to-day activities and that help a company add value to its products and services.
- An organization that implements an enterprise system is creating a highly integrated set of systems, which can lead to many business benefits.
- An organization must have access to data across all of its corporate functions and enterprise systems to help drive decision making

## Learning Objectives

- Identify the basic activities and business objectives common to all transaction processing systems.
- Describe the transaction processing systems associated with the order processing, purchasing, and accounting business functions.
- Identify the basic functions performed and the benefits derived from the implementation of an enterprise resource planning system, customer resource management, and product lifecycle management system.
- Describe the hosted software model for enterprise systems and explain why this approach is so appealing to SMEs.
- Identify the challenges that organizations face in planning, building, and operating their enterprise systems.
- Identify tips for avoiding many of the common causes for failed enterprise system implementations.
- Develop an understanding of how data from one function of the organization can be used to make critical decisions in another.
- Identify tools that can be used to analyze this data, and demonstrate an ability to find valuable relationships between data.

# IS in Action

## Healthcare Rises to Enterprise Systems

### ► SYSTEMS AND PROCESSES, APPLICATION

Physician groups, hospitals, insurance companies, and other healthcare entities require systems that are integrated across the enterprise. These systems help healthcare organizations deliver optimal care to their patients and improve research results that drive future innovation. These enterprise-level systems often support thousands of users and millions of patients, when and where they need it. To enable this level of collaboration and care, electronic health records (EHR) have been instituted with the help of enterprise-level systems.

Barts Health NHS Trust, which is composed of four major hospital sites and a number of community locations, serves more than 2.5 million people in east London, performing more than 23 million tests per year in their network of labs. They have seen dramatic benefits by implementing enterprise level systems in both their Emergency Department and across their pathology network. Within the Emergency Department, they have streamlined workflows using the FirstNet emergency medicine module from Cerner Millennium's enterprise-level healthcare system. As with many emergency departments, Barts Health was experiencing problems with long wait times, resulting in a backlog of patients who needed immediate care. The registration process often entailed gathering information from multiple sources and entering it into multiple systems, slowing the process, increasing the chances of error, and inhibiting communication. With the implementation of FirstNet across all of Barts' emergency locations, patients to the Emergency Department are now registered electronically, previous information about the patient is easily retrieved, and their EHR is immediately updated. Patient registration times have decreased from five to one minute, allowing doctors to see critically ill patients more quickly. Providers are able to make better decisions by having complete information from the patient's history immediately available, when even seconds can make a difference. When the time savings and care improvements are considered over millions of emergency visits, the benefits are clear. Wait times for appointments, open beds, and lab tests have decreased as well, because resource availability is kept current and made available to users throughout the system. Appointment and follow-up documentation is also captured by the system to improve collaboration and coordination among providers for future care.

For their pathology network, Barts migrated from three different lab systems used by their four primary hospital locations and many smaller community providers to WinPath Enterprise offered by Clinisys in 2016 and 2017. With more readily available and complete information, Barts has improved turnaround times for labs and reduced the risk of clinical errors, which both lead to healthier patients. The enterprise-level system also led to dramatic reductions in cost by removing duplicate processes, systems, and IT services. System stability was improved, with IT support calls within the network dropping 74 percent. Barts' now integrated pathology network, is able to connect effectively with other enterprise-level systems within the organization, such as the Cerner Millennium EHR. Now information that is critical for patient care and provider collaboration is available when and where it is needed throughout Barts' different functions and departments.

### As you read about enterprise systems, consider the following:

- What advantages do integrated enterprise systems offer an organization?
- What factors should organizations consider when adopting enterprise systems to support their business processes and plan for the future?
- What tools can organizations use to analyze data and identify trends?

## Why Learn About Enterprise Systems?

Individuals and organizations today are moving from a collection of nonintegrated transaction processing systems to highly integrated enterprise systems that perform routine business processes and maintain records about them. These systems support a wide range of business activities associated with supply chain management, customer relationship management, and product lifecycle management. Although they were initially thought to be cost effective only for very large companies, small- and mid-sized companies are now implementing these systems to reduce costs, speed time to market, and improve service.

In our service-oriented economy, outstanding customer service has become a goal of virtually all companies. To provide good customer service, employees who work directly with customers—whether in sales, customer service, or marketing—require high-quality and timely data to make good decisions. Such workers might use an enterprise system to check the inventory status of ordered items, view the production-planning schedule to tell a customer when an item will be in stock, or enter data to schedule a delivery.

No matter what your role, it is very likely that you will provide input to or use the output from your organization's enterprise systems. Your effective use of these systems will be essential to raise the productivity of your firm, improve customer service, and enable better decision making. Thus, it is important that you understand how these systems work and what their capabilities and limitations are.

This chapter begins with an overview of the individual transaction processing systems that support the fundamental operations of many organizations. Their data collection and processing methods, objectives, and primary activities are covered. Then enterprise systems, collections of integrated information systems that share a common database, are discussed. Enterprise systems ensure that data can be shared across all business functions and all levels of management to support the operational and management decision making needed to run the organization. The basic functions and benefits of these systems as well as the challenges of successfully implementing them are discussed.

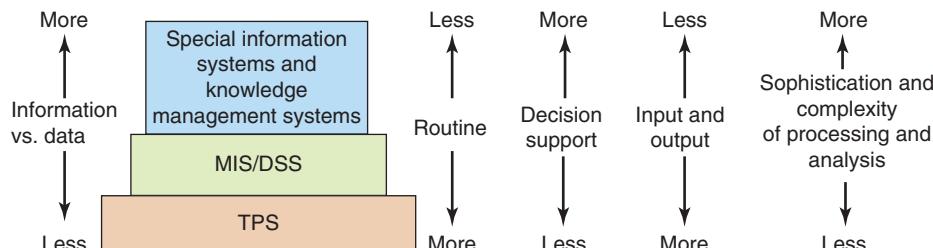
## Transaction Processing Systems

Many organizations employ transaction processing systems (TPSs), which capture and process the detailed data necessary to update records about the fundamental business operations of the organization. These systems include order entry, inventory control, payroll, accounts payable, accounts receivable, and the general ledger, to name just a few. The input to these systems includes basic business transactions, such as customer orders, purchase orders, receipts, time cards, invoices, and customer payments. The processing activities include data collection, data editing, data correction, data processing, data storage, and document production. The result of processing business transactions is that the organization's records are updated to reflect the status of the operation at the time of the last processed transaction.

A TPS also provides valuable input to management information systems, decision support systems, and knowledge management systems. Indeed, transaction processing systems serve as the foundation for these other systems. See Figure 10.1.

**FIGURE 10.1**  
**TPS, MIS/DSS, and special information systems in perspective**

A TPS provides valuable input to MIS, DSS, and KM systems.



Transaction processing systems support routine operations associated with business processes, such as customer ordering and billing, shipping, employee payroll, purchasing, and accounting. TPSs use a large amount of input and output data to update the official records of the company about orders, sales, customers, and so on. TPSs, however, don't provide much support for decision making.

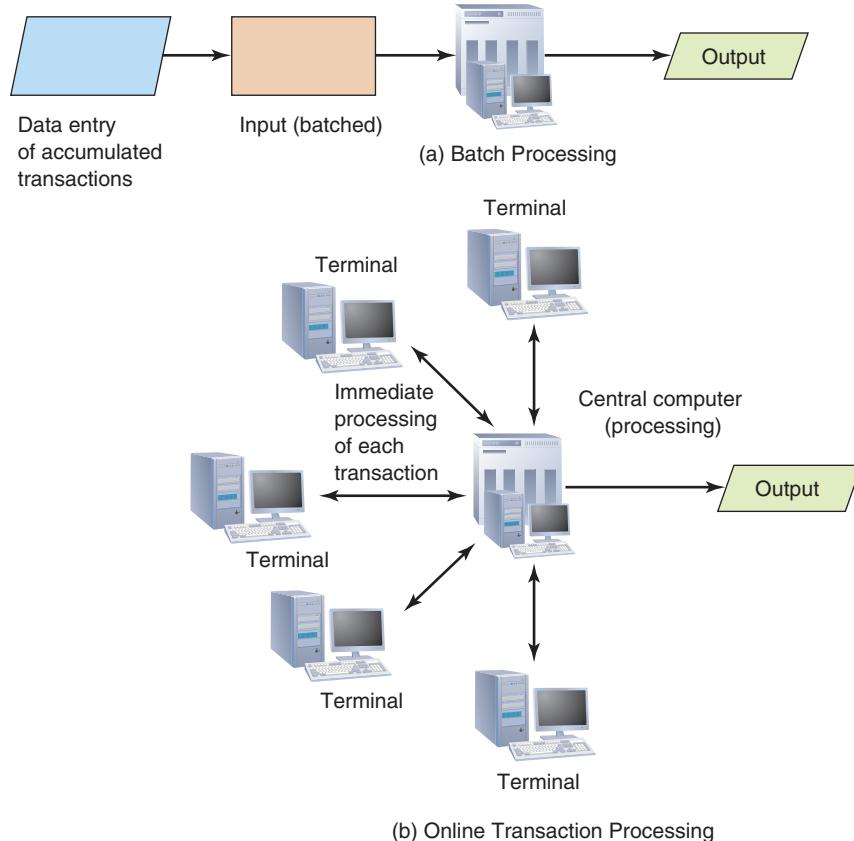
Because TPSs often perform activities related to customer sales and contacts—such as order processing and invoicing—these information systems play a critical role in providing value to the customer. Organizations have a wide range of options when selecting a TPS to meet their customer service support needs. For example, Zendesk is a help desk management software application that helps organizations strengthen customer relationships by supporting communication on multiple channels, including text, phone, email, and social media. Zendesk is used by more than 200,000 companies including Uber, Groupon, Box, Airbnb, and Disney.<sup>1</sup> Quickbooks from Intuit is a software application that provides transaction support for functions such as sales, billing, inventory, and payroll with more than 7 million customers globally.

## Traditional Transaction Processing Methods and Objectives

**batch processing system:** A form of data processing whereby business transactions are accumulated over a period of time and are processed as a single unit or batch.

With **batch processing systems**, business transactions are accumulated over a period of time and prepared for processing as a single unit or batch. See Figure 10.2a. Transactions are accumulated for as long as necessary to meet the needs of the users of that system. For example, it might be important to process invoices and customer payments for the accounts receivable system daily. On the other hand, the payroll system might process time cards biweekly to create checks, update employee earnings records, and distribute labor costs. The essential characteristic of a batch processing system is the delay between an event and the eventual processing of the related transaction to update the organization's records. For many applications, batch processing is an appropriate and cost-effective approach. Payroll transactions and billing are typically done via batch processing.

**FIGURE 10.2**  
**Batch versus online transaction processing**  
(a) Batch processing inputs and processes data in groups. (b) In online processing, transactions are processed as they occur.



Automatic Data Processing (ADP) is a major provider of business outsourcing solutions for payroll administration for more than 740,000 organizations worldwide. It uses a batch processing system to prepare the paychecks, payroll cards, and direct deposits of 40 million other workers around the world, including one out of six workers in the United States.<sup>2</sup>

#### **online transaction processing (OLTP)**

**(OLTP):** A form of data processing where each transaction is processed immediately without the delay of accumulating transactions into a batch.

With **online transaction processing (OLTP)** each transaction is processed immediately without the delay of accumulating transactions into a batch, as shown in Figure 10.2b. Consequently, at any time, the data in an online system reflects the current status. This type of processing is essential for businesses that require access to current data such as airlines, ticket agencies, and stock investment firms. Many companies find that OLTP helps them provide faster, more efficient service—one way to add value to their activities in the eyes of the customer. See Figure 10.3.

**FIGURE 10.3**

#### **Example of OLTP system**

PayPal uses an OLTP system to manage payments between merchants and consumers as well as between individual users.<sup>3</sup>

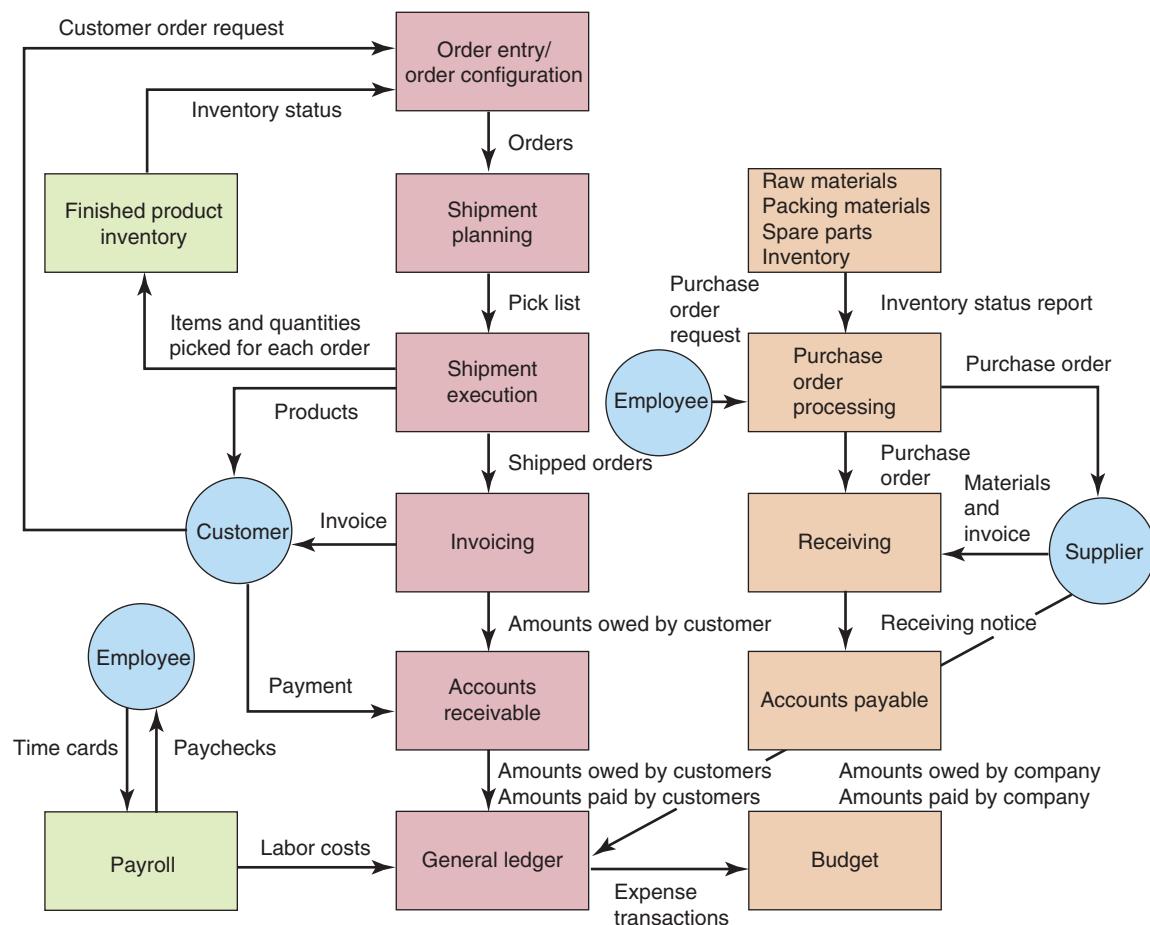


MariaX/Shutterstock.com

Online payments giant PayPal Holdings, Inc. employs a massive OLTP system to process more than 9.9 billion payments annually through its Braintree, PayPal, Venmo, Xoom, and iZettle products. The payments between merchants and consumers—as well as between individual users—total more than \$578 billion annually.<sup>4</sup>

The specific business needs and goals of the organization define the method of transaction processing best suited for the various applications of the company. Increasingly, the need for current data for decision making is driving many organizations to move from batch processing systems to online transaction processing systems when it is economically feasible. For example, the State of Wisconsin Department of Health Services (DHS) runs the Women, Infants, and Children (WIC) program. WIC's goal is to support and sustain the health and well-being of nutritionally at-risk pregnant, breastfeeding, and postpartum women, as well as their infants and children. DHS employed a batch processing system to manage this program and processed the WIC data in a batch at the end of the day. Required integration with Medicaid providers created a built-in delay in obtaining information needed for decision making and government reporting. DHS needs up-to-date data to avoid dual participation incidents, such as a client or caregiver receiving more WIC deposits than are allowed for one month or receiving WIC benefits and the Commodity Supplemental Food Program (CSFP) payments at the same time. DHS moved to an online transaction processing system to ensure that all data is now available on a real-time basis. The system is Web-based, and WIC staff needs only a Web browser and secure Internet access to work with the data.<sup>5,6</sup>

Figure 10.4 shows the traditional flow of key pieces of information from one TPS to another for a typical manufacturing organization. When transactions entered into one system are processed, they create new transactions that flow into another system.



**FIGURE 10.4**  
**Integration of a firm's TPS**

When transactions entered into one system are processed, they create new transactions that flow into another system.

Because of the importance of transaction processing, organizations expect their TPSs to accomplish a number of specific objectives, including the following:

- Capture, process, and update databases of business data required to support routine business activities
- Ensure that the data is processed accurately and completely
- Avoid processing fraudulent transactions
- Produce timely user responses and reports
- Reduce clerical and other labor requirements
- Help improve customer service
- Achieve competitive advantage

A TPS typically includes the following types of systems:

- **Order processing systems.** Running these systems efficiently and reliably is so critical that the order processing system is sometimes referred to as the lifeblood of the organization. The processing flow begins with the receipt of a customer order. The finished product inventory is

checked to see if sufficient inventory is on hand to fill the order. If sufficient inventory is available, the customer shipment is planned to meet the customer's desired receipt date. A product pick list is printed at the warehouse from which the order is to be filled on the day the order is to be shipped. At the warehouse, workers gather the items needed to fill the order and enter the item identifier and quantity for each item to update the finished product inventory. When the order is complete and sent on its way, a customer invoice is created, with a copy included in the customer shipment.

- **Accounting systems.** The accounting systems must track the flow of data related to all the cash flows that affect the organization. As mentioned earlier, the order processing system generates an invoice for customer orders to include with the shipment. This information is also sent to the accounts receivable system to update the customer's account. When the customer pays the invoice, the payment information is also used to update the customer's account. The necessary accounting transactions are sent to the general ledger system, which tracks amounts owed from customers and amounts due to vendors. Similarly, as the purchasing systems generate purchase orders and those items are received, information is sent to the accounts payable system to manage the amounts owed by the company. Data about amounts owed and paid by customers to the company and from the company to vendors and others are sent to the general ledger system, which records and reports all financial transactions for the company.
- **Purchasing systems.** The traditional transaction processing systems that support the purchasing business function include inventory control, purchase order processing, receiving, and accounts payable. Employees place purchase order requests in response to shortages identified in inventory control reports. Purchase order information flows to the receiving system and accounts payable systems. A record is created upon receipt of the items ordered. When the invoice arrives from the supplier, it is matched to the original order and the receiving report, and a check is generated if all data is complete and consistent.

In the past, organizations knitted together a hodgepodge of systems to accomplish the transaction processing activities shown in Figure 10.4. Some of the systems might have been applications developed using in-house resources, some may have been developed by outside contractors, and others may have been off-the-shelf software packages. Much customization and modification of this diverse software was typically necessary for all the applications to work together efficiently. In some cases, it was necessary to print data from one system and then manually reenter it into other systems. Of course, this increased the amount of effort required and increased the likelihood of processing delays and errors.

The approach taken today by many organizations is to implement an integrated set of transaction processing systems—from a single or limited number of software vendors—that handle most, or all, of the transaction processing activities shown in Figure 10.4. The data flows automatically from one application to another with no delay or need to reenter data. For example, Lukas Nursery, a fourth-generation family-owned agri-business in central Florida, implemented a suite of software applications that it integrated into the garden center's POS system. The nursery consolidated its systems (including several manual systems) into an integrated retail business management solution provided by one vendor, allowing it to update its business practices, optimize seasonal inventory, manage a customer loyalty program, and make more informed business decisions through the use of the software's analytics capabilities.<sup>7</sup>

Table 10.1 summarizes some of the ways that companies can use transaction processing systems to achieve competitive advantage.

**TABLE 10.1** Examples of TPSs yielding significant benefits

Competitive Advantage	Example
Better relationship with suppliers	Internet marketplace to allow the company to purchase products from suppliers at discounted prices
Costs dramatically reduced	Warehouse management system employing RFID technology to reduce labor hours and improve inventory accuracy
Customer loyalty increased	Customer interaction system to monitor and track each customer interaction with the company
Inventory levels reduced	Collaborative planning, forecasting, and replenishing system to ensure the right amount of inventory is in stores
Superior information gathering	Order configuration system to ensure that products ordered will meet customer's objectives
Superior service provided to customers	Tracking systems that customers can access to determine shipping status

Depending on the specific nature and goals of the organization, any one of the objectives in Table 10.1 might be more important than others. By meeting these objectives, TPSs can support corporate goals such as reducing costs; increasing productivity, quality, and customer satisfaction; and running more efficient and effective operations.

### Transaction Processing Systems for Entrepreneurs and Small- and Medium-Sized Enterprises

Many software packages provide integrated transaction processing system solutions for small- and medium-sized enterprises (SMEs), wherein SME is a legally independent enterprise with no more than 500 employees. Integrated transaction processing systems for SMEs are typically easy to install and operate and usually have a low total cost of ownership, with an initial cost of a few hundred to a few thousand dollars. Such solutions are highly attractive to firms that have outgrown their current software but cannot afford a complex, high-end integrated system solution. Table 10.2 presents some of the dozens of such software solutions available.

**TABLE 10.2** Sample of integrated TPS solutions for SMEs

Vendor	Software	Type of TPS Offered	Target Customers
AccuFund	AccuFund	Financial reporting and accounting	Nonprofit, municipal, and government organizations
OpenPro	OpenPro	Complete ERP solution, including financials, supply chain management, e-commerce, customer relationship management, and retail POS system	Manufacturers, distributors, and retailers
Intuit	QuickBooks	Financial reporting and accounting	Manufacturers, professional services, contractors, nonprofits, and retailers
Sage	Sage 300 Construction and Real Estate	Financial reporting, accounting, and operations	Contractors, real estate developers, accountants, and residential builders
Redwing	TurningPoint	Financial reporting and accounting	Professional services, banks, and retailers

Sage is a provider of accounting, ERP, human resources, payroll, asset management, and payment systems software. Its Sage 300 Construction and Real Estate software provides an integrated set of applications specifically designed for customers in the construction, property management, and real estate industries. Small- and medium-sized construction businesses can efficiently support their operations and easily access their financial data with Sage's cloud-based project management tools.<sup>8</sup>

Echo Valley Irrigation is a golf course and sports field irrigation design and construction company founded in 1986. For years, Echo Valley utilized a patch-work of processes and technologies to run its business. As the company continued to grow, however, its systems were not keeping up. Eventually, Echo Valley implemented the Sage 300 cloud-based software package, which provides the company with a range of automated accounting functions, like creating a job-level profit-and-loss analysis for more accurate bidding on new projects. Managers can quickly check status and make changes online in this cloud-based system.<sup>9</sup>

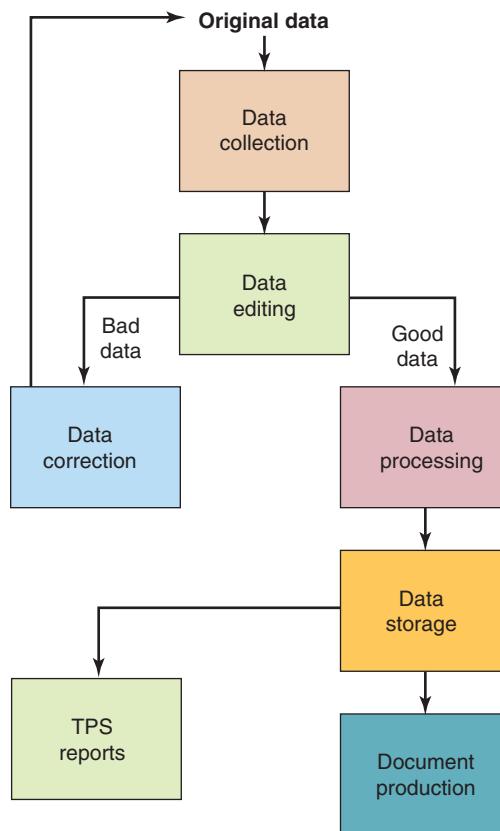
## Transaction Processing Activities

Along with having common characteristics, all TPSs perform a common set of basic data-processing activities. TPSs capture and process data that describes fundamental business transactions. This data is used to update databases and to produce a variety of reports for people both within and outside the enterprise. The business data goes through a **transaction processing cycle** that includes data collection, data editing, data correction, data processing, data storage, and document production. See Figure 10.5.

**transaction processing cycle:** The process of data collection, data editing, data correction, data processing, data storage, and document production.

### FIGURE 10.5 Transaction processing activities

A transaction processing cycle includes data collection, data editing, data correction, data processing, data storage, and document production.



### Data Collection

Capturing and gathering all data necessary to complete the processing of transactions is called **data collection**. In some cases, it can be done manually, such as by collecting handwritten sales orders or inventory update forms. In other cases, data collection is automated via special input devices such as scanners,

**data collection:** Capturing and gathering all data necessary to complete the processing of transactions.

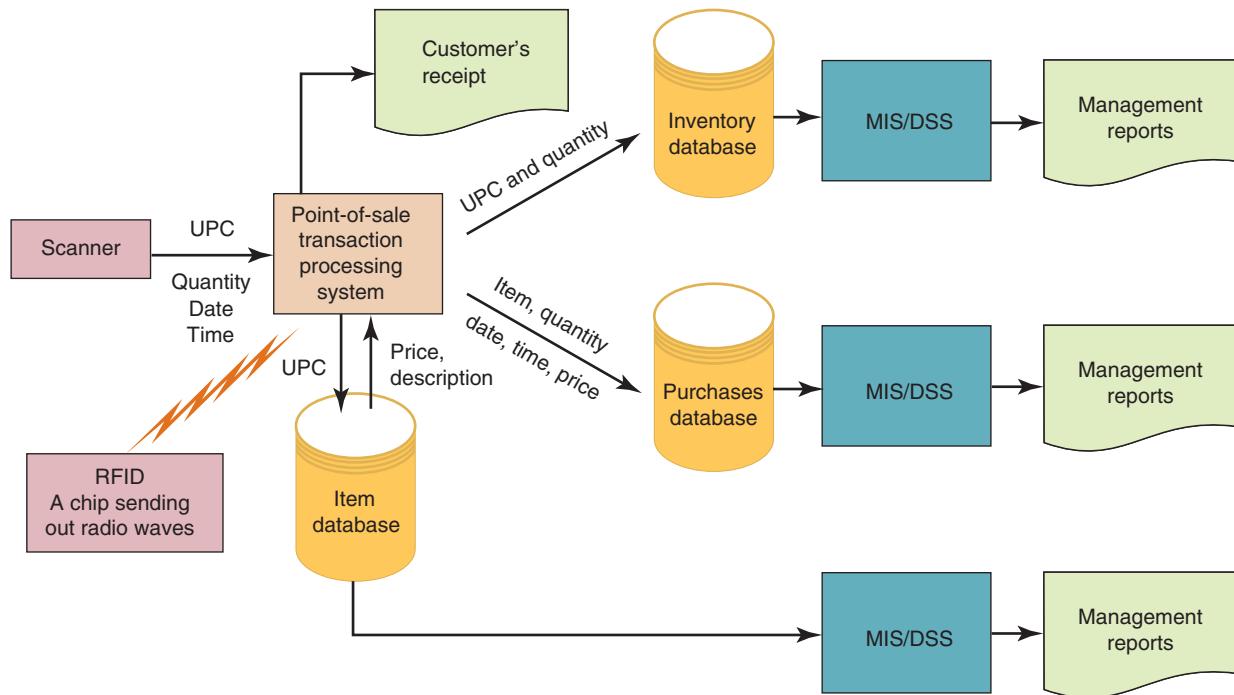
**streaming:** A form of data collection, where data is available through a continuous feed.

#### source data automation:

Capturing data at its source and recording it accurately in a timely fashion, with minimal manual effort and in an electronic or digital form so that it can be directly entered into the computer.

point-of-sale (POS) devices, and terminals. New technologies have enabled the continuous **streaming** of data and have dramatically sped up data collection, whether the data is being processed in batches or real-time. Streaming provides a continuous stream of data that organizations can tap into and process, supporting faster decisions. Streaming is not appropriate to all situations; it depends on the objective. For instance, batch collection and processing may be a better choice if real-time analytics are not required. Streaming data collection is likely the best choice when organizations are using the data to become more agile, innovative, and responsive to threats. Usually it is best to use a combination of collection and processing methods, choosing the methods that best meet the goals of the business.<sup>10</sup>

Data collection begins with a transaction (e.g., taking a customer order) and results in data that serves as input to the TPS. Data should be captured at its source and recorded accurately in a timely fashion, with minimal manual effort and in an electronic or digital form that can be directly entered into the computer. This approach is called **source data automation**. An example of source data automation is an automated device at a retail store that speeds the checkout process—either UPC codes read by a scanner or RFID signals picked up at the register. Using UPC bar codes or RFID tags is quicker and more accurate than having a clerk enter codes manually. The product ID for each item is determined automatically, and its price retrieved from the item database. The point-of-sale TPS uses the price data to determine the customer's total. The store's inventory and purchase databases record the number of units of an item purchased, along with the price and the date and time of the purchase. The inventory database generates a management report notifying the store manager to reorder items that have fallen below the reorder quantity. The detailed purchases database can be used by the store or sold to marketing research firms or manufacturers for detailed sales analysis. See Figure 10.6.



**FIGURE 10.6**  
**Point-of-sale transaction processing system**

A store's inventory database and its database of purchases are both updated as part of the checkout process.

Many grocery stores combine point-of-sale scanners and coupon printers. The systems are programmed so that each time a specific product—for example, a box of cereal—crosses a checkout scanner, an appropriate coupon, perhaps a milk coupon, is printed. Companies can pay to be promoted through the system, which is then programmed to print those companies' coupons if the customer buys a competing brand. These TPSs help grocery stores increase profits by improving their repeat sales and bringing in revenue from other businesses.

Many mobile POS (point-of-sale) systems operate on tablets, smartphones, or other touchscreen devices. Some mobile POS systems include marketing tools that SMEs can use to thank first-time customers and send automated emails to longtime customers who have not visited recently.

Cloud-based POS systems provide a range of capabilities, including advanced integration with digital loyalty programs, various accounting tools, and the ability to generate gift cards and coupons. Popular POS systems include Square, Shopify, and ShopKeep.<sup>11</sup> The owners of The Creative Wedge, an artisan market that sells cheese and charcuterie along with craft beer and local wine, implemented a truly mobile POS system that allows them to sell product out of their store as well as at various local events, including farmer's markets and festivals.<sup>12</sup>

### Data Editing

**data editing:** Checking data for validity and completeness to detect any problems.

An important step in processing transaction data is to check data for validity and completeness to detect any problems, a task called **data editing**. For example, quantity and cost data must be numeric, and names must be alphabetic; otherwise, the data is not valid. Often, the codes associated with an individual transaction are edited against a database containing valid codes. If any code entered (or scanned) is not present in the database, the transaction is rejected.

### Data Correction

**data correction:** Reentering data that was not typed or scanned properly.

It is not enough simply to reject invalid data. The system should also provide error messages that alert those responsible for editing the data. Error messages must specify the problem so proper corrections can be made. A **data correction** involves reentering data that was not typed or scanned properly. For example, a scanned UPC code must match a code in a master table of valid UPCs. If the code is misread or does not exist in the table, the checkout clerk is given an instruction to rescan the item or type the information manually.

### Data Processing

**data processing:** Performing calculations and other data transformations related to business transactions.

Another major activity of a TPS is **data processing**, performing calculations and other data transformations related to business transactions. Data processing can include classifying data, sorting data into categories, performing calculations, summarizing results, and storing data in the organization's database for further processing. In a payroll TPS, for example, data processing includes multiplying an employee's hours worked by the hourly pay rate. Overtime pay, federal and state tax withholdings, and deductions are also calculated. In a doctor's office, patient demographic data is entered and sent to various databases for use by the physician, billing department, referrals department, surgery scheduling, and so forth.

### Data Storage

**data storage:** Updating one or more databases with new transactions.

**Data storage** involves updating one or more databases with new transactions. After the database is updated, the data can be further processed by other systems so that it is available for management reporting and decision making. Thus, although transaction databases can be considered a by-product of transaction processing, they can significantly affect nearly all other information systems and decision-making processes within an organization. The speed at which information is available depends on the processing system being used.

**document production:**

Generating output records, documents, and reports.

### **Document Production**

**Document production** involves generating output records, documents, and reports. These can be hard-copy paper reports or displays on computer screens (sometimes referred to as soft copy). Printed paychecks, for example, are hard-copy documents produced by a payroll TPS, whereas an outstanding balance report for invoices might be an electronic report displayed by an accounts receivable TPS. Often, as shown earlier in Figure 10.6, results from one TPS flow downstream to become input to other systems, which might use the results of an inventory database update to create a stock exception report, a type of management report showing items with inventory levels below the specified reorder point.

In addition to major documents such as checks and invoices, most TPSs provide other useful management information, such as printed or on-screen reports that help managers and employees perform various activities. A report showing current inventory is one example; another might be a document listing items ordered from a supplier to help a receiving clerk check the order for completeness when it arrives. A TPS can also produce reports required by local, state, and federal agencies, such as statements of tax withholding and quarterly income statements.



### **Critical Thinking Exercise**

#### **TPS Needed to Support Small Business**

##### **► REAL-WORLD INTEGRATION, DECISION MAKING**

D5 Consulting is a small grant-writing business that was founded two years ago by Dion Davenport. Since then, Dion has performed a wide range of activities, including business development, grant writing, and invoicing. Because D5 began as a home-based business, with only a few clients, Dion has been generating simple invoices using Microsoft Word. He then uses a manual process to follow up on invoices to ensure they are being paid in a timely manner.

Over the last two years, however, D5 Consulting has grown significantly. The company now works with more than 50 clients on a variety of jobs ranging from small, simple projects to larger, more complex projects requiring multiple invoices. As the company grew, Dion found himself spending as much time creating and tracking down invoices as he did generating billable hours. As a result, he has been putting in very long hours to keep up with the work. D5 also now has several contractors doing work for the firm. Each contractor submits monthly invoices for their work, which means Dion has even more administrative tasks to keep track of. In the last several months, Dion has been late paying a few of the contractors because he has gotten behind processing their invoices or because he did not realize that they had not submitted their invoices in a timely manner.

Dion is frustrated with the inefficiencies in the business and fears that it will either result in lower client satisfaction or him exiting the business due to the long work hours.

#### **Review Questions**

1. What functions would a TPS need to perform in order to alleviate the issues at D5 Consulting?
2. How would these functions benefit D5 Consulting?

#### **Critical Thinking Questions**

What factors should Dion consider when selecting a TPS?

1. What stakeholders should Dion consult with to determine the appropriate needs for a TPS? Why should he consult with those stakeholders, and how will that help alleviate his frustration?

## Enterprise Systems

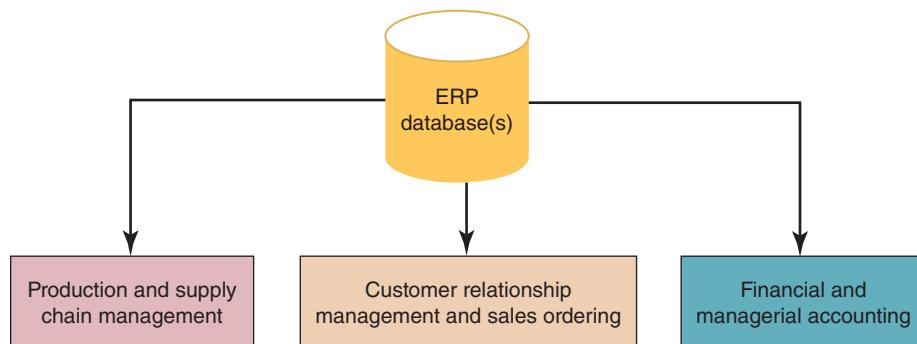
**enterprise system:** A system central to the organization that ensures information can be shared with authorized users across all business functions and at all levels of management to support the running and managing of a business.

An **enterprise system** is central to individuals and organizations of all sizes and ensures that information can be shared with authorized users across all business functions and at all levels of management to support the running and managing of a business. Enterprise systems employ a database of key operational and planning data that can be shared by all, eliminating the problems of missing information and inconsistent information caused by multiple transaction processing systems that each support only one business function or one department in an organization. Examples of enterprise systems include enterprise resource planning systems that support supply chain processes, such as order processing, inventory management, and purchasing, and customer relationship management systems that support sales, marketing, and customer service-related processes.

Businesses rely on enterprise systems to perform many of their daily activities in areas such as product supply, distribution, sales, marketing, human resources, manufacturing, accounting, and taxation so that work can be performed quickly without waste or mistakes. Without such systems, recording and processing business transactions would consume huge amounts of an organization's resources. This collection of processed transactions also forms a storehouse of data invaluable to decision making. The ultimate goal of such systems is to satisfy customers and provide significant benefits by reducing costs and improving service.

### Enterprise Resource Planning

Enterprise resource planning (ERP) is a set of integrated programs that manage a company's vital business operations for an entire organization—even a complex, multisite, global organization. Recall that a business process is a set of coordinated and related activities that takes one or more types of input and creates an output of value to the customer of that process. The customer might be a traditional external business customer who buys goods or services from the firm. An example of such a process is capturing a sales order, which takes customer input and generates an order. The customer in a business process might also be an internal customer, such as an employee in another department of the firm. For example, the shipment process generates the internal documents workers need in the warehouse and shipping departments to pick, pack, and ship orders. At the core of the ERP system is a database that is shared by all users so that all business functions have access to current and consistent data for operational decision making and planning, as shown in Figure 10.7.



**FIGURE 10.7**  
**Enterprise resource planning system**

An ERP integrates business processes and the ERP database.

ERP systems evolved from materials requirement planning (MRP) systems developed in the 1970s. These systems tied together the production planning, inventory control, and purchasing business functions for manufacturing organizations. During the late 1980s and early 1990s, many organizations recognized that their legacy TPSs lacked the integration needed to coordinate activities and share valuable information across all the business functions of the firm. As a result, costs were higher and customer service was poorer than desired. Large organizations, specifically members of the *Fortune* 1000, were the first to take on the challenge of implementing ERP. As they did, they uncovered many advantages as well as some disadvantages, which are summarized in the following sections.

## Advantages of ERP

Increased global competition, new needs of executives for control over the total cost and product flow through their enterprises, and ever-more-numerous customer interactions drive the demand for enterprise-wide access to real-time information. ERP offers integrated software from a single vendor to help meet those needs. The primary benefits of implementing ERP include improved access to quality data for operational decision making, elimination of costly, inflexible legacy systems, improvement of work processes, and the opportunity to upgrade and standardize technology infrastructure. ERP vendors have also developed specialized systems that provide effective solutions for specific industries and market segments.

### ***Improved Access to Quality Data for Operational Decision Making***

ERP systems operate via an integrated database, using one set of data to support all business functions. For example, the systems can support decisions on optimal sourcing or cost accounting for the entire enterprise or business units. With an ERP system, data is integrated from the start, eliminating the need to gather data from multiple business functions and/or reconcile data from more than one application. The result is an organization that looks seamless, not only to the outside world but also to the decision makers who are deploying resources within the organization. Data is integrated to facilitate operational decision making and allows companies to provide better customer service and support, strengthen customer and supplier relationships, and generate new business opportunities. To ensure that an ERP system contributes to improved decision making, the data used in an ERP system must be of high quality.

Based in New York, Women's World Banking is a global nonprofit focused on providing low-income women access to the financial tools and resources they need to build secure and prosperous lives. The organization works through a network of 49 institutions in 31 countries to create new financial products that must meet the needs of women in each of its markets while also being sustainable for its partner financial institutions.<sup>13</sup> Women's World Banking needs access to detailed transaction information so it can maintain complete transparency into its balances by entity, donor, and grant—even down to the project level. To accomplish this, the organization previously utilized two stand-alone systems that often gave front and back office staff very different views of the organization's key performance metrics, resulting in time-consuming data entry and reconciliation between the two systems. To streamline its operations, Women's World Banking implemented an ERP system that provides it with access to the data it needs to apply for new funding grants, quickly and accurately report on existing grants, and make decisions regarding investments in new business development opportunities. Since its ERP roll-out, the organization has cut hundreds of hours of accounts payable and grant-reporting time annually, reduced data entry by almost 15 hours per month, and gained greater visibility into its spending across multiple entities, grants, donors, and projects.<sup>14</sup>

Although having greater access to operational data is beneficial to an organization, being able to analyze it in unique and interesting ways to derive insights can often be a challenge—particularly if the data exists in two separate enterprise systems. Consider the example of Salesforce, a cloud-based customer relationship management (CRM) application used by many *Fortune* 500 companies. Salesforce allows organizations to track the client experience in very flexible and robust ways, and one of its more valuable features is a function that allows client services staff, sales representatives, and even customers to submit requests for new products or product enhancements. This customer information in aggregate would be very useful to product management teams; however, in many companies, product management employees are not given licenses to use Salesforce, meaning they don't have direct access to this information. In this scenario, product suggestions from customers are often only shared anecdotally between product development staff and members of the sales team—leading to a disconnect in what customers are asking for and what the product team is building.<sup>15</sup>

Organizations are solving the problem of disconnected enterprise systems by using data visualization and (business intelligence) BI tools like Birst, Domo, and Tableau to create dashboard experiences that integrate data from multiple enterprise systems. Such a dashboard might show the top product requests from employees and customers in parallel with the product roadmap for the year to highlight any gaps that the product development team should be focusing on.<sup>16</sup>

### ***AI Generated Insights and the Human-Machine Learning Partnership***

One of the benefits of artificial intelligence (AI) and machine learning is the ability to identify unique patterns, correlations, and anomalies within a vast amount of diverse data. However, AI still lacks outside context on the importance of those patterns, including an understanding of how an organization should act on that data. Organizations with an ERP and a centralized database have an opportunity to leverage AI to identify patterns, allowing decision makers to act on significant data trends that might have otherwise gone unnoticed. Organizations that make effective use of machine learning in conjunction with enterprise software ensure that decision makers no longer need to spend the time to manually collect and prepare the data and developing an analysis to find interesting insights.

Google as standard practice is always trying to learn more about what customers are saying about its products and services, including its popular Google Maps application. Google uses analytics techniques that automatically reveal insights from online consumer conversations (social media, blogs, forums, etc.) using machine learning to identify patterns in those conversations. From this data, Google found that people used Google Maps not only to get from point A to point B, but also to plan out running routes, track their distances, and highlight their fitness accomplishments by sharing screenshots of Google Maps on social media. Based on the knowledge gained through the use of this analytics data, Google made changes to the product functionality of Google Maps, making it easier for users to share on social media. The company also developed a marketing strategy to take advantage of this new use of its product.

### ***Elimination of Costly, Inflexible Legacy Systems***

Adoption of an ERP system enables an organization to eliminate dozens or even hundreds of separate systems and replace them with a single integrated set of applications for the entire enterprise. In many cases, these systems are decades old, the original developers are long gone, and the systems are poorly documented. As a result, the systems are extremely difficult to fix when they break, and adapting them to meet new business needs takes too long. They become an

anchor around the organization that keeps it from moving ahead and remaining competitive. An ERP system helps match the capabilities of an organization's information systems to its business needs—even as these needs evolve.

Steinwall Scientific is a Minnesota-based precision thermoplastic injection molder specializing in manufacturing plastic parts using engineering-grade resins. The company has been in business for more than 45 years, and for much of that time, most aspects of the company's business were managed using an outdated proprietary DOS operating system that had been originally programmed by the company's president as a simple inventory management program. In addition to its internally developed system, Steinwall was also using a separate IBM accounting software program. However, the company's two main systems were unable to communicate with each other, creating ongoing data-entry errors and significant manufacturing bottlenecks as the company worked to take on new clients. Ultimately, Steinwall made the choice to upgrade its system to an integrated manufacturing ERP system. Over the course of six months, Steinwall gradually moved all of its processing tasks, along with all of its data, to the new system. Among the many benefits that Steinwall has experienced after moving all of its business functions to its new ERP system are improved inventory control accuracy; enhanced warehouse management; and procedural and culture changes resulting in a greater efficiency across all its departments.<sup>17</sup>

### **Improvement of Work Processes**

Competition requires companies to structure their business processes to be as effective and customer oriented as possible. To further that goal, ERP vendors do considerable research to define the best business processes. They gather requirements of leading organizations within the same industry and combine them with findings from research institutions and consultants. The individual application modules included in the ERP system are then designed to support these **best practices**, the most efficient and effective ways to complete a business process. Thus, implementation of an ERP system ensures work processes will be based on industry best practices. For example, for managing customer payments, the ERP system's finance module can be configured to reflect the most efficient practices of leading companies in an industry. This increased efficiency ensures that everyday business operations follow the optimal chain of activities, with all users supplied the information and tools they need to complete each step.

Prime Meats has been providing high-quality, aged steaks to steakhouses and other restaurants around the country for more than 25 years. The Atlanta-based company now also offers its USDA Prime and Choice quality steaks directly to consumers through its e-commerce Web site. When Prime Meats first launched its Web site, the company found success with its new business model, but it also found challenges as its existing systems were unable to keep up with the company's growth. To overcome these challenges, Prime Meats implemented an ERP system, SAP Business One, that offered the company flexible, fully integrated end-to-end business and accounting software along with prepackaged industry best practice functionality for handling the specific pricing, packaging, and delivery requirements of an online meat business.<sup>18</sup>

### **Opportunity to Upgrade and Standardize Technology Infrastructure**

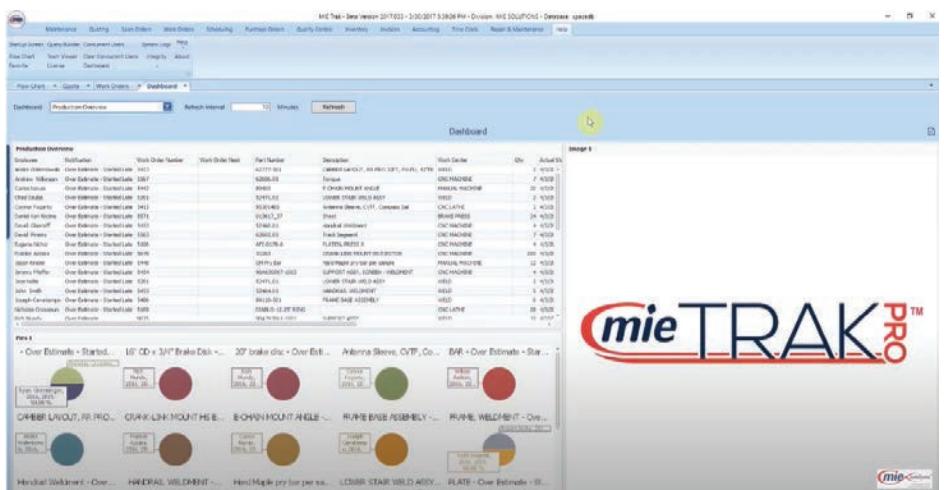
When implementing an ERP system, an organization has an opportunity to upgrade the information technology (such as hardware, operating systems, and databases) that it uses. While centralizing and formalizing these decisions, the organization can eliminate the hodgepodge of multiple hardware platforms, operating systems, and databases it is currently using—most likely from a variety of vendors. Standardizing on fewer technologies and vendors reduces ongoing maintenance and support costs as well as the training load for those who must support the infrastructure.

**best practices:** The most efficient and effective ways to complete a business process.

Whirlpool is the world's leading manufacturer of home appliances, with \$21 billion in sales and over 92,000 employees who work at 65 different manufacturing and technology research centers.<sup>19</sup> While the company has utilized a collection of ERP systems across its global operations for years, the company ultimately decided it need to undertake a complete overhaul of its ERP entire infrastructure, with the goal of creating a new operational backbone to support the company's growth for the next decade. As Whirlpool implemented next-generation SAP ERP software, the company also updated its ERP infrastructure to a hybrid cloud system hosted by IBM. As part of the project, Whirlpool's IT team spent time cleaning up duplicate and inaccurate data, a result of years of cumulative and regionalized ERP system customizations.<sup>20</sup>

## Leading ERP Systems

ERP systems are commonly used in manufacturing companies, colleges and universities, professional service organizations, retailers, and healthcare organizations. The business needs for each of these types of organizations varies greatly. In addition, the needs of a large multinational organization are far different from the needs of a small, local organization. Thus, no one ERP software solution from a single vendor is "best" for all organizations. For example, MIE Trak PRO, which is designed for manufacturers, allows companies to manage the entire production cycle, with the ability to customize the elements. Plus & Minus is an integrated ERP focusing on a single-file system, which would suit a smaller organization.<sup>21</sup> See Figure 10.8.



**FIGURE 10.8**  
**ERP software**

Mie Trak PRO ERP software focuses on manufacturing businesses.

Large organizations were the leaders in adopting ERP systems as only they could afford the associated large hardware and software costs and dedicate sufficient people resources to the implementation and support of these systems. Many large company implementations occurred in the early 2000s and involved installing the ERP software on the organizations' large mainframe computers. In many cases, this required upgrading the hardware at a cost of millions of dollars.

Smaller organizations moved to ERP systems about 10 years after larger organizations did. The smaller firms simply could not afford the investment required in hardware, software, and people to implement and support ERP. However, ERP software vendors gradually created new ERP solutions with

much lower start-up costs and faster, easier implementations. Some ERP vendors introduced cloud-based solutions, which further reduced the start-up costs by eliminating the need to purchase expensive ERP software and make major hardware upgrades. Instead, with a cloud-based solution, organizations can subscribe to the software and run it on the cloud-based hardware. Plex, NetSuite, and Sage Intacct are three of the many cloud-based ERP solutions that enable users to access an ERP application using a Web browser and avoid paying for and maintaining expensive hardware.

As an alternative, many organizations elect to implement open-source ERP systems from vendors such as Compiere.<sup>22</sup> With open-source software, organizations can see and modify the source code to customize it to meet their needs. Such systems are much less costly to acquire and are relatively easy to modify to meet business needs.

Organizations frequently need to customize the vendor's ERP software to integrate other business systems, to add data fields or change field sizes, or to meet regulatory requirements. A wide range of software service organizations can perform the system development and maintenance.

## Supply Chain Management (SCM)

### **supply chain management (SCM):**

A system that includes planning, executing, and controlling all activities involved in raw material sourcing and procurement, the conversion of raw materials to finished products, and the warehousing and delivery of finished products to customers.

An organization can use an ERP system within a manufacturing organization to support what is known as **supply chain management (SCM)**, which includes planning, executing, and controlling all activities involved in raw material sourcing and procurement, conversion of raw materials to finished products, and the warehousing and delivery of finished product to customers. The goal of SCM is to decrease costs and improve customer service, while at the same time reducing the overall investment in inventory in the supply chain.

Another way to think about SCM is that it involves managing materials, information, and finances as they move from supplier to manufacturer to wholesaler to retailer to consumer. The materials flow includes the inbound movement of raw materials from supplier to manufacturer as well as the outbound movement of finished product from manufacturer to wholesaler, retailer, and customer. The information flow involves capturing and transmitting orders and invoices among suppliers, manufacturers, wholesalers, retailers, and customers. The financial flow consists of payment transactions among suppliers, manufacturers, wholesalers, retailers, customers, and their financial institutions.

Manufacturing ERP systems follow a systematic process for developing a production plan that draws on the information available in the ERP system database.

The process starts with *sales forecasting* to develop an estimate of future customer demand. This initial forecast is at a fairly high level, with estimates made by product group rather than by each product item. The sales forecast extends for months into the future; it might be developed using an ERP software module or produced by other means, using specialized software and techniques. Many organizations are moving to a collaborative process with major customers to plan future inventory levels and production rather than relying on an internally generated sales forecast.

The *sales and operations plan (S&OP)* takes demand and current inventory levels into account and determines the specific product items that need to be produced as well as when to meet the forecast future demand. Production capacity and any seasonal variability in demand must also be considered.

*Demand management* refines the production plan by determining the amount of weekly or daily production needed to meet the demand for individual products. The output of the demand management process is the master production schedule, which is a production plan for all finished goods.

*Detailed scheduling* uses the production plan defined by the demand management process to develop a detailed production schedule that specifies production scheduling details such as which item to produce first and when production should be switched from one item to another. A key decision is how long to make the production runs for each product. Longer production runs reduce the number of machine setups required, thus reducing production costs. Shorter production runs generate less finished product inventory and reduce inventory holding costs.

*Materials requirement planning (MRP)* determines the amount and timing for placing raw material orders with suppliers. The types and amounts of raw materials required to support the planned production schedule are determined by the existing raw material inventory and the bill of materials (BOM), which serves as a recipe of ingredients needed to make each item. The quantity of raw materials to order also depends on the lead time and lot sizing. *Lead time* is the amount of time it takes from the placement of a purchase order until the raw materials arrive at the production facility. *Lot size* refers to the discrete quantities that the supplier will ship, which can result in purchasing complexities if those amounts don't line up with quantities that are economical for the manufacturer to receive or store. For example, a supplier might ship a certain raw material in units of 80,000-pound rail cars. The producer might need 95,000 pounds of the raw material. A decision must be made to order one or two rail cars of the raw material.

*Purchasing* uses the information from MRP to place purchase orders for raw materials with qualified suppliers. Typically, purchase orders are released so that raw materials arrive just in time to be used in production and to minimize warehouse and storage costs. Often, producers will allow suppliers to tap into data via an extranet that enables them to determine what raw materials the producer needs, minimizing the effort and lead time to place and fill purchase orders.

*Production* uses the high-level production schedule to plan the details of running and staffing the production operation. This more detailed schedule takes into account employee, equipment, and raw material availability, along with detailed customer demand data.

*Sales ordering* is the set of activities that must be performed to capture a customer sales order. Essential sales order steps include recording the items to be purchased, setting the sales price, recording the order quantity, determining the total cost of the order including delivery costs, and confirming the customer's available credit. If the item(s) the customer wants to order are out of stock, the sales order process should communicate this fact and suggest other items to substitute for the customer's initial choice. Setting sales prices can be quite complicated and can include quantity discounts, promotions, and incentives. After the total cost of the order is determined, a company must check the customer's available credit to see if this order is within the credit limit.

ERP systems do not work directly with manufacturing machines on the production floor, so they need a way to capture information about what was produced. This data must be passed to the ERP accounting modules to keep an accurate count of finished product inventory. Many companies have computers on the production floor, which are used to track the number of cases of each product item produced, typically by having a worker scan a barcode, QR code, or similar standard identifier on the packing cases used to ship the material. Other approaches for capturing production quantities include using RFID chips and manually entering the data.

Separately, production quality data can be added based on the results of quality tests run on a sample of the product for each batch of product produced. Typically, this data includes the batch identification number, which identifies the production run and the results of various product quality tests.

Accurate predictions are crucial for the planning required to profitably manage the complex operations of a manufacturing plant. One heavy machinery manufacturer, however, recently found that its product demand forecasting had an accuracy variance of plus or minus 20 percent—well outside the acceptable control limits set by the company. Evalueserve, a provider of research, analytics, and data management services, worked with the manufacturing company to develop algorithms that analyzed key sales and macroeconomic variables to identify the primary drivers for production and demand for the company's products. The variables evaluated included current and historical sales, GDP per capita, housing starts, construction indices, warranty claims, and dealer density—among others. Using this new data model, the manufacturer was able to bring the forecasting variance down to plus or minus four percent, resulting in a more efficient supply chain with fewer lost sales opportunities along with lower overall inventory levels.<sup>23</sup>

## Customer Relationship Management

**customer relationship management (CRM) system:** A system that helps a company manage all aspects of customer encounters, including marketing, sales, distribution, accounting, and customer service.

A **customer relationship management (CRM) system** helps a company manage all aspects of customer encounters, including marketing, sales, distribution, accounting, and customer service. See Figure 10.9. Think of a CRM system as an address book with a historical record of all the organization's interactions with each customer. The goal of CRM is to understand and anticipate the needs of current and potential customers to increase customer retention and loyalty while optimizing the way that products and services are sold. CRM is used primarily by people in the sales, marketing, distribution, accounting, and service organizations to capture and view data about customers and to improve communications. Businesses implementing CRM systems often report benefits such as improved customer satisfaction, increased customer retention, reduced operating costs, and the ability to meet customer demand.

**FIGURE 10.9**  
**Customer relationship management system**

A CRM system provides a central repository of customer data used by the organization.



CRM software automates and integrates the functions of sales, marketing, and service in an organization. The objective is to capture data about every contact a company has with a customer through every channel and to store it in the CRM system so that the company can truly understand customer actions. CRM software helps an organization build a database about its customers that describes relationships in sufficient detail so that management, salespeople, customer service providers, and even customers can access information to match customer needs with product plans and offerings, remind them of service requirements, and report on the other products the customers have purchased.

Small, medium, and large organizations in a wide variety of industries choose to implement CRM for many reasons, depending on their needs. Expensify is a financial services firm that provides online expense-management services for customers around the world. The company has grown quickly since it was founded in San Francisco in 2008, and it recently opened a London office to support its expansion into the European market. As a start-up, Expensify's initial attempts at CRM were built around an Excel spreadsheet. Before long, the company shifted to Google Apps' CRM tools, but soon found those could not handle its increasing volume of customer data. Eventually, the company implemented a customizable CRM system, Apollo, that provides all the tools Expensify's sales and customers service teams require—without the need to manage and coordinate workflows in other systems. Expensify's top priorities for the CRM system included automated and customizable lead-prioritization tools, the ability to track all sales communication within one system, and the ability to generate in-depth reports to identify areas of opportunity within a geographic region as well as for individual salespeople.<sup>24</sup>

The key features of a CRM system include the following:

- **Contact management.** The ability to track data on individual customers and sales leads and then access that data from any part of the organization.
- **Sales management.** The ability to organize data about customers and sales leads and then to prioritize the potential sales opportunities and identify appropriate next steps.
- **Customer support.** The ability to support customer service representatives so that they can quickly, thoroughly, and appropriately address customer requests and resolve customer issues while collecting and storing data about those interactions.
- **Marketing automation.** The ability to capture and analyze all customer interactions, generate appropriate responses, and gather data to create and build effective and efficient marketing campaigns.
- **Analysis.** The ability to analyze customer data to identify ways to increase revenue and decrease costs, identify the firm's "best customers," and determine how to retain and find more of them.
- **Social networking.** The ability to create and join sites such as Facebook and Instagram, where the company can make contacts with potential customers.
- **Access by mobile devices.** The ability to access Web-based customer relationship management software by smartphones, tablets, and other mobile devices.
- **Import contact data.** The ability for users to import contact data from various data service providers that can be downloaded for free directly into the CRM application.

The focus of CRM involves much more than installing new software. Moving from a culture of simply selling products to placing the customer first is essential to a successful CRM deployment. Before any software is loaded onto a computer, a company must retrain employees. Who handles customer issues and when must be clearly defined, and computer systems need to be integrated so that all pertinent information is available immediately, whether a customer calls a sales representative or a customer service representative.

Nu Skin Enterprises is a \$2 billion direct sales organization that develops and distributes nutritional supplements and personal care products through a network of more than 73,000 independent sales distributors. The company's call center agents are the key point of contact between the company and its customers and distributors; however, rapid turnover of call center staff and three disconnected customer contact tools meant that many customers became quickly frustrated during their interactions with the company. A solution to Nu Skin's customer service challenges came in the form of a CRM system from SAP, which was integrated with the company's existing SAP ERP system to provide agents immediate access to customer sales histories. Nu Skin call center employees now use social media and technology to recruit and manage customers. With a recent move of the technology core to the cloud, Nu Skin Enterprises anticipates an increase in speed and capacity, offering improved flexibility for customers.<sup>25</sup>

Table 10.3 lists a few highly rated CRM systems.<sup>26</sup>

**TABLE 10.3** Highly rated CRM systems

Vendor/Product	Select Customers	Pricing Starts at
Zoho CRM	Amazon Netflix	\$12–\$35 per user/month
Apptivo CRM	Idea Helix OnTrack Rewards	\$8–\$20 per user/month
HubSpot CRM	Nectafy Stafford Global	Basic—free Extras—additional \$6–\$100 per user/month
Freshsales CRM	Ikohaha.com Offset Solar	\$12–\$79 per user/month
Insightly CRM	Global Presence Alliance Discount	\$29–\$99 per user/month
Pipedrive CRM	Eye Hospital Denmark Canine Protection International	\$12–\$49 per user/month
Salesforce Sales Cloud	Dell Dr. Pepper Snapple	\$25 per user/month

Due to the popularity of mobile devices, shoppers can easily compare products and prices on their mobile phones and instantly tweet their experiences with a brand to dozens of friends. Savvy retailers today use their CRM systems to stay on top of what these customers are saying on social networks. BART, the well-known San Francisco Bay area transit system, serves over 420,000 riders a day. Disruptions on BART, especially at rush hour, can ripple through the entire community very quickly. Customer fares constitute the majority of BART's funding, so responding quickly to incidents and managing customer expectations is critical not only to the community but to the financial stability of the transit line. They implemented a customer engagement platform using Salesforce's CRM social module: Social Studio. By using the features of Social Studio, they have been able to respond more quickly to issues and be more transparent with their customers. BART also analyzes the social data collected to support decisions in areas like parking and upgrades.

#### **product lifecycle management (PLM)**

**(PLM):** An enterprise business strategy that creates a common repository of product information and processes to support the collaborative creation, management, dissemination, and use of product and packaging definition information.

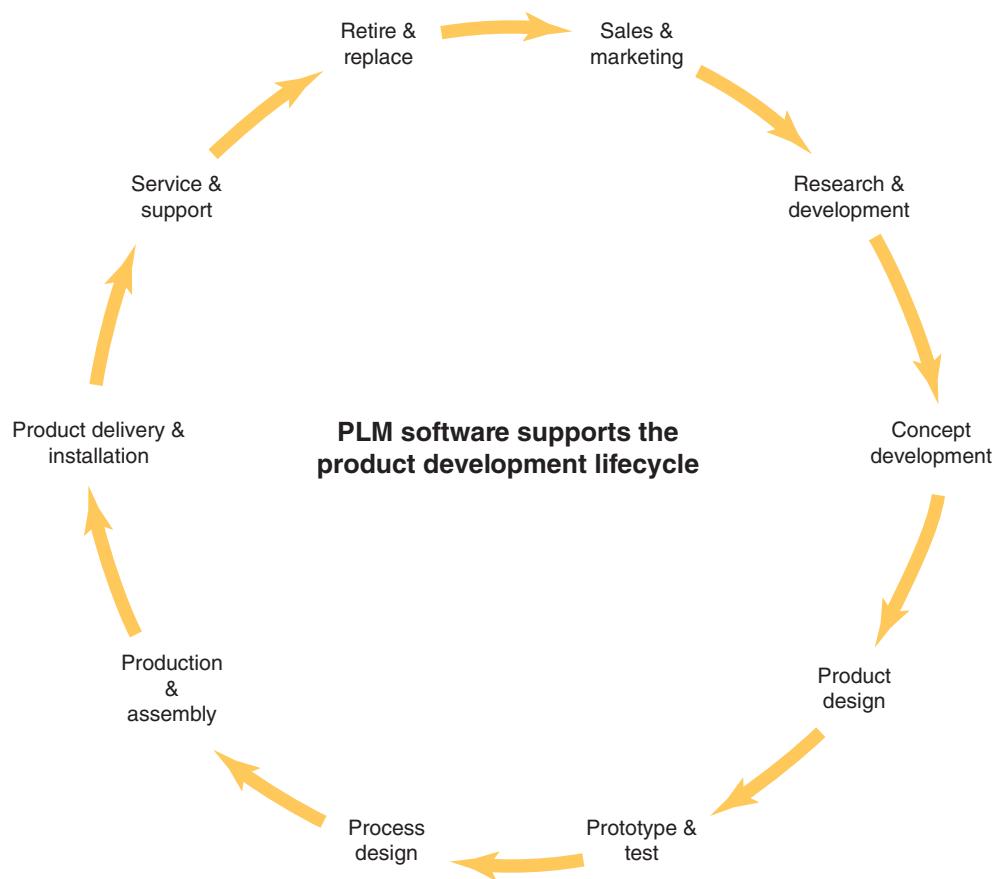
#### **Product Lifecycle Management (PLM)**

**Product lifecycle management (PLM)** is an enterprise business strategy that creates a common repository of product information and processes to support the collaborative creation, management, dissemination, and use of product and packaging definition information.

### product lifecycle management

**(PLM) software:** Software that provides a means for managing the data and processes associated with the various phases of the product lifecycle, including sales and marketing, research and development, concept development, product design, prototyping and testing, process design, production and assembly, delivery and product installation, service and support, and product retirement and replacement.

**Product lifecycle management (PLM) software** provides a means for managing the data and processes associated with the various phases of the product lifecycle, including sales and marketing, research and development, concept development, product design, prototyping and testing, manufacturing process design, production and assembly, delivery and product installation, service and support, and product retirement and replacement. See Figure 10.10. As products advance through these stages, product data is generated and distributed to various groups both within and outside the manufacturing firm. This data includes design and process documents, bill of material definitions, product attributes, product formulations, and documents needed for FDA and environmental compliance. PLM software provides support for the key functions of configuration management, document management, engineering change management, release management, and collaboration with suppliers and original equipment manufacturers (OEMs).



**FIGURE 10.10**  
**Scope of PLM software**

Using PLM software, organizations can manage the data and processes associated with the various phases of the product lifecycle.

### computer-aided design

**(CAD):** The use of software to assist in the creation, analysis, and modification of the design of a component or product.

### computer-aided engineering

**(CAE):** The use of software to analyze the robustness and performance of components and assemblies.

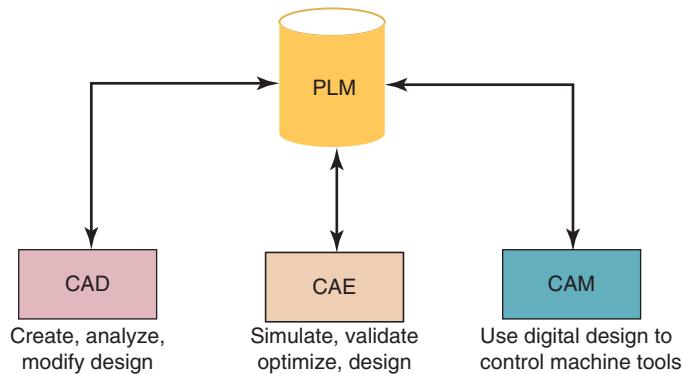
The scope of PLM software may include computer-aided design, computer-aided engineering, and computer-aided manufacturing. **Computer-aided design (CAD)** is the use of software to assist in the creation, analysis, and modification of the design of a component or product. Its use can increase the productivity of the designer, improve the quality of design, and create a database that describes the item. This data can be shared with others or used in the machining of the part or in other manufacturing operations. **Computer-aided engineering (CAE)** is the use of software to analyze the robustness and performance of components and assemblies. CAE software supports the

**computer-aided manufacturing (CAM):** The use of software to control machine tools and related machinery in the manufacture of components and products.

**FIGURE 10.11**  
**CAD, CAE, and CAM software**

In manufacturing, the model generated in CAD and verified in CAE can be entered into CAM software, which then controls the machine tool.

simulation, validation, and optimization of products and manufacturing tools. CAE is extremely useful to design teams in evaluating and decision making. **Computer-aided manufacturing (CAM)** is the use of software to control machine tools and related machinery in the manufacture of components and products. The model generated in CAD and verified in CAE can be input into CAM software, which then controls the machine tool. See Figure 10.11.

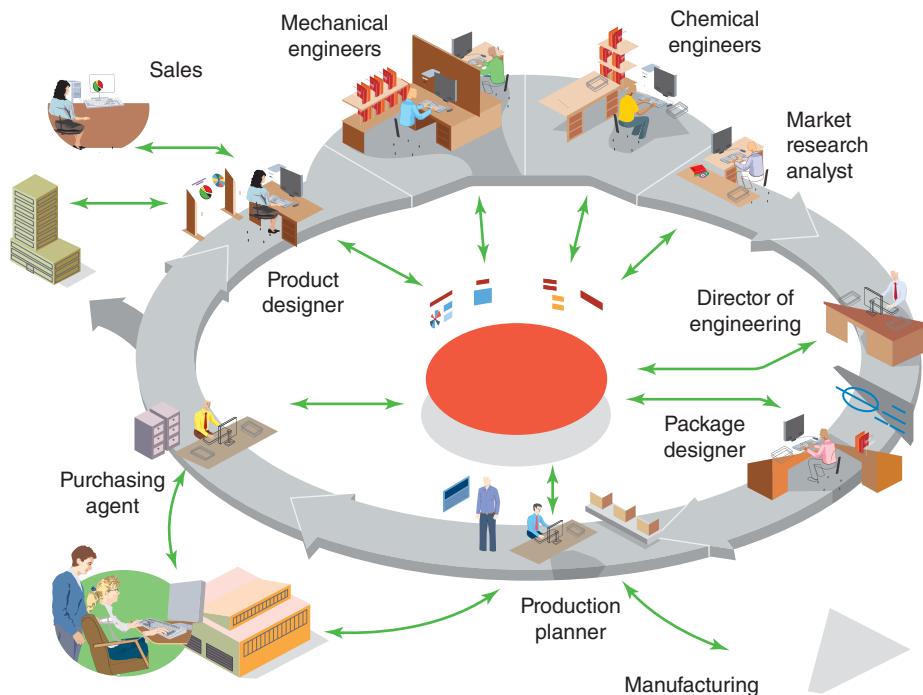


Some organizations elect to implement a single, integrated PLM system that encompasses all the phases of the product lifecycle with which it is most concerned. Other organizations implement multiple, separate PLM software components from different vendors over time. This piecemeal approach enables an organization to choose the software that best meets its needs for a particular phase in the product lifecycle. It also allows for incremental investment in the PLM strategy. However, it may be difficult to link all the various components together in such a manner that a single comprehensive database of product and process data is created.

Use of an effective PLM system enables global organizations to work as a single team to design, produce, support, and retire products, while capturing best practices and lessons learned along the way.<sup>27</sup> PLM powers innovation and improves productivity by connecting people across global product development and manufacturing organizations with the product and process knowledge they need to succeed. See Figure 10.12.

**FIGURE 10.12**  
**PLM business strategy**

PLM powers innovation and improves productivity.



PLM software and its data are used by both internal and external users. Internal users include engineering, operations and manufacturing, procurement and sourcing, manufacturing, marketing, quality assurance, customer service, regulatory, and others. External users include the manufacturer's design partners, packaging suppliers, raw material suppliers, and contract manufacturers. These users must collaborate to define, maintain, update, and securely share product information throughout the lifecycle of the product. Frequently, these external users are asked to sign nondisclosure agreements to reduce the risk of proprietary information being shared with competitors.

Based in Fort Collins, Colorado, Water Pik develops and sells a variety of personal and oral healthcare products under the Water Pik brand. The company prides itself on innovation and since its founding in 1962, Water Pik has acquired more than 500 patents. Over time, the company's approach to managing its product information through traditional directory structures on file systems was resulting in an increasing number of inefficiencies in Water Pik's development and manufacturing processes. To better manage its CAD product data, Water Pik chose to implement ProductCenter PLM software. The company now uses the software to manage product information—which is secured through permissions—for three of its four main product lines. Water Pik also uses the software to manage all of its business processes, which are automatically set to expire every two years, triggering a review and update process that helps the company ensure that its procedures are current and compliant with various industry standards.<sup>28</sup>

Table 10.4 presents a list of some popular PLM software products.<sup>29</sup>

**TABLE 10.4** Popular PLM software products

Organization	Primary PLM Software Product	Technology Model	Select Customers
Infor	PLM Optiva	On-premise solution	Henkel, Sypris
PTC	Windchill	SaaS solution	Medco Equipment, InterComm
SAP	PLM	On-premise solution	Porsche, Anadarko Petroleum
Siemens	Teamcenter PLM	On-premise solution	Procter & Gamble, BAE Systems

**discrete manufacturing:** The production of distinct items such as autos, airplanes, furniture, or toys that can be decomposed into their basic components.

**process manufacturing:** The production of products—such as soda, laundry detergent, gasoline, and pharmaceutical drugs—that are the result of a chemical process; these products cannot be easily decomposed into their basic components.

PLM software is created for two broad categories of manufacturing: discrete manufacturing and process manufacturing. **Discrete manufacturing** is the production of distinct items such as autos, airplanes, furniture, or toys that can be decomposed back into their basic components. **Process manufacturing** is the production of products—such as soda, laundry detergent, gasoline, and pharmaceutical drugs—that are the result of a chemical process; these products cannot be easily decomposed back into their basic components. Within these two broad categories, PLM software manufacturers specialize in specific industries such as aircraft manufacturing, consumer goods manufacturing, or drug manufacturing.

Table 10.5 outlines the benefits a business can realize when using a PLM system effectively.

**TABLE 10.5** Benefits of a PLM system

Benefit	How Achieved
Reduce time to market	<ul style="list-style-type: none"> <li>By connecting design, research and development, procurement, manufacturing, and customer service seamlessly through a flexible collaboration environment</li> <li>By improving collaboration among the organization and its suppliers, contract manufacturers, and OEMs</li> </ul>
Reduce costs	<ul style="list-style-type: none"> <li>By reducing prototyping costs through the use of software simulation</li> <li>By reducing scrap and rework through improved processes</li> <li>By reducing the number of product components through standardization</li> </ul>
Ensure regulatory compliance	<ul style="list-style-type: none"> <li>By providing a secure repository, tracking and audit trails, change and document management controls, workflow and communications, and improved security</li> </ul>

An example of benefits a business can receive comes from Electrolux, a large manufacturer of commercial and consumer appliances, based in Sweden. They have 58,000 employees spread across 46 production sites. Brands they manufacture include AEG, Westinghouse, and Frigidaire. In a move towards further digitization of the product development lifecycle, Electrolux began reviewing PLM solutions in 2010. They chose Siemens PLM software, Teamcenter, and began rollout in 2012. They added 3-D layout simulation modules starting with a pilot in 2016, enabling them to create low cost simulations for various production scenarios and test for feasibility. This technology dramatically decreases the costs and time required to develop and deploy process innovations. Since then, they have been rolling out additional phases worldwide.<sup>30</sup>

Through their efforts, Electrolux has saved over \$2 million by fine-tuning their production lines, and is succeeding in their goals to ‘create globally uniform production facilities and assembly processes’ and ‘achieve higher efficiency in the assembly process and material flow’. They have also decreased errors and delays in production and in building new plants.<sup>31</sup>

## Software Product Planning and Development

Much of the PLM software discussed in this chapter is used extensively in the manufacturing industry; however, software companies also make use of PLM software to streamline their product planning and development efforts. For instance, enterprise solutions such as JIRA, Asana, and Aha! are three such tools used by engineering and product teams to document and manage the tasks necessary for building and delivering their products to market. They are used to support both agile and waterfall software development methodologies. Agile is a very iterative process of defining and managing the completion of product requirements. The waterfall approach is a process that requires all the detail and requirements up front prior to beginning the build.

Nevertheless, the challenges and benefits are still consistent with that of physical product development and manufacturing. The greatest value being that systems like JIRA and Asana provide a robust way for engineers, product managers, and the executive team to monitor the product roadmap and manage associated development tasks.

## Overcoming Challenges in Implementing Enterprise Systems

Implementing an enterprise system, particularly for a large organization, is extremely challenging and requires tremendous amounts of resources, the best IS and businesspeople, and plenty of management support. In spite of all this, many enterprise system implementations fail, and problems with an enterprise

system implementation can require expensive solutions. The following is a sample of major enterprise system implementation project failures:

- Failed technology implementation by SAP's R/3 ERP software caused major problems for Hershey. The supply chain process caused Hershey to miss delivering \$100 million worth of Kisses for Halloween, causing the stock to dip 8 percent.<sup>32</sup>
- MillerCoors, a global beverage company, decided to replace the seven different instances of their SAP ERP systems with one consolidating instance in 2014, after years of industry consolidation. They hired an IT services firm to roll out the new system. The implementation did not go smoothly. The first phase resulted in 8 "critical" defects and 47 high-severity ones. By early 2017, MillerCoors was suing the consulting company for \$100 million. The consulting company counter-sued saying that MillerCoors was to blame for the delay and problem with the project. They settled the case at the end of 2018 after a long "negotiation process" in the court system.
- Revlon, the famous cosmetics manufacturer, was in need of an enterprise-wide system after the acquisition of Elizabeth Arden, Inc. They decided on the SAP HANA option at the end of 2016. The disastrous rollout cost Revlon millions of dollars in lost sales, which they blamed on the lack of effective implementation controls. The situation eventually led to a steep decline in stock value and a suit brought on by Revlon's own stockholders.

Twenty-one percent of ERP implementations worldwide evaluated by Panorama, an ERP consulting firm, were judged to be failures. Table 10.6 lists and describes the most significant challenges to successful implementation of an enterprise system.<sup>33</sup>

**TABLE 10.6** Challenges to successful enterprise system implementation

Challenge	Description
Cost and disruption of upgrades	Most companies have other systems that must be integrated with the enterprise system, such as financial analysis programs, e-commerce operations, and other applications that communicate with suppliers, customers, distributors, and other business partners. Integration of multiple systems adds time and complexity to an ERP implementation.
Cost and long implementation lead time	The average ERP implementation cost in the millions with an average project duration of over a year.
Difficulty in managing change	Companies often must radically change how they operate to conform to the enterprise work processes. These changes can be so drastic to longtime employees that they depart rather than adapt to the change, leaving the firm short of experienced workers.
Management of software customization	The base enterprise system may need to be modified to meet mandatory business requirements. System customizations can become extremely expensive and further delay implementation.
User frustration with the new system	Effective use of an enterprise system requires changes in work processes and in the details of how work gets done. Many users initially balk at these changes and require extensive training and encouragement.

The following list provides tips for avoiding many common causes for failed enterprise system implementations:

- Assign a full-time executive to manage the project.
- Appoint an experienced, independent resource to provide project oversight and to verify and validate system performance.
- Allow sufficient time to transition from the old way of doing things to the new system and new processes.

- Allocate sufficient time and money for training staff; many project managers recommend budgeting 30–60 days per employee for training.
- Define metrics to assess project progress and to identify project-related risks.
- Keep the scope of the project well defined and contained to essential business processes.
- Be wary of modifying the enterprise system software to conform to your firm's business practices.
- Focus on documenting existing workflows before implementing and working directly with key stakeholders, so they understand and buy into the changes that will ultimately be implemented.
- Keep in mind that the best systems require little change to existing workflow as it relates to user input/effort while eliminating the biggest pain points.

## Hosted Software Model for Enterprise Software

Many business application software vendors have migrated much of their offerings to a hosted software model. The goal is to help customers acquire, use, and benefit from new technology while avoiding much of the associated complexity and high start-up costs. Applicor, Intacct, NetSuite, SAP, and Workday are among the software vendors who offer hosted versions of their ERP or CRM software at a cost of \$50 to \$200 per month per user. There are three types of hosted software: on premises, cloud-based, and hybrid, which combines on-premises and cloud-based applications.<sup>34</sup>

This pay-as-you-go approach is appealing because organizations can experiment with powerful software capabilities without making a major financial investment. Organizations can then dispose of the software without large investments if the software fails to provide value or otherwise misses expectations. Also, using the hosted software model means the business firm does not need to employ a full-time IT person to maintain key business applications. The business firm can expect additional savings from reduced hardware costs and costs associated with maintaining an appropriate computer environment (such as air conditioning, power, and an uninterruptible power supply).

Table 10.7 lists the advantages and disadvantages of hosted software.

**TABLE 10.7** Advantages and disadvantages of hosted software model

Advantages	Disadvantages
Decreased total cost of ownership	Potential availability and reliability issues
Faster system start-up	Potential data security issues
Lower implementation risk	Potential problems integrating the hosted products of different vendors
Management of systems outsourced to experts	Savings anticipated from outsourcing may be offset by increased effort to manage vendor

LoneStar Heart is a California company that researches and develops restorative therapies and technologies for patients with advanced heart failure. In its early years as a start-up company, LoneStar relied on a paper-based approach to document control that resulted in researchers spending extensive time searching and managing product documentation—taking them away from their critical design and development work. To gain efficiencies in its development processes and free up time for its research and development team, LoneStar eventually decided to implement a cloud-based PLM that would support employees in the company's facilities as well as those who work remotely. The PLM system from Omniply Software offered LoneStar a secure, yet easily

accessible centralized product information database and the tools it required to maintain compliant with the extensive set of FDA regulations governing its work. By using a cloud-based PLM, LoneStar efficiencies in product development processes resulted in an estimated \$80,000 in savings.<sup>35</sup>



## Critical Thinking Exercise

### Implementing CRM

#### ► SYSTEMS AND PROCESSES, APPLICATION

SalesTeam is a mid-sized company that specializes in providing outsourced sales resources to companies within the life sciences industry that are in need of additional sales staff to assist with major promotions or to cover gaps resulting from turnover. SalesTeam was founded three years ago and has grown quickly since then.

SalesTeam's outsourced salespeople prospect, cultivate, and close new business for clients just as they would if they worked directly for the client. Each month, the salesperson is required to submit documentation to SalesTeam's director of outsourcing regarding the number of calls that they made, the number of meetings they had with potential clients, and the status of their sales prospects.. SalesTeam then compile the information in Excel spreadsheets to pass on to the client. These reports allow SalesTeam's management and the client to determine how sales are progressing and ensure that the salesperson is achieving their goals.

However, some clients have complained that they cannot easily upload the information into their systems, or that the information in the spreadsheets is incomplete. As a result, clients are missing sales opportunities. The leadership at SalesTeam has determined that they need a more sophisticated and automated way to track and report on their employees' activities to enhance the quality of their communication with clients and to improve the results of their sales team.

#### Review Questions

1. How should SalesTeam determine the requirements of a CRM system for its business?
2. What additional activities will SalesTeam salespeople likely be able to perform with a CRM application that they could not perform before?

#### Critical Thinking Questions

1. You have been tasked with gathering the requirements for the new system to ensure that the new CRM software will help SalesTeam achieve the stated objectives. Which stakeholders would you meet with to determine the requirements? Why would you meet with these stakeholders?
2. The cost of a CRM application can vary significantly depending upon the size of the company and the desired features. What would you include in the financial analysis of a CRM?

## Summary

### Principle:

**An organization must have information systems that support routine, day-to-day activities and that help a company add value to its products and services.**

Transaction processing systems (TPSs) are at the heart of most information systems in businesses today. A TPS is an organized collection of people, procedures, software, databases, and devices used to capture fundamental data about events that affect the organization (transactions) and that use that data to update the official records of the organization.

The methods of TPSs include batch and online processing. Batch processing involves the collection of transactions into batches, which are entered into the system at regular intervals as a group. Online transaction processing (OLTP) allows transactions to be processed as they occur.

Organizations expect TPSs to accomplish a number of specific objectives, including processing data generated by and about transactions, maintaining a high degree of accuracy and information integrity, compiling accurate and timely reports and documents, increasing labor efficiency, helping provide increased and enhanced service, and building and maintaining customer loyalty. In some situations, an effective TPS can help an organization gain a competitive advantage.

Order processing systems capture and process customer order data—from the receipt of the order through creation of a customer invoice.

Accounting systems track the flow of data related to all the cash flows that affect the organization.

Purchasing systems support the inventory control, purchase order processing, receiving, and accounts payable business functions.

Organizations today, including SMEs, typically implement an integrated set of TPSs from a single or limited number of software vendors to meet their transaction processing needs.

All TPSs perform the following basic activities: data collection, which involves the capture of source data to complete a set of transactions; data editing, which checks for data validity and completeness; data correction, which involves providing feedback regarding a potential problem and enabling users to change the data; data processing, which is the performance of calculations, sorting, categorizing, summarizing, and storing data for further processing; data storage, which involves placing transaction data into one or more databases; and document production, which involves outputting electronic or hard-copy records and reports.

### Principle:

**An organization that implements an enterprise system is creating a highly integrated set of systems, which can lead to many business benefits.**

Enterprise resource planning (ERP) software supports the efficient operation of business processes by integrating activities throughout a business, including sales, marketing, manufacturing, logistics, accounting, and staffing.

Implementing an ERP system can provide many advantages, including allowing access to data for operational decision making; eliminating costly and inflexible legacy systems; providing improved work processes; creating the opportunity to upgrade technology infrastructure; and creating access to data for generating insights through the use of analytics, artificial intelligence (AI), and machine learning.

Some of the disadvantages associated with ERP systems are that they are time consuming, difficult, and expensive to implement; they can also be difficult to integrate with other systems.

No one ERP software solution is “best” for all organizations. MIE TRAC PRO and Plus & Minus are examples of different ERP suppliers.

Although the scope of ERP implementation can vary, most manufacturing organizations use ERP to support the supply chain management (SCM) activities of planning, executing, and controlling all activities involved in raw material sourcing and procurement, conversion of raw materials to finished products, and the warehousing and delivery of finished product to customers.

The production and supply chain management process starts with sales forecasting to develop an estimate of future customer demand. This initial forecast is at a fairly high level, with estimates made by product group rather than by individual product item. The sales and operations plan (S&OP) takes

demand and current inventory levels into account and determines the specific product items that need to be produced as well as when to meet the forecast future demand. Demand management refines the production plan by determining the amount of weekly or daily production needed to meet the demand for individual products. Detailed scheduling uses the production plan defined by the demand management process to develop a detailed production schedule that specifies details such as which item to produce first and when production should be switched from one item to another. Materials requirement planning determines the amount and timing for placing raw material orders with suppliers. Purchasing uses the information from materials requirement planning to place purchase orders for raw materials and transmit them to qualified suppliers. Production uses the detailed schedule to plan the logistics of running and staffing the production operation. Sales ordering is the set of activities that must be performed to capture a customer sales order. The individual application modules included in the ERP system are designed to support best practices, the most efficient and effective ways to complete a business process.

Organizations are implementing customer relationship management (CRM) systems to manage all aspects of customer encounters, including marketing, sales, distribution, accounting, and customer service. The goal of CRM is to understand and anticipate the needs of current and potential customers to increase customer retention and loyalty while optimizing the way products and services are sold.

Manufacturing organizations are implementing product lifecycle management (PLM) software to manage the data and processes associated with the various phases of the product lifecycle, including sales and marketing, research and development, concept development, product design, prototyping and testing, manufacturing process design, production and assembly, delivery and product installation, service and support, and product retirement and replacement. These systems are used by both internal and external users to enable them to collaborate and capture best practices and lessons learned along the way.

The most significant challenges to the successful implementation of an enterprise system include the cost and disruption of upgrades, the cost and long implementation lead time, the difficulty in managing change, the management of software customization, and user frustration with the new system.

Business application software vendors are experimenting with the hosted software model to see if the approach meets customer needs and is likely to generate significant revenue. There are three types of hosted software: on-premises, cloud-based, and hybrid, which combines on-premises and cloud-based applications. This approach is especially appealing to SMEs due to the low initial cost, which makes it possible to experiment with powerful software capabilities.

### Principle:

**An organization must have access to data across all of its corporate functions and enterprise systems to help drive decision making.**

There have been many types of enterprises systems discussed in this chapter including, but not limited to, customer relationship management tools like Salesforce to transaction processing systems, PLMs, social analytics tools, and more.

The key takeaway is that all these systems include valuable data that could be valuable not only to their own corporate function but to others as well, and by creating centralized repositories, the organization increases its potential for better operational effectiveness and efficiency. Tools like Birst and Domo are two leading solutions for accomplishing this.

Machine learning and AI are playing an important role in making sense of all this data and in bringing insights to decision makers to act on automatically.

## Key Terms

batch processing system	discrete manufacturing
best practices	document production
computer-aided design (CAD)	enterprise system
computer-aided engineering (CAE)	online transaction processing (OLTP)
computer-aided manufacturing (CAM)	process manufacturing
customer relationship management (CRM) system	product lifecycle management (PLM)
data collection	product lifecycle management (PLM) software
data correction	source data automation
data editing	streaming
data processing	supply chain management (SCM)
data storage	transaction processing cycle

## Self-Assessment Test

**An organization must have information systems that support routine, day-to-day activities and that help a company add value to its products and services.**

1. Transaction processing systems (TPS) capture and process the fundamental data about events that affect the organization called \_\_\_\_\_ that are used to update the official records of the organization.
2. The essential characteristic of a(n) \_\_\_\_\_ transaction processing system is that it processes transactions as they occur.
3. Which of the following is *not* one of the basic components of a TPS?
  - a. Databases
  - b. Networks
  - c. Procedures
  - d. Analytical models
4. \_\_\_\_\_ involves providing feedback regarding a potential data problem and enables users to change the data.
  - a. Data collection
  - b. Data correction
  - c. Data editing
  - d. Data processing
5. The specific business needs and goals of the organization define the method of transaction processing best suited for the various application of the company. True or False?
6. Which of the following is not an objective of an organization's batch transaction processing system?
  - a. Capture, process, and update databases of business data required to support routine business activities
  - b. Ensure that data is processed immediately upon occurrence of a business transaction

- c. Avoid processing fraudulent transactions
- d. Produce timely user responses and reports
7. Business data goes through a cycle that includes data collection, data \_\_\_\_\_, data correction, data processing, data storage, and documentation production.
8. Unfortunately, there are few choices for software packages that provide integrated transaction processing system solutions for small- and medium-sized enterprises. True or False?
9. Capturing and gathering all the data necessary to complete the processing of transactions is called \_\_\_\_\_.

**An organization that implements an enterprise system is creating a highly integrated set of systems, which can lead to many business benefits.**

10. Small organizations were slow to adopt ERP systems because of the relative complexity and cost of implementing these systems. True or False?
11. The individual application modules included in an ERP system are designed to support \_\_\_\_\_, the most efficient and effective ways to complete a business process.
12. \_\_\_\_\_ software helps a company manage all aspects of customer encounters, including marketing, sales, distribution, accounting, and customer service.
13. The hosted software model for enterprise software helps customers acquire, use, and benefit from new technology while avoiding much of the associated complexity and high start-up costs. True or False?

14. \_\_\_\_\_ is software used to analyze the robustness and performance of components and assemblies.
- PLM
  - CAD
  - CAE
  - CAM
15. Many multinational companies roll out standard IS applications for all to use. However, standard applications often don't account for all the differences among business partners and employees operating in other parts of the world. Which of the following is a frequent modification required for standard software?
- Software might need to be designed with local language interfaces to ensure the successful implementation of a new IS.
  - Customization might be needed to handle date fields correctly.
  - Users might also have to implement manual processes and overrides to enable systems to function correctly.
  - All of the above
- An organization must have access to data across all of its corporate functions and enterprise systems to help drive decision making.**
16. At the core of the ERP system is a \_\_\_\_\_ that is shared by all users so that all business functions have access to current and consistent data for operational decision making and planning.
- database
  - project plan
  - report
  - project chain
17. A company implementing a new PLM system should do which of the following to maximize its chances for a successful implementation?
- Appoint a full-time manager to the project.
  - Budget enough time and money to train staff.
  - Keep the scope of the project well defined.
  - All of the above
18. Machine learning used in enterprise software is valuable to decision makers because it saves them time while also providing valuable business insights. True or False?
19. One of the problems with machine learning is that it is not able to identify unique patterns. True or False?
20. A cloud-based solution is \_\_\_\_\_ than purchasing ERP software and upgrading hardware.
- more expensive
  - less expensive
  - no more expensive
  - no less expensive

## Self-Assessment Test Answers

- transactions
- online
- d
- b
- True
- b
- editing
- False
- data collection
- True
- best practices
- Customer relationship management (CRM)
- True
- c
- d
- a
- d
- True
- False
- b

## Review and Discussion Questions

- Provide a data processing example for which the use of a batch processing system to handle transactions is appropriate. Provide an example for which the use of online transaction processing is appropriate.
- Define supply chain management (SCM).
- Identify and briefly describe at least four key business capabilities provided by the use of a CRM system.
- What is source data automation? What benefits can it be expected to deliver?

5. Identify and briefly discuss five challenges to the successful implementation of an enterprise system. Provide several tips to overcome these challenges.
6. Why were SMEs slow to adopt ERP software? What changed to make ERP software more attractive for SMEs?
7. Many organizations are moving to a collaborative process with their major suppliers to get their input on designing and planning future product modification or new products. Explain how a PLM system might enhance such a process. What issues and concerns might a manufacturer have in terms of sharing product data with suppliers?
8. Explain why an enterprise solution for software development like JIRA is important for roadmap planning and managing engineering tasks.

## Business-Driven Decision-Making Exercises

1. Assume that you are the owner of a small bicycle sales and repair shop serving hundreds of customers in your area. Identify the kinds of customer information you would like your firm's CRM system to capture. How might this information be used to provide better service or increase revenue? Identify where or how you might capture this data.
2. Imagine that you are a member of the engineering organization for an aircraft parts manufacturer. The firm is considering the implementation of a PLM system. Make a convincing argument for selecting a system whose scope includes CAD, CAE, and CAM software.

## Teamwork and Collaboration Activities

1. With your team members, meet with several business managers at a firm that has implemented an enterprise system. Interview them to document the scope, cost, and schedule for the overall project. Find out why the organization decided it was time to implement the enterprise system. Make a list of what the business managers see as the primary benefits of the implementation. What were the biggest hurdles they had to overcome? Are there any remaining issues that must be resolved before

the project can be deemed a success? What are they? With the benefit of 20–20 hindsight, is there anything they would have done differently that could have made the project go more smoothly?

2. As a team, do research online to identify three candidate PLM software packages. Based on information presented on each company's Web site, score each alternative using a set of criteria your team agrees upon. Which candidate PLM software does your team select?

## Career Exercises

1. Initially thought to be cost-effective for only very large companies, enterprise systems are now being implemented in SME's to reduce costs, improve service, and increase sales revenue. A firm's finance and accounting personnel play a dual role in the implementation of such a system: (1) they must ensure a good payback on the investment in information systems and (2) they must also ensure that the system meets the needs of the finance and accounting organization. Identify three or four tasks that the finance and accounting people

need to perform to ensure that these two goals are met.

2. Enterprise system software vendors need business systems analysts who understand both information systems and business processes. Make a list of six or more specific qualifications needed to be a strong business systems analyst who supports the implementation and conversion to an enterprise system within an SME. Are there additional/different qualifications needed for someone who is doing similar work but for a large multinational organization?

## Case Study

### ► SYSTEMS AND PROCESSES, APPLICATION

#### Wester Digital Implements New ERP System

Western Digital, a developer of storage devices and solutions, has grown dramatically since it was established in 1970. Based in San Jose, California, they employ more than 61,000 with locations around the world. Much of their growth has occurred through mergers and acquisitions. Managing operations and generating timely information in a multi-billion dollar, global organization can be difficult, but what happens when you combine three such companies? How can systems be integrated and processes refined, so that the business can stay competitive? Steve Phillipott, CIO of Western Digital, explains that each of the three organizations had their own ERP. Some tough decisions would need to be made to integrate all three companies. Because each company had been using their own ERP, when they merged, these systems were no longer enterprise-level. Data was isolated, processes were disjointed, and efforts were duplicated. The team could choose one of the three ERPs, and the other two-thirds of the company's employees would need to change over to the selected system, or they could start from scratch and implement a new ERP across all divisions of the new, larger Western Digital. They chose to start from scratch and implement a new ERP and related processes across all three companies. The first phase was rolled out in 2017, and the implementation is currently ongoing.

The decision to choose a new ERP was a great opportunity to update technologies and transform processes at Western Digital. They took this opportunity to redesign processes and build applications that were more likely to scale as they grew to be a \$20+ billion company. Communication and collaboration are essential to integration efforts, so the team focused on setting up those standards and integrated tools first. These new tools and processes not only helped the ERP project succeed, but they removed barriers to communication across all areas and locations of Western Digital, putting them in a better position for possible mergers or acquisitions in the future.

Change management plays a huge role in implementing Western Digital ERP. As the processes and technologies are integrated, the people that use the systems must adjust. By ensuring that users are ready when the system integration is complete, Western Digital is able to attain much larger benefit from the system, more quickly. Phillipott stresses the importance of these underlying structures of communications and change management to the successful implementation and use of an ERP and the resulting competitive advantages.

ERP implementations usually have long timelines, especially in such large organizations. Phillipott says that they are "two years into a four-year (plus or minus) journey." They are phasing the implementation as outlined below:

Phase	Status	Focus
1	Went live in July 2017	Financial consolidation Statutory reporting Operational expenditure planning
2	Went live in June 2018	Capital expenditures planning Indirect Procurement
3	In process	Order orchestration Global trade management
4	Planned	Direct procurement Financial capabilities for logistics, inventory

Phillpott and his team realized that they could not wait until the ERP was fully implemented to receive the benefits of the reports the system would eventually produce. So, to derive the most benefit as soon as possible, they implemented an interim reporting capability. They reviewed the business objectives and decided on the reporting priorities to deploy a predictive analytics platform early in the process. According to Phillipott, this platform "supports manufacturing and operation capabilities, trying to look at how we improve yields and the performance of our manufacturing operations." He also states that not only do these interim reports help improve performance, but they act as a testing ground or prototype for the reporting system that will be rolled out in later phases. As the ERP matures, they will implement various technologies for data analysis, from less to more complex, starting with predesigned reports and a dashboard, moving on to custom reports, predictive analytics, and business intelligence powered by artificial intelligence. They will be able to answer such questions as the following:

- How can we improve our time to market?
- How do accelerate innovation in manufacturing?
- How can we reduce the costs in our product development lifecycle?

Using their analysis and incorporating integrated cloud technologies, they have been able to reduce the time it takes to conduct manufacturing simulations from 30 days down to nine hours or less.

#### Critical Thinking Questions

1. Many of the benefits of an ERP can be realized through the implementation and change process. How can updating and integrating processes and activities, as part of an ERP implementation, provide benefits to the organization? Provide specific examples.
2. What steps did Western Digital take to realize the benefits of integration as it occurred rather than waiting until the system was completely integrated? How do you think this might have been different if they chose

- one of the original three ERPs and had the other two companies convert to it?
- We tend to think of implementation as a single process, done all at once, with a clear starting and ending point, and with benefits realized at the end of the project. However, it is rarely that simple. How does a phased approach and the use of interim solutions or prototypes, like those used by Western Digital, help ensure a successful implementation? How might this

strategy help the ERP provide more benefit after it is fully implemented?

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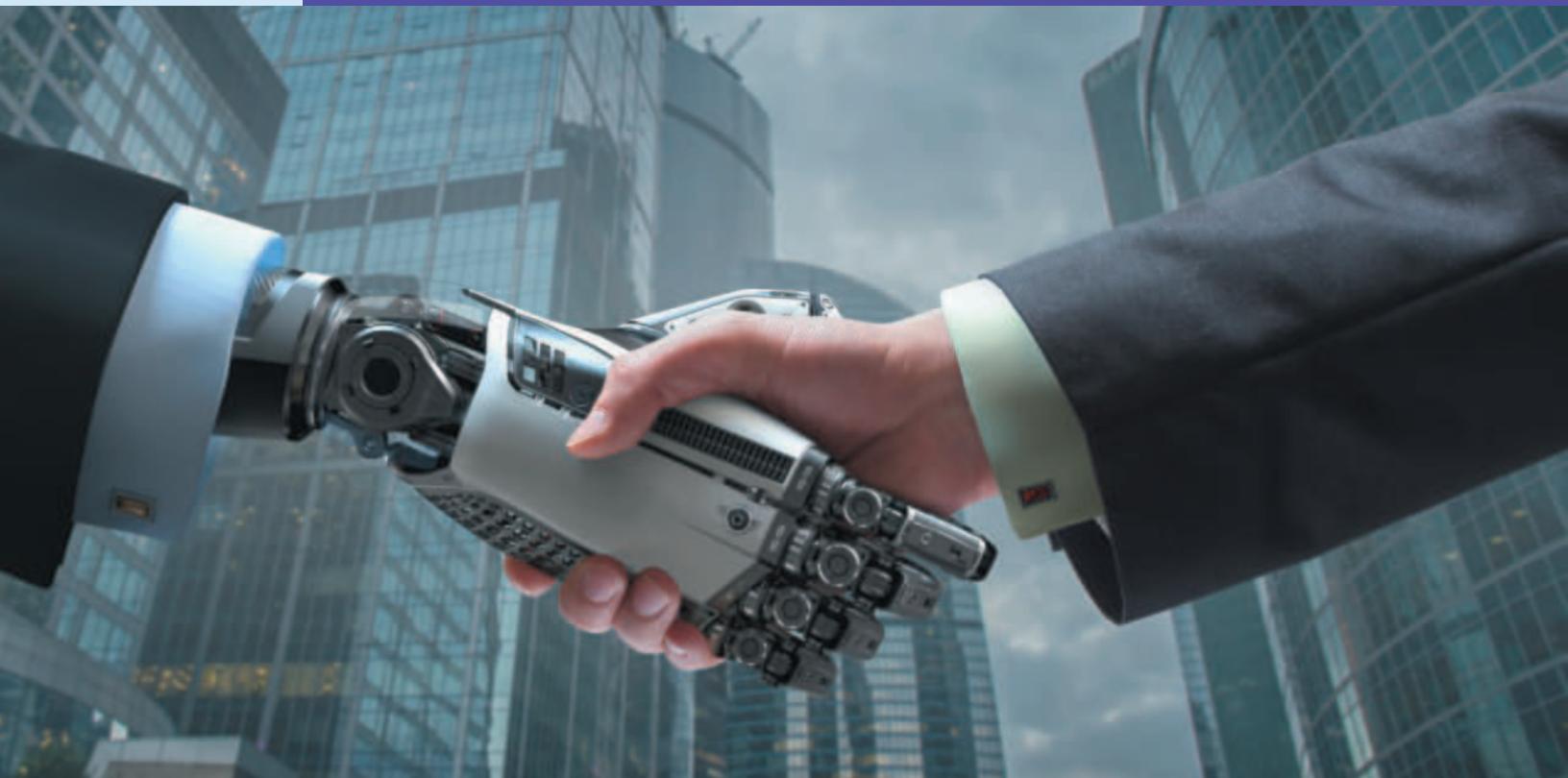
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## Principles

- Organizations are developing new technology using artificial intelligence and expert systems.
- As companies become more automated through the use of artificial intelligence, and expert systems, organizations must strategically plan for a potential impact on future employment.
- Organizations are relying on machines to learn from processes to gain better outcomes.
- Robots are becoming more interactive in business, with new applications being introduced at a rapid pace.

## Learning Objectives

- Briefly explain the nature of artificial intelligence.
- Identify six components of expert systems and explain how they are used.
- Discuss how advancements in augmented reality are improving computer vision capabilities.
- Briefly explain how an artificial neural network works.
- Describe two strategies used to train artificial neural networks.
- Discuss the potential impact of artificial intelligence and automation on future employment.
- Define the term machine learning.
- Identify four types of machine learning training.
- Define the term natural language processing.
- Discuss how the brain computer interface is being advanced through research.
- Briefly explain what comprises a robotic system.
- Describe three types of robots, including the environment in which they operate and the purpose they serve.
- Identify two industry applications of robotics.

# IS in Action

## Healthcare Using AI to Improve Patient Care

### ► ANALYTICAL THINKING

In 2017, IBM committed \$240 million over ten years to establish a machine learning, cognitive computing, and deep learning research laboratory in collaboration with the Massachusetts Institute of Technology (MIT). The lab's top research priorities include healthcare diagnostics and clinical decision support, along with the use of artificial intelligence (AI) to improve cybersecurity and the impacts of integrating data analytics tools into society.

According to the dean of MIT's School of Engineering, Anantha Chandrakasan, "AI is everywhere . . . there are some particular targets we have in mind, including being able to detect cancer (e.g., by using AI with imaging in radiology to automatically detect breast cancer) well before we do now." The new lab is a natural extension of IBM's Watson Health initiative, which has focused on oncology and had positive results in the field during its early pilot phase. This type of system is called an expert system. The MIT lab is working on additional AI initiatives, along with oncology. According to an article released by Xconomy, the lab is seeing early progress with AI. David Cox was hired to direct the lab and stated that "some of the bets we're making are starting to pay off."

In the years since IBM Watson Health was established, however, there have been reports from hospitals and physicians, including some of IBM's partners and internal medical specialists, that Watson did not add value in a clinical setting and—even worse—sometimes recommended the wrong cancer treatments. Although IBM Watson Health has lost some clients and medical advisers because of the disappointing results, Laura Craft, a vice president of research for Gartner's Healthcare Strategy business, has argued that Watson's technology is not the problem, it simply hasn't had enough time or quality data input to become the personalized medicine engine that IBM promoted it to be. Another problem, according to Cynthia Burghard of Healthcare IT Transformation Strategies, is that when training Watson, IBM used data related to simple cancers, even though more complex cancers would be treated differently. In addition, smaller hospitals may not have the same access to treatment options as larger urban facilities, meaning recommendations need to be tailored to specific regions and medical centers.

In 2019, IBM Watson Health announced a new ten-year \$50 million investment in AI partnerships with Vanderbilt University Medical Center in Nashville and Brigham and Women's Hospital in Boston. These partnerships will use AI to improve the usability of Electronic Health Records (EHR) systems, support and increase patient safety, and help foster health equity. "By putting the full force of our clinical and research team together with two of the world's leading academic medical centers, we will dramatically accelerate the development of real-work AI solutions that improve workflow efficiencies and outcomes" says Kuy Rhee, vice president and chief health officer of IBM Watson Health.

On average, physicians spend two hours working in EHR systems for every hour of patient care. This can quickly cause a physician to "burn out" or make mistakes. A lot of these tasks can become repetitive and tedious. According to Mark Lambrecht with SAS, a data analytics company, there is more data than can be analyzed by physicians and AI can help reduce the time needed on the computer. "They do this by capturing the data automatically, making sense of it, providing content, and making sure the data is put in the right field." One example of this is in radiology. Before AI, there were books of images and radiologists had to look to find a match to the scan. Now, with AI, the system can make the match for the radiologist much faster and reduce the time needed behind the desk.

David Bates, chief of general internal medicine at Brigham and Women's Hospital and professor of medicine at Harvard Medical School, knows how urgent the need is to use existing data to improve both patient and physician experience: "We all know that the future of health belongs to AI, but today health around the globe is siloed and not actionable . . . Through AI, we have an opportunity to do better."

Kevin Johnson, MD, MS, chair of biomedical informatics at Vanderbilt, uses machine learning to deliver precision medicine and improve public health. Vanderbilt is using AI in many projects, such as streamlining workflows, personalizing care, and reducing care disparities. They are also working with GE Healthcare on a five-year project researching immunotherapy for cancer patients.

The use of artificial intelligence and machine learning is growing rapidly in the healthcare field as evidenced by the work of MIT, Brigham and Women's Hospital, and Vanderbilt University Medical Center. As more research is conducted and the data grows, so too will the knowledge base for artificial intelligence. Who knows how far this will take us. Where do you see healthcare going in the next ten years?

**As you read about artificial intelligence and automation, consider the following:**

- What forms of artificial intelligence are organizations using today, and how are they being used?
- What are the potential impacts on society as a whole as artificial intelligence and machine learning continue to develop?

## Why Learn About Artificial Intelligence (AI) and Automation?

Artificial intelligence (AI) has been in development for more than sixty years. During this time, advances in AI technology have affected our daily lives—both at home and in business. What is artificial intelligence, and how does a computer become intelligent? What types of careers are available, and what do you need to be successful in an AI field? We need to understand how automation will affect each industry and how to prepare for it. Will jobs be lost due to automation, or will new jobs be created? As we look to the future, it is important for organizations and managers to understand artificial intelligence and automation and their applications, including how these fields will continue to develop.

## Overview of Artificial Intelligence

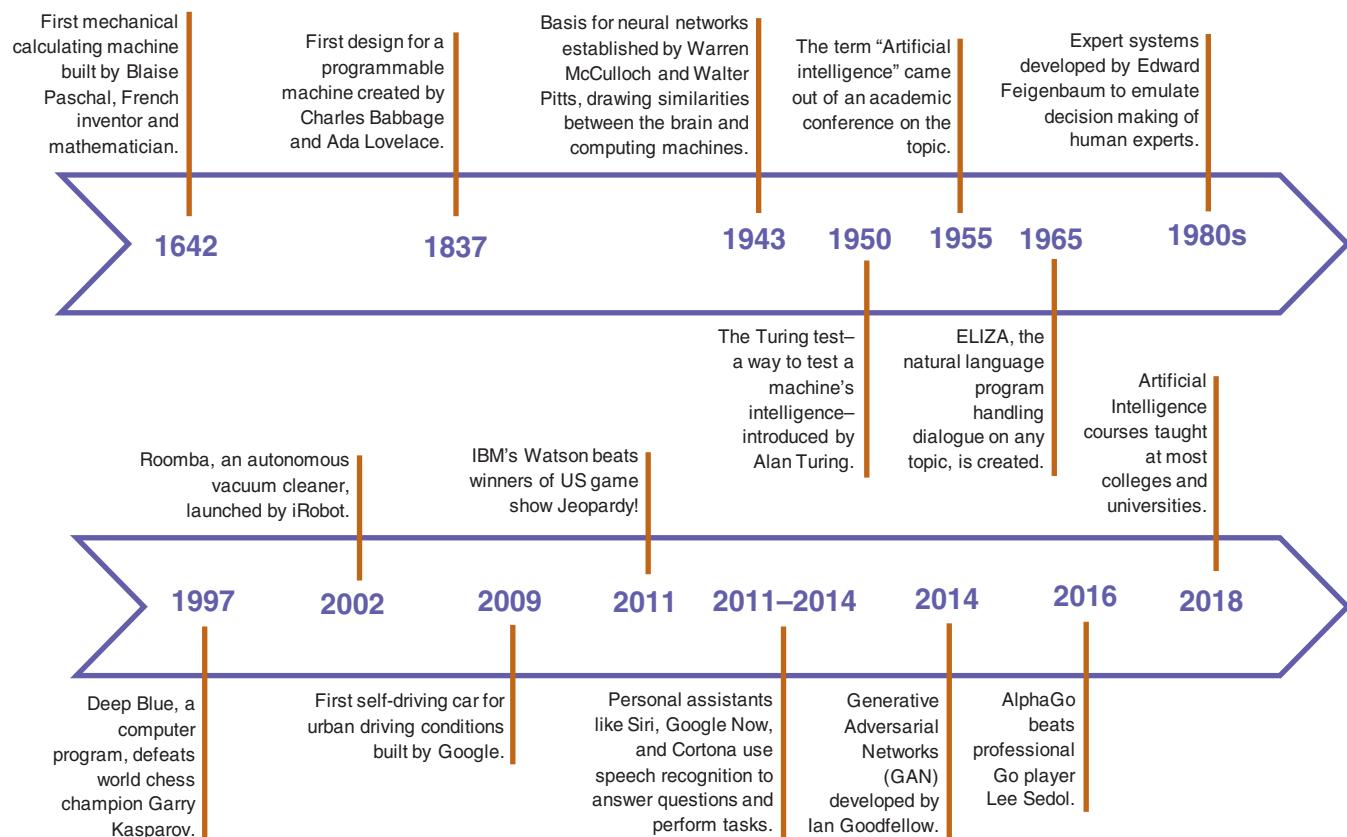
**artificial intelligence (AI):** The ability to mimic or duplicate the functions of the human brain.

At a Dartmouth College conference in 1956, John McCarthy proposed the use of the term **artificial intelligence (AI)** to describe computers with the ability to mimic or duplicate the functions of the human brain. A paper was presented at the conference proposing a study of AI based on the conjecture that “every aspect of learning or any other feature of intelligence can in principle be so precisely described that a machine can be made to simulate it.”<sup>1</sup>

Many AI pioneers attended this first conference; a few predicted that computers would be as “smart” as people by the 1960s. The prediction has not yet been realized, but many applications of AI can be seen today, and research continues.

To gain an understanding of AI requires first understanding the history of AI. Computers, as we know them today, had a very humble beginning in the 1600s when Blaise Pascal, known for his skills as a mathematician, invented the Pascaline, a mechanical calculating machine that worked as a tax calculator.<sup>2</sup> Thus began the process of using calculations to improve business functions. In 1837, Charles Babbage and Ada Lovelace designed the first programmable engines: the Difference Engine, which was designed as a calculator, and the Analytical, which led to the more modern-day computers that were programmed using punch cards.<sup>3</sup> These inventions paved the way for the modern era of AI.

As shown in Figure 11.1, AI developed quickly through the decades since the 1640s from 1642 to 2018.<sup>4</sup> In 1943, Warren McCulloch and Walter Pitts established the parallel between the brain and computers, marking the foundation of neural networks. This will be discussed later in the chapter.



**FIGURE 11.1**  
**Timeline of artificial intelligence**

Historical time of artificial intelligence development.

Source: "History of Artificial Intelligence," <https://qbi.uq.edu.au/brain/intelligent-machines/history-artificial-intelligence>, Queensland Brain Institute.

In 1950, Alan Turing, a mathematician who later became known as the father of modern computer science, developed a way to test a machine's intelligence. His thought was that if the machine could trick a person into thinking it was human, then the machine was intelligent. Turing's initial conclusion was that there was not enough memory and storage available, at the time, and also human's ability to experience emotions and originality in their work. However, he also believed his initial proposal would be realized within fifty years.<sup>5</sup> The Turing Test has not been realized, meaning that there has been no officially confirmed case of a computer being mistaken for a human, but other expert systems may offer a different solution. Expert systems are discussed later in this chapter.

The 1960s brought several robotic innovations, including Unimate, the first industrial robot, which in 1961 was put to use in General Motor (GM) factories, replacing humans on some parts of GM's assembly lines. In 1964, a chatbot called ELIZA that could hold conversations with humans was developed by Joseph Weizenbaum at MIT.<sup>6</sup> In 1966, Shakey the Robot (shown in Figure 11.2) was created. Shakey could perform tasks that involved rearranging simple objects and planning routes. Shakey was shown to have the ability to "perceive

**FIGURE 11.2****Shakey the Robot**

Shakey the Robot is known as the “first electronic person.”

Source: By Marshall Astor from San Pedro, United States—Cropped (by uploader, User: Sanchom) version of Shakey-Robot, CC BY-SA 2.0, <https://commons.wikimedia.org/w/index.php?curid=3627201>



Ralph Crane/The LIFE Picture Collection/Getty Images

and reason about its surroundings,” and in 1970, *Life* magazine referred to it as the “first electronic person.”<sup>7</sup>

Over the next twenty years, the development of AI seemed to stall. Research continued, but there was much work to be done. There had to be a distinction between AI and machine learning. Researchers had determined that AI operated on a set of rules, and machine learning used data to determine the next step in the process. In order to make it work, they had to learn how to program the rules to make the AI work properly. The difference with machine learning is that the machine is learning while it is being used. Once this was understood, the work with AI could resume with a new focus on the programming of artificial intelligence.

In the late 1990s, IBM challenged world chess champion Gary Kasparov to an epic man-versus-machine battle against its supercomputer dubbed Deep Blue. In May 1997, Deep Blue claimed victory after an extended six game match—claiming two wins, one loss, and three draws. Deep Blue became the inspiration for Watson.<sup>8</sup>

Over the next ten years, many robotic toys and household appliances were released on the market—each making use of more advanced AI technology than the last. AiBO, a robotic dog first released in 1999, has a personality that continues to develop as a child plays with it. AI-assisted appliances such as the Roomba, which can vacuum a home without damaging furniture and walls by learning how to navigate around these items, became more common starting in the early 2000s.<sup>9</sup>

The next big advancement in AI came in 2011 when IBM's Watson defeated two prior *Jeopardy!* champions. To prepare for the game, IBM programmers had to give Watson the ability to do natural language processing so that it would understand the nature of each question and be able to formulate a reply in the form of a question.<sup>10</sup> Natural language is discussed later in the chapter.

The last decade has seen rapid growth in the use of AI applications in business settings and in the daily lives of consumers. Applications such as Siri, Cortana, and Alexa provide assistance with everything from the weather to directions to shopping. With these applications, users can simply ask a question to get an answer based on their location and preferences. AI continues to move forward, and in this chapter, we will look at how these developments are likely to impact information technology, our careers, and our daily lives.

## Artificial Intelligence in Perspective

Computers were originally designed to perform simple mathematical operations, using fixed programmed rules and eventually operating at millions of computations per second. When it comes to performing mathematical operations quickly and accurately, computers beat humans hands down. However, computers still have trouble recognizing patterns, adapting to new situations, and drawing conclusions when not provided complete information—all activities that humans can perform quite well. Artificial intelligence systems tackle these sorts of problems. **Artificial intelligence (AI) systems** include the people, procedures, hardware, software, data, and knowledge needed to develop computer systems and machines that can simulate human intelligence processes, including learning (the acquisition of information and rules for using the information), reasoning (using rules to reach conclusions), and self-correction (using the outcome from one scenario to improve its performance on future scenarios).

AI is a complex and interdisciplinary field that involves several specialties, including biology, computer science, linguistics, mathematics, neuroscience, philosophy, and psychology. The study of AI systems causes one to ponder philosophical issues such as the nature of the human mind and the ethics of creating objects gifted with human-like intelligence. Today, AI systems are used in many industries and applications. Researchers, scientists, and experts on how human beings think are often involved in developing these systems.

## Nature of Intelligence

From its earliest stages, the emphasis of much AI research has been on developing machines with the ability to “learn” from experiences and apply knowledge acquired from those experiences; to handle complex situations; to solve problems when important information is missing; to determine what is important and to react quickly and correctly to a new situation; to understand visual images, process and manipulate symbols, and be creative and imaginative; and to use heuristics—all of which together is considered **intelligent behavior**.

As described above, the Turing Test was developed to determine if a computer could convince humans that they were conversing with another human rather than a computer. Since 1951, there has been no declared winner of this award. Some have questioned if the Google Duplex, an AI device that speaks for a user with the help of Google Assistant, may have beat the Turing Test due to the successful completion of a phone call to schedule a hair salon appointment. In a competition, completed before a live audience, Google Duplex was given the information to ask for an appointment and accept the time given. Some would say yes, as the salon receptionist did not know she was talking with a computer and conducted business as usual. Some would say no, as the call was made in front of an audience and an appointment is more of a scripted type of call.<sup>11</sup>

**artificial intelligence (AI) system:** The people, procedures, hardware, software, data, and knowledge needed to develop computer systems and machines that can simulate human intelligence processes, including learning (the acquisition of information and rules for using the information), reasoning (using rules to reach conclusions), and self-correction (using the outcome from one scenario to improve its performance on future scenarios).

**intelligent behavior:** The ability to learn from experiences and apply knowledge acquired from those experiences; to handle complex situations; to solve problems when important information is missing; to determine what is important and to react quickly and correctly to a new situation; to understand visual images, process and manipulate symbols, and be creative and imaginative; and to use heuristics.

Starting in 1991, Hugh Loebner and the Cambridge Centre for Behavioural Studies began hosting a Turing Test contest—one of many contests in existence today that allows businesses and individuals to compete and showcase their chatbots to determine if they can pass the Turing Test. In 2014, the Society for the Study of Artificial Intelligence and Simulation of Behaviour (AISB), the world's first AI society, took over running the contest, which is a blind competition, meaning that both humans and computers are behind curtains while judges converse with them via computer chat. Both humans and computers are trying to convince the panel of judges that they are human. No computer has been successful; however, all humans who have taken part in the contest have successfully convinced the judges they were human—though some by a very slim margin. As of 2019, this is no longer a formal contest; instead, the prize will be awarded by a combine jury and public vote.<sup>12</sup>

Some of the specific characteristics of intelligent behavior include the ability to do the following:

- **Learn from experience and apply the knowledge acquired from experience.** Learning from past situations and events is a key component of intelligent behavior and is a natural ability of humans, who learn by trial and error. This ability, however, must be carefully programmed into a computer system. Today, researchers are developing systems that can “learn” from experience. The 20 Questions (20Q) Website, [www.20q.net](http://www.20q.net) (see Figure 11.3), is an example of a system that learns.<sup>13</sup>

The Web site is an AI game that learns as people play.

**FIGURE 11.3**  
**The 20Q Website**

20Q is a game where users play the popular game 20 Questions against an AI foe.

Source: [www.20q.net](http://www.20q.net)



- **Handle complex situations.** In a business setting, top-level managers and executives must handle a complex market, challenging competitors, intricate government regulations, and a demanding workforce. Even human experts make mistakes in dealing with these matters. Very careful planning and elaborate computer programming are necessary to develop systems that can handle complex situations.
- **Solve problems when important information is missing.** An integral part of decision making is dealing with uncertainty. Often, decisions must be made with little or inaccurate information because obtaining complete information is too costly or impossible. Today, AI systems can make important calculations, comparisons, and decisions even when information is missing. However, it must be noted that the decisions

made by an AI system are only as good as the data. A decision will be based only on the information available to the system. If vital data is missing, it will have an impact on the quality of the decision. This is much like how humans make decisions: We process the information we have available and make the best possible decision. As more data becomes available, the outcome may change.

- **Determine what is important.** Knowing what is truly important is the mark of a good decision maker. Humans can reprogram their thought process and overlook extraneous data to determine what is important. Developing programs and approaches to allow computer systems and machines to identify important information is not a simple task. Algorithms are programmed to “weed out” the bad data and identify the good data. If the algorithms are not programmed correctly, the computer will not know to overlook incorrect data.
- **React quickly and correctly to a new situation.** A small child, for example, can look over an edge and know not to venture too close. The child reacts quickly and correctly to a new situation. On the other hand, without complex programming, computers do not have this ability.
- **Understand visual images.** Interpreting visual images can be extremely difficult, even for sophisticated computers. Moving through a room of chairs, tables, and other objects can be trivial for people but extremely complex for machines, robots, and computers. Such machines require an extension of understanding visual images, called a **perceptive system**. Having a perceptive system allows a machine to approximate the way a person sees, hears, and feels objects.
- **Process and manipulate symbols.** People see, manipulate, and process symbols every day. Visual images provide a constant stream of information to our brains. By contrast, computers cannot intuitively handle symbolic processing and reasoning. Although computers excel at numerical calculations, they must have extensive programming to deal with symbols and three-dimensional objects. Recent developments in computer-vision and machine-vision hardware and software, however, allow some computers to process and manipulate certain symbols. Machine-vision uses cameras to view an image, and computer-vision uses programmed algorithms to interpret the images.
- **Be creative and imaginative.** Throughout history, some people have turned difficult situations into advantages by being creative and imaginative. For instance, when defective mints with holes in the middle arrived at a candy factory, an enterprising entrepreneur decided to market these new mints as LifeSavers instead of returning them to the manufacturer. Ice cream cones were invented at the St. Louis World's Fair when an imaginative store owner decided to wrap ice cream with a waffle from his grill for portability. Developing new products and services from an existing (perhaps negative) situation is a human characteristic. While software has been developed to enable a computer to write short stories, few computers can be imaginative or creative in this way.
- Use **heuristics**. For some decisions, people use heuristics, a trial-and-error method of problem solving used when an algorithmic or mathematical approach is not practical.

**heuristics:** A trial-and-error method of problem solving used when an algorithmic or mathematical approach is not practical.

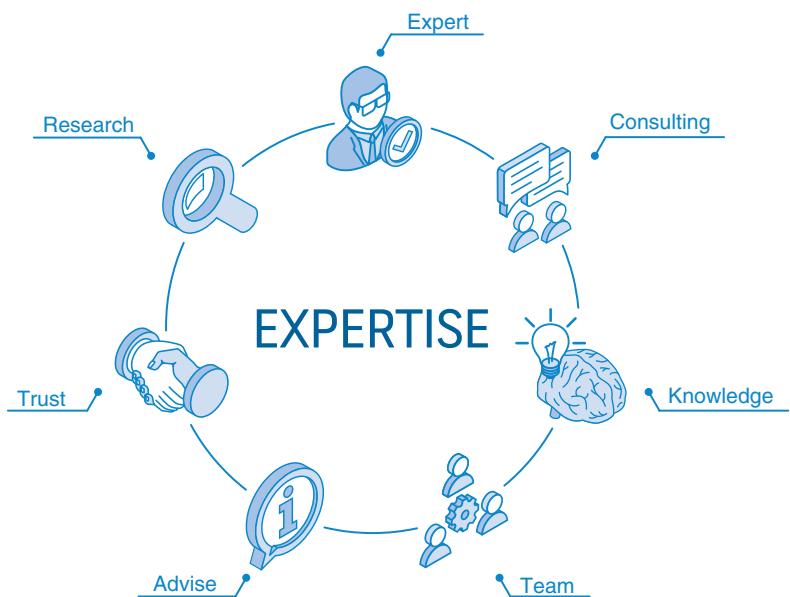
**expert systems:** The decision-making computer systems in AI, designed to be the most advanced and most reliable in solving complex problems.

## Expert Systems

**Expert systems** were the precursor of the modern AI systems.<sup>14</sup> Expert systems are the decision-making computer systems in AI (see Figure 11.4), and they are designed to be the most advanced and most reliable in solving complex

**FIGURE 11.4****Expert systems**

Expert systems analyze complex problems to deliver reliable solutions.



problems, and they work in a specific domain. These systems must be programmed for their issues, as this decision making uses both facts and heuristics to solve the level of problems that would take the highest level of human intelligence and expertise to solve. We are seeing many advances in expert systems in the medical field today, as discussed in the opening case.

### **Characteristics of Expert Systems**

Expert systems must be able to perform whenever they are needed, and the results must be accurate. The programming of such systems is highly complex and can be compared to the intelligence level of the experts, who rely on the results. When working on a complex project, the department, or lab, will take on certain characteristics, such as executing a highly developed plan with the speed and accuracy to make critical decisions when necessary. A good example of this is preparing an operating room for a patient. When preparing for a major surgical procedure, the medical staff has a process they follow to ensure that the patient is prepared for surgery and all equipment is properly sterilized and ready for use. The surgical team has to be highly effective and reliable so the doctors can focus on the patient. When the patient arrives in the operating room, the room has to be ready, and the tone of the room changes, as the patient must be treated professionally and should see and hear only certain information. If the procedure changes, either before or during the surgery, the team must be able to process that information quickly and make the critical decisions necessary to ensure the patient receives the best medical care. All expert systems have the following characteristics: highly effective, understandable, reliable, able to process data quickly, and capable of critical decision making. These characteristics are described in more detail in the following sections, but note that an expert system may also require additional characteristics depending the application or domain the system is programmed for, such as the medical or financial industries.

#### **Highly Effective**

For a system to be considered “expert,” it must be capable of handling complex algorithms with large data sets in a reasonable amount of time. If a human expert is able to process the data faster than the program, with accurate results, then the program will be considered obsolete and will no longer be useful. The system must be efficient and easy to use to remain an expert system.

### ***Understandable***

For information to be useful, it must be accurate and understandable. For instance, if you take a quiz in a class, and the only feedback you receive from your instructor is “Some answers are correct, and some answers are incorrect,” not only will you not know what grade you received on the quiz, you will also not know what areas to focus on when studying for the final exam. You need clear and precise results, such as “You answered questions 5 and 7 incorrectly, the correct answers are B and D, and your grade on the quiz is 93. In the same way, an expert system must give an understandable report for it to be of use. In this chapter’s opening case, we saw that improvements are being made on ways to help physicians reduce time working at their desks by interpreting results from the EHR systems. These results must be understandable, or the patient’s health will suffer.

### ***Reliable***

Not only does the results from an expert system have to be understandable, it also has to be reliable. In the healthcare industry, accurate and reliable results can be the difference between life and death. Airlines use expert systems in scheduling their daily routes and managing some of the world’s largest airports. If these systems do not have reliable information, planes may not arrive at the correct airport, or they may all arrive at the same time.

### ***Able to Process Data Quickly***

Expert systems must be able to process large data sets quickly and efficiently. Expert systems often work with data sets that are measured in terabytes, petabytes, or even exabytes. This data may come from multiple sources and require the expert system to process nonstandard data types, such as images, videos, or recordings. The expert system must be able to perform this type of highly complex processing rapidly to remain useful to the organization.

### ***Capable of Critical Decision Making***

Some expert systems are used to aid critical decision making. Such a system may be used, for instance, to ensure the right person is hired for a dangerous or stressful job, such as one in which the person has responsibility for the safety of many other people. In the airline industry, the Aviation Expert System is used to perform psychological assessments to ensure that pilots are capable of handling the stress of knowing they are responsible for getting everyone on board the planes they are flying safely to their destination. The GAPATS system is another expert system used in the aviation industry. It was developed in the late 1990s and is still in use today as a flight simulator designed to help train pilots for any situation they may encounter in the air.<sup>15</sup> The simulator is built on an AI platform that simulates different scenarios, some of which were based on actual plane crashes caused by the failure of existing computer models, requiring new algorithms to be built into the system. Today, expert systems handle most routine tasks involved in the flying commercial airlines; these simulations are used to train pilots on how to handle emergencies if they should occur.

## ***Capabilities of Expert Systems***

Organizations use expert systems to work more efficiently, save money, make better decisions, and out-perform their competitors. The capabilities of expert systems include aiding in decision making, such as in the area of human resources. Companies that make use of expert systems in hiring may embed questions in online job applications that are used by an expert system to decide whether to accept or reject the application for further consideration based on the job requirements. One company that develops AI recruiting software has developed an algorithm for candidate sourcing that it claims can reduce hiring time from 34 days to just 9 days.<sup>16</sup>

Data analysis, interpreting input, and justifying conclusions are other functions that may be performed by expert systems. Earlier in the chapter we looked at how AI is being used in the medical industry. AI is also being used in the financial industry to predict market trends, make determinations regarding loan applications, and even predict election outcomes. These same systems also offer alternative options to problems to keep business running efficiently and promote customer relationships.

### Components of Expert Systems

An expert system is made up of a collection of integrated and related components, including a knowledge base, a development engine, an inference engine, an explanation facility, a knowledge base acquisition facility, and a user interface. A diagram of a typical expert system is shown in Figure 11.5.

**FIGURE 11.5**  
**Components of an expert system**

An expert system includes a knowledge base, a development engine, an inference engine, an explanation facility, a knowledge base acquisition facility, and a user interface.



As shown in the figure, the user interacts with the user interface, which interacts with the inference engine. The inference engine interacts with the other expert system components to provide expertise. This figure also shows the inference engine coordinating the flow of knowledge to other components of the expert system.

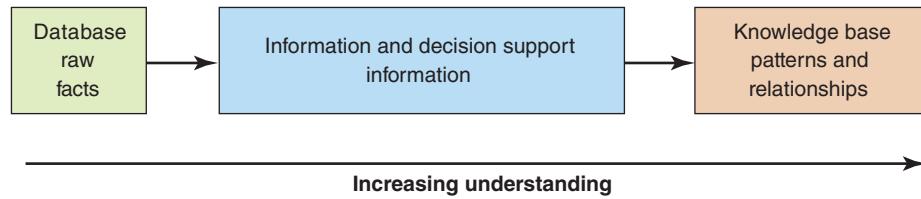
#### Knowledge Base

**knowledge base:** A component of an expert system that stores all relevant information, data, rules, cases and relationships used by the expert system.

The **knowledge base** stores all relevant information, data, rules, cases, and relationships that the expert system uses. The information captured is the knowledge that experts use to make complex decisions. If the information gathered is not complete, then the decisions will not be accurate. As shown in Figure 11.6, a knowledge base is a natural extension of a database and an information and decision-support system. A knowledge base must be developed for each unique expert system application. Rules and cases are frequently used to create a knowledge base.

**FIGURE 11.6**  
**Relationships between data, information, and knowledge**

A knowledge base stores all relevant information, data, rules, cases, and relationships that an expert system uses.



**rule:** A conditional statement that links conditions to actions or outcomes.

**IF-THEN statement:** A rule that suggests certain conclusions.

A **rule** is a conditional statement that links conditions to actions or outcomes. In many instances, these rules are stored as **IF-THEN statements**, which are rules that suggest certain conclusions. The FICO Blaze Advisor system is a rules-based platform that allows business users to develop and test rule-based decision applications. The platform is used by clients to build expert systems for benefits eligibility determination, insurance underwriting, regulatory compliance monitoring, and personal and commercial lending—among other uses.<sup>17</sup>

A case-based system can also be used to develop a solution to a current problem or situation. In such a system, each case typically contains a description of the problem, plus a solution and/or the outcome. The case-based solution process involves (1) finding cases stored in the knowledge base that are similar to the problem or situation at hand, (2) reusing the case in an attempt to solve the problem at hand, (3) revising the proposed solution if necessary, and (4) retaining the new solution as part of a new case. A washing machine repairman who fixes a washer by recalling another washer that presented similar symptoms is using case-based reasoning, so is the lawyer who advocates a particular outcome in a trial based on legal precedents.

### **Development Engine**

**development engine:** Engine that builds the sets of rules and processes used by AI systems.

AI runs on rules and processes, and those sets of rules and processes are created by the **development engine** component of the expert system. These rules and processes are usually built using one of two approaches. The first approach is to use a processor as a shell to work on specific problems by adding the necessary knowledge base. These shells can produce an expert system faster than using a traditional programming language to reprogram a system for each new question.<sup>18</sup>

The second approach involves using traditional programming language to develop the expert system. This approach requires using a human's expert knowledge and developing a plan for the system. Then programming and testing must take place, which may take days, weeks, or months based on the complexity of the system. Some of the major programming languages used in AI are Python, Java, and C++.

### **Inference Engine**

**inference engine:** Part of the expert system that seeks information and relationships from the knowledge base and provides answers, predictions, and suggestions, often taking the place of the human experts.

The main purpose of an **inference engine** is to seek information and relationships from the knowledge base and to provide answers, predictions, and suggestions. Inference engines are considered one of the most important components of an expert system, as these predictions and suggestions often take the place of human experts. In other words, the inference engine is the component that delivers the expert advice. Consider the expert system that forecasts future sales for a product. One approach is to start with a fact such as "The demand for the product last month was 20,000 units." The expert system searches for rules that contain a reference to product demand. For example, "IF product demand is over 15,000 units, THEN check the demand for competing products." The programming in the expert system would use information on the demand for competitive products. Next, after searching additional rules, the expert system might use information on personal income or national inflation rates. This process continues until the expert system can reach a conclusion using the data supplied by the user and the rules that apply in the knowledge base.

Inference engines process a massive amount of data. The engine applies rules to the facts and adds new knowledge to the knowledge base, if it is required. If there is a conflict, multiple rules may have to be applied. As such, the engine must use one of two strategies (forward chaining or backward chaining) to process data and provide an answer, prediction, or suggestion.

**Forward chaining:** A strategy used by the inference engine to process data using a set of known facts to make decisions.

**Forward chaining** follows a set of known facts to make decisions. For each fact, there is a set number of outcomes. The knowledge base is consulted,

and the next decision is made. The process continues until a conclusion is reached. This can be a long process, depending on how complex the problem is and how many possible outcomes there are for each question. For each decision, the knowledge base is consulted, and the data must be processed. This is the slowest of the two strategies.

**backward chaining:** A strategy used by the inference engine to determine how a decision was made.

**Backward chaining** looks at what has already happened and works backward to find out how the decision was made. The same facts, decisions, and outcomes are in the knowledge base, but the process is in reverse order. This makes the processing much faster, as the conclusion is known, and the number of iterations is reduced. The forward chain looks into what happens next, but the backward chain determines why something happened.<sup>19</sup> Backward chaining is used to prove a conclusion. This information can be used to design new systems and faster response times for future decisions.

### **Explanation Facility**

**explanation facility:** Component of an expert system that allows a user or decision maker to understand how the expert system arrived at certain conclusions or results.

Another important part of an expert system is the **explanation facility**, which allows a user or decision maker to understand how the expert system arrived at certain conclusions or results. A medical expert system, for example, might reach the conclusion that a patient has a defective heart valve given certain symptoms and the results of tests conducted on the patient. The explanation facility allows a doctor to find out the logic or rationale of the diagnosis made by the expert system. The expert system, using the explanation facility, can indicate all the facts and rules that were used in reaching the conclusion, which the doctors can look at to determine whether the expert system is processing the data and information correctly and logically.

### **Knowledge Acquisition Facility**

A challenging aspect of developing a useful expert system is the creation and updating of the knowledge base. In the past, when more traditional programming languages were used, developing a knowledge base was tedious and time consuming. Each fact, relationship, and rule had to be programmed—usually by an experienced programmer.

Today, specialized software allows users and decision makers to create and modify their own knowledge bases through the knowledge acquisition facility, using user-friendly menus. The purpose of the **knowledge acquisition facility** is to provide a convenient and efficient means of capturing and storing all components of the knowledge base. The knowledge acquisition facility acts as an interface between experts and the knowledge base.

### **User Interface**

The main purpose of the user interface is to make an expert system easier for users and decision makers to develop and use. At one time, skilled computer personnel created and operated most expert systems; today, simplified user interfaces permit decision makers to develop and use their own expert systems. A user interface is made up of two parts: input and output. The input allows for the user to input the commands, scan images, and give verbal instructions to the program. The output allows for the system to ask for additional input from the user, show errors, and provide solutions and decisions for the given task.

### **Participants in Developing and Using Expert Systems**

**domain expert:** The person or group with the expertise or knowledge the expert system is trying to capture (domain).

**knowledge engineer:** A person who has training or experience in the design, development, implementation, and maintenance of an expert system.

Typically, several people are involved in developing and using an expert system. The **domain expert** is the person or group with the expertise or knowledge the expert system is trying to capture (domain). In most cases, the domain expert is a group of human experts. A **knowledge engineer** is a person who has training or experience in the design, development, implementation, and maintenance of an expert system, including training or experience with expert system shells. Knowledge engineers can help transfer the knowledge from the

**knowledge user:** The person or group who uses and benefits from the expert system.

**vision system:** The hardware and software that permit computers to capture, store, and manipulate visual images.

**augmented reality (AR):** Vision system software that takes computer-generated images and superimposes them on a user's view of the world through the use of specialized glasses or goggles.

expert system to the knowledge user. The **knowledge user** is the person or group who uses and benefits from the expert system. Knowledge users do not need any previous training in computers or expert systems.

## Vision Systems

Another area of AI involves **vision systems**, which include hardware and software that permit computers to capture, store, and process visual images. A rise in Industrial Internet of Things (IIoT) has resulted in a new generation of vision systems, which allow machines to communicate with each other and process information in a fast-paced automated environment. IIoT is used more in industrial settings and applications, with a focus on machine learning, big data, and communication. Manufacturing has long involved automated processes, and the automotive industry relies on 3D vision applications for determining the direction robots should move. Camera placement is crucial for the 3D applications to provide the most accurate information, and the use of these camera and recorded images assist in quality control and the end of production control. Robots, discussed later in the chapter, are used in manufacturing, and vision systems, with the use of captured images, are able to determine what is moving in and around the manufacturing lines. This includes both products and persons. When humans, such as inspectors, are moving around the production lines, the robot will stop if it determines a collision with the human is unavoidable. Otherwise, the robot will not stop, and the plant continues to work efficiently.<sup>20</sup>

**Augmented reality (AR)** is a type of vision system that is being used widely in the medical field. Augmented reality is different from virtual reality, which has been used in business and in homes for many years. Virtual reality allows for the user to take tours or “walk through” different scenes without leaving their chair. For example, if you wanted to walk around the Statue of Liberty, a virtual reality app would allow you to sit on your sofa and take a tour. Augmented reality would place the Statue of Liberty in your living room and you could walk around it by using your mobile device app.

AR takes a computer-generated image and superimposes it on a user's view of the real world through the use of specialized glasses or goggles, as shown in Figure 11.7. Most surgeons rely on 2D images in the surgical suite. The surgeons rely on their memory and skill to pull the individual images together into one image when operating. AR uses AI algorithms along with 3D anatomical algorithms to create images that can be seen with the use of special goggles. These images can then be overlaid onto the patient, and multiple surgical

**FIGURE 11.7**  
**Surgeons use augmented reality goggles in surgery**

AR goggles allow surgeons to superimpose images onto the real world by using specialized goggles during surgery to provide better visualization.



personnel can see the same overlay by wearing AR goggles, which provide more than just images. Chart information and real-time information, such as the patient's heart rate, can be fed directly into the display so doctors do not have to divert their attention to monitors or charts during the procedures. AR has also proven to be a great tool for training physicians by providing skills-based labs in a virtual environment.<sup>21</sup>

## Other AI Applications

**genetic algorithm:** An approach to solving problems based on the theory of evolution; uses the concept of survival of the fittest as a problem-solving strategy.

Other AI applications include **genetic algorithms**, which was inspired by evolutionary biology. Genetic algorithm makes use of selection, mutation, and recombination to solve problems, much like the "survival of the fittest" concept of evolution.<sup>22</sup> The genetic algorithm uses a fitness function that quantitatively evaluates a set of initial candidate solutions. The highest-scoring candidate solutions are allowed to "reproduce," with random changes introduced to create new candidate solutions. These digital offspring are subjected to a second round of fitness evaluation. Again, the most promising candidate solutions are selected and used to create a new generation with random changes. The process repeats for hundreds or even thousands of rounds. The expectation is that the average fitness of the population will increase each round and that eventually very good solutions to the problem will be discovered.

Genetic algorithms have been used to solve large, complex scheduling problems, such as scheduling airline crews to meet flight requirements while minimizing total costs and staying within federal guidelines on maximum crew flight hours and required hours of rest. Genetic algorithms have also been used to design mirrors that funnel sunlight to a solar collection and radio antenna that pick up signals from space.

Another AI application, **intelligent agent** (also called an intelligent robot or bot), consists of programs and a knowledge base used to perform a specific task for a person, a process, or another program. Like a sports agent who searches for the best endorsement deals for a top athlete, an intelligent agent is often used to search for the best price, schedule, or solution to a problem. The programs used by an intelligent agent can search large amounts of data as the knowledge base refines the search or accommodates user preferences. Often used to search the vast resources of the Internet, intelligent agents can help people find information on any topic, such as the best price for a new camera or used car.

## Artificial Neural Networks

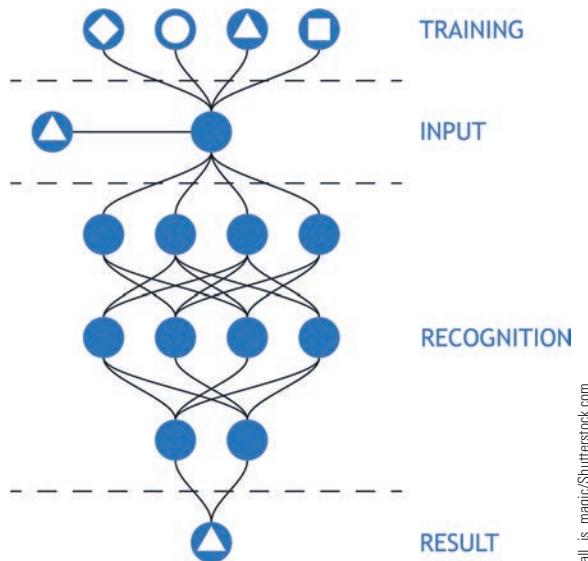
**artificial neural network:** A computer system that can recognize and act on patterns or trends that it detects in large sets of data; developed to operate like the human brain.

An increasingly important aspect of AI involves artificial neural networks, also called neural nets. An **artificial neural network** is a computer system that can recognize and act on patterns or trends that it detects in large sets of data, developed to operate like the human brain. Developed in 1943 by Warren McCulloch and Walter Pitts, neural networks were designed to review patterns and make decisions based on these patterns. The human brain is connected by neurons through which information is filtered so that we can make decisions based on the data that is input through our senses. In much the same way, data is collected and input into an artificial neural network and then filtered through networked connections that have a value associated with them. These values lead the program to make decisions that lead to a final result. The program is trained through supervised learning, through the machine learning process, which is discussed later in the chapter. One example of an artificial neural network is the feedforward neural network. A feedforward neural network is a network where the information flows only in the forward direction, instead of in a circular motion. Most networks will feed data back into the pattern, creating that circular pattern. Feedforward neural networks will send the information forward, creating a straight pattern. Researchers at the University of British Columbia

have trained this network using data representing different temperatures and pressures from the Pacific Ocean to predict underwater volcano eruptions. Volcanic eruptions can cause tsunamis along the western coast of North America, and predictions from this neural network are designed to give people more advanced warning when it becomes necessary to evacuate the coastal areas.<sup>23</sup>

So the question remains, “How does the artificial neural network learn?” Just as a child learns new things, an artificial neural network is programmed to learn from each iteration during the training phase—a process that continues even after the system is implemented. Think back to when you first learned to ride a bicycle. Training wheels likely kept you upright while you learned how to pedal and steer. You were learning how to maneuver the handlebars while also working the pedals. Once the training wheels were removed, you also had to learn how to balance the bicycle, along with pedaling and steering. Each change required you to learn a new skill. The same approach is used with neural networks. Input is given, and feedback is received. The feedback is used to weight the connections, meaning it takes all the options and assigns the most “points” to the choice with the most feedback. The next iteration looks at the choices and takes the one with the highest weight based on the situation, see Figure 11.8. One difference between the human response and the computer response is an emotional one. A child riding a bicycle may experience an emotional response to success or failure while a computer will give an unemotional answer to a given question.

**FIGURE 11.8**  
**A neural networks process from training through result**  
Neural networks are trained, receive input, and then process the information through weighted connections until a result is found.



all\_is\_magic/Shutterstock.com

Neural networks are used in many industries, with more applications continually in development. NASA has been experimenting with neural networks for over twenty years with its Intelligent Flight Control System, which helps pilots land planes after they sustain battle damage or experience major system failures. Google saw a 55–85 percent reduction in translation errors after implementing its Neural Machine Translation, which converts entire sentences from one language into another. Email software uses neural networks to differentiate spam email from genuine email, and you may be using neural networks if you are use a speech-to-text application or a touch screen on your smartphone or tablet.<sup>24</sup>

## AI and Employment

In recent years, the debate about the impact of AI on future employment has been getting more attention. Will there be jobs in the future, or will computers take over the world? AI has already affected many industries, and AI technology is being introduced in new industries and new applications at a rapid pace.

However, the debate over the advantages and disadvantages of new technology in terms of job creation is not a new one.

Automation has often created a fear of job loss. Change can be hard to accept when it appears that it will affect your livelihood. In 1811, the Luddite movement began when textile workers protested the automation of textile manufacturing plants over fears that skilled workers would be displaced. Each decade has brought about its own fears of job loss due to automation. In the 1930s, machines were blamed for the loss of jobs. In the 1940s, a tax on machines was proposed to offset the unemployment rate.<sup>25</sup> In 1961, President Kennedy addressed the nation saying, “the major challenge of the sixties is to maintain full employment at a time when automation is replacing men.” When personal computers became standard in the late 1980s, employers began requiring workers to learn the basics of computers to remain in their positions, setting off an era of “computerphobia.” In the long run, however, the introduction of new technology has always resulted in more jobs being created than were lost. Technology may create cheaper and faster labor, but other—higher paying—jobs are often created as a result of the new technology.<sup>26</sup>

In 2017, McKinsey & Company conducted a study that examined how automation will impact the global workforce by 2030. Included in the calculation was the cost of deploying the solutions, the quality and quantity of labor, wages, the benefits of automation, and social acceptance. The study estimated that approximately 30 percent of the hours worked worldwide could be automated by 2030—meaning 400 million to 800 million displaced individuals will need to learn new skills and move into new occupations. McKinsey & Company does have good news, however. The study estimates that 9 percent of the labor demand in 2030 will be in occupations that did not exist before. The study also predicted that wages in 2030 will be much higher due to automation. The benefits of AI, if managed effectively and efficiently, can drive the economy to create jobs instead of removing jobs.<sup>27</sup>

A report released by the World Economic Forum titled “The Future of Jobs 2018” states that the growth of AI could actually create up to 58 million new jobs by 2022. In order for this to happen, organizations must recognize the talent within their workforce and **upskill** their workforce to meet the demands of new automation. Upskilling refers to training a workforce to perform higher-skilled roles to ensure they meet their full potential. The organization must also have a strategic plan to move forward. For workers to take advantage of this trend, they must take personal responsibility for their own training and development. Employees can take advantage of career and professional development opportunities, return to school for more education, and apply for higher-skilled positions.<sup>28</sup>

A report by LinkedIn noted that between 2015 and 2017, the number of AI skills listed on individual LinkedIn profiles increased by 190 percent. The countries with the highest concentration of AI skills were the United States, China, India, Israel, and Germany. These countries headquartered many fast-moving companies that are driving AI technology. The LinkedIn report also examined three skill sets that are complementary to AI: data and programming skills, skills to use the products or services powered by data, and interpersonal skills. According to LinkedIn’s user base, over the past five years, the fastest growing career has been software engineer, with data analyst making the top ten list. Administrative assistant was the slowest growing career over the past five years.<sup>29</sup>

There are many options for a career in AI. Here are six of the top careers, according to the Business Student website:<sup>30</sup>

- **Data scientist.** A data scientist analyzes large data sets to follow patterns and find trends, allowing organizations to develop strategic plans and make effective decisions in a timely manner.

**upskill:** The practice of training a workforce to perform higher-skilled roles to ensure they meet their full potential.

- **Machine learning engineer.** Computer programmers with a strong background in languages such as Python and Java may work as machine learning engineers in industries such as technology, aerospace, and finance.
- **Software developer.** Programmers with complex programming skills support the development and deployment of AI and machine learning systems in industries such as healthcare, telecommunications, and law enforcement.
- **Robotics scientist.** Engineers who are responsible for robots, such as Alexa and Roomba, develop products that can take years of research and development before being released to the public.
- **Business intelligence developer.** Data scientists working as business intelligence developers look for market trends that make data usable for business; these developers often maintain the cloud-based data storage systems.
- **AI research scientist.** Specialists in machine learning, applied mathematics, and computational statistics, AI research scientists are responsible for developing the machine learning solutions for a variety of applications.



## Critical Thinking Exercise

### Automating with Vision Systems

#### ► DECISION MAKING

Elite Manufacturing (fictional) is a midsized textile manufacturing company. The company has been successful over the past forty years in producing high-end sports clothing for sporting goods stores and athletic teams. Part of the success for Elite Manufacturing has been a team that keeps the company up to date with the latest technology.

The executive leadership at Elite has decided to launch a new line of casual wear but wants this part of the manufacturing plant to be automated. The technology team—led by managers Giovanny Miele and Sarah Lunsford—has been tasked with researching the best solutions for this endeavor. Each team member has been given a different area to research and report back to the group.

Your area of responsibility is identifying the vision system and components needed for the production line. This new endeavor will ultimately move Elite from a midsized company to a large company. Your task is to find solutions that will manage the capture of images that have proven to be successful with automation. Your team is counting on you to have a viable solution to work with their area, such as software and infrastructure (cameras), but not the hardware (robots). The executive leadership at Elite is looking at the technology team to lead them into the future with the successful launch of a new manufacturing venture.

#### Review Questions

1. What advantages might be gained from moving to an AI system, such as a vision system, for a production line in place of a person-driven production line?
2. Can you think of any possible disadvantages to this approach?
3. What software platforms, or vendors, would be recommended for this type of environment and why?

#### Critical Thinking Questions

1. What additional questions need to be answered before you can decide if the database as a service approach is right for your firm?
2. How might such a move affect you and your role?

## Machine and Natural Language

**machine learning:** The ability of a computer to learn without having a programmer change the software for every scenario it encounters.

In 1959, Arthur Samuel defined the term **machine learning** as the ability of a computer “to learn without being explicitly programmed.” In other words, it refers to a computer that can learn without having a programmer change the software for every scenario it encounters. Data analysts use machine learning tools to develop predictive analytic models. From each iteration of data, the computer will learn from the past process and look for trends and patterns to produce reliable results.<sup>31</sup> These predictive data models are used by data and business analysts to predict future business operations, called predictive analytics, enabling faster and more accurate decision making. Predictive analytics is not the same as machine learning, but they are linked through predictive modeling.

The terms AI and machine learning are often used interchangeably; however, the terms refer to different functionality. As discussed in the previous section, AI mimics the function of a human brain. Machine learning, on the other hand, involves a computer carrying out tasks based on inputs and a set of instructions. The difference between the two is how the information is processed. In machine learning, the algorithms change as the machine learns about the information it is processing.<sup>32</sup> In AI, the process runs through an artificial neural network to find the proper response. Both types of systems are learning, but the learning process is different.

Machine learning is a subset of AI, and natural language processing is a function of machine learning. We use natural language processing every day without realizing we are training a machine to provide better service to the next user. Several apps (mobile applications) such as speech-to-text on your cell phones, calling customer service with an automated answering system (“Say Yes to continue”), and using Google search are just a few of the many examples of how natural language processing is used to train a computer.

### Machine Learning Training

Machines must go through training to develop a basis for learning. Different types of machine learning are used in different applications depending on the type of data available for the process. Each learning style has the same goal: Learn from the patterns, restructure the data into something useful, and return an analysis of the data to give an answer to a complex problem. Many of these problems are highly complex, requiring speed and accuracy in calculating the answers. Machine learning is still learning, though, and in some industries, such as healthcare, the answers are still a work in progress.

See Table 11.1 for a comparison of four machine learning types, which are discussed in more detail in the sections that follow.

**TABLE 11.1** Machine learning type comparison<sup>33,34</sup>

Supervised Learning	Unsupervised Learning	Reinforced Learning	Semi-Supervised Learning
<ul style="list-style-type: none"> <li>Labeled data set</li> <li>Comparative answers for feedback</li> </ul>	<ul style="list-style-type: none"> <li>Unlabeled data set</li> <li>No comparative answers</li> <li>Must infer answers from hidden functions</li> </ul>	<ul style="list-style-type: none"> <li>Unlabeled data set</li> <li>Trial-and-error learning</li> <li>Interacts with environment to discover errors and rewards</li> <li>Relies on feedback to determine results</li> </ul>	<ul style="list-style-type: none"> <li>Combined data set</li> <li>Improves learning accuracy</li> <li>Requires skilled and relevant resources</li> </ul>

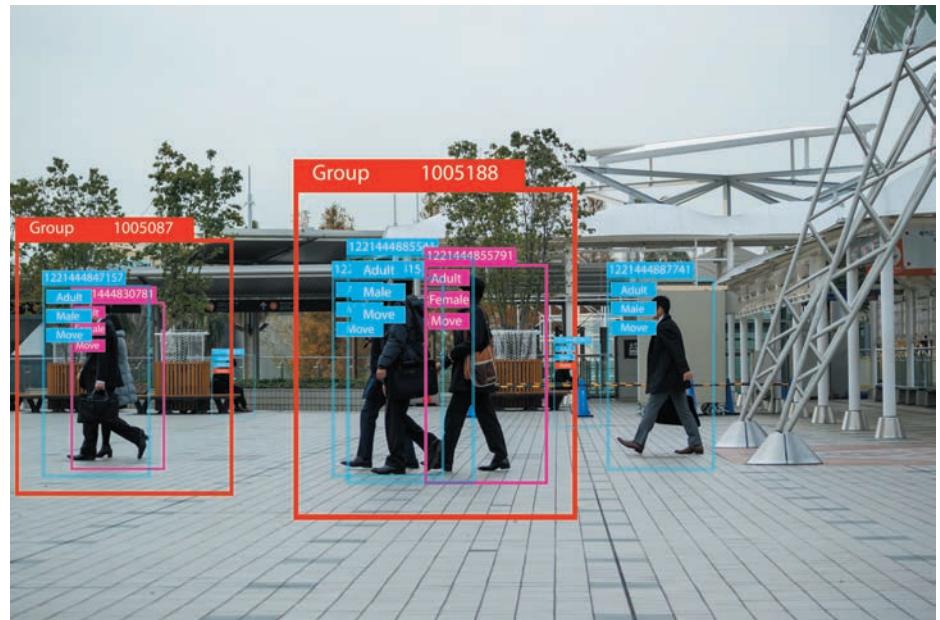
**supervised learning:** Machine learning using a labeled data set and examples to produce output that is compared to a predefined correct output.

### Supervised Learning

**Supervised learning** is like a child learning a new game with rules that must be learned. The child is not expected to remember every rule during the first game. However, as each game is played, the child will remember more rules and will become more proficient until they become the expert player. Machine learning follows this same pattern for much of the learning process.

Supervised training begins with a known set of data in a training environment. The data must be labeled or have a tag applied to it. See Figure 11.9. The data does not have to reside in a structured database, but each piece of data must have some type of name associated with it. For example, a picture of a mountain must have a tag such as “mountain” associated with it. Without this tag or label, the machine cannot associate the correct response when presented with another picture of a mountain or when asked a question requiring the machine to return a picture of a mountain as a response.

**FIGURE 11.9**  
**Labels are applied to data used in supervised learning**  
Labels are applied to each different section of the picture. Each person, group, and movable item are assigned a label to help in the supervised learning process.



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After the data is provided, examples are input into the system, and the machine runs through different scenarios. The output is compared to a pre-defined correct answer. The machine “memorizes” or stores these correct answers, thus learning from each correct test.

### Unsupervised Learning

**unsupervised learning:** Machine learning using an unlabeled data set and no examples. The data is labeled through observations, and learning is through observation.

**Unsupervised learning** is also like a child learning a new game or skill, but with no written directions. Imagine sitting in class and watching a demonstration of a complex math problem being solved. You are not allowed to take any notes, and the instructor works through the problem quickly with no verbal explanations. You are then handed a blank sheet of paper with a series of numbers without any instructions. You do not know what the numbers represent, but you are expected to figure out the answer to a problem. This is much like unsupervised learning.

Unsupervised machine learning requires a training data set. The data in the training set is not labeled, and the machine must learn from observing to infer the correct answer. As each algorithm is processed, the computer restructures the data into something more useful, adding labels or classes that it can use for the next iteration. The computer observes and compares similarity between

objects to assign these classes. For example, if the data set includes two pictures of a mountain, a class of “mountain” may be assigned to both of those images. In the next test, if there is a question concerning a mountain, then these pictures will be retrieved.

With unsupervised learning, tests do not have formal correct answers. The goal of this type of training is for the machine to train itself to learn from the input and be in a mode of continuous improvement. We see this in practice every time we use an online search engine. If we go to our favorite shopping site and enter the search term “oil,” we may see engine oil, cooking oil, essential oils, and bath oils in the search results. If we purchase essential oils, the next time we search that site, essential oil will likely be a recommended search. The machine has learned that our preference in oils is for essential oils and not engine oil.

### **Reinforced Learning**

**reinforced learning:** Machine learning using trial and error on an unlabeled data set. Learning is gained through positive and negative feedback.

**Reinforced learning** begins with the same type of training data set as is used in unsupervised learning. The data is not labeled, and the algorithms must run through multiple iterations to restructure the data into a format that can be used in the next sample. The difference comes in the feedback that is received in reinforced learning. When a solution is returned, either positive or negative feedback is returned from the program, and the machine learns to keep the process as-is or to try again with a new method. The machine also uses input from the environment in the decision-making process.

This trial-and-error method of learning emulates the human approach to learning. A small child learning to walk will take a step, fall down, look for feedback from the parent, and then try again. As we get older, we follow this same pattern in learning in school, in sports, and in play. Do you remember the first time you played your favorite video game? You had to learn each level through trial and error. Each time you failed a level, you learned what not to do, and the next time you advanced further in the game. Each decision you made had a consequence—some good and some bad.

Machine learning using this method may result in multiple errors until the machine learns how to navigate the data for ultimate success. Each failure is recorded, and the machine learns which path not to take in the future. After each successful test, a new scenario is given, and the testing resumes. This is the type of learning used when training autonomous cars. The input from the environment could be from other cars, trees on the side of the road, or even the sun reflecting off another car. All of this input provides valuable information as the machine decides whether to apply the brakes or increase speed.

### **Semi-Supervised Learning**

**semi-supervised learning:** Machine learning using a combination of supervised and unsupervised learning techniques.

**Semi-supervised learning** is a combination of supervised and unsupervised learning. The data set contains both labeled and unlabeled data. The labeled data is a smaller set of data, with the larger set unlabeled. These systems have a greater learning capacity than unsupervised systems.

## **Machine Learning Across Industries**

Machine learning, as a subset of AI, continues to affect many industries. As more functions become automated, companies will need to increasingly rely on machine learning to operate and remain competitive. In our daily lives, we use machine learning every day to navigate everything from our Bluetooth-connected devices to asking for directions to ordering movie tickets.

Each industry has unique technology requirements, and machine learning is developed to work on an industry-specific basis. Business rules must be designed and algorithms developed for each industry before a machine can be trained. In this section, we will look at how machine learning has affected four major industries.

## Data Analytics and Cybersecurity

Data analytics is a growing industry, and more organizations are relying on data models to make strategic plans and make decisions that help them become more profitable and run more efficiently. Strategic planning and forecasting analytical models rely heavily on predictive analytics, and machine learning is an excellent platform for predictive analytics. The algorithms built into the training provide a basis for predictions, and the calculations can be accurately performed at a greater speed than manual.

Cybersecurity is another industry that is advancing through the use of machine learning. Cybersecurity is one of the top risk factors in any organization, and an IT department may spend a large portion of its budget protecting data from hackers. Part of that protection comes in the form of antivirus software. A traditional, non-machine learning, antivirus software definition looks for a signature of known malicious software. Security software that uses machine learning works by finding anomalies in the patterns, or trends, in the data. These anomalies may point to suspicious behavior on the network, which can mean unauthorized entry or virus activity. According to McAfee, hackers are already making use of machine learning in the form of malware. One example is WaterMiner, a cryptocurrency mining malware program. **Cryptocurrency** is a digital currency, such as Bitcoin, used for financial transactions. WaterMiner, a new type of malware distributed through games, which has “learned” to hide from monitoring tools, will disable itself when the Task Manager or an anti-malware scan is launched on the computer on which the program has been downloaded.<sup>35</sup>

One company utilizing machine learning and AI is Palo Alto Networks. Palo Alto uses cloud computing to aggregate customer data and improve cybersecurity. Palo Alto founded the Cyber Threat Alliance, along with Cisco, Intel, Symantec, and Check Point Software Technologies to share information on growing threats and how to defend against them. Palo Alto’s CEO, Nikesh Arora, says “security firms may need to build and share adversary playbooks as threats evolve.”<sup>36,37</sup> These companies are either developing in-house AI applications or merging with smaller AI companies to increase the cybersecurity opportunities. In March 2017, Palo Alto purchased a behavioral analytics firm, Light Cyber, and has recently announced an AI partnership with Mist Systems.

## Insurance

All types of insurance companies gather a tremendous amount of data—about their clients, their competition, and the environment—that is used to set premiums. The automotive insurance industry has turned to machine learning to process this data and improve both business operations and customer satisfaction. Customers want two things from their insurance company—excellent coverage and low prices. For this to happen, companies must be able to ensure that the drivers are meeting safety standards.

Four of the top auto insurance companies are using the same types of applications to lower cost and improve their operations. Chatbots and other similar applications allow customers to get answers quickly or get advice without long wait times over the phone. Allstate’s virtual assistant is called ABIe (pronounced “Abbie”) and processes over 25,000 inquiries a month. Another application is driver performance monitoring. State Farm and Liberty Mutual have launched apps that will help monitor a driver’s safe driving habits—including texting while driving—and give instant feedback in the event of an accident. Drivers can send images of the car to receive quotes on damages to the vehicle. State Farm is using the app for safe driving to calculate discounts for the customer. Progressive Insurance is using predictive analytics algorithms on data gathered from drivers using the Snapshot mobile app or plug-in device. Most drivers receive a discount after six months of safe driving.<sup>38</sup> Each of these

**cryptocurrency:** A digital currency, such as Bitcoin, used for financial transactions.

apps have automated and send the information through an automated process. There is not a human on the other end of the chat window. This is an example of machine learning, in that the machine has learned how to interpret the images sent or the text being sent and return the appropriate response.

Machine learning also helps insurance companies process claims. Using predictive models, created during the machine learning process through multiple iterations of testing, insurers can develop a better understanding of costs, and the automated processes allow for claims to be processed faster. Some claims processing can begin when an accident occurs, as in the case of Liberty Mutual, which allows drivers to send images of vehicle damage and receive a preliminary quote. Other claims can be proactive in their investigations through using **optical character recognition (OCR)**. Tokio Marine, an insurance company headquartered in Japan that has coverage in over thirty countries, has a cloud-based OCR claims notice system that has reduced the document input load by 50 percent and has had an 80 percent reduction in human error. Their claims are now being processed faster and with fewer errors.<sup>39</sup> This system can read the complicated characters of written languages, such as Chinese and Japanese, and translates them into the computer. Although OCR has been around for many years, machine learning has learned how to translate the different languages and dialects into the correct information that allows insurance companies to process claims faster and with fewer errors.

Fraud has been a problem in the insurance industry since its beginning. Auto insurance investigators often find instances of fraud ranging from staged accidents to driving with license tags from a different car or even blaming another driver for an accident. The investigations into these claims takes time and money, and sometimes the claims must be settled in court. The FBI estimates that the cost of insurance fraud, excluding health insurance, exceeds \$40 billion annually. Unfortunately, the cost of this fraud is passed on to all motorists. Insurance companies are increasingly relying on machine learning to improve the accuracy of fraud detection through the use of predictive models. As fraud is not predictable, the data sets are not structured, and the unsupervised learning methodology allows the data to be compared to similar items, allowing for fraudulent behavior to be flagged.<sup>40</sup>

Machine learning has helped the insurance industry lower costs, prosecute fraud, and manage business operations. Customer service has increased, based on the top four insurance companies, and predictive models continue to grow in the insurance industry as machine learning is adopted in more companies.

### **Logistics and Supply Chain Management**

Logistics and supply chain management covers everything from manufacturing to the transportation industry. Goods must be produced and then transported to market. The question is how best to get the supplies to the point of manufacturing and the completed products to the consumers. This has been a logistical problem for every business owner since time began. Predictive analysis, known as forecasting, has been used by manufacturers for many years to predict how much product needs to be produced for the next season. For example, a manufacturer of Christmas ornaments begins receiving orders from retailers in June, with shipments starting in early August. This means ornament production must begin in April to meet the orders. The manufacturer must accurately forecast its production needs so it has the materials on hand and can begin producing the product before the orders even arrive. The production lines are then scheduled based on when the orders are scheduled to ship, and the warehouse is staged for the arrival of the trucks. All of this is accomplished through computer scheduling system.

So how does machine learning work on a much larger scale? The data collected in a global manufacturing company, for instance, is massive. The variables involved include multiple locations, orders coming in via phone and

#### **optical character recognition (OCR)**

**(OCR):** Technology that distinguishes printed or handwritten text in a digital image, such as a scanned document, that is converted into a computer-generated document, such as a PDF.

online, multiple payment methods, and different shipping addresses that must be accounted for—all while keeping customers happy. The computer systems underlying large global operations must run efficiently and provide accurate data. Machine learning allows companies to reduce cost while enhancing responsiveness. The use of computers results in fewer errors, especially in the routine tasks that can be overlooked by humans in a busy high-traffic area. The transportation industry makes use of machine learning and algorithms to schedule the correct number of vehicles for the minimum amount of freight, saving the company shipping costs.<sup>41</sup>

Machine learning involves training computers in the use of visual patterns and environmental recognition. This gives companies the ability to isolate problems during inspection at an earlier point of production and at a faster rate than with traditional methods. The computer can scan supplies before they are placed on the production line, inspect each item as it is produced, and then check each package as it is moved into the shipping process (see Figure 11.10). If an item is damaged, the computer can flag it to be removed. If multiple items in a production line are damaged, the computer can quickly determine if the machine is at fault and suggest corrections. These processes are extending the life of equipment and improving quality management. Production planning and scheduling is becoming more accurate as machine learning helps companies balance the supplier-to-customer load more efficiently. When the suppliers can optimize their delivery schedules, the manufacturers can produce the product faster, and retailers and consumers can receive their goods on time.<sup>42</sup>

**FIGURE 11.10**  
**An industrial robotic arm gripping a blue plastic box container that is put on a conveyor belt for transport to storage in a smart factory warehouse**

The robotic arm moves the shipping containers to the conveyor belt for transport. If the robot detects a problem with the container, it is not placed on the conveyor, but is set aside for manual inspection.



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## Healthcare

AI and machine learning are used in many different ways in the healthcare industry, and the use of technology is continually expanding, with new advances, both in medical research and in operations. Later in the chapter we will discuss the use of robotics in healthcare. In this section, we focus on two applications of machine learning and how they have affected healthcare.

### Electronic Health Records

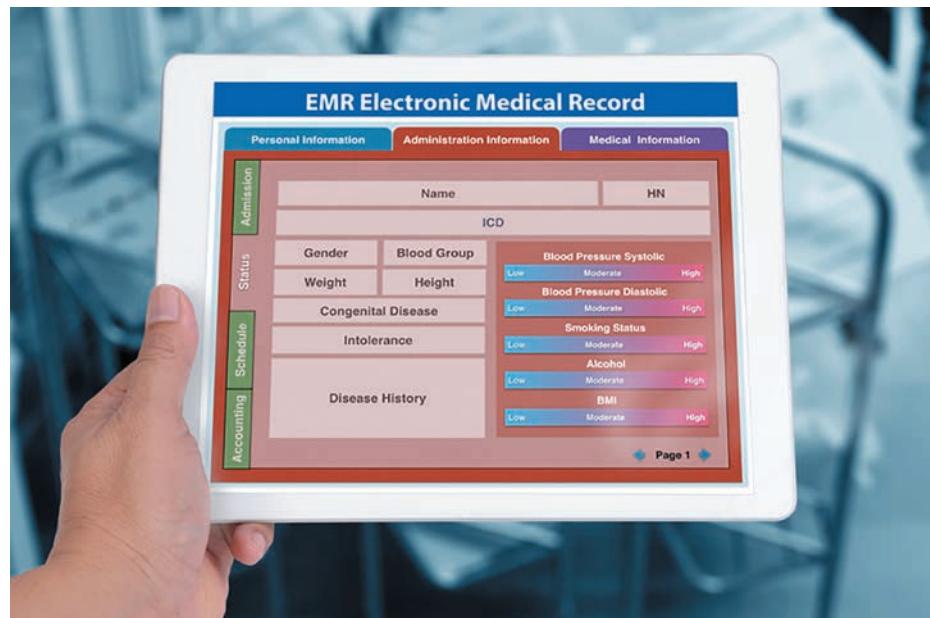
Electronic health record (EHR) systems, which are used in most medical offices in the United States, contain a patient's medical history and can be shared with other medical facilities. Patient portals allow patients to view their records

and send messages to their physicians. After medical providers began moving from paper to electronic records, the amount of data collected and stored grew exponentially. Medical data comes in both structured and unstructured formats. For instance, MRIs, CT scans, and X-rays are now stored digitally and can be transmitted to other facilities through EHR software. Medical offices no longer must print out large scans and send them via courier to your doctor's office for viewing.

The amount of data stored in an EHR allows for data analysts to predict everything from required staffing levels in the emergency department to disease prevention screenings. As discussed in the opening case, machine learning is being used in healthcare diagnostics. As more data is fed into the system, the learning process detects the predictors of disease, including age, family history, environment, weight, along with other factors. Predictive models are then created through the machine learning process. Predictive analytics then uses these models and the algorithms programmed into the computer to review the patient data. When considering disease prevention, one thing that is easily programmed is what tests should be offered for each age level. As you reach milestone ages, for example, age 50, you will begin to receive reminders that preventative tests are due, or suggested, for your age group. You will get these reminders until they are scheduled, or your doctor removes the reminders; see Figure 11.11. More complex predictions involve the use of unstructured data, such as a CT scan, along with the structured data that makes up a patient's medical history. The semi-supervised learning process may be used to prepare the computer to review scans and predict a diagnosis. The data must be reviewed for accuracy, however, as the data (such as family history) in an EHR may be inaccurate or incomplete, impacting the validity of a diagnosis. According to Ziad Obermeyer, assistant professor of emergency medicine at Brigham and Women's Hospital, "another problem is understanding what it is you're getting when you're predicting a disease in an EHR . . . The biggest challenge will be making sure exactly what we're predicting even before we start opening up the black box and looking at how we're predicting it."<sup>43</sup> Patient and family history must be complete and accurate for the machine learning to create the correct prediction; otherwise, the physicians will be working with only partial data.

**FIGURE 11.11**  
**An electronic medical record shown on computer display**

Electronic Medical Record and Electronic Health Record systems are the data collection systems in a medical office. Machine learning uses this data to build the predictive models in helping to predict disease prevention screenings.



### **Healthcare Fraud**

Healthcare fraud comes in many forms. There are some people that try to gain healthcare benefits when they do not qualify. This may come in terms of using a stolen medical identity or claiming benefits after a policy has expired. These types of claims cost the insurance companies and medical practices thousands of dollars each year, and it is the fraudulent activities of healthcare providers that concern insurance and government the most. These cases cost insurance companies, medical facilities, and ultimately consumers millions each year. In 2018, The Department of Health and Human Services Office of Inspector General reported that along with state and federal law enforcement officers, more than 600 defendants in 58 federal districts were charged in fraud schemes totaling approximately \$2 billion dollars in the Medicare and Medicaid system. Along with their investigation into fraud, exclusion notices were issued to 587 doctors, nurses, and providers concerning opioid abuse practices.<sup>44</sup> This task force was sending a clear message that healthcare fraud in a taxpayer system was being taken seriously. See Figure 11.12. In 2019, the Department of Health and Human Services' issued a request for proposals for Intelligent Automation/Artificial Intelligence (IAAI) solution services. These services would use machine learning to look at the data collected and find the data patterns that were not normal to detect fraudulent transactions and help to identify suspects.<sup>45</sup>

**FIGURE 11.12**

#### **Healthcare fraud can cost an individual up to \$250,000 and 10 years in prison if convicted**

Healthcare fraud costs taxpayers approximately \$2 billion a year. Machine learning and AI can help find and prosecute these criminals.



Alexstr/Shutterstock.com

Insurance claims are filed using the same method every time. A physician who is committing fraud for monetary gain will not change the method of filing, as this would draw attention to the claim. These filings may be for procedures or for prescriptions. However, this can also be the way they are caught. A lot of fraudulent claims are for the same procedures, visits, or prescriptions in a short period of time. Most medical practices will electronically transmit prescription to pharmacies. In cases of fraud, a pharmacy may be submitting prescriptions under one person's insurance when they are really for another patient, or the pharmacy may submit and be paid for prescription refills that have not been ordered by the patient. Machine learning is sometimes used to track these patterns to determine when fraudulent billing practices have occurred. One company that employs machine learning is SCAN Health Plan.

When the company began receiving complaints from customers about receiving refills they had not ordered, it used the Alteryx analytics system to monitor the billing data being received from pharmacies in its network. Using the analysis, SCAN was able to identify multiple pharmacies with fraudulent billing practices—saving the company more than \$2 million.<sup>46</sup>

## Natural Language Processing

### natural language processing (NLP)

**(NLP):** The part of machine language that allows computers to understand, analyze, manipulate, and generate natural language for processing.

**Natural language processing (NLP)** is a part of machine learning that allows computers to understand, analyze, manipulate, and generate natural language for processing. This means it translates what it learns into the speaking language of choice when “talking” back to you (press 1 for English, 2 for Spanish, 3 for French, etc.). Many companies provide natural language processing help over the phone to guide a caller to the correct department or person. For example, when a call comes into a bank, department store, or customer service department, the call may be answered by a computer, which offers the caller a menu of options. A caller might be prompted to “say the option or type in the number of the option to continue.” The natural language processing component has been trained to listen for an answer and direct the call to the correct person or department. To accomplish this, the computer must learn to interpret natural language, as people may respond differently to the prompts. One person may say “one,” another may say “number one,” and another may say “option one.” Also, voices, accents, and dialects vary significantly, which can impact the computer’s ability to interpret a response. If the computer cannot correctly interpret the option given, it will direct the caller to try again or will transfer them to an operator. This can sometimes be frustrating for the caller, but in a system that makes use of machine learning, the computer is learning from this process to make it easier for the next caller.

## Search Engines

Natural language processing is widely used in search engines. Each time a search is entered, the engine must interpret what the user is looking for and return the relevant results in a timely manner. If the search engine spent time asking questions to clarify the meaning of the search, the user would likely turn to another software to get answers. One of the challenges is in how computers “listen” and how humans speak. Computers expect to hear a programming language, and humans speak in a variety of ways. Every language may have different dialects, including slang, and the context of the sentence may cause a word to have a different meaning. For example, the sentence, “that’s just great,” may mean a person is very happy with the outcome of a test. However, if they came out of work to find a flat tire on their car, the same sentence could mean extreme disappointment. The computer must learn the context of the sentence to interpret it correctly.

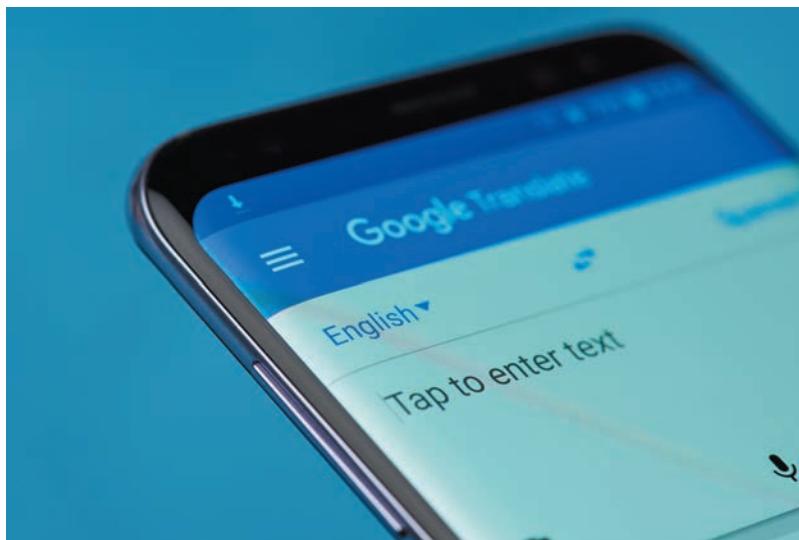
A search engine must look at all the words entered or spoken into the search field to determine which result to display. When searching for “cloud computing,” the program must look at both words to determine that the search is not for the puffy white clouds in the sky, but rather a type of data storage. The more direct the search term, the more relevant the responses will be. Most search engines now also return a list of “also asked questions” to determine if there is another way of asking the same question or to present additional questions that have been asked about the same topic. These algorithms are built into the search engines, but the learning process that builds the algorithms continue to learn as they are used. This is called **deep learning**. Deep learning allows the programs to grow and learn from the many examples provided by the users, either typed or spoken. This is also how a speech-to-text application is trained. Each time you use the speech-to-text app on your smartphone, it learns more about your voice and how you say your words.<sup>47</sup>

**deep learning:** Allows programs to grow and learn from examples provided users, either typed or spoken.

### Translators

Online translators must be trained in more than just word-to-word translations. Grammar rules and punctuation can make a difference on how a sentence is read and how it is interpreted in another language. Figure 11.13 shows the Google translator app that is easy to use. Some translations are more difficult than others. The simple translations are those where the words have a one-to-one match. The harder translations have a different sentence structure. For example, in the sentence, “Look at the red car,” the Spanish translation is “Mira el carro rojo.” Notice that the adjective in the Spanish translation “rojo” (red) comes after the noun “carro” (car), but in the original sentence, the phrase appears as “red car.” The algorithm must translate the entire sentence, not just the word.

**FIGURE 11.13**  
**Google Translate mobile app**  
The Google Translate app allows quick and easy translations on any mobile device.



PixieMe/Shutterstock.com

Translation apps for mobile devices must also be trained for speech recognition. When using an app for business, it is important to know that the translator is accurate, and it has been trained for your voice. If the translation is incorrect, there is a risk of offending someone and losing business. If you are the customer and using a translator to purchase items, you may purchase something you did not want or in quantities that you do not need.

### Brain Computer Interface

AI involves trying to make a computer work like the human brain. The computer needs to accept input, process information, and make a decision based on a set of parameters. The computer must be programmed to make these decisions. To make a computer truly think and act like a human, scientist have spent years studying the human brain. The **brain computer interface (BCI)** is technology that interacts with a human's neural structure (brain) and translates the information (thoughts) into activity (actions). See Figure 11.14. Experiments in BCI have been ongoing for fifty years. The first successful experiment was published in 1977, when a patient was able to move a cursor across a screen using only the brain's electrical signals. Once a successful trial was completed, the door was opened for other areas of research and development in the medical field.<sup>48</sup>

#### brain computer interface

**(BCI):** Technology that interacts with a human's neural structure (brain) and translates the information (thoughts) into activity (actions).

### Medical Research

The medical field is seeing tremendous growth in the use of BCI technology. Researchers have been working on devices such as the cochlear implant, which uses BCI to give the deaf or severely hard-of-hearing patients “the sense of

sound.” The device picks up signals and sends them directly to the brain via the auditory nerve. This is different from normal hearing, and it uses both an external and implanted device to receive and process the sound; see Figure 11.15.<sup>49</sup>

### FIGURE 11.14 Woman wearing a brainwave-scanning headset

To map the brain accurately, a brainwave-scanning headset must be worn during testing. The information is translated into activity.

Shutterstock: 1036798282



Gordontkoff/Shutterstock.com

### FIGURE 11.15 Cochlear implant

The Cochlear Implant picks up signals and converts them into sounds allowing hearing impaired persons to hear.



npudov/Shutterstock.com

BCI is being used in other areas as well, including the development of prosthetic limbs. You are reading this book, either in print, online, or through a reader. Did you stop and think about the steps you used to open or start the book? For a traditional printed book, did you concentrate on moving your arm, then hand, and then fingers to lift the book, open the cover, and turn the page? For an online book, did you think about how you clicked on the book, or selected the reader? How did you select the right spot in the book to start? If you have a prosthetic limb, these are the steps that must be taken for the arm to work. BCI can make these steps possible, and with more advanced technology there comes a higher level of function and control for the patient. Advanced research conducted at Johns Hopkins University has produced a prosthetic limb that can perceive both touch and pain. This research took many hours of mapping, but the result was that the patient could “feel” again through the artificial limb.<sup>50</sup> The research is ongoing, and prosthetics will continue to become more sophisticated as BCI technology advances.

Research is also being done on other types of injuries and diseases. Every day patients arrive in emergency rooms after accidents that have caused spinal cord damage or other trauma resulting in a loss of speech or motor function. BCI can help to restore these functions. Leigh Hochberg, director of the Center of Neurotechnology and Neurorecovery at Massachusetts General Hospital has set a challenging goal for her department: "If I'm in the neurology ICU on a Monday, and I see someone who has suddenly lost the ability to move or to speak, we want to restore that ability to communicate by Tuesday. By using a BCI and AI, we can decode the neural activities associated with the intended movement of one's hand, and we should be able to allow that person to communicate."<sup>51</sup>

### DARPA

The Defense Advanced Research Projects Agency (DARPA) has long been involved with BCI technology. In 2013, President Obama announced the BRAIN (Brain Research through Advancing Innovative Neurotechnologies) Initiative with the goal of uncovering new treatments and cures for brain disorders such as Alzheimer's, epilepsy, and traumatic brain injury. DARPA worked to support this research initiative with several programs. Two of these programs were the RAM (Restoring Active Memory) program and the RAM-Replay program. These two programs were designed to help restore a patient's memory, retrieve existing memories, and facilitate new memories in patients who have sustained a traumatic brain injury or contracted a neurological disease.<sup>52</sup>

DARPA has continued its research into BCI, and in 2015, in an experiment it conducted jointly with the University of Pittsburgh, a paralyzed individual was able to control multiple aircraft in a flight simulator through a surgically implanted microchip. The significance of this study was that the individual was able to receive signals *from* each of the aircraft, thus proving the concept of a bi-directional interface. The operator could sense the environment around each aircraft, understand if the surroundings held potential threats, and react accordingly.<sup>53</sup>

Battelle, an Ohio-based nonprofit focused on applied science and technology development, was awarded a contract in 2019 by DARPA to research and develop a solution for DARPA's Next-Generation Surgical Neurotechnology program (N<sup>3</sup>). N<sup>3</sup> is intended to be a bi-directional BCI that will work with healthy service members as a minimally invasive device. N<sup>3</sup> would allow for multitasking during critical missions. The goal of the program is to create a BCI-based solution that soldiers can use for functions such as communication and control of cyberdefense systems and unmanned ground and air vehicles.<sup>54</sup> Battelle's system, called BrainSTORMS (Brain System to Transmit or Receive Magnetoelectric Signals) is a system that will be temporarily introduced into the body via an injection. The nanotransducer would be placed into a specific area of the brain and would communicate with a receiver in the soldier's helmet. Once the nontransducer is no longer needed, it would be magnetically guided out of the brain to be naturally processed out of the body. The Air Force Research Laboratory will conduct the human demonstration studies before the finalized product is released. This contract is expected to cost DARPA approximately \$20 million over four years.<sup>55</sup>



### Critical Thinking Exercise

#### Intel Profits from AI

#### ► INFORMATION TECHNOLOGY

Intel has incorporated AI, machine learning, and advanced analytics into the many of the organization's key departments, and it is paying off for the company in a big way. In its 2018–2019 IT Annual Performance Report, Intel reported that this strategic move has delivered over \$1 billion in business value. Paula Tolliver, Intel's

vice president and chief information officer, had this to say, “Intel is pushing the boundaries in areas such as AI, 5G, and autonomous vehicles, and Intel’s Information Technology team is a critical partner in this work.” The data has shown a significant saving in hours with the new technology. The time-to-market has decreased by 52 weeks with the implementation of machine learning, and over 930,000 people-hours have been saved per quarter with updated applications and faster deployment of systems.<sup>56</sup> Without the use of AI, the applications could not have been updated and deployed as fast and the time-to-market would not have been decreased. Intel relies on this competitive edge to stay a market leader.

Two areas targeted by Intel were sales and marketing and supply chain management. In sales, Intel piloted its Sales Assist program, which collected more data for analysis. Sales Assist allows customers to put in their orders, both for sales and fitting room orders. This technology is being used in brick-and-mortar stores. This technology enabled the account managers to service the customers more efficiently, with a \$46 million positive impact on sales, as well as gather sales and interest data. Machine learning has helped Intel transform its supply chain management system to optimize parts inventory and delivery systems. Intel has 600 facilities in 63 countries, so the logistics of manufacturing and delivery take complex algorithms and a large amount of data to be accurate. The predictive models allow for more accurate forecasts on where the supplies need to be shipped and the shipments can be staged more efficiently. The implementation of an automated system has increased savings by \$58 million.<sup>57</sup>

### Review Questions

1. Why is supply chain considered a “key area” for Intel in terms of AI and machine learning?
2. Can you think of any possible disadvantages for Intel moving to AI?

### Critical Thinking Questions

1. Intel is not a new technology firm. Why do you think its move to AI has taken so long, and do you think this has helped or hurt the organization?
2. If you were a managing director in the information technology department, what departments would you advise Paula to target next and why?

## Robotics

**robotics:** Technology using a combination of mechanical engineering, computer science, and machine learning to create a device that can perform tasks with a high degree of precision.

**Robotics** is a combination of mechanical engineering, computer science, AI, and machine learning used to create a device that can perform tasks with a high degree of precision. Most of these tasks are deemed tedious or dangerous for humans. The idea of robots is not new; cartoons dating back to the 1960s portrayed robotic housekeepers and pets. However, we are now beginning to see practical applications of robotics in many areas, such as manufacturing, healthcare, gaming, and logistics. Drones are being used to deliver packages, robots are used to vacuum homes, and toy dogs are entertaining children.

Pittsburgh, Pennsylvania, is becoming a center for robotics, as technology firms populate the city’s “Robotics Row.”<sup>58</sup> The need for employees in the field of robotics has continued to grow, and in an effort to help fill that need, Pittsburgh-based Carnegie Mellon University began offering an undergraduate degree in AI through the university’s School of Computer Science in 2018. According to Andrew Moore, dean of the School of Computer Science, “Specialists in artificial intelligence have never been more important, in shorter supply, or in greater demand by employers.” Reid Simmons, the director of the new program whose personal research has focused on mobile robots, says, “By combining the strengths of a number of the departments of the School of Computer Science, we were able to put together a comprehensive curriculum.”

This curriculum will give the students a full education in AI, machine learning, robotics, as well as the ethics to govern their actions.<sup>59</sup>

## Industrial Robots

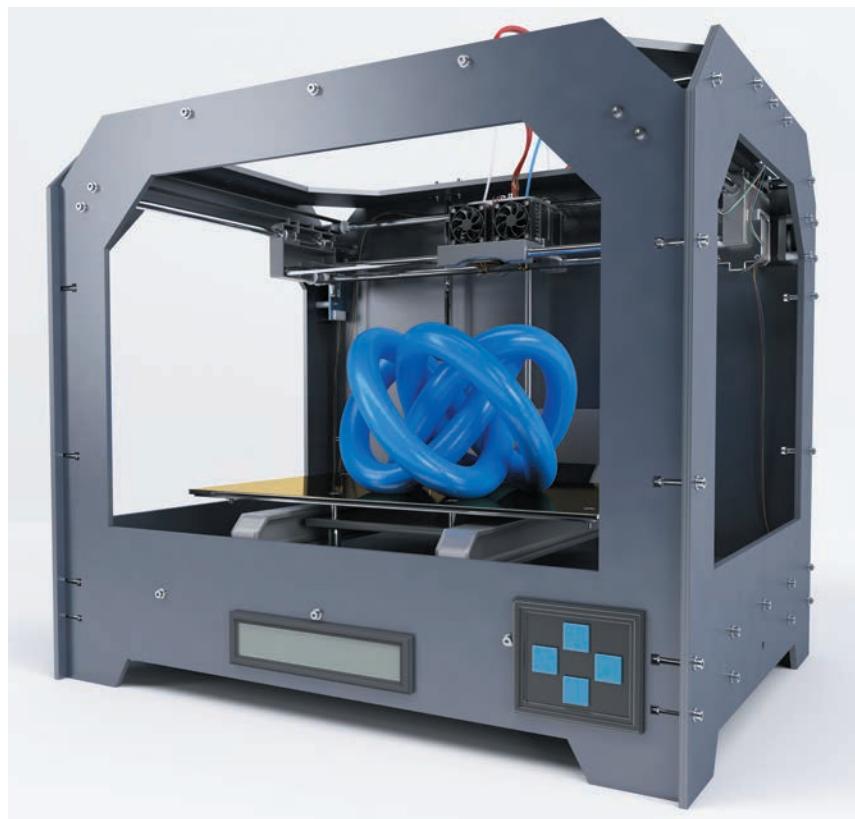
Robots have a different look-and-feel in the industrial world than in healthcare or household products. Industrial robots are designed for speed, accuracy, and safety. The size and look of industrial robots is dependent on the application for which they are designed. Some are large models that work independently, while others are small and designed to work with humans. In the following sections, we discuss three of the most common types of robots used in industrial applications.

### Cartesian Robots

Cartesian robots take up a smaller space, called a footprint, and move in straight lines. One of the most common applications for Cartesian robots is for 3D printing (see Figure 11.16). These robots are easy to program, can be customized for many different projects, and come in different shapes and sizes, based on the needs of the company. 3D printers may be more cube-shaped than other types of robots, based on what they will be printing. Although easy to use, assembly can become very complex based on the level of customization.<sup>60</sup>

**FIGURE 11.16**  
**Cartesian robots can be used for 3D printing**

This 3D printer is a cube-shaped printer capable of printing complex designs.



Kipargeter/Shutterstock.com

## SCARA Robots

Selective Compliance Assembly Robot Arm (SCARA) robots are easier to integrate into complex printing designs than Cartesian robots. SCARA robots have both a lateral movement and a rotary movement, and they can move faster than Cartesian models (see Figure 11.17). SCARA robots are often used in the biomedical field because they are faster and have a wider field of movement.<sup>61</sup>

**FIGURE 11.17**  
**SCARA robots are faster and can have both lateral and rotary movements**

SCARA robots can print faster than a standard 3D printer and are used widely in the healthcare field.



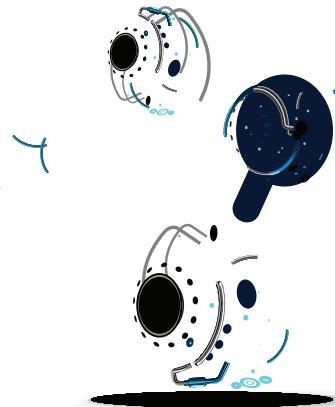
Travelerpix/Shutterstock.com

### Articulated Robot

An articulated robot (see Figure 11.18) is made to function like an arm. These robots may have ten or more rotary joints that can move up and down like an elbow but that can also twist. Articulated robots are frequently used in industrial manufacturing settings, such as on automotive lines, as they can move quickly and with precision. The unique twisting joints allow articulated robots to accomplish tasks that could be hazardous for humans.<sup>62,63</sup>

**FIGURE 11.18**  
**Articulated robotic arms mimic the movement of a human arm**

Articulated robotic arms are used widely on manufacturing production lines because they can function much like a human arm.



Andrey Suslov/Shutterstock.com

### Industry Applications

Robotics, along with AI and machine learning, is being applied in many industries, but the automotive industry was one of the first industries to embrace robotics. At one time, there was fear that robots would take over the auto manufacturing plants and workers would lose their jobs, especially because at the time robots were introduced into the auto industry, they were found very few other industries. In fact, in 2005, over 90 percent of all robots were in the auto industry; see Figure 11.19. However, according to the former CEO of the Center for Automotive Research, Dr. Jay Baron, “Without this automation, our factories would have been obsolete a long time ago. Automation is necessary for safety, quality, and productivity.”<sup>64</sup>

**FIGURE 11.19**

### Robots working on an automotive production line

The articulated robotic arms allow the automotive production line to move quickly with precision movement.



Jenson/Shutterstock.com

The auto industry has made use of collaborative robots (or “cobots”) to work with humans on the manufacturing lines. Cobots handle work that is hard on a person and could cause repetitive injuries. These cobots are programmed to work with humans by knowing the environment and moving out of the way when something is blocking their path. The cobots handle the dangerous work, leaving the work that requires intelligence to the humans. One plant where cobots are used in Detroit builds three models of cars on one assembly line. According to the plant’s general manager, Marty Linn, cobots perform tasks such as stacking tires and using glue that is heated to a very high temperature to apply fabric to the ceiling of the cars. Both of these jobs can cause injuries, and employees hated being assigned these tasks.<sup>65</sup>

Healthcare is another industry that has seen a rapid rise in the use of robots. While it may seem that robotics is new in healthcare, the da Vinci® Surgical System (da Vinci®) has been on the market since 2000. The da Vinci® system allows for minimally invasive surgery by giving the doctors control of instruments via a console. The correct term is robotic-assisted surgery, although some people erroneously believe that the robot is performing the surgery. The physician works behind a console to control the robotic arms (see Figure 11.20). The jointed arms can twist in ways that human arms cannot, giving the surgeon greater flexibility (see Figure 11.21). The console has a 3D high-definition screen, which magnifies the view, so the surgeon often has to make fewer incisions, and the recovery time for the patient is lessened.<sup>66</sup>

Many pharmacies now use robots to prepare medications and IV solutions. According to Cerner, a leading EHR provider, robots working in the pharmacy can receive orders to prepare intravenous medication and deliver them, along with the appropriate syringes, to the patient’s floor to be administered. These same robots can dispense and label medication using barcoded inventory. These robots are not replacing pharmacists, as oversight is still needed and human interaction with patients must be available. However, the robots are making pharmacies more efficient and reducing errors during peak volume times.<sup>67</sup>

## What's Next

What can we expect next in the world of robotics?

One hospital in San Francisco has “delivery robots” that bring lunches to patients and carry specimens to labs. Some of these robots are programmed

**FIGURE 11.20**  
**Surgeon working the controls of the da Vinci® Surgical System**

The da Vinci® Surgical System allows surgeons to use robotic arms to perform precise movements that would be very hard to accomplish by hand.



Sandra Foyt/Shutterstock.com

**FIGURE 11.21**  
**The da Vinci® Surgical System uses instruments controlled by a surgeon at a control panel**

The da Vinci® Surgical System allows for minimally invasive surgery and a reduced recovery time.



MASTERVIDEO/Shutterstock.com

to use the elevators and open doors to maneuver around the building. Other robots are being trained as in-home care givers. Robots that are able to complete tasks such as cleaning, helping someone out of bed or get dressed, or even bringing food could help someone who needs assistance but wants to stay in bed.<sup>68</sup>

Robots are already becoming more commonplace in our everyday lives, and companies are working on new ideas to make our work and home lives easier, with more inventions continually hitting the market. If you go to your favorite online shopping site and search for “robot” you will likely receive information about robotic toys, security robots, and even robotic window cleaners. We are already seeing autonomous cars on the road, and many of us have voice-activated devices that turn on our lights and mobile devices that allow us to ask questions and receive accurate and relevant answers. Ikea is working on a robotic kitchen assistant, and our online purchases may soon be delivered by drones.<sup>69</sup> What could possibly be next?



## Critical Thinking Exercise

### Left Hand Robotics

#### ► INFORMATION TECHNOLOGY

Left Hand Robotics was started in 2016 by Terry Olkin and Mike Ott with the goal of helping business owners and managers, governments, and large property owners more efficiently maintaining their landscape to meet the needs and expectations of their customers, residents, and tenants. Property maintenance is time consuming and, depending on the weather, can be hazardous. In times of high heat or extreme cold, employees working outside can become ill because of the temperature. Left Hand Robotics has designed commercial-class robots that can mow lawns and remove snow for these businesses.<sup>70</sup> These robots can be programmed to just start and go. The programming takes over, and the machines can run autonomously without the need for monitoring. Left Hand has a program to set the path of the mower or snow removal robot. After the robot is set in position and started, it can be monitored via mobile and Web apps, so the operator does not have to be on-site while the machine is running. This allows for multiple robots to be running at one time. Colorado City used the robot in 2019 to clear snow and was pleased with the result. The city staff has also begun using the robot for mowing and estimates an annual savings of over \$800 per acre.<sup>71</sup>

#### Review Questions

1. What advantage, other than monetary, would these types of robots provide to customers? What are some of the disadvantages they might have?
2. To what industries could Left Hand Robotics market the robots?

#### Critical Thinking Questions

1. What could be the impact on employment if city and county agencies utilize more of these types of robots?
2. Left Hand Robotics currently makes mowers and snow removal robots. What other commercial-grade robots would you suggest they design?

## Summary

### Principle:

**Organizations are developing new technology using artificial intelligence and expert systems.**

Artificial intelligence has been in research and development for many years. Scientists have been trying to find ways to make a think and act like a human. The Turing Test has not had a clear winner since 1951.

Artificial intelligence goes beyond running a program and receiving a report. AI is the ability to use that knowledge for intelligent behavior. Since computers were first put into practice, they were able to read from a database and create a report. They must now “think” about the data and quickly solve a problem, understand a visual image, and use heuristics or fill-in-the-blanks when information is missing to come to a conclusion.

Expert systems are the most complex of the AI systems. These systems are designed to handle the most complex problems and the results must be accurate. These systems are used in fast-paced environments where decisions must be made reliably, understandably, and there needs to be a rapid response time. The testing for these systems is extensive, as most of these systems are placed into situations that affect people’s safety. Aviation is one example that uses expert systems to determine a pilot’s ability to fly.

An expert system has many components. Each system must have a knowledge base to pull from. The base stores all the relevant knowledge and must

be kept up-to-date. If this data is not accurate, then any decision made by the system will not be accurate. A development engine builds the rules and processes that run the system. The inference engine seeks out the data from the knowledge base and delivers the decision. This is considered the most important component of the expert system. The explanation of the facility component allows the user to trace the findings of the system. This gives the user a better understanding of the “thought” process of the expert system in the decision making. The knowledge acquisition facility is how the knowledge base is created and updated. Specialized software allows the users and decision makers access to the knowledge base to keep the data current. The user interface allows for the input and output of data. The input could be a typed command, scanned document, or verbal instruction. The output could be a written report, verbal report, or image.

### **Principle:**

**As companies implement more automation, artificial intelligence, and expert systems, organizations must strategically plan for a potential impact on future employment.**

Vision systems allow the computer to store and manipulate visual images. Augmented reality is taking vision systems to another level by allowing the images to be brought into reality without leaving the room. Augmented reality is different from virtual reality in that the image is superimposed over your surroundings. Virtual reality places you into a situation, while augmented reality places an image into your space.

Artificial neural networks are being used to recognize patterns of data in large data sets. Neural networks are programmed to work like the human brain. Each set of test data is run through the many cycles of testing, so the pathway is built to recognize a pattern of data. Any deviation of the pathway must build a new neural net, if the outcome is a desired answer. Data is collected and programmed into the system to create these networked connections. The computers use a supervised method of learning, much like machine learning training. A type of reinforced learning is used, as feedback is given for each cycle. A “weight” is applied, so the algorithm knows which route to take the next time the same situation happens. These two methods of training allow the neural network to work like a human brain.

Since before the Industrial Revolution, there has been a fear that machines, and now computers, will eliminate all jobs and “take over the world.” As history has shown, the more automation has been brought into industries, the more jobs have been created in other areas. Artificial intelligence will have an impact on employment in the future. The question is not *if* or *where*, but *how* it will affect employment. There is responsibility on the organizations to train employees for the future. If a company is moving to more automation, there will be a shift in the types of employees needed. More training can be provided, and employees can transition into different areas of the company. However, the employee is also responsible for their education. In a world of technology, accepting the provided professional development and training from their company, or financial assistance for more education, is the responsibility for the employee. The more AI develops, the skills of the employee will need to develop. These more advanced skills will also demand a higher wage.

### **Principle:**

**Organizations are relying on machines to learn from processes to gain better outcomes.**

In the world of AI, machines must learn new things. Much like humans are trained for a new career, how to play an instrument, or how to drive a car, machines must be taught how to make decisions and perform tasks based on

what is around them. Each decision is made based on a set of parameters and the method of training determines how the machine will react.

Each type of training uses large sets of data. Some of the data is labeled and some is unlabeled. Labeled data has a name, or tag, associated with the items, such as a picture of an elephant will say “elephant.” Unlabeled data will not have a tag, or name, on the item and the computer will have to assign a name based on other information that is available.

Supervised learning uses labeled data and has answers available during training. The machine is put through many different scenarios with a given outcome that can be verified at the end. When a correct outcome is verified, the algorithm is saved, and the next test begins. Each correct algorithm is used to build a master list of outcomes and each test will be more difficult. This method allows for the machine to learn a specific set of scenarios where the variables are known.

Unsupervised learning uses unlabeled data and does not have answers available during training. Many of the answers must come from data that is hidden within functions of the data. The machine observes through input it receives from the users and then applies labels to the data. As the computer receives more input, the data is restructured into a more usable format with labels attached. The computer is training itself into what the user wants and needs to return a correct answer.

Reinforced learning also uses an unlabeled data set for training. This method works on a trial-and-error basis and interacts with the environment to receive more input. The feedback includes an error and reward system. When an error is returned, the result is recorded, and the machine knows to avoid that path in the future. This type of learning is an ongoing process for the machine.

Semi-supervised learning uses both labeled and unlabeled data. A combination of learning techniques is used to train the machine, which improves the learning accuracy of the machine during the training. This type of learning requires skilled resources and relevant scenarios. The learning capacity of machines is greater using this method, as the machine is learning to restructure the data into a usable format and is receiving feedback on the decisions it is making.

### Principle:

**Robots are becoming more interactive in business, with new applications being introduced at a rapid pace.**

The field of robotics is more than just a new way of programming. Robotics combines mechanical engineering, computer science, and AI to create a robot that will operate the complex algorithms needed to perform. A machine learning method will be selected based on the application the robot will perform.

Robots are being used in many different industries, and more applications are being developed. We are seeing more uses each year in medicine, manufacturing, and logistics. Robots are being used for surgery, auto assembly, package delivery, and in education. The Cartesian, SCARA and Articulated robots are used in the industrial industry. Each of these robots have a unique appearance and are built for a specific type of performance. The da Vinci® surgical robot is built for minimally invasive surgeries. Although each of these robots have been in use for years, each of them is continually being improved for additional use. Research and development continue for these industries, and many others, to make organizations more efficient.

Robots have been in science fiction movies for over fifty years. Now, they are becoming employees in our companies, and we are relying on them in our daily lives.

## Key Terms

- |                                      |                                     |
|--------------------------------------|-------------------------------------|
| artificial intelligence (AI)         | intelligent behavior                |
| artificial intelligence (AI) systems | knowledge acquisition facility      |
| artificial neural network            | knowledge base                      |
| augmented reality (AR)               | knowledge engineer                  |
| backward chaining                    | knowledge user                      |
| brain computer interface             | machine learning                    |
| cryptocurrency                       | natural language processing (NLP)   |
| deep learning                        | optical character recognition (OCR) |
| development engine                   | perceptive system                   |
| domain expert                        | reinforced learning                 |
| explanation facility                 | robotics                            |
| expert systems                       | rule                                |
| forward chaining                     | semi-supervised learning            |
| genetic algorithms                   | supervised learning                 |
| heuristics                           | unsupervised learning               |
| IF-THEN statements                   | upskill                             |
| inference engine                     | vision systems                      |
| intelligent agent                    |                                     |

## Self-Assessment Test

**Organizations are developing new technology using artificial intelligence and expert systems.**

1. The people, procedures, hardware, software, data, and knowledge needed to develop computer systems and machines that can simulate human intelligence process include \_\_\_\_\_, \_\_\_\_\_, and \_\_\_\_\_.
2. A trial-and-error method of problem solving used when an algorithmic or mathematical approach is called \_\_\_\_\_.
3. Characteristics of expert systems include all of the following except
  - a. Highly effective
  - b. Understandable
  - c. Reproducible
  - d. Capable of critical decision making

**As companies become more automated through the use of artificial intelligence and expert systems, organizations must strategically plan for a potential impact on future employment.**

4. An artificial neural network does all of the following except
  - a. Looks for patterns in large data sets
  - b. Reacts to emotional stimulation

- c. Uses feedback in training
- d. Processes multiple attempts looking for the correct answer
5. What type of computer system can recognize and act on patterns or trends that it detects in large sets of data and is developed to operate like the human brain?
6. The ability to learn without being programmed is known as \_\_\_\_\_.

**Organizations are relying on machines to learn from processes to gain better outcomes.**

7. Machine learning and AI are the same thing. True or False.
8. Which of these is not a type of training for machine learning?
  - a. Semi-supervised learning
  - b. Reinforced learning
  - c. Supervised learning
  - d. Unsupported learning
9. Natural language processing may be found in which of these activities?
  - a. Typing a research paper
  - b. Calling technical support
  - c. Using a microwave
  - d. Taking an elevator

**Robots are becoming more interactive in business, with new applications being introduced at a rapid pace.**

10. Which of these is not a type of industrial robot?
  - a. Cartesian
  - b. SCARA

- c. SCUBA
- d. Articulated
11. \_\_\_\_\_ handle work that is hard on a person and could cause repetitive injuries.
12. An \_\_\_\_\_ functions like an arm, with rotary joints that can move up and down and also twist.

## Self-Assessment Test Answers

1. Learning, reasoning, self-correction
2. a
3. c
4. b
5. artificial neural network
6. machine learning
7. False
8. d
9. c
10. c
11. Cobots
12. articulated robot

## Review and Discussion Questions

1. What is the difference between artificial intelligence and machine learning?
2. List five characteristics of intelligent behavior.
3. List and briefly define the key components of an expert system.
4. An engine that builds the set of rules and processes used by an AI system best describes what?
5. Part of the expert system that seeks information and relationships from the knowledge base and provides answers, predictions, suggestions, often taking the place of a human expert best describes what?
6. A computer system that can recognize and act on patterns or trends best describes what?
7. Which type of learning uses trial and error where learning is gained through positive and negative feedback?
8. Define the term development engine.
9. A computer system that can recognize and act on patterns or trends that it detects in large sets of data, developed to operate like the human brain best describes what?
10. The technology that interacts with a human's neural structure and translates the information into activity is known as what?
11. Describe how AI, if managed effectively and efficiently, can lead to higher rather than lower employment.
12. Describe the differences between AI and machine learning.
13. Discuss the five characteristics of an expert system.
14. Why are inference engines considered one of the most important components of an expert system?
15. Explain how augmented reality is being used in the medical field.
16. Explain why systems trained using the semi-supervised machine learning method have the greatest learning capacity compared to the other three training methods.
17. Describe three industrial robots that are described in the chapter. Give an example of where the robots could be used in industry.
18. How are cobots being used in industry?
19. Discuss how robots are affecting employment.
20. What are some of the research ideas in production for robotics? What could be the future for robots?

## Business-Driven Decision-Making Exercises

1. You are working for a logistics company that is expanding. Since opening the company in 2005, the company has been a packaging and shipping company for a tri-state region and is now

expanding into a national company. The company has purchased a logistics firm in another state to broaden its customer base and increase its warehouse capacity. As an IT director, you have

- been asked to lead a project team to automate the supply chain and logistics systems. Which system would you tackle first, or would you opt to automate both systems at the same time? Using an Excel spreadsheet or a Word document, detail what types of automation you think would work best for this size company. What types of robots are available, and are they sustainable for your company?
2. You are the IT project manager for a local hospital that purchased a robotic surgical

assistance device last year. The surgical schedule has increased in volume, meaning more patients are moving through the surgical floor and occupying hospital rooms. The hospital is now looking for additional help and has asked for your team's help. Are there additional surgical robotic devices available? What other robotic devices would be available for the hospital? How could these devices help and what impact could they have on the patients?

## Teamwork and Collaboration Activities

1. You work for a local automotive manufacturing plant in the IT department. The company has four plants, with yours being the headquarters. Your team of five IT professionals has been tasked to design the new automotive manufacturing production line. Research the best robotic technologies available and how they would work for your organization. Each member of the group should take one of each of these tasks: Draw the manufacturing floor plan and place the robots and human employees in place, showing how they will work together. Describe the work environment—will the robots and humans interact, will they work autonomously, and so on. Research the robotics needed, if any, and approximate costs. If cameras are to be used, what is the optimal placement?
2. Your team is working with the government designing a new technology for a BCI. What type of technology would be helpful for police officers in a crisis such as a hostage situation, a terrorist act, or a high-speed chase? Separate into groups of three. Research what devices are in use today and how they can be improved. Using this research, draw the groups' new device design and give an example of how it would work. Develop a chart that shows what options the current devices have and what new options your device has.

## Career Exercises

1. Using what you have learned from this chapter, research what education and skills are needed for career opportunities in AI, machine learning, and robotics. Find colleges and universities that offer these types of degrees. Document your findings in a Word document or Excel spreadsheet.
2. Research the types of programming languages most frequently used in machine learning and expert systems. How much education and experience are needed to program in these languages? Where are most of these jobs located? How can you get a start with these companies?

## Case Study

### ► DECISION MAKING

#### DHL Uses Artificial Intelligence to Transform Logistics Operations

DHL was founded in 1969 by Adrian Dalsey, Larry Hillblom, and Robert Lynn. In the competitive world of logistics, DHL is one of the world leaders, with a presence in over 220 countries and over 380,000 employees—which doesn't even include the robots that work for the company. DHL is also a leader in using AI, machine learning, and robotics to enhance its business and satisfy customers.

DHL has been proactive in its approach to technology. Matthias Heutger, senior vice president and global head of innovation explains, "As the technological progress in the field of AI is proceeding at a great pace, we see it as our duty to explore, together with our customers and employees, how AI will shape the logistics industry's future."

DHL's Resilience360 Supply Watch software uses both machine learning and natural language processing to look for anomalies in the supply chain process. According to the

company, the software scans for “140 different risk categories including financial, environmental, and social factors among risk resulting from crime, labor breeches, quality defects, and supply chain perils such as shortages, capacity constraints, and delays.” This software allows DHL to be proactive rather than reactive to issues—informing customers of issues before the customer becomes aware through other means. This level of customer service helps foster loyalty with DHL’s customers.

Air freight is a large part of DHL’s service. With locations in over 220 countries, DHL ships merchandise all over the world. As anyone who has ever been to an airport knows, flights are not always on time. There are many factors that affect schedules—weather, maintenance, crew delays, and factors outside normal operations. Because of this, DHL has developed a machine learning tool to predict air freight transit time based on 58 different parameters. The model allows the company to determine, up to a week in advance, if a shipment will, or even should, fly. Most of these shipments are international shipments.

DHL delivers over 1.5 billion packages every year. The use of robotics is allowing customers to track their packages using voice-activated devices, such as Amazon Alexa. These devices allow the customer to ask for an update on the status and be connected to customer service if there is a delay. Robots are also being used to automate the more repetitive tasks and those tasks that can cause injuries. Using machine learning training, the robots can then stage the shipments for the optimal loading/unloading sequence.

When making the move to AI and automation, DHL, working with IBM, recommends companies use the following four techniques to ensure a successful implementation: (1) design thinking to reveal any unmet needs, (2) traditional IT management techniques to scope the resources needed, (3) AI-specific methodologies for knowledge and training, and (4) agile methodologies for continuous development and improvement.

## Critical Thinking Questions

1. DHL is being proactive in notifying customers of problems. Why would this create customer loyalty? Would it not be better to fix the problem and not notify the customer? What would you tell the customer in the event of a problem?
2. Autonomous vehicles and trucks are being tested for use in commercial applications. If DHL uses an autonomous vehicle for local deliveries, what else will they need to be successful? How can they ensure that the packages are received, and how will the packages get from the vehicle to the person?
3. DHL works with home voice-activation devices for package tracking. What other features could work with these devices that would make logistics and shipping easier for the customer and enhance loyalty to DHL?

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# PART 4

# Planning, Implementing, and Managing Information Systems



**Chapter 12**  
**Strategic Planning and**  
**Project Management**

**Chapter 13**  
**System Acquisition and**  
**Development**



## Principles

- Organizations that are more advanced in their planning processes develop multiple-year strategic plans.
- Organizations must always make a clear connection among business objectives, goals, and projects. In addition, projects must be consistent with business strategies.
- The organizational appetite for innovation drives the changes within the firm's selected projects and processes.

## Learning Objectives

- Describe the four phases of a goals-based strategic planning process.
- Discuss how the seven layers of the strategic planning pyramid can improve the planning process.
- Outline a process for prioritizing IS projects and initiatives.
- Discuss why project management is considered to be a core competency for many organizations.
- Identify the five highly interrelated parameters that define a project.
- Briefly discuss the 10 knowledge areas associated with the science of project management.
- Identify the primary difference between business process reengineering and continuous improvement.
- Identify the appropriate strategy to employ with each of five categories of innovation adopters.

# IS in Action

## E-Trade's Strategic Projects

### ► SYSTEMS AND PROCESSES

The online brokerage firm E-Trade was born as online platforms such as AOL and CompuServe were beginning to gain traction in the early 1980s. Founders William Porter and Bernard Newcomb were looking to transform an industry based on paper and in-person trading, by making online trading available to individual investors. Today, E-Trade is a powerhouse in the trading industry. The company, which manages \$414 billion in customer assets, earned a net revenue of \$2.87 billion in 2018.

Successful companies such as E-Trade know why they are in business. This “why” is the company’s mission, or reason for being. E-Trade’s stated mission is “To enhance the financial independence of traders and investors through a powerful digital offering and professional guidance.” E-Trade understands that its goals and objectives must align with its corporate mission statement if it is going to stay relevant and maintain its market share, so the company has outlined a corporate strategy that focuses on two key objectives: (1) accelerating the growth of its core brokerage business to improve market share and (2) generating robust earnings growth and healthy returns on capital to deliver long-term value to its stockholders. E-Trade has broken down its first objective into several different goals, including growing its brokerage business by focusing on its corporate services channel, through which the company administers corporate stock plans.

The next step for E-Trade was to identify the projects it would launch in support of its stated goals and objectives. Those projects included a new “digital dashboard,” rolled out in September 2018, designed to aid stock plan participants who were interested in incorporating their plan benefits into a specific investment strategy. The dashboard, or planning center, includes multiple tools for users to find out about upcoming events related to their stock plan, research potential tax implications and benefits, learn how to use their investment proceeds to meet their financial goals, and review other educational content specific for their specific stock plan. The mission of E-Trade is to make the traders more independent (“...to enhance the financial independence of traders and investors...”) and the corporate strategy is to ensure that their customers “generat(e) robust earnings growth and healthy returns on capital to deliver long-term value to its stockholders.” The proposed digital dashboard will aid investors in growing their portfolios independently.

### As you read this chapter, consider the following:

- What is an effective strategic planning process, who needs to participate in it, and what are the deliverables of such a process?
- What is project management, and what are the key elements of an effective project management process?
- How is innovation linked to business process reengineering and continuous improvement?

## Why Learn About Strategic Planning and Project Management?

Ever since the dawn of the computer age, business and IS executives have been working to improve the alignment between business and IS as a top business priority. In this context, alignment means that the IS organization and its resources are focused on efforts that support the key objectives defined in the strategic plan of the business. This implies that IS and business managers have a shared vision of where the organization is headed and agree on its key strategies. This shared vision will guide the IS organization in hiring the right people with the correct skills and competencies, choosing the right technologies and vendors to explore and develop, installing the right systems, and focusing on projects that will best help the organization meet its mission. Projects are the way that much of an organization's work gets done. No matter what the industry and no matter whether the organization is a for-profit company or a nonprofit organization—large or small, multinational or local—good strategic planning coupled with good project management is a positive force that enables an organization to get results from its efforts. Knowing the basics of strategic planning and project management will make you an extremely valuable resource within any organization.

This chapter defines strategic planning and outlines an effective process for accomplishing this critical activity. It also clarifies the importance of project management and outlines a proven process for successful project management. Additionally, this chapter looks at the effects of innovation on strategies, projects, and organizational processes. Today's organizations need people who can develop strategic plans and use technology to realize corporate benefits.

### Strategic Planning

**strategic planning:** A process that helps managers identify desired outcomes and formulate feasible plans to achieve their objectives by using available resources and capabilities.

**Strategic planning** is a process that helps managers identify desired outcomes and formulate feasible plans to achieve their objectives by using available resources and capabilities. The strategic plan must take into account that the organization and everything around it is changing: consumers' likes and dislikes change; old competitors leave and new ones enter the marketplace; the costs and availability of raw materials and labor fluctuate, as does the fundamental economic environment (interest rates, growth in gross domestic product, inflation rates); and there is a degree of industry and government regulation change.

The following is a set of frequently cited benefits of strategic planning:

- Provides a framework and a clearly defined direction to guide decision making at all levels throughout the organization
- Ensures the most effective use is made of the organization's resources by focusing those resources on agreed-upon key priorities
- Enables the organization to be proactive and take advantage of opportunities and trends, rather than passively reacting to them
- Enables all organizational units to participate and work together toward accomplishing a common set of goals
- Provides a set of measures for judging organizational and personnel performance
- Improves communication among management and the board of directors, shareholders, and other interested parties

In some organizations with immature planning processes, strategic planning is an annual process timed to yield results used to prepare the annual expense budget and capital forecast. The process is focused inward, concentrating on the individual needs of various departments. Organizations that are more advanced in their planning processes develop multiple-year plans based on a situational analysis, competitive assessments, consideration of factors external to the organization, and an evaluation of strategic options.

The CEO of an organization must make long-term decisions about where the organization is headed and how it will operate and has ultimate responsibility for strategic planning. Subordinates, lower-level managers, and consultants typically gather useful information, perform much of the underlying analysis, and provide valuable input. But the CEO must thoroughly understand the analysis and be heavily involved in setting high-level business objectives and defining strategies. The CEO must also be seen as a champion and supporter of the chosen strategies; otherwise, the rest of the organization is unlikely to “buy into” those strategies and take the necessary actions to make it all happen.

#### **issues-based strategic planning:**

A strategic planning process that begins by identifying and analyzing key issues facing the organization, setting strategies to address those issues, and identifying projects and initiatives that are consistent with those strategies.

#### **organic strategic planning:**

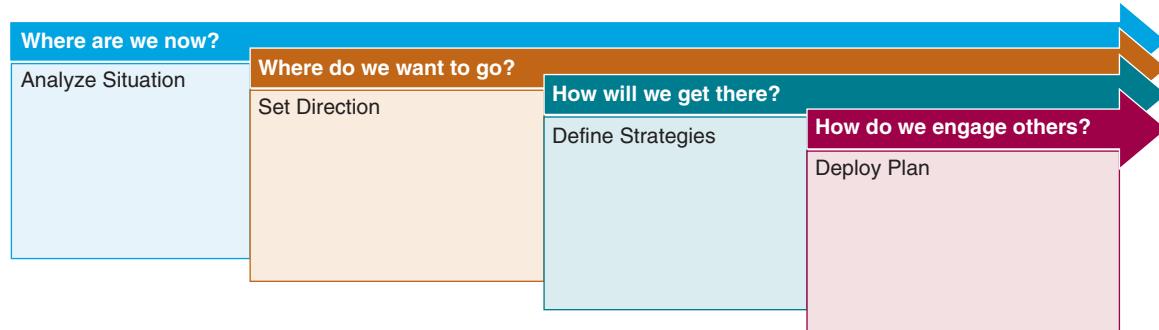
A strategic planning process that defines the organization's vision and values and then identifies projects and initiatives to achieve the vision while adhering to the values.

#### **goals-based strategic planning:**

A multiphase strategic planning process that involves analyzing an organization and its environment, defining strategies, and executing initiatives to help an organization meet its long-term goals and objectives.

There are a variety of strategic planning approaches, including issues-based, organic, and goals-based. **Issues-based strategic planning** begins by identifying and analyzing key issues facing the organization, setting strategies to address those issues, and identifying projects and initiatives that are consistent with those strategies. **Organic strategic planning** defines the organization's vision and values and then identifies projects and initiatives to achieve the vision while adhering to the values.

**Goals-based strategic planning** is a multiphase strategic planning process that involves analyzing an organization and its environment, defining strategies, and executing initiatives to help an organization meet its long-term goals and objectives. Goals-based strategic planning begins by performing a situation analysis to identify an organization's strengths, weaknesses, opportunities, and threats. Next, management sets the direction for the organization by defining its mission, vision, values, objectives, and goals. The results of the analysis and direction-setting phases are used to define strategies to enable the organization to fulfill its mission. Initiatives, programs, and projects are then identified and executed to enable the organization to meet the objectives and goals. These ongoing efforts are evaluated to ensure that they remain on track toward achieving the goals of the organization. The major phases in goals-based strategic planning are (1) analyze situation, (2) set direction, (3) define strategies, and (4) deploy plan (see Figure 12.1).



**FIGURE 12.1**

#### **The goals-based strategic planning process**

The overlapping phases of goals-based strategic planning ensure that all company initiatives, programs, and projects tie back to specific organizational goals.

### **Analyze Situation**

All levels and business units of an organization must be involved in assessing its strengths and weaknesses. Preparing a historical perspective that summarizes the company's development is an excellent way to begin this strategic planning step. Next, a multitude of data is gathered about internal processes and operations, including survey data from customers and suppliers and other objective assessments of the organization. The collected data is analyzed to identify and assess how well the firm is meeting current objectives and goals, and how well its current strategies are working. This process identifies many of the strengths and weaknesses of the firm.

Strategic planning requires careful study of the external environment surrounding the organization and assessing where the organization fits within it. This analysis begins with an examination of the industry in which the organization competes: What is the size of the market? How fast is it growing or shrinking? What are the significant industry trends?

Next, the organization must collect and analyze facts about its key customers, competitors, and suppliers. The goal is two-fold: capture a clear picture of the strategically important issues that the organization must address in the future and reveal the firm's competitive position against its rivals. During this step, the organization must get input from customers, suppliers, and industry experts—all of whom will likely be able to provide more objective viewpoints than employees. Members of the organization should be prepared to hear things they do not like, but that may offer tremendous opportunities for improvement. It is critical that unmet customer needs are identified to form the basis for future growth.

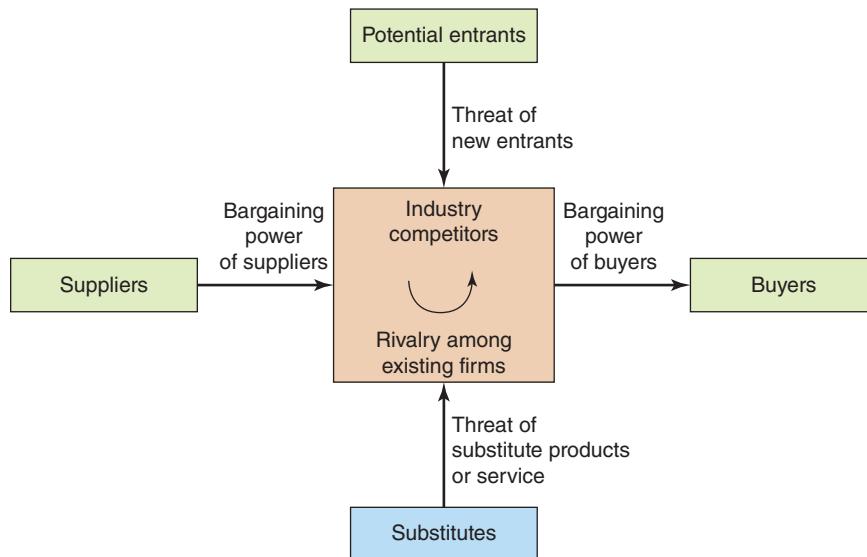
The most frequently used model for assessing the nature of industry competition is **Michael Porter's Five Forces Model**, which identifies the bargaining power of suppliers and buyers, the threat of new entrants and substitute products, and the existing industry competitors, which determine the level of competition and long-term profitability of an industry (see Figure 12.2).

### Michael Porter's Five Forces Model

**Model:** A model that identifies the bargaining power of suppliers and buyers, the threat of new entrants and substitute products, and the existing industry competitors, which determine the level of competition and long-term profitability of an industry.

**FIGURE 12.2**  
**Michael Porter's Five Forces Model**

This model can be used to determine the level of competition and long-term profitability of an industry.



The fundamental factors that determine the level of competition and long-term profitability of an industry are the following:

1. The threat of new competitors will raise the level of competition. Entry barriers determine the relative threat of new competitors. These barriers include the capital required to enter the industry and the cost to customers to switch to a competitor.
2. The threat of substitute products can lower the profitability of industry competitors. The willingness of buyers to switch products and the relative cost and performance of substitutes are key factors in this threat.
3. The bargaining power of buyers determines prices and long-term profitability. This bargaining power is stronger when there are relatively few buyers but many sellers in the industry or when the products offered are all essentially the same.
4. The bargaining power of suppliers can significantly affect the industry's profitability. Suppliers have strong bargaining power in industries that have many buyers and only a few dominant suppliers and in industries that do not represent a key customer group for suppliers.
5. The degree of rivalry between competitors is high in industries with many equally sized competitors or little differentiation between products.

Many organizations also perform a competitive financial analysis to determine how their revenue, costs, profits, cash flow, and other key financial parameters match up against those of their competitors. Most of the information needed to prepare such comparisons is readily available from competitors' annual reports.

**Strengths, Weaknesses, Opportunities, Threats (SWOT) matrix:** A simple way to illustrate what a company is doing well, where it can improve, what opportunities are available, and what environmental factors threaten the future of the organization.

The analysis of an organization's internal assessment and study of its external environment is summarized into a **Strengths, Weaknesses, Opportunities, Threats (SWOT) matrix**, as shown in Table 12.1, which provides a SWOT matrix for Starbucks.<sup>1</sup> The SWOT matrix is a simple way to illustrate what the company is doing well, where it can improve, what opportunities are available, and what environmental factors threaten the future of the organization. Typically, the internal assessment identifies most of the strengths and weaknesses, while the analysis of the external environment uncovers most of the opportunities and threats. The technique assumes that an effective strategy derives from maximizing a firm's strengths and opportunities and minimizing its weaknesses and threats.

**TABLE 12.1** SWOT analysis for Starbucks<sup>2</sup>

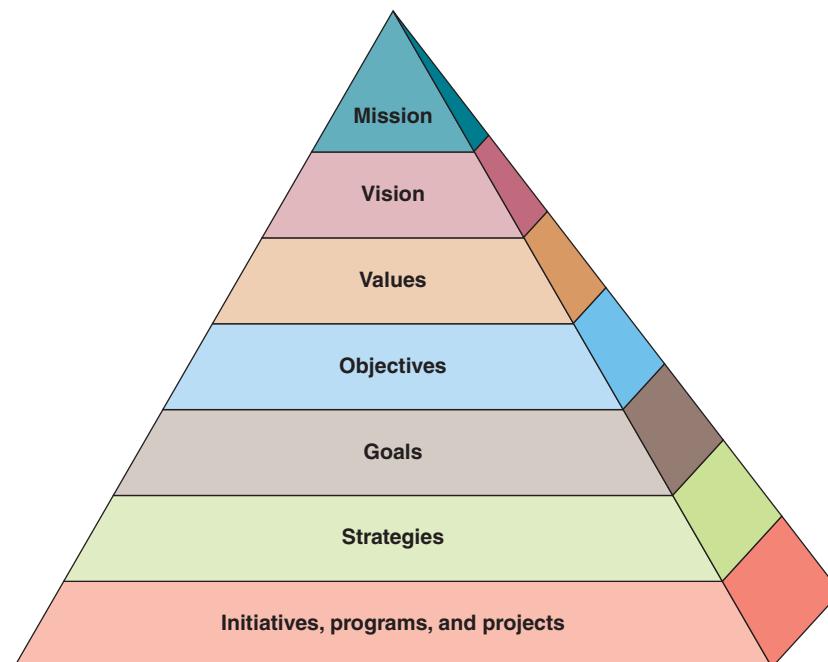
Strengths	Weaknesses
<ul style="list-style-type: none"> <li>Strong revenue and profit growth</li> <li>Strong global supply chain</li> <li>Well-known brand</li> </ul>	<ul style="list-style-type: none"> <li>Known for relatively expensive coffee</li> <li>Coffee is easy to imitate</li> </ul>
Opportunities	Threats
<ul style="list-style-type: none"> <li>Developing markets ready for expansion</li> <li>Partnerships with other companies</li> </ul>	<ul style="list-style-type: none"> <li>Independent coffeehouses gaining momentum</li> <li>Rising competition (e.g., Dunkin' and Tim Hortons)</li> </ul>

## Set Direction

The direction-setting phase of strategic planning involves defining the mission, vision, values, objectives, and goals of the organization. Determining these will enable the organization to identify the proper strategies, initiatives, programs, and projects, as shown in Figure 12.3.

**FIGURE 12.3**  
**The strategic planning pyramid**

The strategic planning pyramid is a top-down approach to identify initiatives, programs, and projects that are well-suited for the organization.



## Vision, Mission, and Core Values

**vision/mission statement:**

A statement that communicates an organization's overarching aspirations to guide it through changing objectives, goals, and strategies.

**mission statement:** A statement that concisely defines an organization's fundamental purpose for existing.

**vision:** A concise statement of what an organization intends to achieve in the future.

**core value:** A widely accepted principle that guides how people behave and make decisions in the organization.

Senior management must create a **vision/mission statement** that communicates an organization's overarching aspirations to guide it through changing objectives, goals, and strategies. The organization's vision/mission statement forms a foundation for making decisions and taking action. The most effective vision/mission statements inspire and require employees to stretch to reach the organization's goals. These statements seldom change once they are formulated. An effective statement consists of three components: a mission statement, a vision of a desirable future, and a set of core values.

The **mission statement** concisely defines the organization's fundamental purpose for existing. It usually is stated in a challenging manner to inspire employees, customers, and shareholders.

The organization's **vision** is a concise statement of what the organization intends to achieve in the future. The following are the earmarks of a good vision:

- It motivates and inspires.
- It is easy to communicate, simple to understand, and memorable.
- It is challenging and yet achievable and moves the organization toward greatness.

A **core value** is a widely accepted principle that guides how people behave and make decisions in the organization.

Table 12.2 provides the mission, vision, and values of Google.<sup>3</sup>

**TABLE 12.2** Google's mission, vision, and values

Mission
To organize the world's information and make it universally accessible and useful
Vision
To provide access to the world's information in one click
Values
1) Focus on the user and all else will follow. 2) It's best to do one thing really, really well. 3) Fast is better than slow. 4) Democracy on the Web works. 5) You don't need to be at your desk to need an answer. 6) You can make money without doing evil. 7) There's always more information out there. 8) The need for information crosses all borders. 9) You can be serious without a suit. 10) Great just isn't good enough.

## Objectives

**objective:** A statement of a compelling business need that an organization must meet to achieve its vision and mission.

The terms *objective* and *goal* are frequently used interchangeably. For this discussion, we distinguish between the two—defining **objective** as a statement of a compelling business need that an organization must meet to achieve its vision and mission.

Each week, Walmart serves close to 275 million customers<sup>4</sup> in its stores and through its websites globally. Recent annual revenue for the company exceeded \$500 billion.<sup>5</sup> The organization has defined its mission, vision, values, and objectives, as shown in Table 12.3.

**TABLE 12.3** Walmart's mission, vision, values<sup>6,7</sup>

<b>Mission:</b> We save people money so they can live better.
<b>Vision:</b> Be THE destination for customers to save money, no matter how they want to shop.
<b>Core Values:</b>
<ul style="list-style-type: none"> <li>• <b>Service to the Customer</b> <ul style="list-style-type: none"> <li>• <b>Customer first:</b> Listen to, anticipate, and serve customer wants and needs.</li> <li>• <b>Frontline focused:</b> Support and empower associates to serve customers every day.</li> </ul> </li> <li>• <b>Respect for the Individual</b> <ul style="list-style-type: none"> <li>• <b>Listen:</b> Be visible and available, collaborate with others, and be open to feedback.</li> <li>• <b>Lead by example:</b> Be humble, teach, and trust others to do their jobs; give honest and direct feedback.</li> <li>• <b>Inclusive:</b> Seek and embrace differences in people, ideas, and experiences.</li> </ul> </li> <li>• <b>Strive for Excellence</b> <ul style="list-style-type: none"> <li>• <b>High performance:</b> Set and achieve aggressive goals.</li> <li>• <b>Accountable:</b> Take ownership, celebrate successes, and be responsible for results.</li> <li>• <b>Strategic:</b> Make clear choices, anticipate changing conditions, and plan for the future.</li> </ul> </li> <li>• <b>Act with Integrity</b> <ul style="list-style-type: none"> <li>• <b>Honest:</b> Tell the truth, keep your promises, and be trustworthy.</li> <li>• <b>Fair:</b> Do right by others, be open, and transparent.</li> <li>• <b>Courageous:</b> Speak up, ask for help, make tough calls, and say no when appropriate.</li> </ul> </li> </ul>
<b>Objectives:</b>
<ul style="list-style-type: none"> <li>• Make every day easier for busy families.</li> <li>• Change how we work.</li> <li>• Deliver results and operate with discipline.</li> <li>• Be the most trusted retailer.</li> </ul>

## Goals

**goal:** A specific result that must be achieved to reach an objective.

A **goal** is a specific result that must be achieved to reach an objective. In fact, several goals may be associated with a single objective. The objective states what must be accomplished, and the associated goals specify how to determine whether the objective is being met.

Goals track progress in meeting an organization's objectives. They help managers determine if a specific objective is being achieved. Results, determined by how well the goals are met, provide a feedback loop. Depending on the difference between the actual and desired results, adjustments may be needed in the objectives, goals, and strategies as well as with the actual projects being worked on.

Some organizations encourage their managers to set Big Hairy Audacious Goals (BHAGs) that require a breakthrough in the organization's products or services to achieve. Such a goal "may be daunting and perhaps risky, but the challenge of it grabs people in the gut and gets their juices flowing and creates tremendous forward momentum."<sup>8</sup>

Elon Musk is one CEO is determined to set the "hairiest" of goals. One of his companies, The Boring Company, is trying to solve the problem of vehicular traffic. Musk decided that the most efficient way to cure traffic woes is not to fix the existing highways or build flying cars. Rather, he is building underground tunnels, where cars would be self-driven at speeds over 150 miles per hour. These cars would access the tunnels through elevators on the street level.<sup>9</sup>

However, engineers and other professionals are skeptical of Elon's underground tunnels. Many engineers doubt the cost estimates of building the tunnels, the high speeds that pods or automobiles will be able to achieve once in the tunnel, and the speed and traffic concerns of utilizing the proposed "elevator" technology.<sup>10</sup>

If Elon Musk is successful, he will have accomplished two major feats: The construction of tunnels would be reduced by 1/10 of the current cost, and electric autonomous vehicles would take over the automobile market. It is yet to be seen whether this big hairy audacious goal will achieve success.

The use of so-called SMART goals has long been advocated by management consultants.<sup>11</sup> The principal advantages of SMART goals are that they are easy to understand, are easily tracked, and contribute real value to the organization. The SMART acronym stands for:

- **Specific.** Specific goals have a much greater chance of being understood and accomplished than vague goals. Specific goals use action verbs and specify who, what, when, where, and why.
- **Measurable.** Goals that are measurable include numeric or descriptive measures that define criteria such as quantity, quality, and cost so that progress toward meeting the goal can be determined.
- **Achievable.** Goals should be ambitious yet realistic and attainable. Goals that are either completely out of reach or below standard performance are worthless and demotivating.
- **Relevant.** Goals should strongly contribute to the mission of the department, why else expend the effort?
- **Time constrained.** A time limit should be set to reach the goal to help define the priority to assign to meeting the goal.

An example of a SMART goal for a customer service organization of a large retail store might be to reduce customer complaints about mispriced merchandise from 9 per day to less than 3 per day by June 30.

### **Strategies**

**strategy:** A plan that describes how an organization will achieve its vision, mission, objectives, and goals.

A **strategy** describes how an organization will achieve its vision, mission, objectives, and goals. Selecting a specific strategy focuses and coordinates an organization's resources and activities from the top down to accomplish its mission. Indeed, creating a set of strategies that will garner committed supporters across the organization—all aligned on the mission and vision—is key to organizational success.

### **Initiatives, Programs, and Projects**

**project:** A temporary endeavor that creates an actionable plan, allowing organizations to achieve their goals and objectives.

After an organization has established why it is in business (mission/vision), how it wants its employees to conduct themselves (values), what its business needs are (objectives), what it is hoping to accomplish (goals), and how it plans to make its goals a reality (strategies), the firm must execute specific initiatives, programs, or projects to make changes. Without specific projects, creating the top of the strategic planning pyramid is simply academic. **Projects** are temporary endeavors that create an actionable plan, allowing organizations to achieve their goals and objectives. In other words, a project is an opportunity for the organization to implement specific actions to achieve its goals.

### **Define Strategies**

Common themes in setting strategies include “increase revenue,” “attract and retain new customers,” “increase customer loyalty,” and “reduce the time required to deliver new products to market.” In choosing from alternative strategies, managers should consider the long-term impact of each strategy on revenue and profit, the degree of risk involved, the amount and types of resources that will be required, and the potential competitive reaction. In setting strategies, managers draw on the results of the SWOT analysis and consider the following questions:

- How can we best capitalize on our strengths and use them to their full potential?
- How do we reduce or eliminate the negative impact of our weaknesses?

- Which opportunities represent the best opportunities for our organization?
- How can we exploit these opportunities?
- Will our strengths enable us to make the most of this opportunity?
- Will our weaknesses undermine our ability to capitalize on this opportunity?
- How can we defend against threats to achieve our vision/mission, objectives, and goals?
- Can we turn this threat into an opportunity?

Amazon has made a strategic decision to explore the possible use of delivery drones to gain a real competitive advantage over competitors who rely on less efficient ground transportation. Because a large percentage of Amazon packages weigh less than 5 pounds, drones could make the ideal rapid-delivery vehicles. Amazon has detailed plans for this service; however, the company cannot announce if or when the program will start until regulators change the rules regarding the commercial use of drones. Such a strategy has the potential to attract new customers and increase revenue if changes in government regulations allow the company to move forward.<sup>12</sup>

## Deploy Plan

The strategic plan defines objectives for an organization, establishes SMART goals, and sets strategies on how to reach those goals. These objectives, goals, and strategies are then communicated to the organization's business units and functional units so that everyone is "on the same page." The managers of the various organizational units can then develop more detailed plans for initiatives, programs, and projects that align with the firm's objectives, goals, and strategies. Alignment ensures that the efforts will draw on the strengths of the organization, capitalize on new opportunities, fix organizational weaknesses, and minimize the impact of potential threats.

The extent of strategic planning done at lower levels within the organization depends on the amount of autonomy granted those units as well as the leadership style and capabilities of the managers in charge of each unit. For these reasons, the amount of effort, the process used, and the level of creativity that goes into the creation of a business unit strategic plan can vary greatly across an organization.

Alstom Transport, which develops and markets railway systems, equipment, and services, won a contract to supply Virgin Trains' West Coast Mainline operations in the United Kingdom.<sup>13</sup> Alstom supplied Virgin Trains 52 of its high-speed (125 mph) Pendolino trains. However, the train was initially too unreliable—too many trains were shut down on any given day due to maintenance issues.<sup>14</sup> Only 38 of the 52 trains were available on a given day; however, 46 trains were needed to meet service-level goals. The situation was affecting Alstom's relationship with Virgin Trains, and, if not improved, would likely affect contract renewal. Alstom Transport executives met and set key objectives to improve the relationship with Virgin Trains:

- Meet availability goals and improve reliability.
- Do not increase costs.
- Provide greater value to the customer.

Alstom leaders then employed a "catch-ball" process to deploy these objectives to other workers at the firm. The management team "threw" the goals back and forth with the entire management chain, including senior management, operations leaders, and depot and production management. By means of this process, Alstom identified over 15 potential improvement projects to support the goals, leading to an increased train availability rate—72 percent to 90 percent—while headcount and costs were kept flat. Alstom won renewal of a service maintenance contract with Virgin Trains three years earlier than expected because of its improved service.<sup>15</sup>



## Critical Thinking Exercise

### Strategic Planning at Johns Hopkins Medicine

#### ► GLOBAL, FINANCE

Johns Hopkins Medicine, with headquarters in Baltimore, Maryland, is a \$8 billion global health care organization that operates six academic and community hospitals, six suburban health care and surgery centers, and 40 primary and specialty care outpatient sites. The organization strives to create a culture in which diversity, inclusion, civility, collegiality, and professionalism are championed through actions, incentives, and accountability. Johns Hopkins Medicine's mission, vision, core values, and objectives are presented in Table 12.4.<sup>16</sup>

**TABLE 12.4** Johns Hopkins Medicine mission, vision, values, and objectives<sup>17, 18</sup>

<b>Mission:</b> To improve the health of the community and the world by setting the standard of excellence in medical education, research, and clinical care
<b>Vision:</b> Johns Hopkins Medicine pushes the boundaries of discovery, transforms health care, advances medical education, and creates hope for humanity. Together we will deliver the promise of medicine.
<b>Core Values:</b>
<ul style="list-style-type: none"> <li>• Excellence and discovery</li> <li>• Leadership and integrity</li> <li>• Diversity and inclusion</li> <li>• Respect and collegiality</li> </ul>
<b>Objectives:</b>
<ul style="list-style-type: none"> <li>• Advance discovery through use of diverse data sources.</li> <li>• Develop Precision Medicine Centers of Excellence (PMCOEs) that encompass both clinical and basic science research.</li> <li>• Enhance individualized care decisions and outcomes through stratification of patient data.</li> <li>• Ensure data integrity and create an integrated clinical and operational analytics platform.</li> <li>• Transform educational practice and content to tailor learner experience to individual needs.</li> <li>• Create forward-looking workforce plans that align with clinical and academic objectives.</li> </ul>

You are a member of a three-person team within the finance organization that is working under the direction of the CFO to define a set of strategies that will support Johns Hopkins Medicine's financial objectives and goals.

#### Review Questions

The CFO has asked each member of the team to express his or her thoughts on two topics:

1. Should any resources from outside the finance organization be recruited to help identify and evaluate alternative strategies? Why or why not?
2. How should potential strategies for the finance organization be evaluated?

#### Critical Thinking Questions

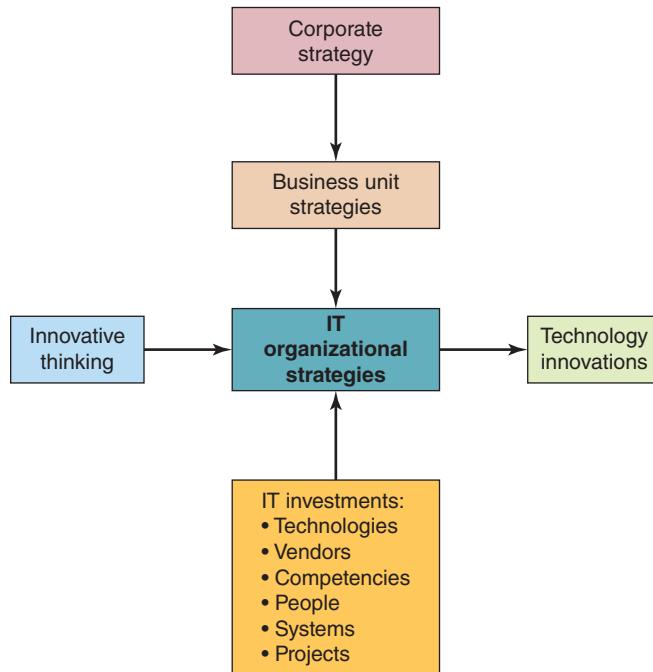
1. Develop two hypothetical objectives specific to the finance organization that are consistent with Johns Hopkins Medicine's overall vision, mission, and objectives.
2. For each objective develop one SMART goal.

## Setting the Information System Organizational Strategy

The strategic plan of the information system (IS) organization must identify those technologies, vendors, competencies, people, systems, and projects in which the organization will invest to support the corporate and business unit objectives, goals, and strategies. The IS strategic plan is strongly influenced by new technology innovations (e.g., increasingly more powerful mobile devices, advanced printers that can generate three-dimensional objects from a digital file, access to shared computer resources over the Internet, and advanced software that can analyze large amounts of structured and unstructured data) and innovative thinking by others both inside and outside the organization (see Figure 12.4).

**FIGURE 12.4**  
**Drivers that set IS organizational strategy and determine information system investments**

Planners must consider many factors in setting IS organizational strategy.



The strategic planning process for the IS organization and the factors that influence it depend on how the organization is perceived by the rest of the organization. An IS organization can be viewed as a cost center/service provider, a business partner/business peer, or as a game changer (see Table 12.5).

**TABLE 12.5** The IS strategic planning spectrum

	Cost Center/Service Provider	Business Partner/Business Peer	Game Changer
<b>Strategic planning focus</b>	Inward looking	Business focused	Outward looking
<b>IS goals</b>	Reduce IS costs; improve IS services	Control IS costs; expand IS services	Make IS investments to deliver new products and services
<b>Strategy</b>	React to strategic plans of business units	Execute IS projects to support plans of business	Use IS to achieve competitive advantage
<b>Typical projects</b>	Eliminate redundant or ineffective IS services	Implement corporate database and/or enterprise systems	Provide new ways for customers to interact with organization

In a recent survey of CIOs, 32 percent said that their IS organization is viewed as a cost center/service provider that is expected to reduce IS costs and improve IS services.<sup>19</sup> The strategic planning process for such an organization is typically directed inward and focused on determining how to do what it is currently doing but cheaper, faster, and better.

The IS organization of the state of Delaware is viewed as a cost center/service provider. One of the organization's primary strategic initiatives is to consolidate IS resources and to eliminate redundant functions and resources within the various state agencies. The goal is to deliver significant improvements in customer service and to reduce costs.<sup>20</sup>

The majority of CIOs surveyed, about 45 percent, said their IS organization is viewed as a business partner/business peer that is expected to control IS costs and expand IS services in support of business initiatives.<sup>21</sup> The strategic planning process of these organizations is based on understanding the collective business plans for the next year and determining what those mean for the IS organization in terms of new technologies, vendors, competencies, people, systems, and projects.

As a key government agency, the Federal Deposit Insurance Corporation (FDIC) is continually looking for ways it can improve its internal operations and insure that its mission-critical systems are available during a crisis. The purpose of the FDIC's IS organization is to help the FDIC more effectively and efficiently achieve its core business objectives. Recent IS department projects in support of those objectives include projects focused on cybersecurity—including the development of secure mobile applications that allow users to work remotely—as well as initiatives designed to increase data analysis capabilities, and improve service response times.<sup>22</sup>

IT organizations are making great strides in becoming transformational forces within their larger organizations. In the past four years, the percent of surveyed CIOs who indicated that their IS organization is viewed by fellow employees as a game-changing organization asked to lead product innovation efforts and open new markets has risen from 10 to 36 percent.<sup>23</sup> The strategic planning process for these IS organizations is outwardly focused and involves meeting with customers, suppliers, and leading IS consultants and vendors to answer questions like "What do we want to be?" and "How can we create competitive advantage?"<sup>24</sup> In such organizations, IS is not only a means for implementing business-defined objectives, but also a catalyst for achieving new business objectives unreachable without IS. Becoming truly transformational requires an IT organization (and its larger organization) to rethink the role technology and processes play in creating competitive advantage. For the year 2019, global digital transformation technologies spending is expected to exceed \$2 trillion as companies try to make that shift.<sup>25</sup>

Founded in 2000, the online ticket marketplace StubHub now has over \$1.2 billion in annual sales.<sup>26</sup> The company's recent efforts to transform its business include an initiative to enable ticket sellers to take pictures of tickets and post them for sale because half of StubHub's purchases come from mobile devices. Additionally, the company's online presence is poised to become a destination website, including music and allowing Facebook friends to purchase tickets for each other.<sup>27</sup> This new content will be a game changer for StubHub, driving more visits to their website.

No matter how an IS organization is perceived, the odds of achieving good alignment between the IS strategic plan and the rest of the business are vastly increased if IS workers have experience in the business and can talk to business managers in business terms rather than technology terms. IS staff must be able to recognize and understand business needs and develop effective solutions. The CIO especially must be able to communicate well and should be accessible to other corporate executives. However, the entire burden of achieving alignment between the business and IS cannot be placed solely on the IS organization.

## Identifying IS Projects and Initiatives

In mature planning organizations, IS workers are constantly picking up ideas for potential projects through their interactions with various business managers and from observing other IS organizations and competitors. They also

keep abreast of new IS developments and consider how innovations and new technologies might be applied in their firm. As members of the IS organization review and consider the corporate objectives, goals, and strategies, they can generate many ideas for IS projects that support corporate objectives and goals. They also recognize the need for IS projects that help other corporate units fulfill their business objectives. Often, experienced IS managers are assigned to serve as liaisons with the business units in order to gain a deeper understanding of each business unit and its needs. The IS managers are then able to help identify and define IS projects needed to meet those needs.

Most organizations find it useful to classify various potential projects by type. One such classification system is shown in Table 12.6.

**TABLE 12.6** Project classification example

Project Type	Definition	Risk Factors Associated with Project Type
Breakthrough	Creates a competitive advantage that enables the organization to earn a greater than normal return on investment than its competitors	High cost; very high risk of failure and potential business disruption
Growth	Generates substantial new revenue or profits for the firm	High cost; high risk of failure and potential business disruption
Innovation	Explores the use of technology (or a new technology) in a new way	Risk can be managed by setting cost limits, establishing an end date, and defining criteria for success
Enhancement	Upgrades an existing system to provide new capabilities that meet new business needs	Risk that scope of upgrade may expand, making it difficult to control cost and schedule
Maintenance	Implements changes to an existing system to enable operation in a different technology environment (e.g., underlying changes in hardware, operating systems, or database management systems)	Risk that major rework may be required to make system work in a new technology environment; potential for system performance degradation
Mandatory	Needed to meet requirements of a legal entity or regulatory agency	Risk that mandated completion date is missed; may be difficult to define tangible benefits; costs can skyrocket

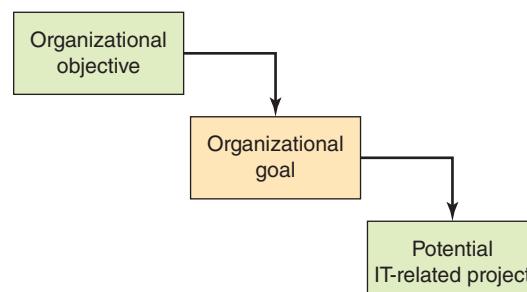
## Prioritizing IS Projects and Initiatives

Typically, an organization identifies more IS-related projects and initiatives than it has the people and resources to staff. An iterative process of setting priorities and determining the resulting budget, staffing, and timing is needed to define which projects will be initiated and when they will be executed. Many organizations create an IS investment board of business unit executives to review potential projects and evaluate them from several different perspectives:

1. First and foremost, each viable project must relate to a specific organizational goal. These relationships make it clear that executing each project will help meet important organizational objectives (see Figure 12.5).

**FIGURE 12.5**  
**Projects must be related to goals and objectives**

Objectives define goals lead that in turn identify projects consistent with those objectives and goals.



**tangible benefit:** A benefit that can be measured directly and assigned a monetary value.

**intangible benefit:** A benefit that cannot directly be measured and cannot easily be quantified in monetary terms.

2. Can the organization measure the business value of the initiative? Will there be tangible benefits, or are the benefits intangible? **Tangible benefits** can be measured directly and assigned a monetary value. For example, the number of staff before and after the completion of an initiative can be measured, and the monetary value is the decrease in staffing costs, such as salary, benefits, and overhead. **Intangible benefits** cannot directly be measured and cannot easily be quantified in monetary terms. For example, an increase in customer satisfaction due to an initiative is important but is difficult to measure and cannot easily be converted into a monetary value.
3. What kinds of costs (hardware, software, personnel, consultants, etc.) are associated with the project, and what is the likely total cost of the effort over multiple years? Consider not just the initial development cost but the total cost of ownership, including operating costs, support costs, and maintenance fees.
4. Preliminary costs and benefits are weighed to see if the project has an attractive rate of return. Unfortunately, costs and benefits may not be well understood at an early phase of the project, and many worthwhile projects do not have benefits that are easy to quantify.
5. Risk is another factor to consider. Managers must consider the likelihood that the project will fail to deliver the expected benefits; the actual cost will be significantly more than expected; the technology will become obsolete before the project is completed; the technology is too “cutting edge” and will not deliver what is promised; or the business situation will change so that the proposed project is no longer necessary.
6. Some projects enable other projects. For example, a new customer database may be required before the order-processing application can be upgraded. Therefore, some sequencing of projects must be considered.
7. Is the organization capable of taking on this project? Does the IS organization have the skills and expertise to execute the project successfully? Is the organization willing and able to make the required changes to receive their full value?



## Critical Thinking Exercise

### *Virtual Printing*

#### ► COMMUNICATION AND PROBLEM SOLVING

You are working as a business analyst at MAX Printing Systems (MPS), a company that makes high-speed printers. MPS dominates the mature high-speed printing industry, with approximately one-third of the total market. Because many companies are transitioning to paperless bills, however, this is not a growth industry. Your company is still profitable, due to its large market share, but revenue is stagnant.

You have been working at MPS for a little more than a year and are looking for opportunities to make a name for yourself. The vice president of sales, Dom Caruso, joins a meeting where you are in attendance. Dom pulls you aside after the meeting and tells you that he would like to roll out virtual reality software to his salesforce. Dom is extremely influential, having one of the longest tenures at the organization. You know that if you successfully led a project he was championing, you would almost be guaranteed a promotion.

Excitedly, you ask Dom how he envisions using the virtual reality software. He replies, “I don’t know. But we have to get it!” and then walks out of the room. You are left wondering what to do next.

#### Review Questions

1. What is the first thing you should do when you return to your desk?
2. How would you go about determining the viability of this project?

### Critical Thinking Questions

1. Would you investigate this type of software further or just wait until Dom speaks to an IS manager?
2. Should your company use technology to innovate in this mature industry, or would it be better to simply maintain the status quo because the company has such a large market share?

## Innovation & Change in the Organization

Your organization's current products, services, and ways of accomplishing work are doomed to obsolescence. Fail to change and your competition will take away your customers and your profits. Positive change is a key ingredient for any successful organization. This section will discuss important topics related to change including innovation, reengineering, continuous improvement, outsourcing, offshoring, and downsizing.

### Innovation

**Innovation:** The application of new ideas to the products, processes, and activities of a firm, leading to increased value.

**Innovation** is the application of new ideas to the products, processes, and activities of a firm, leading to increased value. Innovation is the catalyst for the growth and success of any organization. It can build and sustain profits, create new challenges for the competition, and provide added value for customers. Innovation and change are absolutely required in today's highly competitive global environment; without both, the organization is at risk of losing its competitiveness and becoming obsolete. The following is a list of just a few of today's most innovative products:

- Tile is an innovative product that helps solve a problem we all encounter—occasionally misplacing everyday items and wasting time trying to find them. Tile is a smartphone app combined with small devices (tiles) that consumers can stick on their keys, TV remote controls, purses, and wallets. A proximity sensor plays a musical sound through the smartphone app when you come within 100 feet of the tile, so you can walk around to see if the missing item is hiding nearby.
- Health care technology company iHealth has introduced several different sensors that can measure and report on a wide array of biometric data, including steps taken, distance covered, and calories burned; sleep efficiency; blood pressure; glucose level; and blood oxygen saturation level and pulse rate.
- Ooma Butterfleye offers an economical home security product that employs a megapixel camera smart enough to recognize you, members of your family, and even your pets. If a stranger is caught inside your home within view of the camera, Ooma Butterfleye uses your home Wi-Fi system to alert you via an app.
- NeuroMetrix created Quell, an FDA-approved device that stimulates the brain to block pain receptors for patients with chronic conditions. The device is worn around the calf and calibrated to the user's body to ensure that it delivers the exact amount of relief needed. Quell performs functions similar to existing devices that must be surgically implanted at much higher cost.

Various authors and researchers have identified different ways of classifying innovation. A simple classification developed by Clayton Christensen, a leading researcher in this field, is to think of two types of innovation—sustaining and disruptive.<sup>28</sup>

Sustaining innovation results in enhancements to existing products, services, and ways of operating. Such innovations are important because they enable an organization to continually increase profits, lower costs, and gain market share. Several high-tech companies have become industry powerhouses

through the use of sustaining innovation. Apple disrupted the cellular phone market in 2007 when releasing the first iPhone, but since then the company has made nearly \$383 billion in net income in large part by continually improving upon the same technology.<sup>29</sup> Another powerhouse, Microsoft, owes over half of its earnings since 1985 to the company commitment to sustaining innovation of its Windows operating system and Office products.<sup>30</sup> And Intel's source of income comes from improving upon its x386 microprocessor chip, which was introduced in 1985.<sup>31</sup>

A disruptive innovation is one that initially provides a lower level of performance than the marketplace has grown to accept. Over time, however, the disruptive innovation is improved to provide new performance characteristics, becoming more attractive to users in a new market. As it continues to improve and begins to provide a higher level of performance, it eventually displaces the former product or way of doing things. The cell phone is a good example of a disruptive innovation. The first commercial handheld cell phone was invented in 1973. It weighed 2.5 pounds, had a battery life of less than 30 minutes, cost more than \$3000, and had extremely poor sound quality.<sup>32</sup> Compare that with today's ubiquitous smart cell phones that have one-fifteenth the weight, one-fifth the cost, and over 40 times longer battery life<sup>33, 34</sup>; smartphones can not only place calls but also serve as a camera, a video recorder, and a handheld computer that can run applications and access the Internet.

## Reengineering and Continuous Improvement

To stay competitive, organizations must occasionally make fundamental changes in the way they do business. In other words, they must innovate and change the activities, tasks, or processes they use to achieve their goals.

**Reengineering**, also called **process redesign** and **business process reengineering (BPR)**, involves the radical redesign of business processes, organizational structures, information systems, and values of the organization to achieve a breakthrough in business results. See Figure 12.6. Successful reengineering can reduce delivery time, increase product and service quality, enhance customer satisfaction, and increase revenues and profitability.

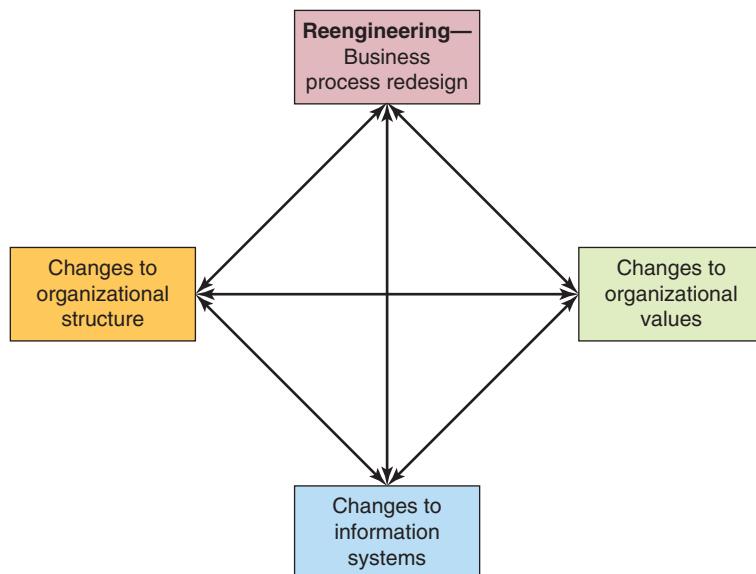
Michael Hammer, former professor of computer science at MIT, coined the term “business process reengineering.” His message was simple. He implored businesses not to automate what has always been done, but rather to eliminate steps that do not add value and then to reimagine the process. This simple, yet profound idea, has resulted in saving time and money for many companies.<sup>35</sup>

**reengineering (process redesign/business process reengineering [BPR]):** The radical redesign of business processes, organizational structures, information systems, and values of the organization to achieve a breakthrough in business results.

**FIGURE 12.6**

### Reengineering

Reengineering involves the radical redesign of business processes, organizational structure, information systems, and the values of an organization to achieve a breakthrough in business results.



In the 1990s, Ford Motor Company decided that cost cutting was necessary in its bloated accounts payable department. The accounts payable process was quite complex and inefficient at Ford. With a workforce of 500 people in the department, errors were unavoidable. In order to repair the process, management initially set a goal of reducing the department headcount by 20 percent. When discovered that their competitor, Mazda, was able to run their accounts payable department with only five people, Ford's management decided that a full redesign process was needed. In the end, Ford was able to reduce the size of the department by 75 percent and also improved their vendor relationships in the process.<sup>36</sup>

**continuous improvement:** A form of innovation that involves constantly seeking ways to improve business processes and add value to products and services.

In contrast to reengineering, the idea of **continuous improvement** (often referred to by the Japanese word “Kaizen”) is a form of innovation that involves constantly seeking ways to improve business processes and add value to products and services. This continual change will increase customer satisfaction and loyalty and ensure long-term profitability. Manufacturing companies make continual product changes and improvements. Service organizations regularly find ways to provide faster and more effective assistance to customers. By doing so, organizations increase customer loyalty, minimize the chance of customer dissatisfaction, and diminish the opportunity for competitive inroads.

Popular continuous improvement methods include Lean, Six Sigma, and Total Quality Management. Toyota invented the Lean process, which involves taking a customer-centric approach by looking to eliminate processes that don't deliver value to the customer, result in errors, or waste resources. Six Sigma, on the other hand, takes a quality approach that focuses on identifying and rectifying the root causes of problems or defects. Total Quality Management (TQM), developed by W. Edward Deming, is the oldest of these methods, and it emphasizes the need to involve all employees in improving quality by eliminating errors.<sup>37</sup>

In 2010, Sky Deutschland, the leading pay-TV provider in Germany and Austria, was in real financial trouble. Business was growing very slowly and many current customers were leaving the cable-provider. Additionally, the fixed costs were high, and the company frequently had insufficient stock of their products. Simply put, the company was losing money. As a result, a new vice president of logistics was hired to turn the company around. With a multiyear Lean plan to focus on supply chain and continuous improvement, the company started making a profit again in 2016. The new VP made several changes, setting the cable company to become solvent once again. As an example of such a change, the new VP honed in on the insufficient stock issues. The base problem was discovered to be a lack of forecasting in the customer service department. By better forecasting the future needs of products, Sky Deutschland could eliminate the problem of insufficient stock and repairing relationships with suppliers. Sky Deutschland's turnaround was a remarkable feat given the recent changes in the industry and the television market.<sup>38</sup>

Table 12.7 compares the strategies of business process reengineering and continuous improvement.

**TABLE 12.7** Comparing business process reengineering with continuous improvement

Business Process Reengineering	Continuous Improvement
Strong action taken to solve serious problem	Routine action taken to make minor improvements
Top-down change driven by senior executives	Bottom-up change driven by workers
Broad in scope; cuts across departments	Narrow in scope; focuses on tasks in a given area
Goal is to achieve a major breakthrough	Goal is continuous, gradual improvements
Often led by resources from outside the company	Usually led by workers close to the business
Information systems are integral to the solution	Information systems provide data to guide the improvement team

## Organizational Culture and Change

**culture:** A set of major understandings and assumptions shared by a group, such as within an ethnic group or a country.

**organizational culture:** The major understandings and assumptions for a business, corporation, or other organization.

**organizational change:** The way in which for-profit and nonprofit organizations plan for, implement, and handle change.

### soft side of implementing change

**change:** The work designed to help employees embrace a new information system and way of working.

**Culture** is a set of major understandings and assumptions shared by a group, such as within an ethnic group or a country. **Organizational culture** consists of the major understandings and assumptions for an organization. The understandings, which can include common beliefs, values, and approaches to decision making, are often neither stated nor documented as goals or formal policies. For example, salaried employees might be expected to check their email and instant messages around the clock and be highly responsive to all such messages.

Mark Twain said, “It’s not the progress I mind, it’s the change I don’t like.” **Organizational change** deals with how organizations successfully plan for, implement, and handle change. Change can be caused by internal factors, such as those initiated by employees at all levels, or by external factors, such as those wrought by competitors, stockholders, federal and state laws, community regulations, natural disasters, and general economic conditions.

Implementing change, such as a new information system introduces conflict, confusion, and disruption. People must stop doing things the way they are accustomed to and begin doing them differently. Successful implementation of change only happens when people accept the need for change and believe that the change will improve their productivity and enable them to better meet their customers’ needs. The so-called **soft side of implementing change** involves work designed to help employees embrace a new information system and way of working. This effort represents the biggest challenge to successful change implementation, yet it is often overlooked or downplayed, resulting in project failure. Indeed, both the Standish Group and Gartner, two highly respected organizations that track project implementations globally, believe that a significant contributor to project failures is overlooking the need to address employee adoption and resistance jointly.<sup>39</sup>

A recent study of almost 4,000 project management professionals, senior executives, and PMO (project management office) directors from around the world found that worldwide, organizations lose \$97 million for every \$1 billion spent on projects and programs due to failure.<sup>40</sup> Often, failure is caused by not managing the organizational change along with the processes and technology.<sup>41</sup>

The California Department of Consumer Affairs is made up of more than 40 entities (including multiple boards, bureaus, committees, and one commission) that regulate and license professional and vocational occupations that serve the people of California. Each year, the department processes over 350,000 applications for professional licensure along with some 1.2 million license renewals. The BreEZe project was initiated in 2009 to streamline the way the department does its business and interacts with its license applicants and consumers.<sup>42</sup> The resulting information system was intended to eliminate many paper-based processes and speed up the entire licensing process. Unfortunately, the project team failed to adequately involve the business users in the definition of the system requirements and instead made many erroneous decisions about how the system should work. The initial cost estimate for the system was \$28 million; however, as of early 2015, project costs exceeded \$37 million and less than half the licensing and regulatory boards were using the system. At completion, the project cost \$96 million and the system was implemented at only half of the planned regulatory agencies. Much of the delay and overspending could have been avoided had the project team worked better with the business users to understand their needs.<sup>43</sup>

The dynamics of how change is implemented can be viewed in terms of a change model. A **change model** represents change theories by identifying the phases of change and the best way to implement them. A number of models for dealing with the soft side of implementing change will now be introduced.

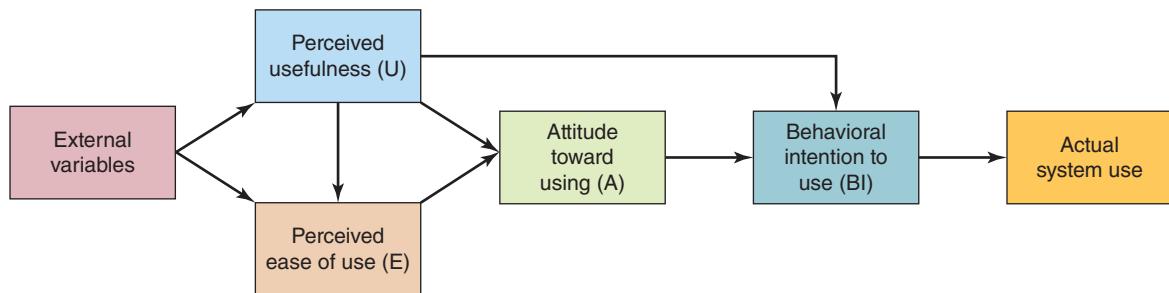
**change model:** A representation of change theories that identifies the phases of change and the best way to implement them.

## User Satisfaction and Technology Acceptance

### technology acceptance model (TAM)

**(TAM):** A model that specifies the factors that can lead to better attitudes about an information system, along with higher acceptance and usage of it.

Reengineering and continuous improvement efforts (including implementation of new information systems) must be adopted and used to achieve the defined business objectives by targeted users. The **technology acceptance model (TAM)** specifies the factors that can lead to better attitudes about the use of a new information system, along with its higher acceptance and usage. See Figure 12.7. In this model, “perceived usefulness” is defined as the degree to which individuals believe that use of the system will improve their performance. The “perceived ease of use” is the degree to which individuals believe that the system will be easy to learn and use. Both the perceived usefulness and ease of use can be strongly influenced by the expressed opinions of others who have used the system and the degree to which the organization supports use of the system (e.g., providing incentives and offering training and coaching from key users). Perceived usefulness and ease of use in turn influence an individual’s attitude toward the system, which affect their behavioral intention to use the system.<sup>44</sup>



**FIGURE 12.7**  
**Technology acceptance model**

Perceived usefulness (U) and perceived ease of use (E) strongly influence whether someone will use an information system. Management can improve that perception by demonstrating that others have used the system effectively and by providing user training and support.

As with any other technology, autonomous cars (or driverless cars) are subject to the technology acceptance model. When the first horseless carriage (automobile) was invented in 1897, the general population did not embrace this technology. In fact, the magazine, *A Horseless Age*, published an article about horseless carriages in 1897 stating, “There is a sense of incompleteness about it. You seemed to be sitting on the end of a huge pushcart, propelled by an invisible force and guided by a hidden hand. . . . Gradually I felt that I did not need the protection of a horse in front of me.”<sup>45</sup> As resistant as people were back then, cars became commonplace and traveling more than 5–10 miles from home became normal.

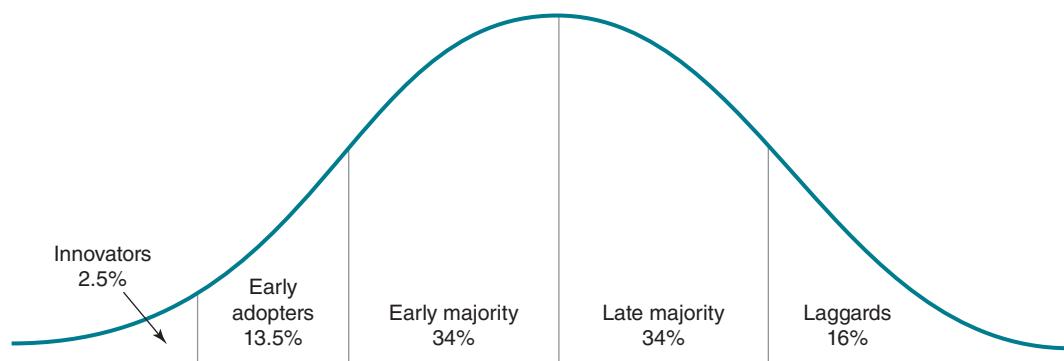
Fast forward 120+ years as we find a resistance to yet another technology—the autonomous car. The benefits to autonomous vehicles are numerous; this technology can reduce vehicular deaths due to human error and reduce traffic and carbon emissions. Why isn’t the public rushing to adopt this new technology? Issues regarding data collection (privacy), safety, and accident liability are still concerning. Furthermore, the public does not yet “trust” the car to get to the intended location safely. And some people enjoying the driving experience, knowing that by driving themselves they will get where they want to go without needing extra technology. In time, we will wonder why it took us so long to embrace driverless transportation that can service every age and every ability. As the perceived usefulness and ease of use increases, adoption of the driverless technology will become inevitable.<sup>46</sup>

## Diffusion of Innovation Theory

### diffusion of information theory:

A theory developed by E.M. Rogers to explain how a new idea or product gains acceptance and diffuses (or spreads) through a specific population or subset of an organization.

The **diffusion of innovation theory** was developed by E.M. Rogers to explain how a new idea or product gains acceptance and diffuses (or spreads) through a specific population or subset of an organization. A key point of this theory is that adoption of any innovation does not happen all at once for all members of the targeted population; rather, it is a drawn-out process, with some people quicker to adopt the innovation than others. See Figure 12.8. Rogers defined five categories of adopters, shown in Table 12.8, each with different attitudes toward innovation. When promoting an innovation to a target population, it is important to understand the characteristics of the target population that will help or hinder adoption of the innovation and then to apply the appropriate strategy. This theory can be useful in planning the rollout of a new information system.



**FIGURE 12.8**  
**Innovation diffusion**

Adoption of any innovation does not happen all at once for all members of the targeted population; rather, it is a drawn-out process, with some people quicker to adopt the innovation than others.  
Source: Everett Rogers, *Diffusion of Innovations*

**TABLE 12.8** Five categories of innovation adopters

Adopter Category	Characteristics	Strategy to Use
Innovator	Risk takers; always the first to try new products and ideas	Simply provide them with access to the new system and get out of their way
Early adopter	Opinion leaders whom others listen to and follow; aware of the need for change	Provide them assistance getting started
Early majority	Listen to and follow the opinion leaders	Provide them with evidence of the system's effectiveness and success stories
Late majority	Skeptical of change and new ideas	Provide them data on how many others have tried this and have used it successfully
Laggards	Very conservative and highly skeptical of change	Have their peers demonstrate how this change has helped them and bring pressure to bear from other adopters

## Project Management

**project:** A temporary endeavor undertaken to create a unique product, service, or result.

A **project** is a temporary endeavor undertaken to create a unique product, service, or result. Each project attempts to achieve specific business objectives and is subject to certain constraints, such as total cost and completion date. Organizations must always make clear connections among business objectives, goals, and projects; also, projects must be consistent with business strategies. For example,

an organization may have a business objective to improve customer service by offering a consistently high level of service that exceeds customers' expectations. Initiating a project to reduce costs in the customer service area by eliminating all but essential services would be inconsistent with this business objective.

At any point in time, an organization may have dozens or even hundreds of active projects, aimed at accomplishing a wide range of results. Projects are different from operational activities, which are repetitive activities performed over and over again. Projects are not repetitive; they come to a definite end once the project objectives are met or the project is cancelled. Projects come in all sizes and levels of complexity, as you can see from the following examples:

- A senior executive led a project to integrate two organizations following a corporate merger.
- A consumer goods company executed a project to launch a new product.
- An operations manager led a project to outsource part of a firm's operations to a contract manufacturer.
- A hospital executed a project to load an app on physicians' smartphones that would enable them to access patient data.
- A computer software manufacturer completed a project to improve the scheduling of help desk technicians and reduce the time on hold for callers to its telephone support services.
- A staff assistant led a project to plan the annual sales meeting.
- A manager completed a project to enter her departmental budget into a preformatted spreadsheet template.

Unfortunately, IS-related projects are not always successful. The Standish Group has been tracking the success rate of IS projects for over 20 years, and although the success rate has improved over time due to improved methods, training, and tools, roughly 14 percent<sup>47</sup> of all IS projects fail outright, but many more face major challenges such as lateness, budget overruns, and lack of required features.<sup>48</sup>

Researchers Hamel and Prahalad defined the term **core competency** to mean something that a firm can do well and that provides customer benefits, is hard for competitors to imitate, and can be leveraged widely to many products and markets.<sup>49</sup> Today, many organizations recognize project management as one of their core competencies and see their ability to manage projects better as a way to achieve an edge over competitors and deliver greater value to shareholders and customers. As a result, those organizations spend considerable effort identifying potential project managers and then training and developing them. For many managers, their ability to manage projects effectively is a key to their success within an organization.

## Project Variables

Five highly interrelated parameters define a project—scope, cost, time, quality, and user expectations. If any one of these parameters changes for a project, there must be a corresponding change in one or more of the other parameters. A brief discussion of these parameters follows.

### Scope

**Project scope** is a definition of which tasks are and which tasks are not included in a project. Project scope is a key determinant of the other project factors and must be carefully defined to ensure that a project meets its essential objectives. In general, the larger the scope of the project, the more difficult it is to meet cost, schedule, quality, and stakeholder expectations.

In April 2016, the Canadian government rolled out a new payroll system named Phoenix that was intended to modernize payroll processing for all government employees. The system, which was originally budgeted to cost

**core competency:** Something that a firm can do well and that provides customer benefits, is hard for competitors to imitate, and can be leveraged widely to many products and markets.

**project scope:** A definition of which tasks are and which tasks are not included in a project.

C\$155 million, was C\$119 million over budget at the time it launched. Even before the rollout was over, it was clear the system suffered from major flaws and security weaknesses that resulted from poor decision making throughout the project—including decisions made to change the project scope to try to contain budget overruns. For instance, to save money during development, senior executives involved in the project decided to scale back work on 100 of the system's 984 pay-processing functions; nevertheless, those functions were reinstated—without testing—when the system was deployed. And incredibly, not only was the system never put through end-to-end testing, it was also based on a version of PeopleSoft, a human resource application suite, that the project team knew was no longer going to be supported after 2018. As a result of the system's flaws, many civil servants went without paychecks or were paid incorrectly by the new system over the course of many months. Even the security of the system was in jeopardy, resulting in several breaches of confidential employee information. The system is now expected to cost the Canadian government C\$1.2 billion through the end of 2019 and many millions more before it can be replaced in 2025. Phoenix is a vivid example of a project that had almost no project management oversight and terrible IT decision making throughout.<sup>50</sup>

### Cost

The cost of a project includes all the capital, expenses, and internal cross-charges associated with the project's buildings, operation, maintenance, and support. Capital is money spent to purchase assets that appear on the organization's balance sheet and are depreciated over the life of the asset. Capital items typically have a useful life of at least several years. A building, office equipment, computer hardware, and network equipment are examples of capital assets. Computer software also can be classified as a capital item if it costs more than \$1000 per unit, has a useful life exceeding one year, and is not used for research and development.

Expense items are non-depreciable items that are consumed shortly after they are purchased. Typical expenses associated with an IS-related project include the use of outside labor or consultants, travel, and training. Software that does not meet the criteria to be classified as a capital item is classified as an expense item.

Many organizations use a system of internal cross-charges to account for the cost of employees assigned to a project. For example, the fully loaded cost (salary, benefits, and overhead) of a manager might be set at \$120,000 per year. The sponsoring organization's budget is cross-charged this amount for each manager who works full time on the project. (The **sponsoring business unit** is the business unit most affected by the project and the one whose budget will cover the project costs.) So, if a manager works at a 75 percent level of effort on a project for five months, the cross-charge is  $\$120,000 \times 0.75 \times 5/12 = \$37,500$ . The rationale behind cross-charging is to enable sound economic decisions about whether employees should be assigned to project work or to operational activities. If employees are assigned to a project, cross-charging helps organizations determine which project makes the most economic sense.

Organizations have different processes and mechanisms for budgeting and controlling each of the three types of costs: capital, expense, and internal cross-charge. Money from the budget for one type of cost cannot be used to pay for an item associated with another type of cost. Thus, a project with a large amount of capital remaining in its budget cannot use the available dollars to pay for an expense item even if the expense budget is overspent.

Table 12.9 summarizes and classifies various types of common costs associated with an IS-related project.

**sponsoring business unit:** The business unit most affected by the project and the one whose budget will cover the project costs.

**TABLE 12.9** Typical IS-related project costs

	Development Costs		
	Capital	Internal Cross-Charge	Expense
<b>Employee-related expenses</b>		X	
• Employees' effort			X
• Travel-related expenses			X
• Training-related expenses			X
<b>Contractor and consultant charges</b>			X
<b>IS-related capital and expenses</b>			
• Software licenses (software purchases that qualify as a capital expense)	X		
• Software licenses (software that does not qualify as a capital expense)			X
• Computing hardware devices	X		
• Network hardware devices	X		
• Data capture/data entry equipment	X		
<b>Total development costs</b>	X	X	X

### Time

The timing of a project is frequently a critical constraint. For example, in most organizations, projects that involve finance and accounting must be scheduled to avoid any conflict with operations associated with the closing of end-of-quarter books. Often, projects must be completed by a certain date to meet an important business goal or a government mandate.



Source: Twitter, Inc.

Reasons for the failure of the Fyre Festival are numerous, but time was definitely not on the founders' side. Billy McFarland and rapper Ja Rule envisioned an upscale music festival that would bring together top musical artists, famous models and celebrities, and thousands of attendees on a beautiful private island in the Bahamas. The festival was positioned as a classy music festival for millennials, featuring private villas, private airplanes, water sports,

and upscale food and drink. However, the time constraints of this project quickly overwhelmed the founders. The island originally chosen for the festival could not accommodate 8,000<sup>51</sup> attendees and had to be changed a few months before the scheduled event. Top acts were not booked until two months out, and housing, bathroom, and shower facilities were not fully constructed before the guests arrived on the island. None of the musical acts ever made it to the island, and after the first wave of guests spent their first night in tents with only cheese sandwiches to eat, they returned to the airport to spend the next night awaiting a flight home. Attendees lost thousands of dollars on a vacation that never happened. The Fyre Festival is a prime example of a poorly managed project with time constraints the founders were completely unable to meet. Whether the entire thing was a scam or just a project that needed more time to become a reality, founder Billy McFarland now resides in prison, found guilty of fraud charges in connection with the festival.<sup>52, 53</sup>

### Quality

**quality:** The degree to which a project meets the needs of its users.

The **quality** of a project can be defined as the degree to which the project meets the needs of its users. The quality of a project that delivers an IS-related system may be defined in terms of the system's functionality, features, system outputs, performance, reliability, and maintainability.

Failure to meet users' functionality and performance needs detracted from the initial introduction of the iPhone 6. Apple sold an astounding 10 million of the iPhone 6 and iPhone 6 Plus models in the first few days they were available. Unfortunately, the new iPhones had both hardware and software problems that caused the devices to fail to meet users' functionality and performance expectations. Apple's new mobile operating system iOS 8 for the devices came without promised apps that used a health and fitness feature called HealthKit. In addition, it turned out that the iPhone 6 Plus was too pliable, with some users complaining that the phone bent when sitting in their pockets for extended periods. Then, when Apple released an iOS 8 update aimed at fixing the HealthKit problem, some users complained the update had caused their iPhones to lose the ability to make phone calls.<sup>54</sup>

### User Expectations

As a project begins, stakeholders will form expectations—or will already have expectations—about how the project will be conducted and how it will affect them. For example, based on previous project experience, the end users of a new IS system may expect that they will have no involvement with the system until it is time for them to be trained. However, the project manager may follow a more progressive development process that requires users to help define system requirements, evaluate system options, try out system prototypes, develop user documentation, and define and conduct the user acceptance test.

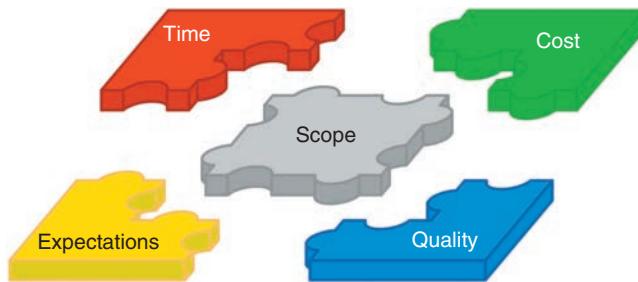
As another example, end users may expect to participate in weekly project status meetings to hear progress reports firsthand. However, the project manager may not have considered involving them in the status meetings or may not even be planning weekly meetings.

Both examples illustrate the huge differences in expectations that can exist between stakeholders and project members. It is critical to a project's success to identify expectations of key stakeholders and team members; any differences must be resolved to avoid future problems and misunderstandings.

The five project parameters—scope, cost, time, quality, and user expectations—are all closely interrelated, as shown in Figure 12.9. For example, if the time allowed to complete the project is decreased, it may require an increase in project costs, a reduction in project quality and scope, and a change of expectations among the project stakeholders, as shown in Figure 12.10.

**FIGURE 12.9**  
**The five parameters that define a project**

The five parameters that define a project are all highly interrelated.



Thorir Aron Stefansson/Shutterstock.com

**FIGURE 12.10**  
**Revised project definition**

A change in any one of the project variables (cost, time, scope, quality, or expectations) can impact the other variables.



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## What Is Project Management?

**Project management** is the application of knowledge, skills, and techniques to project activities to meet project requirements. Project managers must deliver a solution that meets specific scope, cost, time, and quality goals while managing the expectations of the **project stakeholders**—the people involved in the project or those affected by its outcome.

The essence of artistic activity is that it involves high levels of creativity and freedom to do whatever the artist feels. Scientific activity, on the other hand, involves following defined routines and exacting adherence to laws. Under these definitions, part of project management can be considered an art, because project managers must apply intuitive skills that vary from project to project and even from team member to team member. The “art” of project management also involves salesmanship and psychology in convincing others of the need to change and that this project is right to do.

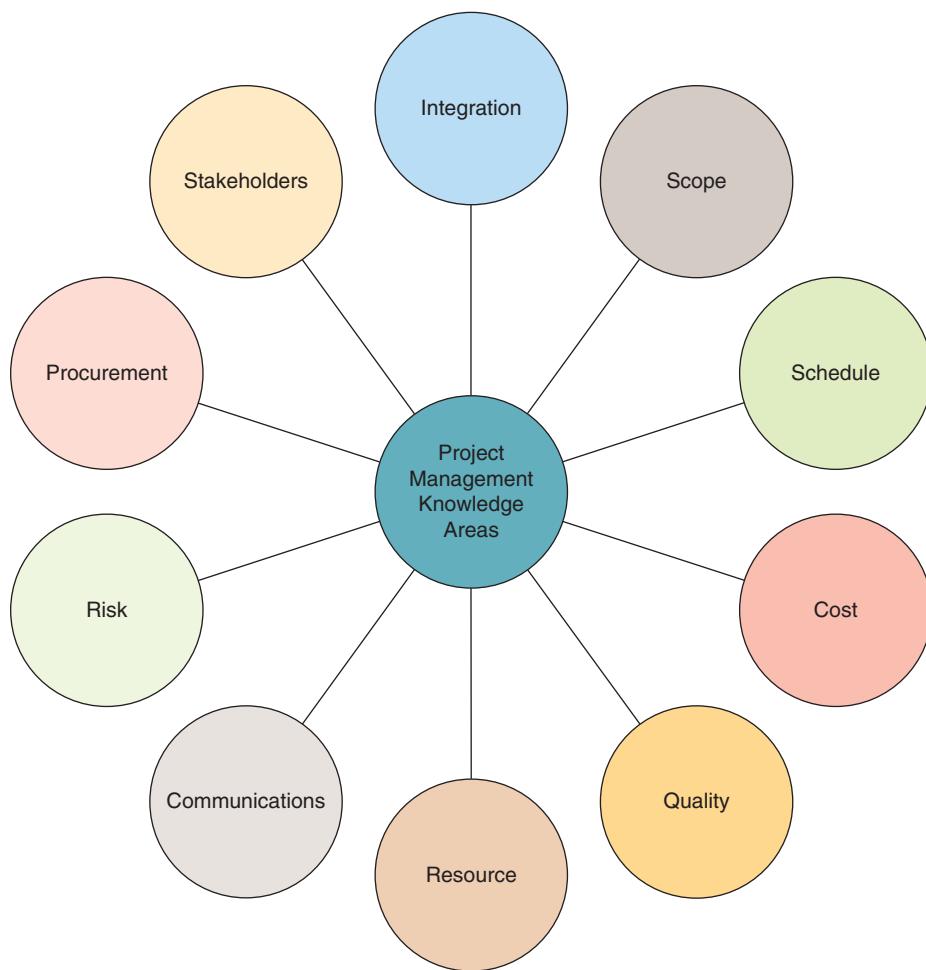
Project management is also part science because it uses time-proven, repeatable processes and techniques to achieve project goals. Thus, one challenge to successful project management is recognizing when to act as an artist and rely on one’s own instinct and when to act as a scientist and apply fundamental project management principles and practices. The following section covers the 10 areas associated with the science of project management.

## Project Management Knowledge Areas

According to the Project Management Institute (PMI), project managers must coordinate 10 areas of expertise: scope, schedule, cost, quality, resource, communications, risk, procurement, integration, and stakeholder management as shown in Figure 12.11.

**FIGURE 12.11**  
**The 10 project management knowledge areas**

There are 10 areas associated with the science of project management.



### Scope Management

**scope management:** A set of activities that include defining the work that must be done as part of a project and then controlling the work to stay within the agreed-upon scope.

**Scope management** includes defining the work that must be done as part of the project and then controlling the work to stay within the agreed-upon scope. Key activities include initiation, scope planning, scope definition, scope verification, and scope change control.

To avoid problems associated with a change in project scope, a formal scope change process should be defined before the project begins. The project manager and key business managers should decide whether they will allow scope changes at any time during the project, only in the early stages of the project, or not at all. The trade-off is that the more flexibility you allow for scope changes, the more likely the project will meet users' features and performance requirements. However, the project will be more difficult to complete within changing time and budget constraints as it is harder to hit a moving target.

The change process should capture a clear definition of the change that is being requested, who is requesting it, and why. If the project team has decided not to allow any scope changes during the project, then each new requested scope change is filed with other requested changes. Once the original project is complete, the entire set of requested scope changes can be reviewed, and the project team can decide which, if any, of the changes will be implemented and when. Often, it is cheaper to initiate one project to implement numerous related changes rather than start several independent projects. A follow-on project can then be considered to implement the recommended changes. The scope, cost, schedule, and benefits of the project must be determined to ensure that it is well defined and worth doing.

If the project team has decided to allow scope changes during the project, then time and effort must be allowed to assess how the scope change will affect the interrelated project variables of cost, schedule, quality, and expectations. This impact on the project must be weighed against the benefits of implementing the scope change, and the team must decide whether to implement the scope change. Of course, there may be alternatives for implementing a particular scope change, and the pros and cons must be weighed for each. The time required just to research scope changes can add considerable cost and time to the original project. Each scope change should be formally approved or rejected by the project manager and key stakeholders.

### Schedule Management

**schedule management:** A set of activities that includes defining an achievable completion date that is acceptable to the project stakeholders, developing a workable project schedule, and ensuring the timely completion of the project.

**project schedule:** A plan that identifies the project activities that must be completed, the expected start and end dates, and what resources are assigned to each task.

**project milestone:** A critical date for completing a major part of the project, such as program design, coding, testing, and release (for a programming project).

**project deadline:** The date the entire project should be completed and operational—when the organization can expect to begin to reap the benefits of the project.

**slack time:** The amount of time an activity can be delayed without delaying the entire project.

**critical path:** All project activities that, if delayed, would delay the entire project.

**gantt chart:** A graphical tool used for planning, monitoring, and coordinating projects; it is essentially a grid drawn on a timescale that lists activities and deadlines.

**work breakdown structure (WBS):** An outline of the work to be done to complete the project.

**predecessor task:** A task that must be completed before a later task can begin.

**Schedule management** includes defining an achievable completion date that is acceptable to the project stakeholders, developing a workable project schedule, and ensuring the timely completion of the project. Successful schedule management requires identifying specific tasks that project team members and/or other resources must complete; sequencing these tasks, taking into account any task dependencies or hard deadlines; estimating the amount of resources required to complete each task, including people, material, and equipment; estimating the elapsed time to complete each task; analyzing all this data to create a project schedule; and controlling and managing changes to the project schedule.

The bigger the project, the more likely that poor planning will lead to significant problems. Well-managed projects use effective planning tools and techniques, including schedules, milestones, and deadlines. A **project schedule** identifies the project activities that must be completed, the expected start and end dates, and what resources are assigned to each task. A project schedule is needed to complete a project by a defined deadline, avoid rework, and ensure that people know what to do and when to do it. A **project milestone** is a critical date for completing a major part of the project, such as program design, coding, testing, and release (for a programming project). The **project deadline** is the date the entire project should be completed and operational—when the organization can expect to begin to reap the benefits of the project.

In a systems development project, each activity is assigned an earliest start time and an earliest finish time. Each activity is also allocated **slack time**, which is the amount of time an activity can be delayed without delaying the entire project. The **critical path** of a project consists of the set of project activities that, if delayed, would delay the entire project. These activities have zero slack time. Any problems with critical path activities will cause problems for the entire project. To ensure that critical path activities are completed on time, project managers use certain approaches and tools such as Microsoft Project to help compute these critical project attributes.

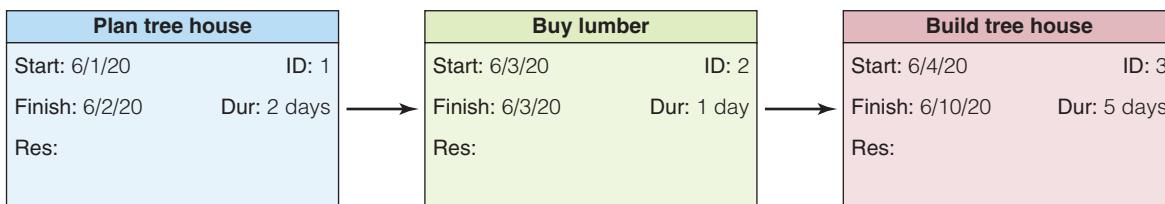
A **Gantt chart** is a graphical tool used for planning, monitoring, and coordinating projects; it is essentially a grid drawn on a timescale that lists activities and deadlines. Each time a task is completed, a marker such as a darkened line is placed in the proper grid cell to indicate the completion of a task.

The development of a work breakdown structure is a critical activity needed for effective schedule management. A **work breakdown structure (WBS)** is an outline of the work to be done to complete the project. You start by breaking the project into various stages or groups of activities that need to be performed. Then, you identify the tasks associated with each project stage. A task typically requires a week or less to complete and produces a specific deliverable—a tangible output such as a flowchart or end-user training plan.

After the activities are identified in the WBS, the tasks within each stage are sequenced. All **predecessor tasks** are identified—these are tasks that must be completed before a later task can begin. For example, the testing of a unit of program code cannot begin until the program has been coded, compiled,

**network diagram:** A diagram outlining the relationships among all of the project's tasks.

and debugged. Next, you must determine how long each task will take. After the predecessor tasks are identified, a **network diagram** can be created. A network diagram displays the relationships among all the project's tasks and will help determine the length of the project. Figure 12.12 shows a sample network diagram for building a tree house.



**FIGURE 12.12**  
Sample network diagram

Thus, building a WBS allows you to look at a project in great detail to get a complete picture of all the work that must be performed. Developing a WBS is another approach to defining the scope of a project—work not included in the WBS is outside the scope of the project.

Figure 12.13 shows a WBS for a project whose goal is to establish a wireless network in a warehouse and install RFID scanning equipment on forklift trucks for the tracking of inventory. The three phases of the project in Figure 12.13 are “Define warehouse network,” “Configure forklift trucks,” and “Test warehouse network.”

**FIGURE 12.13**  
Sample work breakdown structure (WBS)

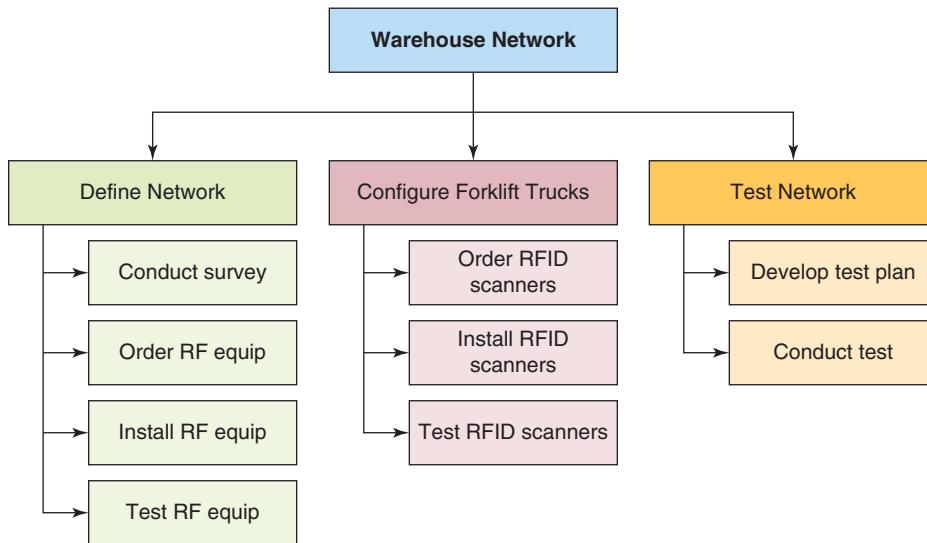


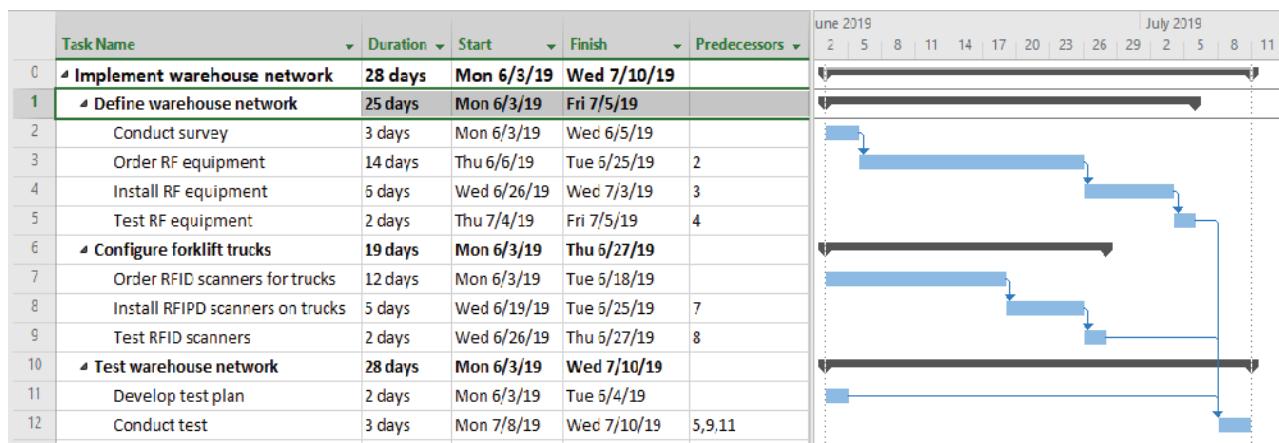
Table 12.10 shows a list of tasks for the same RFID project.

**TABLE 12.10** Task list

Task Name	Duration	Start	Finish	Predecessors
0 Implement warehouse network	28 days	Mon 6/3/19	Wed 7/10/19	
1 Define warehouse network	25 days	Mon 6/3/19	Fri 7/5/19	
2 Conduct survey	3 days	Mon 6/3/19	Wed 6/5/19	
3 Order RF equipment	14 days	Thu 6/6/19	Tue 6/25/19	2
4 Install RF equipment	6 days	Wed 6/26/19	Wed 7/3/19	3

5	Test RF equipment	2 days	Thu 7/4/19	Fri 7/5/19	4
6	<b>Configure forklift trucks</b>	<b>19 days</b>	<b>Mon 6/3/19</b>	<b>Thu 6/27/19</b>	
7	Order RFID scanners for trucks	12 days	Mon 6/3/19	Tue 6/18/19	
8	Install RFIPD scanners on trucks	5 days	Wed 6/19/19	Tue 6/25/19	7
9	Test RFID scanners	2 days	Wed 6/26/19	Thu 6/27/19	8
10	<b>Test warehouse network</b>	<b>28 days</b>	<b>Mon 6/3/19</b>	<b>Wed 7/10/19</b>	
11	Develop test plan	2 days	Mon 6/3/19	Tue 6/4/19	
12	Conduct test	3 days	Mon 7/8/19	Wed 7/10/19	5,9,11

Figure 12.14 shows the associated schedule in the form of a Gantt chart, with each bar in the chart indicating the start and end dates of each major activity (heavy black lines) and task (lighter lines).



**FIGURE 12.14**

### Gantt chart

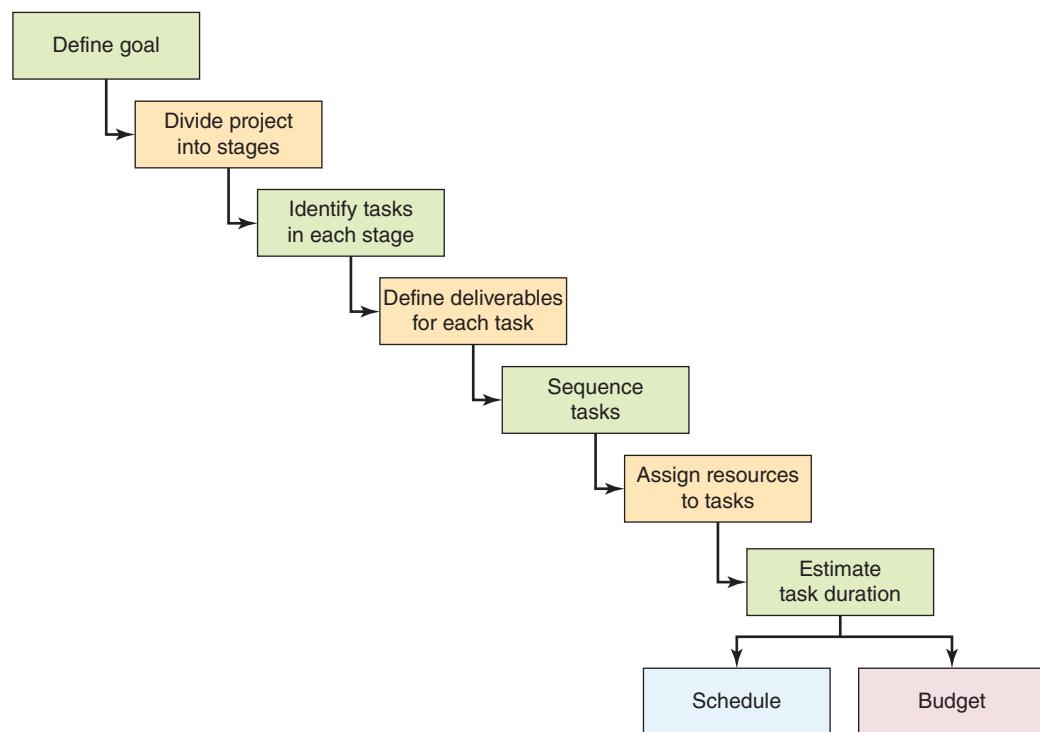
A Gantt chart depicts the start and finish dates for project tasks.

## Cost Management

**cost management:** A set of activities that includes the development and management of the project budget.

**Cost management** includes developing and managing the project budget. This area involves resource planning, cost estimating, cost budgeting, and cost control. As previously discussed, a separate budget must be established for each of the three types of costs—capital, expense, and internal cross-charge—and money in one budget cannot be spent to pay for another type of cost.

One approach to cost estimating uses the WBS to estimate all costs (capital, expense, and cross-charge) associated with the completion of each task. This approach can require a fair amount of detail work, such as determining the hourly rate of each resource assigned to the task and multiplying by the hours the resource will work on the task, estimating the cost per unit for supplies and multiplying that by the number of units required, and so on. If possible, the people who will complete the tasks should be allowed to estimate the duration and associated costs. This approach helps them to better understand the tasks they are expected to complete, gives them some degree of control in defining how the work will be done, and obtains their “buy-in” to the project schedule and budget. You can develop a project duration based on the sequence in which the tasks must be performed and the duration of each task. You can also sum the cost of each task to develop an estimate of the total project budget. This entire process of creating a WBS is outlined in Figure 12.15. The budget developed using this approach for the warehouse network project is depicted in Table 12.11.



**FIGURE 12.15**  
**Process to create a work breakdown structure (WBS)**

**TABLE 12.11** Project budget

Task	Capital	Expense	Cross-Charges
1 <b>Implement warehouse network</b>			
2 <b>Define warehouse network</b>			
3    Conduct survey		\$2400	
4    Order RF equipment	\$9000		
5    Install RF equipment		\$7800	
6    Test RF equipment			\$ 960
7 <b>Configure forklift trucks</b>			
8    Order RFID scanners for trucks	\$12,500		
9    Install RFID scanners on trucks			\$2400
10   Test RFID scanners			\$1200
11 <b>Test warehouse network</b>			\$ 960
12   Develop test plan			
13   Conduct test			\$1440
<b>TOTAL Costs</b>	<b>\$21,500</b>	<b>\$10,200</b>	<b>\$6960</b>

**quality management:** A set of activities designed to ensure that a project will meet the needs for which it was undertaken.

**quality planning:** The determination of which quality standards are relevant to the project and determining how they will be met.

**quality assurance:** The evaluation of the progress of the project on an ongoing basis to ensure that it meets the identified quality standards.

**quality control:** The checking of project results to ensure that they meet identified quality standards.

**project resource management:** A set of activities designed to identify, acquire, and manage resources for a project.

**forming-storming-norming-performing adjourning model:** A model that describes how teams develop and evolve.

## Quality Management

**Quality management** is a set of activities designed to ensure that a project will meet the needs for which it was undertaken. This process involves quality planning, quality assurance, and quality control. **Quality planning** involves determining which quality standards are relevant to the project and determining how they will be met. **Quality assurance** involves evaluating the progress of the project on an ongoing basis to ensure that it meets the identified quality standards. **Quality control** involves checking project results to ensure that they meet identified quality standards.

In many IS-related systems development projects, the source of the majority of defects uncovered in system testing can be traced back to an error in specifying requirements. Thus, most organizations put a heavy emphasis on accurately capturing and documenting system requirements and carefully managing changes in user requirements over the course of the project. A useful checklist for assessing the validity of system requirements includes the following questions:<sup>55</sup>

- Does the requirement describe something actually needed by the customer?
- Is the requirement correctly defined?
- Is the requirement consistent with other requirements?
- Is the requirement defined completely?
- Is the requirement verifiable (testable)?
- Is the requirement traceable back to a user need?

Hewlett Packard's Quality Center, Jama from Jama Software, and Inno slate from SPEC Innovations are three examples of requirements management software.

## Project Resource Management

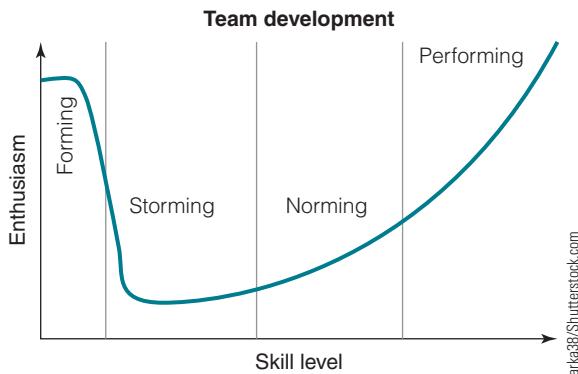
**Project resource management** is a set of activities designed to identify, acquire, and manage resources for a project. Activities within this area include estimating the amount and type of resources required for the project; acquiring equipment, materials, and staff; improving team communication and competencies; tracking team performance; and resolving team issues.<sup>56</sup>

When planning for team resources, all members of a project team may be assigned, or the project manager may have the luxury of selecting all or some team members. Ideally, team members are selected based on their skills in the technology needed for the project, their understanding of the business area affected by the project, their expertise in a specific area of the project, and their ability to work well on a team. Often, compromises must be made. For example, the best available subject matter expert may not work well with others, which becomes an additional challenge for the project manager.

Experienced project managers have learned that forming an effective team to accomplish a difficult goal is a challenge in itself. It takes considerable effort and a willingness to change on the part of all team members in order for a team to reach high levels of performance. A useful model to describe how teams develop and evolve is the **forming-storming-norming-performing adjourning model**, which was first proposed by Bruce Tuckman (see Figure 12.16).<sup>57</sup>

**FIGURE 12.16**  
**Tuckman's forming-storming-norming-performing-adjourning model**

Forming an effective team is a challenge in itself.



During the forming stage, the team meets to learn about the project, agrees on basic goals, and begins to work on project tasks. Team members are on their best behavior and try to be pleasant to one another while avoiding any conflict or disagreement. Team members work independently of one another and focus on their role or tasks without understanding what others are attempting to do. In the formation stage, the team's project manager tends to be highly directive and tells members what needs to be done. If the team remains in this stage, it is unlikely to perform well, and it will never develop breakthrough solutions to problems or effectively solve a conflicting set of priorities and constraints.

The team has moved into the storming stage when it recognizes that differences of opinion exist among team members and allows these ideas to compete for consideration. Team members will raise such important questions as "What problems are we *really* supposed to solve?" "How can we work well together?" "What sort of project leadership will we accept?" The team might argue and struggle, so it can be an unpleasant time for everyone. An inexperienced project manager, not recognizing what is happening, may give up, feeling that the team will never work together effectively. The project manager and team members must be tolerant of one another as they explore their differences. The project manager may need to continue to be highly directive.

If the team survives the storming stage, it may enter the norming stage. During this stage, individual team members give up their preconceived judgments and opinions. Members who felt a need to take control of the team give up this impulse. Team members adjust their behavior and begin to trust one another. The team may decide to document a set of team rules or norms to guide how they will work together. Teamwork actually begins. The project manager can be less directive and can expect team members to take more responsibility for decision making.

Some teams advance beyond the norming stage into the performing stage. At this point, the team is performing at a high level. Team members are competent, highly motivated, and knowledgeable about all aspects of the project. They have become interdependent on one another and have developed an effective decision-making process that does not require the project manager. Dissent is expected, and the team has developed an effective process to ensure that everyone's ideas and opinions are heard. Work is done quickly and with high quality. Problems that once seemed unsolvable now have "obvious" solutions. The team's effectiveness is much more than the sum of the individual members' contributions. The project manager encourages participative decision making, with the team members making most of the decisions.

Adjourning, the final stage in the model, involves the dissolution of the team. Ideally, this occurs when the project has been completed successfully and all team members can move on to new projects or assignments with a positive sense of accomplishment. From an organizational perspective, it is important that team members be recognized and rewarded for their contributions.

No matter what stage a team is operating in, it commonly will revert to less-advanced stages in the model when confronted with major changes in the work to be done, a change in project leadership, or substantial changes in the team's makeup. The project manager and business managers must recognize and consider this important dynamic when contemplating project changes.

Another key aspect of project resource management is getting the project team and the sponsoring business unit to take *equal* responsibility for making the project a success. The project team members must realize that on their own they cannot possibly make the project a success. They must ensure that the business managers and end users become deeply involved in the project and take an active role. The project team must actively involve the end users, provide information for them to make wise choices, and insist on their participation in major decisions. The business unit must remain engaged in the project, challenge recommendations, ask questions, and weigh options. It cannot simply sit back and "let the project happen to them." Key users need to be identified as part of the project team with responsibility for developing and reviewing deliverables. Indeed, some organizations require that the project manager come from the sponsoring business unit. Other organizations assign co-project managers to IS-related projects—one from the IS organization and one from the business unit.

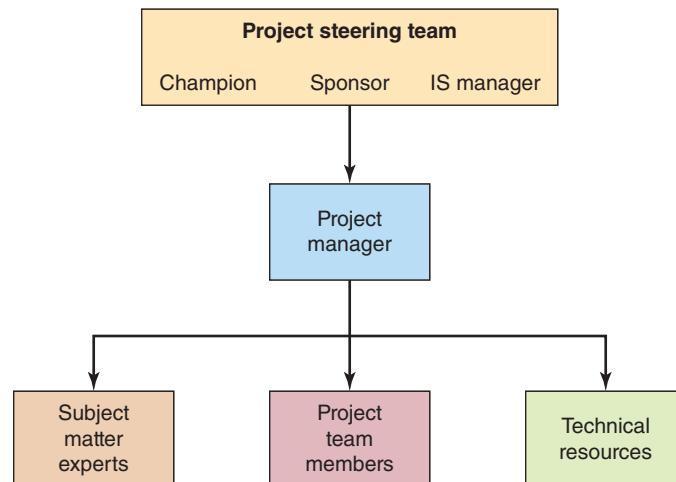
**project steering team:** A group of senior managers representing the business and IS organizations that provide guidance and support to a project.

**project champion:** A well-respected manager with a passion to see a project succeed and who removes barriers to the success of the project.

**project sponsor:** A senior manager from the business unit most affected by a project and who ensures the project will indeed meet the needs of his or her organization.

In addition to the development team, each project should have a **project steering team**—made up of senior managers representing the business and IS organizations—to provide guidance and support to the project. The number of members on the steering team should be limited (three to five) to simplify the decision-making process and ease the effort to schedule a quorum of these busy executives. The project manager and select members of the development team should meet with the steering team on an as-needed basis, typically at the end of each project phase or every few months. The three key members of the steering team include: (1) the **project champion**, who is a well-respected manager with a passion to see the project succeed and who removes barriers to the success of the project; (2) the **project sponsor**, who is a senior manager from the business unit most affected by the project and who ensures the project will indeed meet the needs of his or her organization; and (3) the IS manager, who ensures proper IS staffing for the project and ensures the project uses approved technology and vendors. These roles are further explained in Figure 12.17 and outlined in Table 12.12.

**FIGURE 12.17**  
**Project organization**  
A project steering team is critical to the success of any project.



**TABLE 12.12** Responsibilities of the project steering team

Project Champion	Project Sponsor	IS Manager
Well-respected senior manager with a passion to see the project succeed	Senior manager of business unit most affected by the project	Well-respected IS manager
Assures that project goals and objectives are aligned with organizational goals and objectives	Ensures that the business unit's expectations and needs are clearly communicated and understood	Ensures the project is staffed with appropriate IS staff
Convinces other senior managers of the project's merits in order to gain their approval to fund and staff it	Ensures that the project solution is truly workable and consistent with business and end-user requirements	Ensures technology and vendors suggested for inclusion in the project are consistent with IS strategy
Acts as a vocal and visible champion for the project to gain the support of others	Works to overcome resistance to change and prepare the organization to embrace the new system and way of doing things	
Identifies and removes barriers to project success	Identifies workers from the business unit to be assigned on a full- or part-time basis to project	
Resolves any issues outside the control of the project manager		
Provides advice and counsel to the project team		
Keeps informed of major project activities and developments		
Has final approval of all requests for changes in project scope, budget, and schedule		
Signs off on approvals to proceed to each succeeding project phase		

**subject matter expert:** Someone who provides knowledge and expertise in a particular aspect important to the project.

**technical resource:** A subject matter expert in an IS topic of value to the project.

**communications management:** The generation, collection, dissemination, and storage of project information in a timely and effective manner.

Many projects also draw on key resources who are not assigned to the project team but who provide valuable input and advice. A **subject matter expert** is someone who provides knowledge and expertise in a particular aspect important to the project. For example, an accounting system project may seek advice from a member of the internal auditing group in defining the mandatory control features of a new system. A **technical resource** is essentially a subject matter expert in an IS topic of value to the project. For example, the accounting system project may seek advice from a database management system guru (either inside or outside the company) to minimize the response time for certain key business transactions.

### Communications Management

**Communications management** involves the generation, collection, dissemination, and storage of project information in a timely and effective manner. It includes communications planning, information distribution, performance reporting, and managing communications to meet the needs of project shareholders. The key stakeholders include the project steering team, the team itself, end users, and others who may be affected by the project (potentially customers or suppliers).

In preparing a communications plan, the project manager should recognize that the various project stakeholders have different information needs. A useful tool for identifying and documenting these needs is the stakeholder analysis matrix, shown in Table 12.13. This matrix identifies the interests of

the stakeholders, their information needs, and important facts for managing communications with the champion, sponsor, project team members, and key end users associated with the project. The project manager should include his or her manager in this analysis. Based on analysis of this data, the preferred form and frequency of communication is identified for each stakeholder.

**TABLE 12.13** Sample stakeholder analysis matrix

Key Stakeholders	Ray Boaz	Klem Kiddlehopper	John Smith	Forklift Drivers
<b>Organization</b>	Project champion and VP of supply chain	Project sponsor and warehouse manager	Experienced forklift driver	15 different drivers
<b>Useful facts</b>	<ul style="list-style-type: none"> <li>Very persuasive</li> <li>Trusted by CEO</li> </ul>	<ul style="list-style-type: none"> <li>Risk taker, very aggressive</li> <li>Will push this through, no matter what</li> </ul>	<ul style="list-style-type: none"> <li>Has driven forklift truck for five years</li> <li>Well respected by peers</li> </ul>	<ul style="list-style-type: none"> <li>Not highly motivated to make project a success</li> </ul>
<b>Level of interest</b>	High	High	Medium	Low
<b>Level of influence</b>	High	Medium	High	Low
<b>Suggestions on managing relationship</b>	<ul style="list-style-type: none"> <li>Demands respect, somewhat formal</li> <li>Speak in business terms, never get technical; no surprises!</li> </ul>	<ul style="list-style-type: none"> <li>Poor listener, forgets details</li> <li>Put it in writing</li> </ul>	<ul style="list-style-type: none"> <li>Must keep John enthusiastic about project</li> </ul>	<ul style="list-style-type: none"> <li>Don't ignore</li> <li>Attend occasional shift changeover meeting</li> </ul>
<b>Information needs</b>	<ul style="list-style-type: none"> <li>ROI, budget, and schedule</li> </ul>	<ul style="list-style-type: none"> <li>Schedule and potential operational conflicts</li> </ul>	<ul style="list-style-type: none"> <li>Schedule, especially timing of training</li> <li>Safety and productivity issues</li> </ul>	<ul style="list-style-type: none"> <li>Schedule, especially timing of training</li> <li>Safety issues</li> </ul>
<b>Information medium, format, and timing</b>	<ul style="list-style-type: none"> <li>Biweekly face-to-face meeting</li> </ul>	<ul style="list-style-type: none"> <li>Weekly newsletter</li> <li>Biweekly face-to-face meeting</li> </ul>	<ul style="list-style-type: none"> <li>Newsletter</li> <li>Catch-as-catch-can</li> </ul>	<ul style="list-style-type: none"> <li>Brief updates at weekly department meeting</li> </ul>

If the project team is unable to recruit either a project champion or sponsor, the problem may be that management does not see clearly that the benefits of the project outweigh its costs, or that the project appears to run counter to organizational goals and strategies. A potential project without either a champion or a sponsor is highly unlikely to get the needed resources, and for good reason. No project should be started without both a champion and a sponsor.

### Risk Management

**project risk:** An uncertain event or condition that, if it occurs, has a positive or a negative effect on a project objective.

“Things will go wrong, and at the worst possible time,” according to a variation of Murphy’s Law, a popular adage. **Project risk** is an uncertain event or condition that, if it occurs, has a positive or a negative effect on a project objective. Known risks are risks that can be identified and analyzed. For example, in creating a new IS-related system that includes the acquisition of new computing and/or networking hardware, a known risk might be that the hardware will take longer than expected to arrive at the installation site. If the hardware is delayed by several weeks, it could have a negative effect on the project completion date. Countermeasures can be defined to avoid some

known risks entirely, and contingency plans can be developed to address unavoidable known risks if they occur. Of course, some risks simply cannot be anticipated.

**risk management:** A deliberate and systematic process designed to identify, analyze, and manage project risks.

A hallmark of experienced project managers is that they follow a deliberate and systematic process of **risk management** to identify, analyze, and manage project risks. Having identified potential risks, they can make plans to avoid them entirely. When an unavoidable risk occurs and becomes an issue, the project team has already defined an alternative course of action to minimize the impact on the project. They waste no time executing the backup plan. Unknown risks cannot be managed directly; however, an experienced project manager will build some contingency into the project budget and schedule to allow for their occurrence.

While inexperienced project managers realize that things may go wrong, they often fail to identify and address known risks and do not build in contingencies for unknown risks. Thus, they are often unsure of what to do, at least temporarily, when a project setback occurs. In their haste to react to a risk, they may not implement the best course of action.

The project manager needs to lead a rigorous effort to identify all risks associated with the project. The project team, business managers, and end users should participate in the effort. These resources can include seasoned project managers and members of the organization's risk management department. After each risk is identified and defined, as shown in Table 12.14, the group should attempt to classify the risk by the probability that it will occur and the impact on the project if the risk does occur. Both the probability and the impact can be classified as high, medium, or low, as shown in the example in Table 12.14.

**TABLE 12.14** Identification of project risks

Risk	Example
R1	The required new servers arrive at the installation site more than two weeks late.
R2	Business pressures make key end users unavailable to develop the user acceptance test by the date it is needed.
R3	Business pressures make end users unavailable during the time scheduled for training.
R4	One or more end-user computers have insufficient memory or CPU capacity to run the new software efficiently (or at all).
Rn	....

**TABLE 12.15** Example of an assessment of project risks

		Impact on Project		
		Low	Medium	High
Probability of risk occurring	High	R10		R2, R3
	Medium	R5, R6	Rn	R1
	Low	R8, R11	R7, R9	R4

Dark = High risk/high impact; risk management plan is needed

Lightest = Medium or high risk and impact; risk management plan recommended

Lighter = Low or medium risk and impact; risk management plan not needed

**risk owner:** The individual responsible for developing a risk management strategy and monitoring the project to determine if the risk is about to occur or has occurred.

The project team then needs to consider which risks need to be addressed with some sort of risk management plan. Generally, the team can ignore risks with a low probability of occurrence and low potential impact. Risks with a high probability of occurrence and a high potential impact need to have a risk owner assigned. The **risk owner** is responsible for developing a risk management strategy and monitoring the project to determine if the risk is about to occur or has occurred. One strategy is to take steps to avoid the risk altogether, while another is to develop a backup plan. The risk management plan can be documented as shown in Table 12.16.

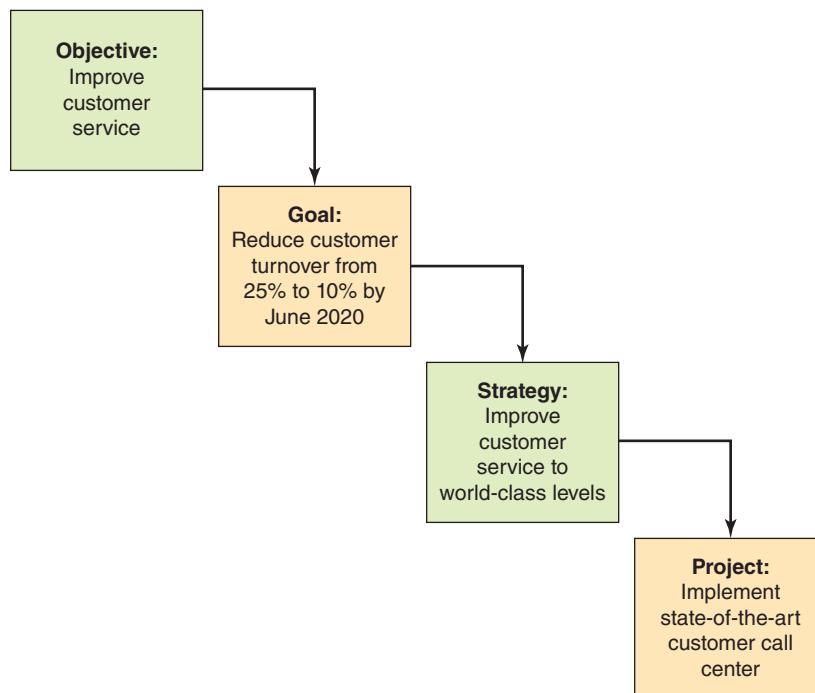
**TABLE 12.16** Risk management plan

Risk	Description	Risk Owner	Risk Strategy	Current Status
R2	Business pressures make key end users unavailable to develop the user acceptance test by the deadline.	Jon Andersen, manager of end users in the business area	Try to avoid this problem by starting development of the user acceptance test three weeks earlier than originally planned. Monitor progress carefully.	Key users have been identified and have started developing the test.
R3	Business pressures make end users unavailable during the time scheduled for training.	Jon Andersen, manager of end users in the business area	Try to avoid this problem by hiring and training four temporary workers to fill in for end users as they participate in training.	Three of four temporary workers have been hired. Their training is scheduled to begin next week.
R1	The required new servers arrive at the installation site more than two weeks late.	Alice Fields, team member responsible for hardware acquisition	Set a firm delivery deadline with the vendor, with a substantial dollar penalty for each day that the equipment is late.	The contract with the penalty clause has been signed by the vendor, who agrees to provide a shipment status update each Tuesday and Friday.

One of the biggest risks associated with a project is that considerable time, energy, and resources might be consumed with little value to show in return. To avoid this potential risk, an organization must ensure that a strong rationale exists for completing a project. The project must have a direct link to an organizational strategy and goal, as shown in Figure 12.18. In this example, assume that an organization has been losing sales because of customer dissatisfaction. It has set an objective of improving customer service, with a goal of increasing the retention rate of existing customers. The organization has defined one of its key strategies as improving customer service to world-class levels. A project that is consistent with this strategy and that can deliver results to achieve this goal is clearly aligned with the organization's objectives.

- **Objective.** Improve customer service.
- **Goal.** Reduce customer turnover from 25 percent per year to 10 percent by June 2020 by responding to 95 percent of customers' inquiries within 90 seconds, with less than 5 percent callbacks about the same problem.
- **Strategy.** Improve customer service to world-class levels.
- **Project.** Implement a state-of-the-art customer call center with "24/7" availability and a well-trained staff.

**FIGURE 12.18**  
**Projects must be well linked to an organizational goal and strategy**



Risk management software—such as Risk Management from Intelix, Full Monte from Barbecue, and RiskyProject from Intaver Institute—integrates with project scheduling software and can reflect the potential impact of various risks on the project schedule and cost. Use of such software can lead to more realistic estimates for project milestones and budgets.

### Procurement Management

**procurement management:** A set of activities related to the acquisition of goods and/or services for the project from sources outside the performing organization.

**Procurement management** is a set of activities related to the acquisition of goods and/or services for a project from sources outside the performing organization. Procurement management is divided into the following processes:

- **Plan purchase and acquisition.** This process determines what is needed and when.
- **Plan contracting.** This process documents requirements for products and services and identifies potential providers.
- **Request seller responses.** This process obtains bids, information, proposals, or quotations from potential providers.
- **Select seller.** During this process, offers are reviewed, the preferred provider is identified, and negotiations are started.
- **Contract administration.** This process manages all aspects of the contract and the relationship between the buyer and the provider. The process includes tracking and documenting the provider's performance, managing contract changes, and taking any necessary corrective actions.
- **Contract closure.** This process completes and settles the terms of any contracts, including resolving any open items.

**make-or-buy decision:** The act of comparing the pros and cons of in-house production versus outsourcing of a given product or service.

The make-or-buy decision is a key decision made during the plan purchase and acquisition process. The **make-or-buy decision** involves comparing the pros and cons of in-house production versus outsourcing of a given product or service. In addition to cost, two key factors to consider in this decision are (1) "Do we have a sufficient number of employees with the skills and experience required to deliver the product or service at an acceptable level of quality and within the required deadlines?" and (2) "Are we willing to invest the management time, energy, and money required to identify, recruit, train, develop, and manage people with the skills to do this kind of work?"

A contract is a legally binding agreement that defines the terms and conditions of the buyer–provider relationship, including who is authorized to do what, who holds what responsibilities, costs and terms of payment, remedies in case of breach of contract, and the process for revising the contract. Contract types fall into three main categories:

**fixed-price contract:** A contract in which the buyer and provider agree to a total fixed price for a well-defined product or service.

**cost-reimbursable contract:** A contract that requires the buyer to pay the provider an amount that covers the provider's actual costs plus an additional amount or percentage for profit.

**time and material contract:** A contract that requires the buyer to pay the provider for both the time and materials required to complete the contract.

- **Fixed-price contract.** With this type of contract, the buyer and provider agree to a total fixed price for a well-defined product or service. For example, the purchase of a large number of laptop computers with specified capabilities and features frequently involves a fixed-price contract.
- **Cost-reimbursable contract.** This type of contract requires the buyer to pay the provider an amount that covers the provider's actual costs plus an additional amount or percentage for profit. Three common types of cost-reimbursable contracts exist. In a cost-plus-fee or cost-plus-percentage of cost contract, the provider is reimbursed for all allowable costs and receives a percentage of the costs as a fee. In a cost-plus-fixed-fee contract, the provider is reimbursed for all allowable costs and receives a fixed fee. In a cost-plus-incentive-fee contract, the provider is reimbursed for all allowable costs. In addition, a predetermined fee is paid if the provider achieves specified performance objectives—for example, the provider's hardware must be received, installed, and operational by a specific date. In such contracts, buyers run the risk of paying more for the work but are rewarded by having their objectives met or exceeded. Providers run the risk of reduced profits if they fail to deliver, but can be rewarded for superior performance.
- **Time and material contract.** Under this type of contract, the buyer pays the provider for both the time and materials required to complete the contract. The contract includes an agreed-upon hourly rate and unit price for the various materials to be used. The exact number of hours and precise quantity of each material are not known, however. Thus, the true value of the contract is not defined when the contract is approved. If not managed carefully, time and material contracts actually can motivate suppliers to extend projects to maximize their fees.

Poor procurement management can result in serious project problems and even a project's outright cancellation.

### **Project Integration Management**

Project integration management is perhaps the most important knowledge area because it requires the assimilation of all nine other project management knowledge areas. **Project integration management** requires the coordination of all appropriate people, resources, plans, knowledge, and efforts to complete a project successfully. According to the Project Management Institute (PMI), project integration management comprises seven project management processes:

1. Developing the project charter that formally recognizes the existence of the project, outlines the project objectives and how they will be met, lists key assumptions, and identifies major roles and responsibilities.
2. Developing the project management plan that describes the overall scope, schedule, and budget for the project; this plan coordinates all subsequent project planning efforts and is used in the execution and control of the project.
3. Directing and managing project execution by following the project management plan.
4. Managing project knowledge by using past projects and documenting new knowledge acquired.

#### **project integration management:**

The coordination of all appropriate people, resources, plans, knowledge, and efforts to complete a project successfully.

5. Monitoring and controlling the project work to meet the project's performance objectives; this process requires regularly measuring effort and expenditures against the project tasks, recognizing when significant deviations occur from the schedule or budget, and taking corrective action to regain alignment with the plan.
6. Performing integrated change control by managing changes over the course of the project that can affect its scope, schedule, and/or cost.
7. Closing the project successfully by gaining stakeholder and customer acceptance of the final product, closing all budgets and purchase orders after confirming that final disbursements have been made, and capturing knowledge from the project that may prove useful for future projects.

As an example of a firm that excels in project integration management, consider Atos, an international IS services company that employs over 110,000 workers in more than 73 countries,<sup>58</sup> with 2018 annual revenue of €13 billion (\$12.2 billion U.S. dollars).<sup>59</sup> The firm successfully delivered the information technology systems that enabled the smooth running of the Sochi 2014 Olympic Games in Russia. Atos had the primary responsibility for project integration, consulting, systems integration, operations management, information security, and software applications development for the games. Through its experience with previous Olympics (Atos has been the worldwide IS partner for the Olympic Games, both winter and summer, since Salt Lake City in 2002), Atos has developed an effective project management process. The firm spent over four years configuring, testing, and retesting some 10,000 pieces of equipment deployed to 30 different venues. Atos coordinated the work of hundreds of subcontractors to deliver a reliable IS infrastructure and IS services in support of one of the world's widely viewed sporting events. The Sochi project was coordinated so that custom software, thousands of workstations and laptops, tens of thousands of phones, hundreds of servers, and multiple operations centers and data centers all operated together effectively and efficiently.<sup>60</sup>

### **Stakeholder Management**

**stakeholder management:** A set of activities that involves identifying, engaging, communicating with all the people, groups, or organizations who are or could be impacted by a project.

As the newest addition to the *Project Management Body of Knowledge (PMBOK Guide, 6<sup>th</sup> edition)*, **stakeholder management** has recently been recognized as an essential component of a successful project. Stakeholder management is a set of activities that involves identifying, engaging, communicating with all the people, groups, or organizations who are or could be impacted by a project. It is important to note that different people and groups have different levels of engagement needs. For example, imagine that ABC Corporation is building a new customer invoicing system. Once system development begins, the company's president wants to know high-level information, such as cost and schedule overruns. The IT director will need to know resource and data needs, as well as testing results. The employees who will use the new system only need to know when the system will be implemented and when they will be trained.

Within stakeholder management, there are four processes:

1. All stakeholders must be identified. This process is not a one-time endeavor; rather, this list must be regularly reviewed and updated.
2. The level of stakeholder engagement must be known and planned for. This is based on each stakeholder's need, expectations, and interest level in the project.
3. The level of engagement must be managed. The project manager must work with the stakeholders to satisfy their desired levels of engagement.
4. The levels of engagement must be monitored. Changes must be made to satisfy the desired levels of engagement.<sup>61</sup>

Several types of matrices can be used to manage the engagement and communications plans for stakeholders. In the stakeholder engagement assessment matrix (shown in Table 12.17), each stakeholder is assessed in two different ways: their current engagement level and their desired engagement level.

**TABLE 12.17** Stakeholder engagement assessment matrix

Stakeholder	Unaware	Resistant	Neutral	Supportive	Leading
Mary Jones	C			D	
David Smith			C	D	
Andre Ruiz				D C	

"C" denotes current level of engagement

"D" denotes desired level of engagement

The matrix is used to depict each stakeholder's current engagement level with the project and the engagement level that they desire.

Comparatively, the stakeholder registry (shown in Table 12.18) contains information regarding the stakeholder's position, requirements, expectations, influence level, and interest level.

**TABLE 12.18** Stakeholder registry

Name	Title	Department	Requirements	Influence (L/M/H)	Interest (L/M/H)
Mary Jones	Accounts Payable Clerk	Accounting	Needs to invoice customers	L	H
David Smith	IT Manager	IT	Must integrate new system with database	M	H
Andre Ruiz	Accounts Payable Manager	Accounting	Invoicing system must be efficient	H	H

Additionally, communications with stakeholders needs to be planned and executed on a regular basis. Project managers also develop a stakeholder communication plan (see Table 12.19) to manage the level of communication required throughout the project.

**TABLE 12.19** Stakeholder communication plan

Name/Group	Contact Information	Type of Information	Delivery Method	Delivery Frequency	Person Responsible
Mary Jones	mjones@abc.com	Monthly status	Email	Monthly	Project Manager
David Smith	dsmith@abc.com	Status reports, Monthly budget report, Goals, implementation plans, Scope changes	Email	Weekly status reports, Monthly reports, as needed	Business Analyst, Project Manager
Andre Ruiz	aruiz@abc.com, Bldg 12	Status reports, Monthly budget report, Requirements	Email, Paper	Weekly	Project Manager



## Critical Thinking Exercise

### Reluctant Project Sponsor

#### ► BEHAVIORS IN ORGANIZATIONS

You are on the phone with the project sponsor of a \$2 million project you are managing. She informs you that she accepted the role reluctantly, and now, one month into this eight-month project, she is considering withdrawing as project sponsor. She does not see the need for this role and is extremely busy with her other responsibilities.

#### Review Questions

1. What is the role of the project sponsor?
2. What might be the impact on the project if you attempt to proceed without a sponsor? Is it likely that some project tasks would need to be redone if a new sponsor is appointed?

#### Critical Thinking Questions

1. If you are unable to persuade the sponsor to remain on the project, should you enlist the help of the project champion? How might you do this in such a way that you do not appear weak and ineffective and avoid creating hard feelings with the current sponsor?
2. After speaking to the project champion, you and she both agree that the current sponsor should be replaced with someone new. What characteristics, traits, and experiences would you look for in a new sponsor?

## Summary

### Principle:

**Organizations that are more advanced in their planning processes develop multiple-year strategic plans.**

Strategic planning is a process that helps managers identify desired outcomes and formulate feasible plans to achieve their objectives using available resources and capabilities.

Goal-based strategic planning is divided into four phases: analyze situation, set direction, define strategies, and deploy plan.

The analyze situation phase involves looking internally to identify the organization's strengths and weaknesses and looking externally to determine its opportunities and threats.

An analysis of an organization's internal assessment and study of its external environment are frequently summarized into a Strengths, Weaknesses, Opportunities, Threats (SWOT) matrix.

The set direction phase involves defining the mission, vision, values, objectives, and goals of the organization.

SMART goals are specific, measurable, achievable, relevant, and time constrained.

The define strategies phase involves describing how an organization will achieve its mission, vision, objectives, and goals.

Deploy plan includes communicating the organization's mission, vision, values, objectives, goals, and strategies so that everyone can help define the actions required to meet organizational goals.

## Principle:

**Organizations must always make a clear connection among business objectives, goals, and projects. In addition, projects must be consistent with business strategies.**

The strategic planning process for the IS organization and the factors that influence it depend on how the organization is perceived by the rest of the organization. An IS organization can be viewed as a cost center/service provider, a business partner/business peer, or a game changer.

IS strategic planning is influenced by the corporate and business unit strategic plans as well as technology innovations and innovative thinking.

The IS strategy will set direction for the technologies, vendors, competencies, people, systems, and projects.

## Principle:

**Positive change is a key ingredient for any successful organization.**

Innovation is the application of new ideas to the products, processes, and activities of a firm, leading to increased value. Innovation is the catalyst for the growth and success of any organization. Innovation may be classified as sustaining or disruptive.

Business process reengineering is a form of innovation that involves the radical redesign of business processes, organizational structure, information systems, and values of the organization to achieve a breakthrough in results. Continuous improvement is a form of innovation that continually improves business processes to add value to products and services.

## Principle:

**The organizational appetite for innovation drives the changes within the firm's selected projects and processes.**

A project is a temporary endeavor undertaken to create a unique product, service, or result.

Roughly 14 percent of all IS projects fail.

Today, many organizations have recognized project management as one of their core competencies.

Five highly interrelated parameters define a project—scope, cost, time, quality, and user expectations. If any one of these project parameters is changed, there must be a corresponding change in one or more of the other parameters.

Project scope is the definition of which work is and which work is not included in a project.

The cost of a project includes all the capital, expenses, and internal cross-charges associated with the project's buildings, operation, maintenance, and support.

The timing of a project is frequently a critical constraint.

Quality of a project can be defined as the degree to which the project meets the needs of its users.

Project management is the application of knowledge, skills, and techniques to project activities to meet project requirements. Project managers must attempt to deliver a solution that meets specific scope, cost, schedule, and quality goals while managing the expectations of the project stakeholders—the people involved in the project or those affected by its outcome.

According to the Project Management Institute (PMI), project managers must coordinate 10 areas of expertise: scope, schedule, cost, quality, resources, communications, risk, procurement, integration, and stakeholder management.

Scope management includes defining the work that must be done as part of the project and then controlling the work to stay within the agreed-upon scope.

A process is a set of logically related tasks performed to achieve a defined outcome.

Schedule management includes defining an achievable completion date that is acceptable to the project stakeholders, developing a workable project schedule, and ensuring the timely completion of the project.

Cost management includes developing and managing the project budget.

Quality management is a set of activities designed to ensure that the project will meet the needs for which it was undertaken.

Project resource management includes activities to identify, acquire, and manage resources for a project.

The forming-storming-norming-performing-adjourning model describes how teams form, evolve, and dissolve.

Each project should have a project steering team—made up of senior managers representing the business and IS organizations—to provide guidance and support to the project. Three key members of the steering team are the project champion, project sponsor, and IS manager.

Communications management involves the generation, collection, dissemination, and storage of project information in a timely and effective manner.

Risk management is a process that attempts to identify, analyze, and manage project risks. Experienced project managers follow a deliberate and systematic process of risk management to avoid risks or minimize their negative impact on a project.

Procurement management is a set of activities related to the acquisition of goods and/or services for the project from sources outside the organization.

Project integration management is a critical knowledge area of project management that involves chartering, scoping, planning, executing, monitoring and controlling, change control, and project closing.

Stakeholder management is a set of activities that involves identifying, engaging, communicating with all the people, groups, or organizations who are or could be impacted by a project.

## Key Terms

core value	communications management
business process reengineering (BPR)	continuous improvement
goal	core competency
goals-based strategic planning	cost management
intangible benefit	cost-reimbursable contract
issues-based strategic planning	critical path
Michael Porter's Five Forces Model	culture
mission statement	diffusion of innovation theory
objective	fixed-price contract
organic strategic planning	forming-storming-norming-performing-adjourning model
strategic planning	Gantt chart
strategy	innovation
Strengths, Weaknesses, Opportunities, Threats (SWOT) matrix	make-or-buy decision
tangible benefit	network diagram
vision	organizational change
vision/mission statement	organizational culture
change model	predecessor task

procurement management  
 project  
 project champion  
 project deadline  
 project integration management  
 project management  
 project management  
 project milestone  
 project risk  
 project schedule  
 project scope  
 project sponsor  
 project stakeholder  
 project steering team  
 process redesign  
 quality  
 quality assurance  
 quality control

quality management  
 quality planning  
 process resource management  
 reengineering  
 risk management  
 risk owner  
 scope management  
 slack time  
 soft side of implementing change  
 sponsoring business unit  
 stakeholder management  
 subject matter expert  
 technical resource  
 technology acceptance model (TAM)  
 time and material contract  
 schedule management  
 work breakdown structure (WBS)

## Self-Assessment Test

**Organizations that are more advanced in their planning processes develop multiple-year strategic plans.**

1. Which phase of the goals-based strategic planning involves an in-depth analysis of the company and its competitors?
  - a. Analyze situation
  - b. Set direction
  - c. Define strategies
  - d. Deploy plan
2. The \_\_\_\_\_, \_\_\_\_\_, and \_\_\_\_\_ must be established before an organization can establish its goals and objectives.
  - a. Values, strategies, projects
  - b. Mission, values, strategies
  - c. Mission, vision, values
  - d. Vision, strategies, projects
3. The SWOT analysis is part of which phase in goals-based strategic planning?
  - a. Analyze situation
  - b. Define strategies
  - c. Set direction
  - d. Deploy plan
4. If an IS organization focuses on stopping IS redundancies and saving money, it would be considered a \_\_\_\_\_.
  - a. Cost center
  - b. Business partner
  - c. Game changer
  - d. Disruptive innovation

**Organizations must always make a clear connection among business objectives, goals, and projects. In addition, projects must be consistent with business strategies.**

5. Business value of a proposed project can be which of the following?
  - a. Tangible benefits
  - b. Intangible benefits
  - c. Unstructured benefits
  - d. Both A and B
6. Which type of project should result in an increase of company revenue?
  - a. Maintenance
  - b. Breakthrough
  - c. Mandatory
  - d. Enhancement
7. When identifying and selecting projects, an organization does all of the following EXCEPT:
  - a. Assess the risk of using new technologies
  - b. Assess the skill level of the proposed users
  - c. Consider other technological changes that this new project will require
  - d. Calculate the cost of the project and its expected rate of return

**The organizational appetite for innovation drives the changes within the firm's selected projects and processes.**

8. A \_\_\_\_\_ is a temporary endeavor undertaken to create a unique product, service, or result.

9. The five highly interrelated parameters of a project are:
  - a. scope, time, quality, stakeholders, and services
  - b. time, user expectations, quality, Gantt chart, and cost
  - c. quality, cost, services, time, and stakeholders
  - d. cost, time, quality, user expectations, and scope
10. According to the Project Management Institute (PMI), project managers must coordinate \_\_\_\_\_ areas of expertise.
  - a. three
  - b. five
  - c. seven
  - d. ten
11. The forming-storming-norming-performing-adjourning model describes:
  - a. the project phases
  - b. how teams form, evolve, and dissolve
  - c. how teams are selected
  - d. management phases of a project
12. The \_\_\_\_\_ category of innovation adoption is the first group to try new products and ideas.
  - a. early adopters
  - b. innovators
  - c. late majority
  - d. laggards

## Self-Assessment Test Answers

1. a
2. c
3. a
4. a
5. d
6. b
7. b
8. project
9. d
10. d
11. b
12. b

## Review and Discussion Questions

1. What organizational benefits are gained through strategic planning?
2. Uber's mission statement is "We ignite opportunity by setting the world in motion." As Uber expands into food delivery (UberEats), freight (UberFreight), transporting medical patients (UberHealth), and business rides (Uber for Business), is the mission statement still suitable for all of these business lines? What would prompt Uber to change the mission statement? Explain each item called out in Porter's Five Forces Model. How might an organization use this model?
3. Explain why the strategic planning pyramid is shaped as a pyramid. Why are the items displayed in this particular order?
4. In a SWOT matrix, how do strengths compare to opportunities? How do weaknesses compare to threats?
5. Explain why goals should be "SMART." What are the advantages of establishing SMART goals?
6. When resulting in mostly intangible benefits, how would you rank a project's priority level against other projects with quantifiable outcomes? How can technical innovations or other innovations drive strategy? Give examples where innovation changed the direction of a company.
7. How do you think the theory of innovation diffusion can be applied to Elon Musk's idea of underground tunnels and car elevators?
8. Define the term "project."
9. What is a core competency? Project scope? Project stakeholder?
10. Identify the five highly interrelated parameters that define a project. If one parameter is changed, how would the other four parameters be affected?
11. Identify and briefly describe the 10 areas of expertise that a project manager must coordinate.
12. Explain the difference between a WBS and a Gantt chart.
13. Imagine that you are going to put on a play at your college. Create a WBS diagram to outline all the activities necessary to complete this project.
14. What is the difference between quality planning, quality assurance, and quality control?
15. What is the difference between the stakeholder engagement assessment matrix, the stakeholder registry, and the stakeholder communication plan?

16. Think of a team of which you've been a part. Can you explain why the team performed so well (or poorly) using the forming-storming-norming-performing-adjourning model?
17. Identify some of the challenges of performing project integration management on a project in which team members are distributed globally and cannot physically meet in one location. How might these challenges be overcome?
18. What is the purpose of risk management? Outline the risks you faced on the first day of college. Have any of these risks changed since then?
19. What is the difference between business process reengineering and continuous improvement? Which one of these would qualify as a project?
20. Imagine that you are hiring a firm to complete a large project using unproven technology. Which form of contract would you prefer and why?

## Business-Driven Decision-Making Exercises

1. Many free and open source project management software programs are available online, such as Asana, BaseCamp, Bitrix24, GanttProject, MeisterTask, Trello, and Zoho. Choose one of these programs or use a spreadsheet or another project management program with which you are familiar. Create a Gantt chart using the values from the table below. How long will it take to complete a project consisting of these tasks? Identify the critical path for this project.

Task	Duration	Predecessor Task
A	5	
B	3	
C	4	A, B
D	8	D
E	5	C
F	3	D, E

2. Think of a project that you have previously worked on. Create a stakeholder registry for this project.

## Teamwork and Collaboration Activities

1. Your team has just inherited \$500,000. The team has agreed to invest this money by purchasing an existing business. Choose a local business and perform a SWOT analysis on this business. Look at the business' website and compare it to its competitors. Identify reasons to purchase or not purchase this business. Is a Web presence necessary for this business? What critical changes should be made to the current website to meet the business' and customers' needs?
2. As a team, you are to analyze the IS department at your school. One or two team members will begin by interviewing the IS manager to find out what IS projects are currently underway. Concurrently, other team members will research your school's strategic plan, mission statement, vision, and values. Armed with this information, your team must decide if the IS department at your school should be classified as a cost center, business partner, or game changer? Why? Do the current projects align with the school's strategic plan? Why or why not?
3. Your team has been hired as consultants to work with a large city to implement a program to place hundreds of high-tech digital cameras in strategic locations to aid in reducing crime and speeding help to victims. The cameras are state-of-the-art with infrared capability for night vision, high resolution, and rapid zoom in and out capability. Your city will be the first in the United States to deploy them. The manufacturer is a relative newcomer to the digital camera industry. The program has not yet been fully funded, nor has it been announced to the residents of the city. The city management and top-level officers within the police department are fully behind the program; however, lower level officers and cops on the street have mixed support. Your team has been asked to perform a risk assessment for this project. You are to identify various risks that could occur; assign them a high, medium, or low level of risk, and assess the potential impact (high, medium, or low) on the project if that risk should occur.

## Career Exercises

1. Visit the Project Management Institute (PMI) website at [www.pmi.org](http://www.pmi.org). Do research to learn more about the value that employers place on project management certification. What are the certifications offered by PMI that you may be qualified to take? Search job listings for project managers. Do they require PMI or other certifications?
2. Can you state the vision and mission of your organization or college? Has it documented its core values? Can you identify any key objectives and strategies?
3. Talk with your manager and others at work about the need for good project management in your organization. Do the people you spoke with see project management as a core competency? Do they feel that there is a shortage of good project managers?

## Case Study

### ► GLOBAL

#### Strategic Shift at Microsoft

Microsoft, a company known well for its operating systems and productivity software, is currently one of the world's most valuable companies, valued at around \$1 trillion, as of 2019. The value stems from a strategic shift by Microsoft from their obsessive focus on the Windows operating system to a focus on delivering cloud services and embracing open source. This turnaround is not only affecting the planning and strategy of Microsoft, but also caused a major change in their employees and the company culture.

There has been a tremendous growth in cloud services, as more and more companies store their data in the cloud rather than on-premise. Microsoft's Azure cloud division has grown rapidly and is strongly competing with Amazon's cloud services. Judson Althoff, EVP Worldwide Commercial Business at Microsoft says, "It's not about selling product anymore," he said. "It's using cloud services to transform their business. This new wave of compute – the intelligent cloud and the intelligent edge – will shape everything we do for decades to come. This is your opportunity. This will create more opportunities for the Microsoft ecosystem than we have seen in our history. It's not some science future story. It's here and it's now."

Interest in the cloud has not only changed the way companies save data, but it's also changed the way the providers make their money. The method that Microsoft accounts for their sales has completely changed with the new strategy. Before, money was earned by customers buying licenses for the software operating systems. Now, money is only earned with the time that the customer uses the cloud service.

Since the market-focus has been turned to a completely different model, the company culture has changed dramatically. 40,000 Employees had to be trained to understand how their customers used the cloud, so they could encourage more usage. Sales personnel no longer prepared sales forecasts but concentrated more on retaining and obtaining customers. In addition, salespeople were given different incentives for sales, since the revenue generated is so different with cloud services. Microsoft also used technology to make meetings less frequent but more productive, enable salespeople to spend more time with their customers and change manager's behavior through technology to spend

more time with employees. Meeting technology allows participants to gauge how useful meetings are by measuring how much the participants were on their smartphones. "The shift has been successful so far because it has not just strategic insight but change in focus across the workforce."

Microsoft is also working with regulators to ensure compliance. The design of Azure ensure that any data-protection laws can be easily adhered to. Azure's top officer, Brad Smith, proposed policies, "such as a 'Digital Geneva Convention' to protect people from cyber-attacks by nation-states. He is also behind Microsoft's comparatively cautious use of artificial intelligence and calls for oversight of facial recognition. The firm has been relatively untouched by the current backlash against tech firms and is less vulnerable to new regulation."

In conclusion, the technology disruption that Microsoft faced could have brought down the company, since they were so focused on their operating system. But they were able to not only make a strategic planning shift, but also change the employees and their culture to greatly succeed.

#### Critical Thinking Questions

1. Trace the history of Microsoft's financials. Use Excel to graph its stock value to see when the turnaround discussed in this case began to have an effect.
2. Microsoft was able to make meetings less frequent but more productive. Research the Internet for software that enables productive meetings. Choose one that looks the best and write a one-page paper on its features.

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## Principles

- Organizations can obtain software using one of three basic approaches: subscribe, buy, or build.
- When evaluating and purchasing off-the-shelf software, an organization must consider the effort required to modify both the new software package and the existing software so that they work well together.
- A system developed using the Waterfall approach moves from one phase to the next, with a management review at the end of each phase.
- Agile development is an iterative system development process that develops a system in “sprint” increments lasting from two weeks to two months.

## Learning Objectives

- Identify the pros and cons associated with subscribing to, buying, and building software.
- Explain the advantages and disadvantages of the software as a service (SaaS) model.
- Identify two approaches to software development.
- Outline a process for evaluating and selecting a software package.
- Identify the key factors to be considered when selecting a software package.
- Identify the advantages and disadvantages of the Waterfall approach to system development.
- Identify and state the goal of each of the six phases of the Waterfall approach.
- Identify and briefly describe the primary tools and techniques used during system development.
- Define five types of feasibility that must be assessed.
- Identify the purpose and participants involved in various types of testing from unit testing to user acceptance testing.
- Identify three approaches for system cutover.
- Describe the Agile development process.
- Identify the advantages and disadvantages of the Agile system development approach.
- Describe the role of the Scrum master and product owner in the Scrum framework.
- Discuss extreme programming (XP) and DevOps.

# IS in Action

## Maine Goes Agile

### ► ANALYTICAL THINKING, APPLICATION

When Jim Smith started as CIO for the state of Maine, the Office of Information Technology was using traditional Waterfall methods for all its development projects. However, when Jim began looking into current and past IT projects at the state level, he found that many projects were failing. They were coming in late or over budget—or not coming in at all. With the Waterfall methodology, projects were taking two to three years to complete. Technology was changing at a much faster rate than the IT staff could develop.

Based on his findings, Smith, along with Associate CIO Paul Sandlin, decided it was time for the department to make significant changes to the way in which new systems and applications were developed. They began a transition into Agile development, knowing that it would take time to have everyone trained. “It’s a cultural shift, because people are used to that two or three years of analysis and design” says Smith. According to Sandlin, the first step was ensuring that both the product owner and the IT staff were making the right decisions based on the needs of the agency and not their own individualized needs.

By making a slow and well-planned transition to Agile methods, Maine’s IT department has learned over the years how to harness the power of Agile to meet the needs of their customers and end users. Part of that transition has been educating others about why the department has chosen to move from Waterfall to Agile development by sharing lessons learned on the Web site of the department’s Project Management Office.

One key lesson is to start small. Agile has a learning curve, and it is better to learn and make mistakes on a smaller project than a large one. Also, team members need to be trained before they can be successful. Training during a project may result in a failed project. The department also emphasized the importance of communication. For an Agile project to be successful, the product owner must communicate effectively—in part, because if the owner is not communicating, the outcome may not fit the business needs. Communication with the customers and end users, who may not be familiar with IT and Agile terminology, is also critical. Talk on the level of the user so everyone can understand what is being said.

These are just a few of the lessons the IT department has identified as being key to success on Agile projects. Smith and Sandlin noted that while they were not perfect in their implementation, they learned a lot from their efforts and continue to work to make the process even better. Although there was not a “silver bullet” to their success, getting the businesses involved, engaging the customers, and delivering on time were all important factors.

Projects can fail for many reasons. Each company must decide which method will work best for them. Companies that are not getting the desired outcome should reevaluate their methodologies to identify necessary changes, provide additional training, and improve communication within the team.

#### As you read this chapter, consider the following:

- What options exist for organizations to acquire or develop an information system?
- What role should end users and other stakeholders play in the acquisition or development of a new system?

## Why Learn About System Acquisition and Development?

Throughout this book, you have seen many examples of the use of information systems to support organizations and people in a variety of careers. But where does an organization start when looking to acquire or develop these systems? And how can you work with IS personnel, such as system analysts and computer programmers, to get the information systems you need to succeed on the job or in your own business? This chapter provides the answers to these questions, along with specific examples of how new or modified systems are initiated, analyzed, designed, constructed, tested, and implemented in a number of industries. We start with a discussion of the forces that lead an organization to acquire new software and then move on to an overview of the three basic approaches to acquiring software.

### Subscribe vs. Buy vs. Build

Organizations continue to spend considerable time and resources developing and acquiring software to support a wide range of applications, including business intelligence and analytics, e-commerce, enterprise-level functions, and mobile apps. Opportunities and problems that frequently trigger the initiation of an information system project include the following:

- Organizations may pursue opportunities to use information systems to support a key organization strategy or to seize a significant, and ideally long-term, competitive advantage. To better leverage its cloud-based logistics software and keep up with customer demand, Amazon started the Amazon Delivery Service Partner program, which allows individuals to start a small delivery service company as a partner with Amazon. Once an individual's application to the program is accepted and approved, Amazon provides three weeks of training along with an operations and technology tool kit that helps the new owners start to build their delivery service business.<sup>1</sup>
- The need to improve business processes prompts some businesses to pursue opportunities outside their traditional areas of business. Dealer Tire, a tire and automotive parts distributor, asked its data analytics team to predict when each customer would need new tires. This simple question led to the development of the Tire Trigger application, which allows dealers to send notifications to consumers when it is time to consider replacement purchases, much like a health care notification for a checkup. Dealer Tire has different models of the Tire Trigger application that it can sell to dealers, in addition to its more traditional automotive products, based on their needs. The expectation is that "By 2020, analytics that can help companies predict outcomes and prescribe courses of action will attract 40 percent of enterprises' new investment in business intelligence and analytics software, according to Gartner research."<sup>2</sup>
- To stay competitive and profitable, companies must upgrade the core tools they use to deliver products and services to their customers. Suddath Company, a successful, 100-year-old commercial moving company, did just that with the development of its Suddath Estimator software. By combining mobile and cloud technology, machine learning, and software algorithms, Suddath was able to transform its business by eliminating the time-consuming manual estimating process used by its salespeople. Using the Estimator software, Suddath salespeople are now

able to quickly create accurate digital estimates. The new platform has not only saved the company time by cutting down on data entry and administrative tasks, it has also increased the sale conversion rate—resulting in higher revenue for the company.<sup>3</sup>

Organizations can obtain software using one of three basic approaches: subscribe, buy, or build. Subscribing to an on-demand software service, also known as software as a service (SaaS) or application as a service (AaaS), can be a more cost-effective way for an organization to obtain software.

Buying off-the-shelf software is less risky and leads to quicker deployment; however, maintenance and support costs may become expensive with this approach, and the software may not be an exact match to the needs and work processes of the organization.

Building custom software can provide a better match to the current work processes along with a potential competitive advantage; however, software development can be extremely costly, and it can take months or even years to develop custom software.

The advantages and disadvantages of these three approaches are summarized in Table 13.1.

**TABLE 13.1** The pros and cons of subscribing versus buying versus building

Strategy	Pros	Cons
<b>Subscribe</b>	The software can be a more cost-effective solution for small projects and a good fit for temporary needs. Software updates and upgrades are completed by the vendor after being tested for consistency. Technical support is typically available 24/7.	On-demand software is usually offered “as-is” and cannot be modified to match the organization’s needs. An organization incurs recurring licensing costs.
<b>Buy</b>	A software solution can be acquired and deployed relatively quickly. An organization can “test drive” software before acquiring it.	Unmodified, the software may not be a good match to an organization’s needs. Maintenance and support costs can become excessive.
<b>Build</b>	Customized software is more likely to be a good match to an organization’s needs. A custom application provides the potential to achieve competitive advantage.	The cost to build a system can be quite high compared to the cost of purchasing off-the-shelf software. Customized software can take months or even years to deploy.

Recall that SaaS is a software distribution model under which a third-party provider hosts an application and makes it available over the Internet to subscribers who typically pay a monthly fee per user. SaaS is discussed in detail in the next section.

Buying existing software developed by a software manufacturer enables an organization to test drive and evaluate it before making a major commitment to purchase it and install it. Once purchased, the existing software can be installed with minimal disruption (ideally) so that user needs can be quickly met, and the organization can begin reaping the benefits from the information system. Software buyers do not actually own the software, nor can they access it to make changes or improvements; they are simply licensed to use the software on a computer. With no access to the underlying source code, user organizations must pay maintenance and support costs to the manufacturer or to a third party authorized to fix bugs or add new functionality. For some organizations, these costs can become excessive. As a result, many organizations

turn to open source software, which permits access to the source code, so that it can be studied, changed, and improved by the organization's own software professionals—with no maintenance charges. Indeed, the amount and quality of support for open source software is dependent on whether there are people, resources, and interest among the organizations using the software to develop updates and fix bugs.

**system development:** The set of activities involved in building information systems to meet users' needs.

The set of activities involved in building information systems to meet users' needs is called **system development**. System development projects can range from small to very large and are conducted in fields as diverse as nuclear science research and video game development. If an organization elects to build a system, it can use its own employees (perhaps augmented with contractors) to develop the system, or it can hire an outside company to manage and/or perform all the system development work. The latter approach allows an organization to focus on what it does best, by delegating software development to companies that have world-class development capabilities. This can be important because the system development efforts for even relatively small projects can require months, with large projects requiring years of effort. Unfortunately, despite everyone's best efforts, a significant number of large system development projects fail.

Organizations can use several different approaches when developing their own software. Two of those—the Waterfall and Agile software development processes—are discussed later in this chapter.



## Critical Thinking Exercise

### Buy or Build for Investment Opportunity

#### ► SYSTEMS AND PROCESSES, DECISION MAKING

Package Form (fictional) is a small manufacturing company that creates display packaging for boxed items, such as toys and household items. To increase sales, the owners of the company have decided to expand into floor displays and billboards. Their financial advisors have told them that investors will want to see design samples before committing money to their project, which means the expansion can only take place if the investors are impressed by the designs.

You are a member of the IT department at Package Form, and you have been asked to research the software required to develop the new product demonstrations. You have found that the software can be purchased from various vendors and that there are even some open source options that could be modified to fit the organization's needs. You also have in-house software developers that could modify your existing software so it could be used to develop the product samples. The decision on how to proceed must be made quickly, and you have a limited budget.

#### Review Questions

1. Outline the available options, including the pros and cons of each.
2. Given the short time frame, would you consider modifying the current software to meet the needs of the company? Why or why not?

#### Critical Thinking Questions

1. How would you go about identifying the requirements for the new software? How would you research the software needed?
2. What do you think might be the biggest barriers to finding the right software to meet the needs of the company with a limited budget?

## Software as a Service (SaaS)



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Microsoft Office 365 is an example of a SaaS product. Microsoft offers this productivity suite for individuals and organizations, with multiple subscription options available, including monthly or annual commitments. The price of the subscription varies based on which applications and services are included, as well as the number of users.<sup>4</sup>

Adobe also offers subscription-based licenses for its Creative Cloud suite, which includes applications such as InDesign, Illustrator, and Photoshop. As with Office 365, different Creative Cloud licenses are designed to meet the needs of individual, businesses, schools, and universities. The license costs are based on the number of applications—with up to 20 applications available—and the number of users. Different pricing structures allows individuals and companies to select the option that best meet their needs. Adobe even offers a consultant to help businesses and other organizations select the right licensing option.<sup>5</sup>

SaaS is often associated with platform as a service (PaaS) and infrastructure as a service (IaaS). PaaS is an application cloud deployment method that provides users with a complete computing platform, typically including operating system, programming language execution environment, database services, and Web server. PaaS enables an organization's developers to create software applications and collaborate on project regardless of their physical location. The management of the software and data storage is performed by the vendor.

With IaaS, an organization outsources the equipment used to support its data processing operations, including servers, storage devices, and networking components. Under an IaaS license, the organization manages the data and applications while the vendor manages the operating system and virtualization. Unlike a PaaS license, an IaaS license allows the organization to pay only for the amount of hardware it uses. As the usage increases, the fee will increase.<sup>6</sup>

### Advantages of SaaS

There are many advantages to obtaining software via a SaaS subscription. One advantage is how quickly the company can benefit from the software. After a decision has been made to acquire new software, a timeline is established for the project. Sometimes this timeline is short due to the needs of the company. Utilizing SaaS allows the company to bypass the process of verifying if existing hardware will run the new software and avoid the expense of upgrading hardware before purchasing and installing software. Because SaaS runs in the cloud, companies can more quickly realize a return on their investment.<sup>7</sup>

Another advantage of subscription-based software is the technical support typically offered with this type of license. A business relies on its data being available, so technical support is vital to ensuring its operations are not interrupted. When evaluating subscription-based software, an organization must determine the level of technical support that will be provided with the subscription. Researching this topic might be a simple matter of reviewing the vendor's Web site for technical support details, Microsoft and Adobe, for instance, include information on the availability of technical support (24 hours a day, 7 days a week) on their Web sites. Technical support should be on the list of factors reviewed before purchasing any SaaS software.

SaaS is deployed over the Internet, meaning deployment and management is handled from a centralized location. SaaS models utilize cloud storage and Internet browsers for data access and user interface, which lets companies save money on technical support staff and in-house technology expense.<sup>8</sup> A company can run its business from a computer with any browser—or even from a mobile device. Employees can access data from anywhere in the world, and the data remains secure on the server.

Another advantage of SaaS is its lower implementation costs. Most SaaS providers develop software to run on a wide variety of browsers, so companies can run on existing hardware. SaaS software can be implemented, or deployed, during normal business hours, as the software is not installed on the organization's computers. Users can be trained online, or the price of training can be negotiated within the contract, for minimal impact on productivity. All of this enables quick integration and little to no downtime.

Unlike off-the-shelf software, which must be licensed for each computer, SaaS software can be licensed on a per user basis, meaning the fees are based on the number of users logged into the system at any given time. Once capacity is reached, additional users must wait until someone exits the system before they can gain entry. As the company grows, the licenses or seats, can be increased. Adding capacity in this manner saves both time and money for the organization. Depending on the size of the organization, this feature can give the company flexibility in managing its software costs.

Upgrades to software can be costly for purchased software. If a **perpetual license** has been purchased, then upgrades, which can be expensive, must be evaluated. If a security-related upgrade is not performed, the business risks opening itself to viruses, hackers, and ransomware. Some software packages may require that upgrades be installed for continued support. SaaS software upgrades, on the other hand, are tested by the provider and then deployed via the Web. These upgrades are included in the contract, unless requested otherwise. If the software has been customized, the vendor performs testing to ensure the upgrades are not affected.

Scalability, the ability of the software and hardware to expand and adapt with increasing demand, can be a concern to a growing company. SaaS software offers a solution in terms of both scalability and flexibility. As the company grows, new tools or capabilities can be turned on by the provider without the company needing to upgrade servers or expand data storage. The provider controls, or owns, those responsibilities, so the company's IS department can focus their efforts on the day-to-day operations of the business. For smaller companies that outsource their support services, or do not have developers on staff, this level of service can provide significant savings in terms of both time and money.

## Disadvantages of SaaS

Companies must also evaluate any potential disadvantages before deciding to implement SaaS. If a company does not do its due diligence, it could end up paying for a software subscription that is costly and does not meet its needs.

**perpetual license:** A license provided for one installation, with new software editions requiring new licenses; usually purchased by the bundle, called seats, and loaded on individual computers.

Because SaaS is deployed over the Internet, it requires a company to have a stable Internet connection. Although most software packages allow users to work offline and synchronize data when a connection becomes available, this is not the optimal way to conduct business. If users rely on having the most up-to-date data, working offline may cause errors and rework. Even after a connection is reestablished, if a record has been updated by multiple users, the software may not be able to synchronize all the updates. Before utilizing SaaS, a company should perform an analysis of its connectivity to ensure the best outcome for productivity.<sup>9</sup>

Another potential area of concern is the sharing of data with a third-party provider. Security and privacy are topics that must be addressed by all organizations. Software companies that rely on a third-party vendor to host their data must be secure in the knowledge that the data is protected. Some questions that must be asked are (1) What security protocols are in place? (2) Are regular security updates being performed? (3) Who has access to the server? (4) What type of monitoring is in place? (5) What is your reporting protocol? These questions should be answered before any contract is signed. Some organizations must take it even farther due to regulations, such as HIPAA (the Health Insurance Portability and Accountability Act), which has strict guidelines related to security and privacy. Under HIPAA, organizations that have data breaches can be penalized millions of dollars per breach. One question that should be asked by organizations covered under HIPAA is “Where is the data stored?” Even if the data storage unit is outside of the United States, the organization must still ensure that security measures are taken to protect the data. If the data is breached, federal laws, including the penalties of HIPAA, still apply.<sup>10</sup>

When researching SaaS options, the decision makers in the organization must look at more than just the functionality of the software. Along with security issues and the availability of specific tools, the software provider itself must be researched. After a provider is selected and the software is implemented, there will be an ongoing relationship between the business and the provider. A contractual agreement should detail the conditions under which either party can terminate the contract. For example, what happens if the provider files for bankruptcy? Who would be the legal owner of the data on the provider’s servers? Would the software cease to run? Including contract clauses that address these types of concerns is standard practice for established SaaS providers.



## Critical Thinking Exercise

### New Project Software

#### ► DECISION MAKING

Alpha Furniture Company (fictional) is a small, family-owned furniture company that uses installed licensed software. The company now wants to expand operations, and it needs a retail point-of-sale system that is designed for the furniture industry.

Although the company currently has a small staff, some employees move between the corporate office, the showroom, and the warehouse. The company needs to ensure that all employees have access to the software from all three locations. For example, Sonia is the accounting manager. Her office is in the corporate building. During inventory, however, she may be working out of the warehouse but will still need access to the accounting system. Alpha is also hoping to open two new locations in the next five years, so it needs a solution that is easily scalable to the new locations. In addition, the owners of the company are spending more time out of the office on business and would like access to the system while they are traveling.

As the new IT director, you have been asked to find a software solution to meet the changing needs of the company. Because you do not have a programming staff, the options include purchasing off-the-shelf software or subscribing to on-demand software.

### Review Questions

1. What questions would you ask internally before beginning the search for new software?
2. Would you select PaaS for this software implementation? Why or why not?

### Critical Thinking Questions

1. What advantages does SaaS offer your company? Do these advantages outweigh other factors—even if paying for a subscription would be more expensive?
2. What are the disadvantages you might find in SaaS for your company? Could this make you recommend against SaaS? Why or why not?

## Buying Off-The-Shelf-Software

Today, most organizations purchase or subscribe to the software services they need—simply because it costs too much and takes too long to build a quality information system. An organization elects to build proprietary systems only when its information system requirements are unique. This may be because of the nature of the business or because the organization is attempting to build an information system that will provide it with a strategic competitive advantage.

A software application can vary from an unmodified, commercial off-the-shelf (COTS) software package at one extreme to a custom, written-from-scratch program at the other extreme. Between those two extremes is a range of options based on the degree of customization. A comparison of the two extreme approaches is shown in Table 13.2. One question that must be answered during the system analysis phase is “Which solution approach is best for this system?” This decision is often called the make-or-buy decision.

**TABLE 13.2** Comparison of developed and off-the-shelf software

Factor	Develop (Make)	Off-the-Shelf (Buy)
Cost	The cost to build the system can be difficult to estimate accurately and is frequently higher than off-the-shelf software.	The full cost to implement an off-the-shelf solution is also difficult to estimate accurately but is likely to be less than a custom software solution.
Needs	Custom software is more likely to satisfy an organization's needs.	Buyers might not get exactly what they need.
Process improvement	Custom software tends to automate existing business processes even if they are poor.	Adoption of a package may simplify or streamline a poor existing business process.
Quality	Quality can vary depending on the programming team.	Buyers can assess the quality before buying.
Speed	Custom software can take years to develop.	Off-the-shelf software can be acquired immediately.
Staffing and support	Development requires skilled in-house resources to build and support a custom-built solution.	Organizations purchasing off-the-shelf software need to pay the vendor for support.
Competitive advantage	An organization can develop a competitive advantage with good software.	Other organizations may use the same software and therefore have the same advantage.

## Package Evaluation Phase

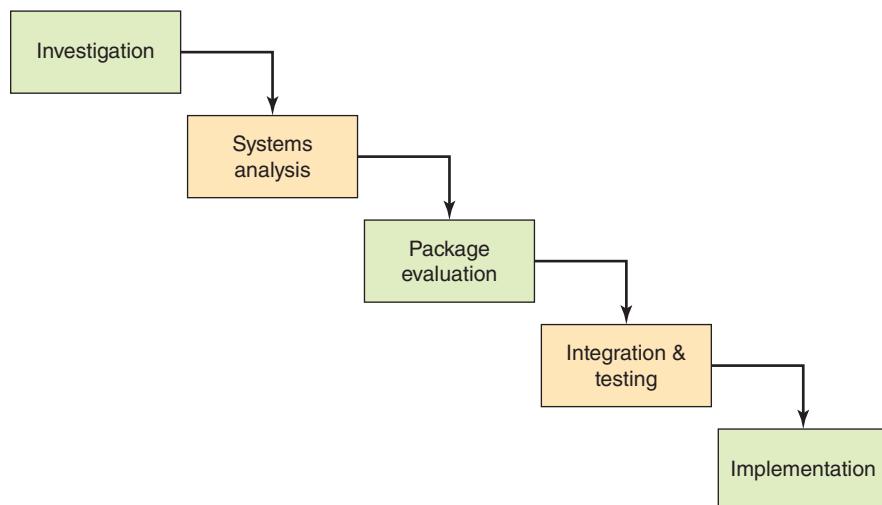
Purchasing off-the-shelf software requires that an organization go through several steps to ensure that it purchases the software that best meets its needs and then implements it effectively. These steps are part of the package evaluation phase of a project that comes after the system analysis phase, as shown in Figure 13.1. By purchasing a software package, an organization can eliminate several phases of the Waterfall development approach (discussed later in this chapter). At this point in the project, the scope of the system and critical business and user requirements should be known. There should be a rough budget and schedule as well.

The steps in the project evaluation phase include the following:

1. Identify potential solutions
2. Select top contenders
3. Research top contenders
4. Perform final evaluation of leading solutions
5. Make selection
6. Finalize contract

**FIGURE 13.1**  
**Software package implementation process**

Software package implementation eliminates several of the phases of the waterfall approach.

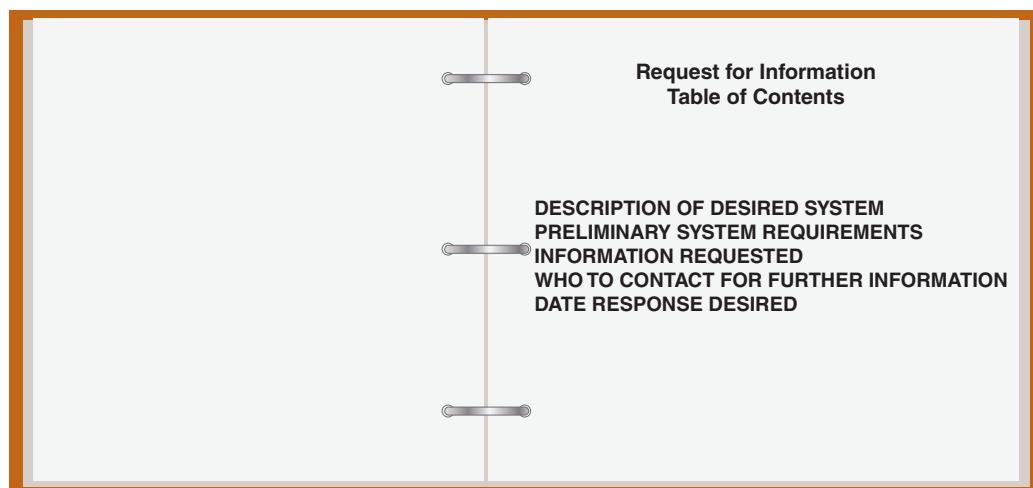


### Identify Potential Solutions

The project team should make a preliminary assessment of the software marketplace to determine whether existing packages can meet the organization's needs. The primary tool for doing this is the **request for information (RFI)**, a document that outlines an organization's needs and requests vendors to respond with information about if and how they can meet those needs and the time and resources required. See Figure 13.2. The RFI outlines the scope of the desired system and preliminary system requirements based on the results so far of the system analysis. Importantly, the RFI should ask each vendor to identify two or three customers who may be contacted as references. The RFI is typically sent to several vendors who are thought to be capable of providing the desired software.

#### request for information (RFI)

**(RFI):** A document that outlines an organization's hardware or software needs and requests information from vendors about if and how they can meet those needs and the time and resources required.

**FIGURE 13.2****Recommended table of contents for a request for information**

The RFI outlines the desired system and its requirements, identifying key pieces of data that the software vendor must include in the proposal.

**Select Top Contenders**

The project team will review the information provided by the vendors in response to the RFI and then narrow the options to the most promising alternatives for further evaluation. This may require a visit to a vendor's place of business to meet key managers and observe a demo of the vendor's system. This selection is made on the basis of how well the vendor's software appears to meet the organization's needs, preliminary cost and timing estimates, information gleaned from references, and how easy the vendor has been to work with so far.

**Research Top Contenders**

A final evaluation begins with a detailed investigation of the contenders' proposals as well as in-depth discussions with two or three customers of each contender to learn about their experience with the vendor and the software. An organization must carefully evaluate each vendor's software package to see how well it supports the business processes that are within the scope of the project. Looking at each business process, the organization should determine if the package supports the process fully and exactly as it needs to be performed. If not, must the software be modified to meet the organization's requirements, or must the organization modify its business process? If an organization decides it must modify the software to meet its business requirements, it must then determine who will do the necessary modifications, how long they will take, and how much they will cost.

Often, purchased software must integrate with other existing software (e.g., a new accounts payable and accounts receivable software package must integrate with the firm's existing general ledger system). The amount of effort required to modify the new software and existing software so that they work well together must be determined and considered as a major factor when selecting the final vendor and software.

For major software purchases, the contenders should be asked to make a final presentation and to fully demonstrate their solution using a **performance evaluation test** conducted in a computing environment (e.g., computing hardware, operating system software, database management system) and with a workload (e.g., number of concurrent users, database size, and number of transactions) that matches the intended operating conditions. Such a test can help measure system performance attributes such as ease of use and response time.

**performance evaluation test:**

A comparison of vendor options conducted in a computing environment (e.g., computing hardware, operating system software, database management system) and with a workload (e.g., number of concurrent users, database size, and number of transactions) that matches its intended operating conditions.

### Make Selection

Selecting the best software package solution involves weighing the following factors:

- How well the vendor's solution matches the needs of the users and business
- The amount of effort required to integrate the new software with existing software
- Results of the performance evaluation test
- Relative costs (including any software modifications) and benefits
- The technical, economic, legal, operational, and schedule feasibility
- Input from legal and purchasing resources on the legal and financial viability of the contender
- Feedback from customers on how well the software performs as well as on the quality of the support provided by the vendor

### Finalize Contract

After a selection is made, a contract with the vendor must be negotiated and finalized. Although the vendor may insist that everyone signs a standard contract, every contract should be thoroughly reviewed by experienced members of an organization's legal and purchasing departments. Recognize that the standard contract is written from the vendor's perspective and protects its interests, not yours. Request a copy of the vendor's standard contract at the start of the software package evaluation process and allow at least two months for review and negotiation of a final contract.

Organizations that use the cloud-computing or SaaS approach need to take special precautions in signing contracts with the service provider. The contract should clarify how the provider ensures data privacy, handles discovery if there is a lawsuit, resolves service-level problems, and manages disaster recovery; it should also detail where the cloud-computing servers and computers are located. Organizations should confirm this information in discussions with other customers of the service provider and by a visit to the service provider's facilities.

A contract covering the modification of a software package should have provisions for monitoring system modification quality and progress, ownership and property rights of the new or modified system, contingency provisions in case something doesn't work as expected, and dispute resolution if something goes wrong. Customizing the package changes the package into custom-made software, resulting in the potential loss of support from the original vendor. This might necessitate third-party support, which should be factored into the contract negotiations.

### Integration and Testing

Several types of testing must be conducted before a software package is ready to be put into production. This is particularly true if the software package has been modified to meet the needs of the organization or if the software package must integrate with existing information systems.

The following types of tests, discussed later in the chapter, need to be completed:

1. Integration testing
2. System testing
3. Volume testing
4. User acceptance testing

## Implementation

The organization cannot just count on the vendor to execute the implementation of the package—full and active participation by the project’s stakeholders and end users is essential to success. Key implementation tasks include the following:

- Use data-flow diagrams to map current business processes and requirements to the software, and identify any gaps that must be filled by changing current processes or by modifying the software.
- Install the software and configure all its capabilities and options to meet the project requirements.
- Customize aspects the solution as needed for the organization.
- Integrate existing software with the new software.
- Train end users.
- Test the software to ensure that it meets all processes and requirements.
- Convert historical data from the old software so that it can be used by the new software.
- Roll out the new software to users in a live work environment.
- Provide for ongoing end-user support and training.



### Critical Thinking Exercise

#### Hospital Switches EHR Software

##### ► DECISION MAKING

Midwest Regional Hospital (fictional) is a 500-bed general medical and surgical facility with 25,000 admissions and 7,500 annual inpatient and 17,500 outpatient surgeries annually. Its emergency room has 52,000 visits each year. It is a nonprofit hospital that treats both adult and child patients. More than 1200 nurses, technicians, doctors, and physicians practice at the hospital.

An electronic health record (EHR) is an electronic version of a patient’s medical history that is maintained by the provider over time, and it may include all of the key administrative clinical data relevant to that person’s care, including demographics, progress notes, problems, medications, vital signs, past medical history, immunizations, laboratory data, and radiology reports. The EHR automates access to this information, and the more sophisticated versions of EHR software can also produce an online “digital chart” that displays up-to-date patient information in real time, complete with decision-support tools for physicians and nurses. One of the key features of an EHR is that health information can be created and managed by authorized providers in a digital format capable of being shared with other providers across more than one healthcare organization, including laboratories, specialists, medical imaging facilities, pharmacies, emergency facilities, and school and workplace clinics.

Midwest Hospital was an early pioneer in the adoption of EHR software. Unfortunately, the vendor that Midwest selected has not been able to keep up with evolving regulatory requirements and the changing needs of its healthcare clients. Its software is fast becoming obsolete, and it is rumored that the firm will soon eliminate support of its software. You have been hired as a consultant to lead a project to replace the original software with software from one of the current leading EHR software providers—Allscripts, Cerner Corporation, or Epic Systems Corporation.

#### Review Questions

1. Is there a need to conduct a preliminary software package evaluation? Why or why not?
2. What tasks would you attempt to complete in your first two weeks as project leader?

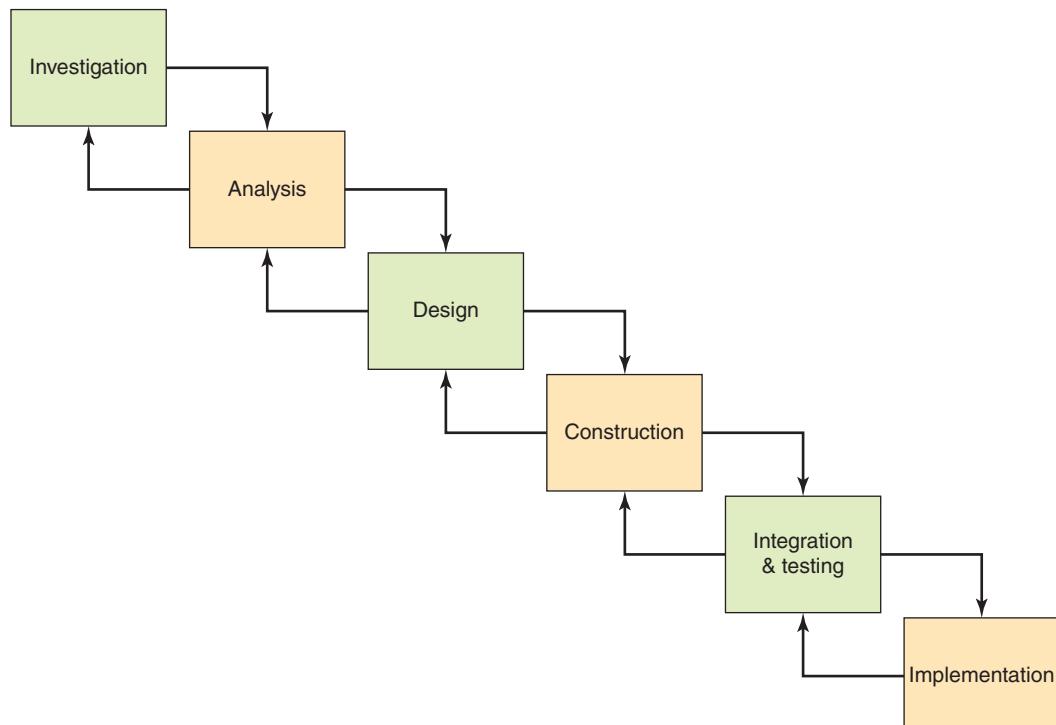
### Critical Thinking Questions

1. The hospital administrators have made it clear to you that the software vendor must be chosen and the software installed as soon as possible. What measures do you feel comfortable taking to accelerate the process without raising the risk of choosing the wrong software or having a rough system start-up?
2. A safety-critical system is one whose failure or misuse may cause human injury or death. Given that an EHR system is such a system, which tasks associated with software implementation deserve special attention?

## Waterfall System Development Process

**Waterfall system development process:** A sequential, multistage system development process in which work on the next stage cannot begin until the results of the current stage are reviewed and approved or modified as necessary.

The **Waterfall system development process** is a sequential, multistage system development process in which work on the next stage cannot begin until the results of the current stage are reviewed and approved or modified as necessary. It is referred to as a Waterfall process because progress is seen as flowing steadily downwards (like a Waterfall) through the various phases of development. The phases of the Waterfall system development process can vary from one company to the next, but many organizations use an approach with six phases: investigation, analysis, design, construction, integration and testing, and implementation. Once the system is built, organizations complete the additional steps of operation and maintenance and disposition. See Figure 13.3.



**FIGURE 13.3**  
**Waterfall system development process**

Progress flows steadily downwards (like a Waterfall) through the various phases of development.

As shown in Figure 13.3, a system under development moves from one phase of the Waterfall process to the next. At the end of each phase, a review is conducted to ensure that all tasks and deliverables associated with that phase were produced and that they are of good quality. In addition, at the end of each phase, the overall project scope, costs, schedule, and benefits associated with the project are reviewed to ensure that the project is on track and worth completing. As a result, the Waterfall approach allows for a high degree of management control. It is for this reason that this approach is frequently followed when an organization contracts with another to build its information system. However, a major problem with this approach is that users do not interact with the solution until the integration and testing phase, when the system is nearly complete. This can lead to a mismatch between system capabilities, users' expectations, and organizational needs. Table 13.3 lists additional advantages and disadvantages of the Waterfall system development process.

**TABLE 13.3** Advantages and disadvantages of Waterfall system development process

Advantages	Disadvantages
Formal review at the end of each phase allows maximum management control.	Users get a system that meets the needs as understood by the developers; however, this might not be what the users really needed.
This approach requires creation of considerable system documentation so that system requirements can be traced back to stated business needs.	Often, user needs go unstated or are miscommunicated or misunderstood.
This approach produces many intermediate products that can be reviewed to measure progress toward developing the system.	Users can't easily review intermediate products and evaluate whether a product (e.g., a data-flow diagram) will lead to a system that meets their business requirements.

The Office of Information Technology for the U.S. Department of Veterans Affairs (VA) has an annual budget of over \$4 billion—the vast majority of which is used to maintain legacy, or existing, systems that need to be updated or replaced. Over the last twenty years, the VA undertook three separate projects intended to upgrade the agency's electronic health record system. All three projects came in over budget and behind schedule, and they produced faulty systems that were not integrated as a whole. These projects obviously would have benefitted from a higher degree of management control; unfortunately, CIOs at the VA lasted less than two years on average, meaning no one stayed in that critical leadership position long enough to establish the strategic planning and project management practices necessary to effectively complete such complex projects.<sup>11</sup>

## System Investigation

**system investigation:** The initial phase in the development of a new or modified business information system whose purpose is to gain a clear understanding of the specifics of the problem to solve or the opportunity to address.

**System investigation** is the initial phase in the development of a new or modified business information system whose purpose is to gain a clear understanding of the specifics of the problem to solve or the opportunity to address. What is the scope of the problem? Who is affected and how? How often does this occur? After gaining a good understanding of the problem, the next question is, “Is the problem worth addressing?” Given that organizations have limited resources—people and money—this question deserves careful attention.

What are the potential costs, both the one-time initial costs and recurring costs? What risks are associated with the project? If successful, what benefits, both tangible and intangible, will the system provide? The steps of the investigation phase are outlined next and discussed on the following pages:

1. Review system investigation request.
2. Identify and recruit team leader and team members.
3. Develop budget and schedule for investigation.
4. Perform investigation.
5. Perform preliminary feasibility analysis.
6. Prepare draft of investigation report.
7. Review results of investigation with steering team.

### **Review System Investigation Request**

Because system development requests can require considerable time and effort to investigate, many organizations have adopted a formal procedure for initiating a system investigation. Ideally, a system investigation request is completed by members of the organization that will be most affected by the new or modified system. This request typically includes the following information:

- A preliminary statement of the problem or opportunity to be addressed (this will be refined during the investigation)
- A brief discussion of how this effort aligns with previously defined company and organization objectives, goals, and strategies
- Identification of the general areas of the business and business processes to be included in the scope of the study (e.g., the handling of customer discounts in the order-processing system)

The information in the system request helps senior management rationalize and prioritize the activities of the IS department and decide which investigation projects should be staffed. Based on the overall IS plan, the organization's needs and goals, and the estimated value and priority of the proposed projects, managers make decisions regarding which system investigation requests will be approved.

### **Identify and Recruit Team Leader and Team Members**

After managers grant approval to initiate a system investigation, the next step is to identify and recruit the person who will lead the investigation phase, followed by the other members of the investigation team. The members of the investigation team are responsible for gathering and analyzing data, preparing an investigation phase report, and presenting the results to the project steering team. The system investigation team can be quite diverse, often with members located around the world. Business knowledge of the areas under study, communication, and collaboration are keys to successful investigation teams. Members of the development team may change as a project moves through the various development phases, depending on the knowledge, experience, and skills required during each phase.

### **Develop Budget and Schedule for Investigation**

After the team has been formed, its members work together to develop a list of specific objectives and activities that must be accomplished during the system investigation phase along with a schedule for completing the work. The team establishes major milestones to help monitor progress and determine whether problems or delays occur in performing system investigation. The group also prepares a budget to complete the investigation, including any travel required and funds necessary to cover the use of any outside resources or consultants.

### Perform Investigation

The major tasks to perform during investigation include refining the initial problem definition and scope described in the system investigation request, identifying the high-level business requirements the system must meet, and identifying any issues or risks associated with the project.

**joint application development (JAD):** A structured meeting process that can accelerate and improve the efficiency and effectiveness of the investigation, analysis, and design phases of a system development project.

### Joint Application Development

**Joint application development (JAD)** is a structured meeting process that can accelerate and improve the efficiency and effectiveness of not only the investigation phase but also the analysis and design phases of a system development project. JAD involves carefully planned and designed meetings in which users, stakeholders, and IS professionals work together to analyze existing systems, define problems, identify solution requirements, and propose and evaluate possible solutions, including costs and benefits. See Figure 13.4. The JAD process has proven to be extremely effective and efficient at accomplishing these tasks. In addition, the highly participative nature of the sessions goes a long way to helping ensure stakeholders and users buy into the results. With technology such as group decision support systems and video conferencing, it is possible to conduct effective live JAD sessions with people located in many different places without the need for expensive travel.



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**FIGURE 13.4**  
**JAD session**

JAD can accelerate and improve the efficiency and effectiveness of the investigation, analysis, and design phases of a system development project.

The success or failure of a JAD session depends on how well the JAD facilitator plans and manages the session. It is not unusual for the facilitator to spend three hours planning and preparing for the JAD session for each hour the JAD session lasts. In addition, the participants of a JAD session must be carefully chosen to include users of the system as well as people from other areas who will likely be affected by, provide input for, or receive output from the system. Ideally, people from the operational level as well as the executive level will attend. Table 13.4 identifies the JAD session participants as well as their role and qualifications.

**TABLE 13.4** JAD participants and their role

Role	Responsibilities	Qualifications
Facilitator	<ul style="list-style-type: none"> <li>Determine JAD session objective</li> <li>Plan JAD session to meet objectives</li> <li>Lead JAD session</li> <li>Encourage everyone to participate</li> </ul>	<ul style="list-style-type: none"> <li>Excellent meeting facilitator</li> <li>Unbiased and does not take sides</li> </ul>
Decision makers	<ul style="list-style-type: none"> <li>Resolve conflicts</li> <li>Avoid gridlock</li> </ul>	<ul style="list-style-type: none"> <li>Stakeholders selected by project sponsor to make decisions</li> <li>Have the authority and willingness to make decisions</li> </ul>
Users	<ul style="list-style-type: none"> <li>Describe business as it is and as it should be</li> <li>Provide business expertise</li> <li>Define problems, identify potential benefits, analyze existing system, define requirements of a new system, and propose and evaluate possible solutions</li> </ul>	<ul style="list-style-type: none"> <li>Represent all major areas affected</li> <li>Expert in their area of the business</li> </ul>
System developers	<ul style="list-style-type: none"> <li>Observe carefully</li> <li>Offer technical opinion on cost or feasibility, if requested</li> <li>Gain deep understanding of customers' needs and desires</li> </ul>	<ul style="list-style-type: none"> <li>Member of system development team</li> </ul>
Scribe	<ul style="list-style-type: none"> <li>Participate in discussion to clarify points and capture them accurately</li> <li>Document key points, issues, next steps, and decisions throughout the JAD session</li> <li>Publish results of JAD session and solicit feedback</li> </ul>	<ul style="list-style-type: none"> <li>Excellent listening skills</li> <li>Experience in using software engineering tools to document requirements and create system models</li> </ul>

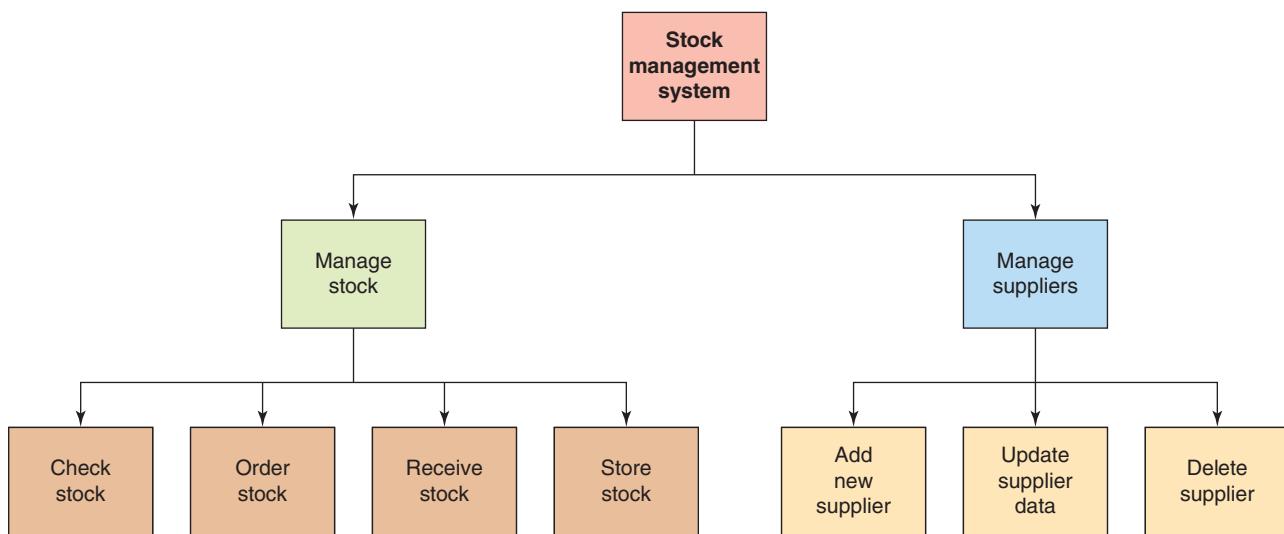
The consulting firm Pierson Requirements Group uses JAD in working with its clients on a routine basis to provide business analysis solutions and process improvement training.<sup>12</sup>

### ***Functional Decomposition***

**functional decomposition:** A technique that involves breaking down complex problems or systems into smaller parts, making them easier to manage and understand.

**Functional decomposition** is a technique that involves breaking down a complex problem or system into smaller parts that are more manageable and easier to understand. It is frequently used during the investigation phase to define the business processes included within the scope of the system. Recall that a process is a set of logically related tasks performed to achieve a defined outcome. A process is usually initiated in response to a specific event and requires input that it processes to create output. Often, feedback is generated that is used to monitor and refine the process.

To create a functional decomposition chart (see Figure 13.5), begin with the name of the system and then identify the highest-level processes to be performed. Each process should have a two word “verb–subject” name that clearly defines the process. Next, break those high-level processes down into lower-level subprocesses. For the system investigation phase, two or three levels of decomposition are usually sufficient to define the scope of the system.

**FIGURE 13.5****Functional decomposition chart**

Functional decomposition is used to define the scope of the system.

### Perform Preliminary Feasibility Analysis

The technical, economic, legal, operational, and schedule feasibility are assessed during the **feasibility analysis**, which is only a preliminary analysis that will be repeated with more accuracy during the analysis and design phases, when more details about the system and its requirements are known.

**Technical feasibility** examines whether a project is feasible within the current limits of available technology. Determining the technical feasibility is critical when new technology is first being considered for use within an organization, prior to its widespread use. The agriculture industry is looking at ways to combat high labor costs by using sensors to obtain data on the specific nutrient compounds required by crops throughout the growing season and then employing robots and drones to apply the required nutrients only where needed. The farmers and the technology companies they are working with are looking at the technical (and economic) feasibility studies to determine the best way to leverage precision ag technology.<sup>13</sup>

**Economic feasibility** determines whether the expected benefits associated with the project outweigh the expected costs sufficiently to make the project financially attractive. Cost and benefit estimates should be made for multiple years to allow for calculation of the internal rate of return or net present value of the project. It is important to recognize that at this early stage of the development process, the cost and benefit amounts are rough estimates and subject to change should the project continue. So, while the mathematics involved may make it appear that the results are precise, the result is no more accurate than cash flow estimates, which are often no more than refined guesses. Table 13.5 lists some of the typical costs and benefits that need to be considered.

**economic feasibility:** The process of determining whether the project makes financial sense and whether predicted benefits offset the cost and time needed to obtain them.

**TABLE 13.5** Cost/benefit table

Costs	Year 1	Year 2	Year ...	Year N
Costs to analyze, design, construct, integrate and test, and implement system				
Employees				
Vendor				
Software customization				

Costs	Year 1	Year 2	Year . . .	Year N
Travel				
Hardware costs				
Software tools costs				
Other costs				
<b>Initial costs to establish system</b>				
Software license fees				
New hardware costs				
Cost to upgrade existing hardware				
Cost to upgrade network				
User training				
Purchase of any necessary data				
Cost to migrate existing data to new system				
Other costs				
<b>Ongoing operations costs</b>				
Software lease or rental fees				
Hardware lease or rental fees				
Network usage fees				
System operations and support staff				
User training				
Increased electric and other utilities				
Costs associated with disaster recovery				
Other costs				
<b>Tangible benefits (can be quantified in dollars)</b>				
<b>Reduction in current costs</b>				
Reduction in current staff				
Reduction in inventory levels				
Reduction in computer hardware costs				
Reduction in software costs				
Other reduced costs				
<b>Increase in revenue</b>				
Increase in sales from reaching new customers				
Increase in sales from charging more				
Acceleration in cash flow				
Other increases in revenue				
<b>Intangible benefits (difficult to quantify in dollars)</b>				
Improved customer service				
Improved employee morale				

Organizations must guard against spending more than is appropriate as the success or failure of a system development effort will, at least to some degree, be measured against meeting the project budget. Systems projects can fail for many reasons but going over budget is one reason that can costs companies time and reputation. One project that was recorded as a failure was the electronic health record system for the U.S. Coast Guard. The project began in September 2010 and ended in September 2015. The Coast Guard officially terminated the project in April 2016. After two years of reviewing the project, a House subcommittee hearing revealed that a lack of management oversight allowed the project to exist with “poor or non-existent system development, management, and governance practices over the duration.” This failed project has accumulated a total price of over \$67 million dollars, excluding the cost of personnel.<sup>14</sup>

**legal feasibility:** The process of determining whether laws or regulations may prevent or limit a system development project.

**Legal feasibility** is the process of determining whether laws or regulations may prevent or limit a system development project. Legal feasibility involves an analysis of existing and future laws to determine the likelihood of legal action against the system development project and the possible consequences of such action. For example, nearly every country in Europe and many in Latin America, Asia, and Africa have implemented data protection laws that prohibit the disclosure or misuse of information held on private individuals. These laws make it possible for the human resources departments of multinational companies to share personal employee data across country borders only in limited circumstances.

**operational feasibility:** The process of determining how a system will be accepted by people and how well it will meet various system performance expectations.

**Operational feasibility** is the process of determining how a system will be accepted by people and how well it will meet various system performance expectations. Assessing the operational feasibility of a project includes taking into consideration people issues, such as overcoming employee resistance to change, gaining managerial support for the system, providing sufficient motivation and training, and rationalizing any conflicts with organizational norms and policies. In other words, if the system is developed, will it be used? Operational feasibility also takes into account the need to meet certain system performance requirements (e.g., response time for frequent online transactions, number of concurrent users it must support, reliability, and ease of use) that are considered important to system users and stakeholders.

**schedule feasibility:** The process of determining whether the project can be completed within a desired time frame.

**Schedule feasibility** is the process of determining whether a project can be completed within a desired time frame. This process involves balancing the time and resource requirements of the project with other projects. For example, many projects that involve delivering a new financial information system have a desired start-up date at the beginning of the organization’s fiscal year. Unfortunately, it is not always possible to meet this date, and so a compromise must be made—deliver part of the system at the start of the fiscal year or wait another year to deliver the full system.

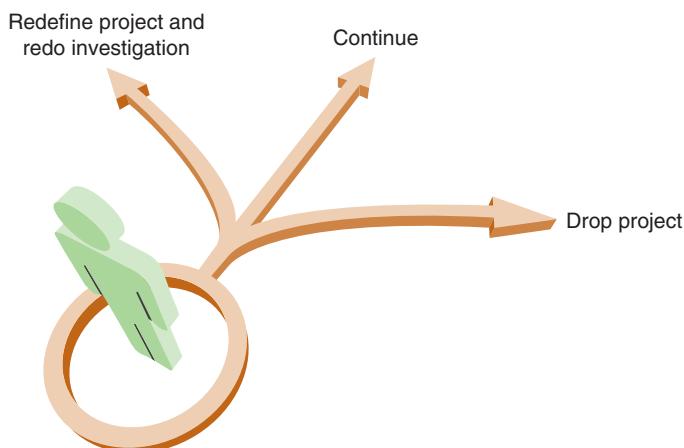
### **Prepare Draft of Investigation Report**

**system investigation report:** A summary of the results of the system investigation, with a recommendation of a course of action.

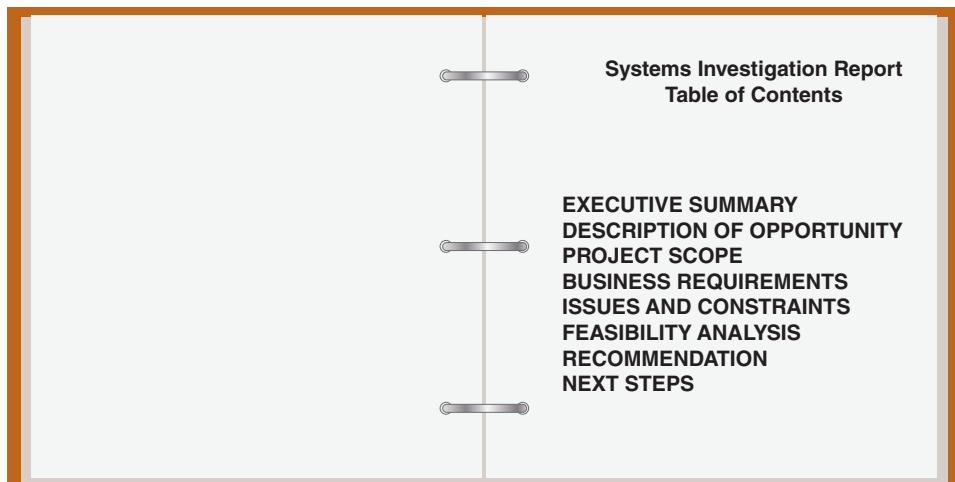
The system investigation ends with production of a **system investigation report** that summarizes the results of the system investigation and recommends a course of action: continue on to system analysis, modify the project in some manner and perhaps repeat the system investigation, or drop the project altogether. See Figure 13.6. A typical table of contents for a system investigation report is shown in Figure 13.7.

**FIGURE 13.6**  
**System investigation recommendation**

The system investigation report summarizes the results of the system investigation and recommends a course of action.



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**FIGURE 13.7**  
**Table of contents for a system investigation report**

A typical system investigation report begins with an executive summary and ends with a list of next steps.

**Review Results of Investigation with Steering Team**

The system investigation report is reviewed with the steering team to gain their input and counsel. Typically, the written report is shared in advance and then the project manager and selected members of the team meet with the steering team to present their recommendations.

After the project review, the steering team might agree with the recommendations of the system development team, or it might suggest a change in project focus to concentrate more directly on meeting a specific company objective. Another alternative is that everyone might decide that the project is not feasible and thus cancel the effort. This input is used to finalize the system investigation report.

## System Analysis

**system analysis:** The phase of system development that focuses on gathering data on the existing system, determining the requirements for the new system, considering alternatives within identified constraints, and investigating the feasibility of alternative solutions.

After a project has completed the investigation phase and been approved for further study, the next step is to answer the question, “What must the information system do to solve the problem or capitalize on the opportunity?” The overall emphasis of the **system analysis** is on gathering data on the existing system, determining the requirements for the new system, considering alternatives within identified constraints, and investigating the feasibility of alternative solutions. The primary outcome of system analysis is a prioritized list of system requirements and a recommendation of how to proceed with the project. The steps in the system analysis phase are outlined next and discussed in the following pages. Note that many of the steps were also performed during system investigation:

1. Identify and recruit team leader and team members.
2. Develop budget and schedule for system analysis activities.
3. Study existing system.
4. Develop prioritized set of requirements.
5. Identify and evaluate alternative solutions.
6. Perform feasibility analysis.
7. Prepare draft of system analysis report.
8. Review results of system analysis with steering team.

The Los Angeles Police Department (LAPD) is comprised of over 9000 officers and serves 3.9 million residents spread across the 485-square miles of the city of Los Angeles. The LAPD conducted a system analysis to define the requirements for a Use of Force System (UOFS) to monitor officer performance and behavior. The UOFS collects information about each use of force incident including suspect, officer, and witness data. The application applies a series of business rules that trigger a review and investigation into the use of force by appropriate parties, often by multiple levels of LAPD management.<sup>15</sup>

### Identify and Recruit Team Leader and Team Members

In many cases, there is some personnel turnover when a project moves from the system investigation phase to the system analysis phase. Some project team members may no longer be available to participate in the project, and new members with a different set of skills and knowledge may be required. So, the first step in system analysis is to identify and recruit the team leader and members. Ideally, some members of the original investigation team will participate in the system analysis to provide project continuity.

### Develop Budget and Schedule for System Analysis Activities

After the participants in the system analysis phase are determined, the team develops a list of specific objectives and activities required to complete the system analysis. The team also establishes a schedule—complete with major milestones to track project progress. The group also prepares a budget of the resources required to complete the system analysis, including any required travel expenses as well as funds to cover the use of outside resources.

### Study Existing System

The purpose of studying the system is to identify the strengths and weaknesses of the existing system and examine current inputs, outputs, processes, security and controls, and system performance. While analysis of the existing system is important to understanding the current situation, the study team must recognize that after a point of diminishing returns, further study of the existing system will fail to yield additional useful information.

Many useful sources of information about the existing system are available, as shown in Figure 13.8. JAD sessions, direct observation with one or more members of the analysis team directly observing the existing system in action, and surveys are often used to uncover pertinent information from the various sources.

**FIGURE 13.8**  
**Internal and external sources of data for system analysis**

JAD sessions, direct observation, and surveys are often used to uncover data from the various sources.

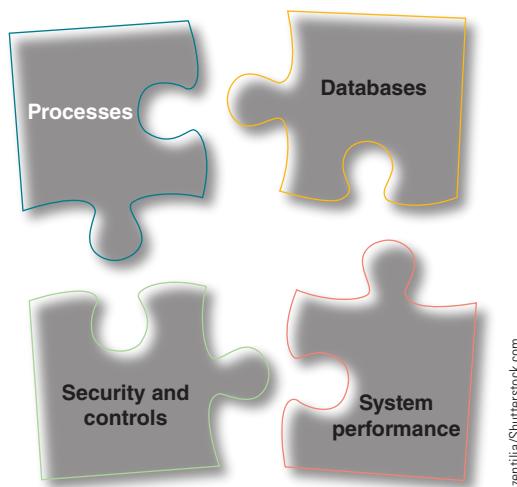
Internal Sources	External Sources
Users, stakeholders, and managers	Customers
Organization charts	Suppliers
Forms and documents	Stockholders
Procedure manuals and policies	Government agencies
Financial reports	Competitors
IS manuals	Outside groups
Other measures of business process	Journals, etc.
	Consultants

### Develop Prioritized Set of Requirements

The purpose of this step is to determine user, stakeholder, and organizational needs for the new or modified system. A set of requirements must be determined for system processes (including inputs, processing, outputs, and feedback), databases, security and controls, and system performance. See Figure 13.9. As requirements are identified, an attempt is made to prioritize each one by using the following categories:

- **Critical.** Almost all users agree that the system is simply not acceptable unless it performs this function or provides this capability. Lack of a critical feature or capability would cause users to call a halt to the project.
- **High priority.** Most users have a list of high-priority items that they feel are must-have requirements, even if they are not critical. Although such items would not stop the project from moving forward, they are identified as requirements for which there is no workaround. These are the items that the development team should focus on first in the list of project details.
- **Medium priority.** Most users agree that although their work will be somewhat impaired, the system will still be effective without features or capabilities identified as medium priority. Some users may argue strongly for this feature or capability, but in the end, would want the project to continue even without this capability.
- **Low priority.** Most users agree that their ability to use the system to accomplish their work will only be minimally impaired by lack of a low-priority feature or capability, although it would be “nice to have.” Almost no user argues strongly for this feature or capability.

**FIGURE 13.9**  
**Defining system requirements**  
 System requirements must be checked for consistency so that they all fit together.



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Identifying, confirming, and prioritizing system requirements is perhaps the single most critical step in the entire Waterfall system development process because failure to identify a requirement or an incorrect definition of a requirement may not be discovered until much later in the project, causing much rework, additional costs, and delay in the system effort.

The use of JAD sessions with a cross section of users and stakeholders in the project is an effective way to define system requirements. A technique often used in a JAD session is to ask managers and decision makers to list only the factors that are critical to the success of their areas of the organization. A critical success factor (CSF) for a production manager might be adequate raw materials from suppliers, while a CSF for a sales representative could be a list of customers currently buying a certain type of product. Starting from these CSFs, the processes, databases, security and control, and performance requirements associated with each CSF can be identified.

### Processes

The functional decomposition performed during the investigation phase identifies most of the processes to be included within the scope of a new system. Now, to avoid project delays, the processes must be further defined so that they will be practical, efficient, economical, accurate, and timely. In addition, the individuals or organizations responsible for completing each step in the process must be identified.

A process requires input that it uses to create output. Often, feedback is generated. The questions that need to be answered during system analysis are “What data entities are required, where will this data come from, what methods will be used to collect and enter the data, who is responsible for data input, and what edits should be performed on the input data to ensure that it is accurate and complete?” Another important consideration is the creation of an audit trail that records the source of each data item, when it entered the system, and who entered it. The audit trail may also need to capture when the data is accessed or changed and by whom.

Because the success of a new system is highly dependent upon the acceptability of its output, the identification of common system outputs—such as printed reports, screens, and files—is critical to developing a complete set of system requirements.

### Data-Flow Diagram

A **data-flow diagram (DFD)** is a diagram used during both the analysis and design phases to document the processes of the current system or to provide a model of a proposed new system. A DFD shows not only the various processes

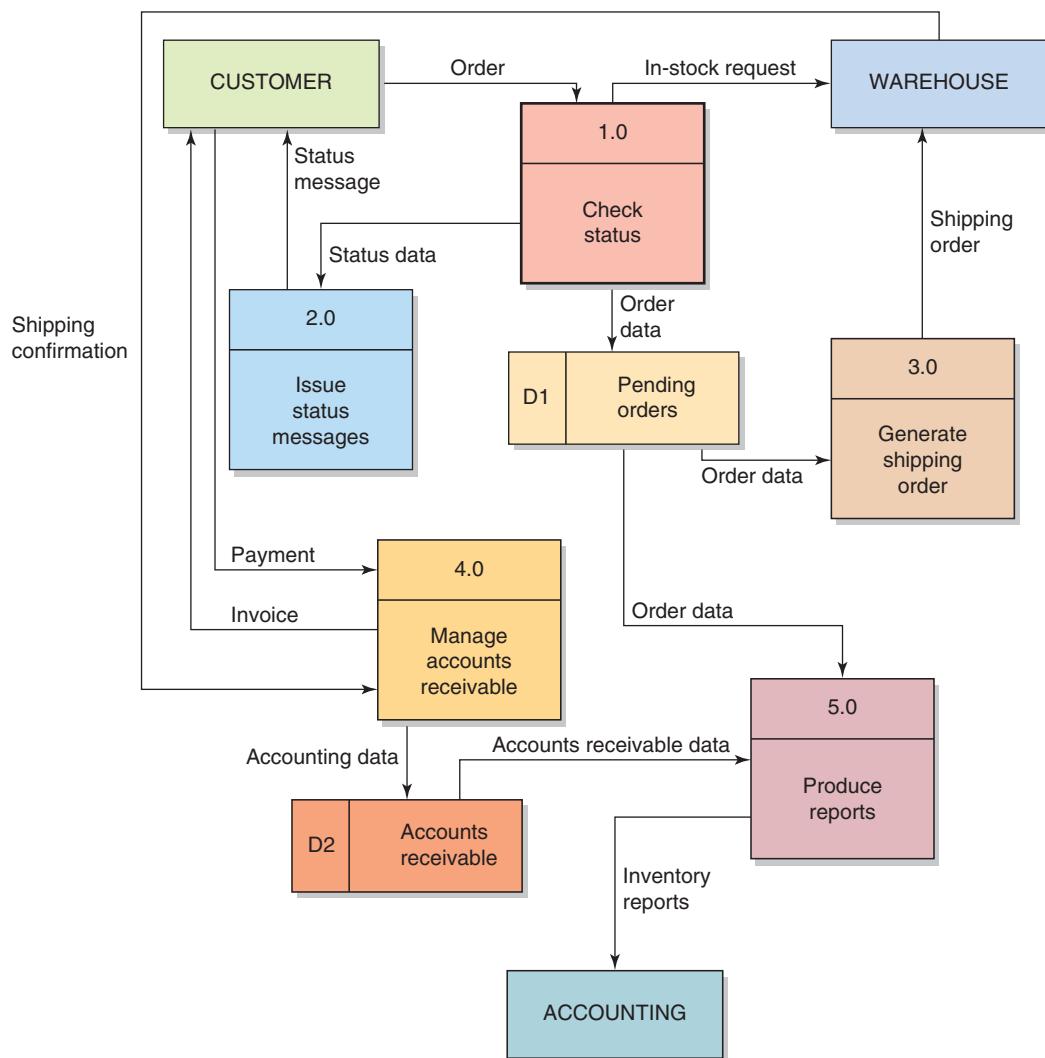
**data-flow diagram (DFD):** A diagram used during both the analysis and design phases to document the processes of the current system or to provide a model of a proposed new system.

within the system but also where the data needed for each process comes from, where the output of each process will be sent, and what data will be stored and where. The DFD does not provide any information about the process timing (e.g., whether the various processes happen in sequence or are parallel).

DFDs are easy to develop and are easily understood by nontechnical people. Data-flow diagrams use four primary symbols:

- The data-flow line includes arrows that show the direction of data movement.
- The process symbol identifies the function being performed (e.g., check status, issue status message).
- The entity symbol shows either the source or destination of the data (e.g., customer, warehouse).
- A data store symbol reveals a storage location for data (e.g., pending orders, accounts receivable).

Figure 13.10 shows a level 1 DFD. Each of the processes shown in this diagram could be documented in more detail to show the subprocesses and create a level 2 DFD. Frequently, level 3 DFD diagrams are created and used in the analysis and design phases.



**FIGURE 13.10**  
**Data-flow diagram**

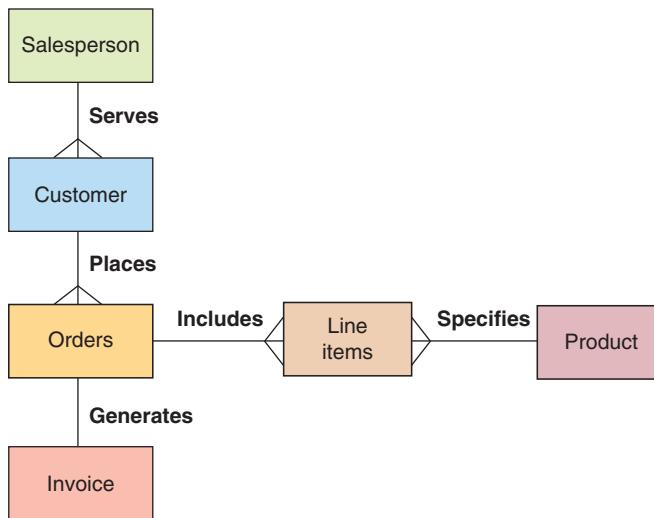
A data-flow diagram documents the processes of the current system or provides a model of a proposed new system.

### Databases

Data modeling is the process of defining the databases that a system will draw data from as well as any new databases that it will create. The use of entity-relationship (ER) diagrams is one technique that is frequently used for this critical step. An ER diagram is used to show logical relationships among data entities, such as in Figure 13.11. An ER diagram (or any other modeling tool) cannot by itself fully describe a business problem or solution because it lacks descriptions of the related activities. It is, however, a good place to start because it describes entity types and attributes about which data might need to be collected for processing.

**FIGURE 13.11**  
**Entity-relationship (ER)**  
**diagram for a customer order**  
**database**

Development of ER diagrams helps ensure that the logical structure of application programs is consistent with the data relationships in the database.



### Security and Control

Security and control considerations need to be an integral part of the entire system development process. Unfortunately, they are often treated as an afterthought—only addressed after system requirements have been defined and system design is well underway. This approach usually leads to problems that become security vulnerabilities, which can cause major security breaches resulting in significant legal and system modification expenses. A more effective and less costly approach is to define security and control requirements when other system requirements are being identified. The following list provides examples of areas for which security and control requirements might need to be defined:<sup>16</sup>

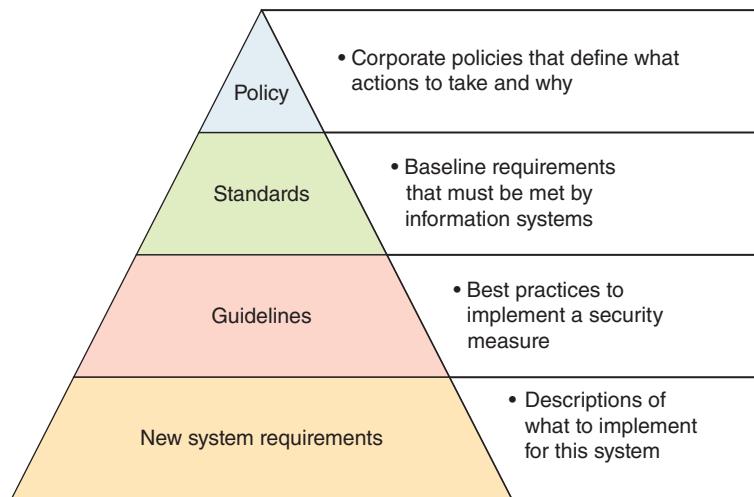
- Access controls, including controls to authenticate and permit access only to authorized individuals
- Encryption of electronic customer information, including while in transit or in storage on networks or systems to which unauthorized individuals may have access
- Dual control procedures, segregation of duties, and employee background checks for employees with responsibilities for or access to customer, employee, or organization-sensitive information
- Monitoring systems and procedures to detect actual and attempted attacks on or intrusions into information systems
- Measures to protect against destruction, loss, or damage of customer, employee, or organization-sensitive data due to potential environmental hazards, such as fire and water damage, technological failures, or disasters such as hurricanes and terrorism
- Business resumption procedures to get the system up and running with no major business disruption and with no loss of data in the event of a disaster (e.g., fire, hurricane, terrorism)

People with a special interest in security and control include the organization's internal auditors and members of senior management. They should provide input and advice during the system analysis and design phases.

System security and control requirements need to be defined in the context of the organization's existing policies, standards, and guidelines. See Figure 13.12. For example, the Gramm-Leach-Bliley Act requires companies legally defined as financial institutions to ensure the security and confidentiality of customer information. Thus, financial institutions have established policies, standards, and guidelines to which any new information system must adhere.

**FIGURE 13.12**  
**Context for new system security and control requirements**

New system security and control requirements must be developed within the organization's existing policies, standards, and guidelines.



### System Performance

How well a system performs can be measured through its performance requirements. Failure to meet these system performance requirements results in unproductive workers, dissatisfied customers, and missed opportunities to deliver outstanding business results. System performance is usually determined by factors such as the following:

- **Timeliness of output.** Is the system generating output in time to meet organizational goals and operational objectives? After GEICO began advertising that consumers could save 15 percent on auto insurance in just 15 minutes, speed became a key factor for many people when selecting an insurance company. Nationwide touts its online tool as the fastest path to a quick car insurance quote, and The General insurance company boasts, “Give us two minutes and we’ll give you an auto insurance quote.”
- **Ease of use.** Developing applications that managers and employees can easily learn and use is essential to ensure that people will work with the applications productively.
- **Scalability.** A scalable information system can handle business growth and increased business volume without a noticeable degradation in performance.
- **System response time.** The average response time for frequent online transactions is a key factor in determining worker productivity and customer service.
- **Availability.** Availability measures the hours per month the system is scheduled to be available for use. Systems typically must be unavailable a few hours a week to allow for software upgrades and maintenance.
- **Reliability.** Reliability measures the hours the system is available for use divided by the hours the system is scheduled to be available and is expressed as a percentage. Worker productivity decreases and customer dissatisfaction increases as system reliability decreases.

### Identify and Evaluate Alternative Solutions

The analysis team must think creatively and consider several system solution options. By looking at the problem in new or different ways, questioning current assumptions and the way things are done today, and removing constraints and barriers, the team is free to identify highly creative and effective information system solutions. Such critical analysis requires unbiased and careful questioning of whether system elements are related in the most effective ways, considering new or different relationships among system elements, and possibly introducing new elements into the system. Critical analysis also involves challenging users about their needs and determining which are truly critical requirements rather than “nice to have” features.

**Pareto principle:** An observation that for many events, roughly 80 percent of the effects come from 20 percent of the causes.

The **Pareto principle** (also known as the 80–20 rule) is a rule of thumb used in business that helps people focus on the vital 20 percent that generate 80 percent of the results. This principle means that 80 percent of the desired system benefits can be achieved by implementing 20 percent of the system requirements. An 80–20 option will have a low cost and quick completion schedule relative to other potential options. However, this option may not be an ideal solution and may not even be acceptable to the users, stakeholders, and the steering team who may be expecting more. Additional candidate solutions can be defined that implement all or most of the critical priority system requirements and team-selected subsets of the medium and low-priority requirements. Table 13.6 illustrates some of the many potential candidates the analysis team may want to evaluate.

**TABLE 13.6** Additional candidates for system analysis

Scope of System	Build System	Customize Software Package
Build system that meets all critical requirements, but no medium or low priority requirements	Option #1	
Modify package so that it meets all critical requirements, but no medium or low priority requirements		Option #2
Build system that meets 20 percent of all requirements that will provide 80 percent of the system benefits	Option #3	
Modify package so that it meets 20 percent of all requirements that will provide 80 percent of the system benefits		Option #4
Implement software package as is, with no customization to enable it to meet unique requirements		Option #5

### Perform Feasibility Analysis

At this stage in the system development process, the project team has identified several promising solutions based on implementing all or most of the critical requirements and various subsets of the medium and low-priority requirements. The feasibility analysis conducted during the investigation phase is repeated for each of the candidate solutions the team wants to consider. At this stage, the analysis can be more in-depth because more is known about the system and its requirements, as well as the costs and benefits of the various options.

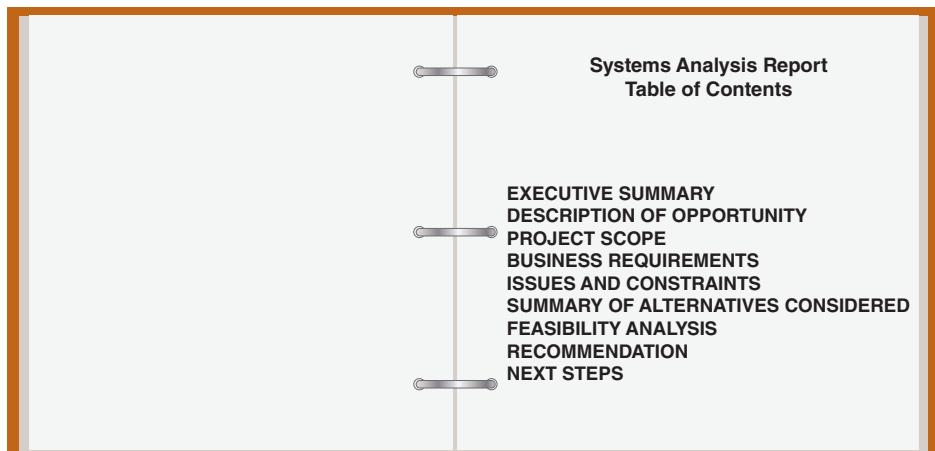
### Prepare Draft of System Analysis Report

System analysis concludes with a formal system analysis report summarizing the findings of this phase of the project. The table of contents for a typical system analysis report is shown in Figure 13.13. This report is a more detailed version of the system investigation report. At this phase of the project, the costs and benefits of the project should be fairly accurate, certainly more accurate than at the end of the investigation phase.

**FIGURE 13.13**

#### Typical table of contents for a report on an existing system

The system analysis report is a more detailed version of the system investigation report.



### Review Results of System Analysis with Steering Team

The system analysis report is presented to the project steering team with a recommendation to stop, revise, or go forward with the system development project. Following the steering team meeting, the project team incorporates the recommendations and suggested changes into the final report. It is not unusual for changes to the project scope, budget, benefits, or schedule to be requested based on the findings from the analysis phase. However, the project sponsor and the steering team must request and formally approve of any changes.

## System Design

The purpose of system design phase is to answer the question, “How will the information system solve this problem?” The primary result of the system design phase is a technical design that details system outputs, inputs, controls, and user interfaces; specifies hardware, software, databases, telecommunications, personnel, and procedures; and shows how these components are interrelated. In other words, **system design** creates a complete set of technical specifications that can be used to construct the information system. The steps in the system design phase are outlined next and discussed in the following pages. Again, note that many of the steps were performed in the investigation and system analysis phase but are now repeated with more current and complete information.

1. Identify and recruit team leader and team members.
2. Develop schedule and budget for system design activities.
3. Design user interface.
4. Design system security and controls.
5. Design disaster recovery plan.
6. Design database.
7. Perform feasibility analysis.
8. Prepare draft of system design report.
9. Review results of system design with steering team.

**system design:** The stage of system development that answers the question, “How will the information system solve a problem?”

### **Identify and Recruit Team Leader and Team Members**

Because some personnel turnover is likely when moving from the system analysis phase to the system design phase, the first step in system design is to identify and recruit the team leader and members. Ideally, some members of the system analysis team will participate in the system design to ensure project continuity.

### **Develop Schedule and Budget for System Design Activities**

The system design team begins by developing a list of specific objectives and activities required to complete the system design phase. It also establishes a schedule complete with major milestones to track project progress. Some tasks may involve working with the steering team to resolve issues and questions raised during the review of the system analysis phase. The group also prepares a budget for completing the system design, including any required travel costs and funds to cover the use of outside resources.

### **Design User Interface**

How users experience an information system determines whether the system will be accepted and used. In speaking about the importance of user interface design for Apple software products, Jef Raskin, an interface expert, once said, “As far as the customer is concerned, the interface is the product.”<sup>17</sup>

User interface design integrates concepts and methods from computer science, graphics design, and psychology to build interfaces that are accessible, easy to use, and efficient. Over the years, various authors have identified user interface design principles, including those listed in Table 13.7.<sup>18, 19</sup>

**TABLE 13.7** Principles of good user interface design

Principle	How To Apply
Strive for consistency	Consistent sequences of actions should be required in similar situations; identical terminology should be used in prompts, menus, and help screens; and consistent commands should be employed throughout.
Offer informative feedback	For every user action, there should be some system feedback. For frequent and minor actions, the response can be modest, while for infrequent and major actions, the response should be more substantial.
Offer simple error handling	As much as possible, design the system so the user cannot make a serious error. If an error is made, the system should be able to detect the error and offer simple, comprehensible instructions for handling the error.
One primary action per screen	Every screen should support a single action of real value to the user.
Provide progressive disclosure	Show only what is necessary on each screen. If the user is making a choice, show enough information to allow the user to choose, and then display details on a subsequent screen.
Strive for aesthetic integrity	The graphic design elements used in an interface should be simple and clean, pleasant to look at, and easy to understand.

User interface design must consider several components. Most systems provide a sign-on procedure that requires identification numbers, passwords, and other safeguards to improve security and prevent unauthorized use. With a menu-driven system, users select what they want to do from a list of alternatives. Most people can easily operate these types of systems. In addition, many designers incorporate a help feature into the system or program. When users want to know more about a program or software feature or what type of response is expected, they can activate the help feature. Systems often use lookup tables to simplify and shorten data entry. For example, if you are entering a sales order for a company, you can type its abbreviation, such as

ABCO. The program searches the customer table, normally stored on a disk, the Internet, or other storage device, and looks up the information you need to complete the sales order for the company abbreviated as ABCO.

Using screen painter software, an analyst can efficiently design the features, layout, and format of the user interface screens. See Figure 13.14. Several screens can be linked together to simulate how the user can move from screen to screen to accomplish tasks. Conducting an interactive screen design session with a few users at a time is an effective process for defining the system user interface.

#### FIGURE 13.14 User Interface Design

Analysts can develop screen mock-ups and simulate how the user moves from screen to screen.



Africa Studio/Shutterstock.com

#### Design System Security and Controls

The system analysis phase identified areas where system security and controls need to be defined. During the design phase, designers must develop specific system security and controls for all aspects of the information system, including hardware, software, database systems, telecommunications, and Internet operations, as shown in Table 13.8. Security considerations involve error prevention, detection, and correction; disaster planning and recovery; and systems controls. The goal is to ensure secure systems without burdening users with too many identification numbers and passwords for different applications.

**TABLE 13.8** Using systems controls to enhance security

Controls	Description
Input controls	Maintain input integrity and security; their purpose is to reduce errors while protecting the computer system against improper or fraudulent input. Input controls range from using standardized input forms to eliminate data-entry errors and using tight password and identification controls.
Processing controls	Deal with all aspects of processing and storage; the use of passwords and identification numbers, backup copies of data, and storage rooms that have tight security systems are examples of processing and storage controls.
Output controls	Ensure that output is handled correctly; in many cases, output generated from the computer system is recorded in a file that indicates the reports and documents that were generated, the time they were generated, and their final destinations.
Database controls	Deal with ensuring an efficient and effective database system; these controls include the use of identification numbers and passwords, without which a user is denied access to certain data and information. Many of these controls are provided by database management systems.
Telecommunications controls	Provide accurate and reliable data and information transfer among systems; telecommunications controls include firewalls and encryption to ensure correct communication while eliminating the potential for fraud and crime.
Personnel controls	Ensure that only authorized personnel have access to certain systems to help prevent computer-related mistakes and crime; personnel controls can involve the use of identification numbers and passwords that allow only certain people access to data. ID badges and other security devices (such as smart cards) can prevent unauthorized people from entering strategic areas in the information systems facility.

After the controls are developed, they should be documented in standards manuals that indicate how to implement the controls. The controls should then be implemented and frequently reviewed. It is common practice to measure how often control techniques are used and to take action if the controls have not been implemented. Organizations often have compliance departments to make sure the IS department is adhering to its systems controls along with all local, state, and federal laws and regulations.

### **Design Disaster Recovery Plan**

**disaster recovery plan:** A documented process to recover an organization's business information system assets including hardware, software, data, networks, and facilities in the event of a disaster.

A **disaster recovery plan** is a documented process to recover an organization's business information system assets including hardware, software, data, networks, and facilities in the event of a disaster. It is a component of the organization's overall business continuity plan, which also includes an occupant emergency plan, a continuity of operations plan, and an incident management plan. A disaster recovery plan focuses on technology recovery and identifies the people or the teams responsible for taking action in the event of a disaster, what exactly these people will do when a disaster strikes, and the information system resources required to support critical business processes.

Disasters can be natural or manmade, as shown in Table 13.9. In performing disaster recovery planning, organizations should think in terms of not being able to gain access to their normal place of business for an extended period, possibly up to several months.

**TABLE 13.9** Various disasters can disrupt business operations

Intentional Man-Made Disaster	Accidental Man-Made Disasters	Natural Disasters
Sabotage	Auto accident knocks down power lines to a data center	Flood
Terrorism	Backhoe digs up a telecommunications line	Tsunami
Civil unrest	Operator error	Hurricane/cyclone
	Fire	Earthquake
		Volcanic eruption

As part of defining the business continuity plan, organizations conduct a business impact analysis to identify critical business processes and the resources that support them. The recovery time for an information system resource should match the recovery time objective for the most critical business processes that depend on that resource. Some business processes are more pivotal to continued operations and goal attainment than others. These processes are called **mission-critical processes**. An order-processing system, for example, is usually considered mission-critical. Without it, the sales organization cannot continue its daily activities, which generate the cash flow needed to keep the business operating.

For some companies, personnel backup can be critical. Without the right number of trained employees, the business process can't function. For information system hardware, hot and cold sites can be used as backups. A duplicate, operational hardware system that is ready for use (or immediate access to one through a specialized vendor) is an example of a **hot site**. If the primary computer has problems, the hot site can be used immediately as a backup.

**mission-critical process:** A process that plays a pivotal role in an organization's continued operations and goal attainment.

**hot site:** A duplicate, operational hardware system that is ready for use (or immediate access to one through a specialized vendor).

**cold site:** A computer environment that includes rooms, electrical service, telecommunications links, data storage devices, and the like.

However, the hot site must be situated so that it will not be affected by the same disaster. Another approach is to use a **cold site**, which is a computer environment that includes rooms, electrical service, telecommunications links, data storage devices, and similar equipment. If a primary computer has a problem, backup computer hardware is brought into the cold site, and the complete system is made operational.

Cloud computing has added another dimension to disaster recovery planning. If your organization is hit by a disaster, information systems that are running on the cloud are likely to be operational and accessible by workers from anywhere they can access the Internet. Data is also stored safely and securely at the site of the cloud-computing service provider, which could be hundreds of miles from the organization. On the other hand, if the cloud service provider is hit by a disaster, it may cause a serious business disruption for your organization even if it is otherwise unaffected by a distant disaster. Thus, part of the evaluation of a cloud service provider must include analysis of the provider's disaster recovery plans. Also keep in mind that state or federal regulations, such as HIPAA, may dictate certain conditions of cloud storage, so organizations should be aware of where the data storage facility is located before signing contracts.

Files and databases can be protected by making a copy of all files and databases changed during the last few days or the last week, a technique called incremental backup. This approach to backup uses an image log, which is a separate file that contains only changes to applications or data. Whenever an application is run, an image log is created that contains all changes made to all files. If a problem occurs with a database, an old database with the last full backup of the data, along with the image log, can be used to re-create the current database.

Organizations can also hire outside companies to help them perform disaster planning and recovery. EMC, for example, offers data backup in its RecoverPoint product.<sup>20</sup> For individuals and some applications, backup copies of important files can be saved online. **Failover** is another approach to backup. When a server, network, or database fails or is no longer functioning properly, failover automatically switches applications and other programs to a redundant or replicated server, network, or database to prevent an interruption of service. SteelEye's LifeKeeper and Continuous Application Availability by NeverFail are examples of failover software.<sup>21, 22</sup> Failover is especially important for applications that must always be operational.

With \$21.6 billion in revenue in the first quarter of 2019, Wells Fargo is one of the largest financial institutions in the United States. In an average quarter, Wells Fargo takes in more than \$1 trillion in deposits and services 29 million digital customers—including more than 23 million who use the bank's mobile applications.<sup>23</sup> In February of 2019, a failure at the bank's Minnesota server facility caused a nationwide operations outage that lasted 24 hours. Smoke in the facility triggered a fire suppression system, resulting in the shutdown of all the servers at that location. The backup system that should have engaged another facility to take over operations failed—causing Wells Fargo's online and mobile banking systems, ATM network, card processing system, and call center to go offline. According to Doron Pinhas, the chief technology officer at Continuity Software, "What most likely happened is that Wells did not pay enough attention and did not have enough controls and prior testing in place to get operations back up and running in an acceptable time frame." In the wake of this massive outage, Wells Fargo should expect to face additional regulatory scrutiny of its disaster recovery plans in the future.<sup>24</sup>

**failover:** A backup technique that involves automatically switching applications and programs to a redundant or replicated server, network, or database to prevent interruption of service.

### **Design Database**

The database provides a user view of data and makes it possible to add and modify data, store and retrieve data, manipulate the data, and generate reports. One of the steps in designing a database involves “telling” the database management system (DBMS) the logical and physical structure of the data and the relationships among the data for each user. Recall that this description is called a schema, and it is entered into the DBMS using a data definition language. A data definition language (DDL) is a collection of instructions and commands that define and describe data and relationships in a specific database.

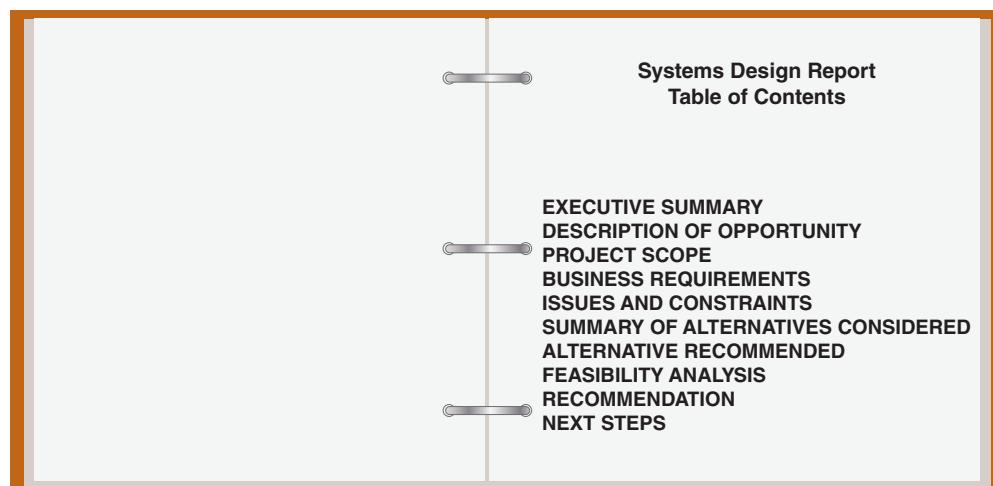
Another important step in designing the database is to establish a data dictionary, a detailed description of all data used in the database. A data dictionary is valuable in maintaining an efficient database that stores reliable information with no redundancy, and it makes it easy to modify the database when necessary. Data dictionaries also help computer and system programmers who require a detailed description of data elements stored in a database create the code to access the data. Adhering to the standards defined in the data dictionary also makes it easy to share data among various organizations without the need for extensive data scrubbing and translation.

### **Perform Feasibility Analysis**

As a result of the work done during the design phase, the project team has a much better understanding of what it will take to build the system, how it will operate, and what benefits it can deliver. It is appropriate to reassess the technical, economic, legal, operational, and schedule feasibility based on these new learnings.

### **Prepare Draft of System Design Report**

System design concludes with a formal system design report summarizing the findings of this phase of the project. Any changes from the system analysis findings are highlighted and explained. The table of contents for a typical system design report is shown in Figure 13.15. This report is a more detailed version of the system investigation report.



**FIGURE 13.15**

#### **Typical table of contents for a system design report**

The system design report is a more detailed version of the system investigation report.

## **Review Results of System Design with Steering Team**

The system design report is presented to the project steering team with a recommendation to stop, revise, or go forward with the system development project. The steering team carefully reviews the recommendations because if the project is to proceed, considerable human and financial resources will be committed, and legally binding vendor contracts will be signed. Following the steering team meeting, the project team incorporates the recommendations and changes suggested into the final report.

At the end of the design phase, organizations employing the Waterfall system development process freeze the scope and the user and business requirements. Any potential changes that are identified or suggested after this point must go through a formal scope change process. This process requires the organization to assess how the proposed changes affect the project feasibility, cost, and schedule. It may be necessary to rerun cost/benefit analyses to ensure that the project is still financially viable. Next, the proposed changes are presented to the project steering team along with their associated costs and schedule impact. The steering team must approve the changes before the project team can begin work to incorporate them into the current design. Frequently, the steering team disapproves changes to ensure that the project is completed without exceeding the current budget and schedule. If the steering team approves the changes, however, the project team might need to repeat portions of the system analysis and design phases to incorporate the changes.

## **Construction**

The system construction phase follows the completion of the system design phase when the project steering team approves of proceeding with the project.

**System construction** converts the system design into an operational system by coding and testing software programs, creating and loading data into databases, and performing initial program testing. These steps are outlined next and are discussed in the following sections:

1. Code software components
2. Create and load data
3. Perform unit testing

### **Code Software Components**

Software code must be written according to defined design specifications so that the system meets user and business needs and operates in the manner the user expects. Most software development organizations use a variety of software tools to generate program source code that conforms to those specifications. The following list includes a sampling of these types of software tools:

- Some template-driven code generators can create source code automatically. CodeSmith Generator is an example of a template-driven code generator that automates the creation of common application source code for several languages (e.g., C#, Java, VB, PHP, ASP.NET, and SQL). The templates are designed to create typical types of business programs. Developers using CodeSmith Generator can modify a template or create a customized template to generate necessary code.<sup>25</sup>
- Screen-painter programs are used to design new data-entry screens for software applications. This easy-to-use software allows developers to create screens by “painting” them and then using “dialogue boxes” to define the characteristics of the data that goes in each field.

**system construction:** The phase of system development that converts the system design into an operational system by acquiring and installing hardware and software, coding and testing software programs, creating and loading data into databases, and performing initial program testing.

- Menu-creation software allows users to develop and format menus with features such as color palettes, graphics characters, automatically generated boxes, headings, and system variables.
- Report generator software captures an image of a desired report and generates the code to produce that report based on the database and database schema you are using. In many cases, users can design and code reports with this software.

DataLab Consulting is a leading financial firm in Uruguay whose main product is a credit card. As such, it must manage its data efficiently and effectively to maintain its customer base. In this highly competitive market, there was a need for rapid application development. DataLab turned to GeneXus, a multi-language development platform. GeneXus is a software generator that works on the Agile platform to create everything from the database to the end software product. GeneXus works with multiple environments, such as IBM, SQL, and Microsoft languages to allow for the rapid development needs of DataLab. DataLab used the GeneXus platform for the development of a data analysis system to track customer's habits, history of payments and purchases, their preferences, and their portfolios. This has allowed DataLab to retain its customer base and maximize the turnover of its customers' investments.<sup>26</sup>

**technical documentation:**

Written details used by computer operators to execute the program and by analysts and programmers to solve problems or modify the program.

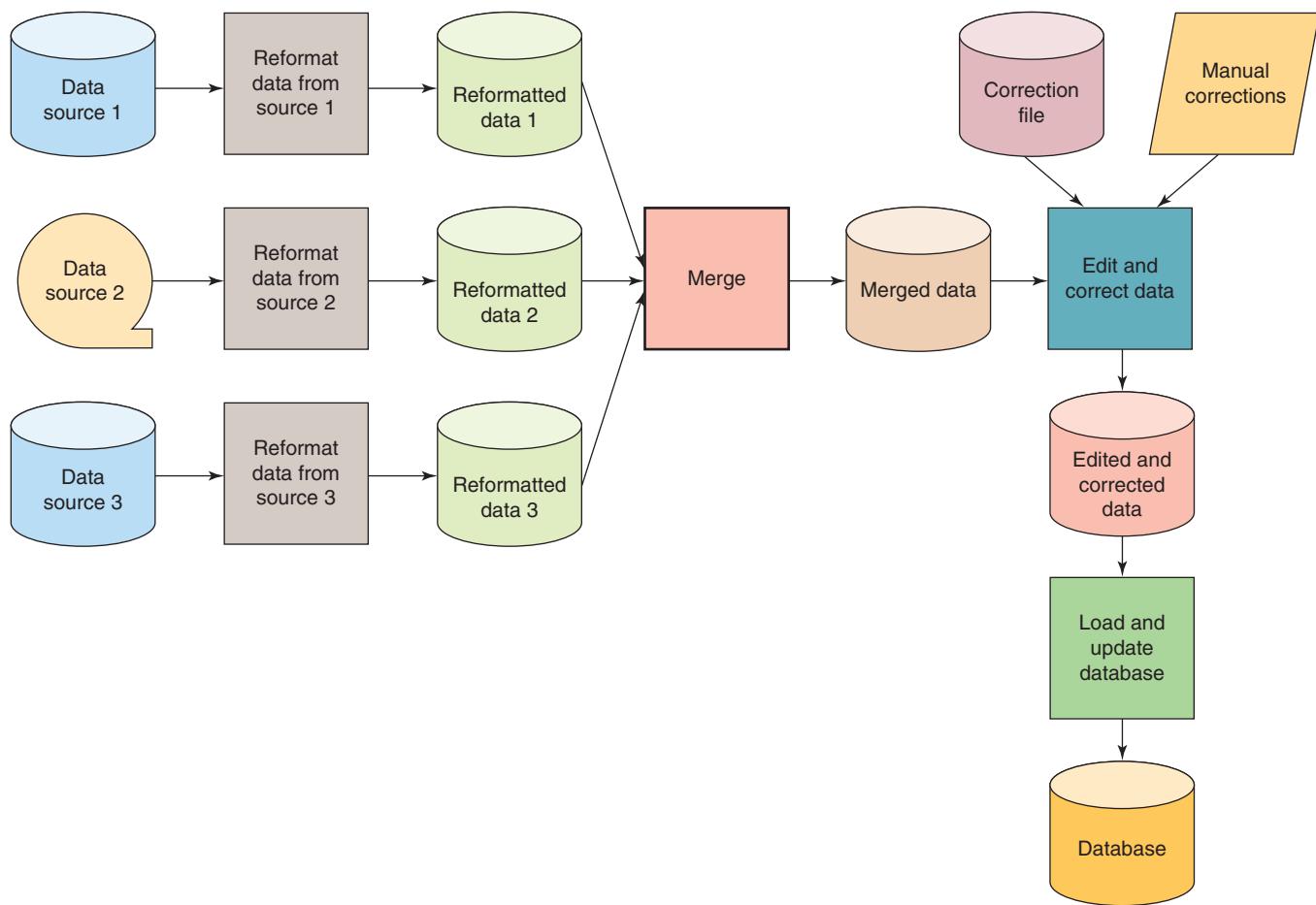
**user documentation:** Written descriptions developed for people who use a program; in easy-to-understand language, it shows how the program can and should be used to meet the needs of its various users.

An organization also needs useful software documentation to accompany the software code. **Technical documentation** includes written details that computer operators follow to execute the program and that analysts and programmers use to solve problems or modify the program. Technical documentation explains the purpose of every major piece of computer code. It also identifies and describes key variables.

**User documentation** is developed for the people who use the system. In easy-to-understand language, this type of documentation shows how the program can and should be used to perform user tasks. Linx Software produces LinxCRM, a customer relationship management system. The company implemented special software to help it create high-quality user documentation including annotated screen shots from the system. Linx also created a video to help train users.<sup>27</sup>

### Create and Load Data

This step of the construction phase involves making sure that all files and databases are populated and ready to be used with the new information system. Data for the initial loading of a new database may come from several sources—the old files or database of the system being replaced, from files of other systems used in the organization, or from data sources purchased from an outside organization. In any case, it may be necessary to write at least one new program to read the old data from these sources, reformat the data into a format compatible with the database design of the new system, and then merge these data sources together. Another program may be needed to edit the merged data for accuracy and completeness and to add new entities, attributes, and/or relationships. For example, if an organization is installing a new customer relationship management program, a program might need to read the old customer contact data and convert it a format that the new system can use. However, if the old customer contact data does not format or contain the same data, such as a separate “bill to” and “ship to” address for existing customers, this data may need to be added manually. The “bill to” address may be used to calculate to which of the organization’s sales regions the customer belongs for sales reporting and accounting purposes. For many project, considerable time and effort is expended in creating and loading a new database. See Figure 13.16.



**FIGURE 13.16**  
**Database preparation tasks**

Creating and loading a new database can take considerable resources.

**unit testing:** Testing of individual components of code (subroutines, modules, and programs) to verify that each unit performs as designed.

### Perform Unit Testing

With the programs written and the database available, it is now possible for the developers to do initial testing of code components. This process is called **unit testing**, which involves testing individual components of code (subroutines, modules, and programs) to verify that each unit performs as designed. Unit testing is accomplished by developing test data that ideally will force an individual component to execute all its various functions and user features. In addition, each program is tested with abnormal input to determine how it will handle erroneous input. As testers find problems, they modify the programs to work correctly. A good set of unit tests can be saved and rerun each time any code is changed to quickly detect any new defects.

### Integration and Testing

Several types of testing must be conducted before a new or modified information system is ready to be put into production. These tests are outlined next and discussed in the following sections:

1. Integration testing
2. System testing
3. Volume testing
4. User acceptance testing

**integration testing:** Testing that involves linking all the individual components together and testing them as a group to uncover any defects in the interfaces between individual components.

**system testing:** Testing the complete, integrated system (hardware, software, databases, people, and procedures) to validate that the information system meets all specified requirements.

**volume testing:** Testing to evaluate the performance of the information system under varying yet realistic work volume and operating conditions to determine the work load at which system performance begins to degrade and to identify and eliminate any issues that prevent the system from reaching its required service-level performance.

**user acceptance testing (UAT):** Testing performed by trained system users to verify that the system can complete required tasks in a real-world operating environment and perform according to the system design specifications.

### Integration Testing

**Integration testing** involves linking individual components together and testing them as a group to uncover any defects in the interface between one component and another (e.g., component 1 fails to pass a key parameter to component 2). Even if unit testing is successful, developers cannot assume that individual components can be combined into a working system. Unfortunately, one component that functions incorrectly can affect another component and, if these problems go undetected, they can cause serious trouble later.

### System Testing

**System testing** involves testing the complete, integrated system (hardware, software, databases, people, and procedures) to validate that the information system meets all specified requirements. System testing is often done by independent testers who were not involved in developing program code. They attempt to make the system fail. They frequently employ testing called black box testing because it requires no specific knowledge of the application's code and internal logic. In other words, the system tester is aware of what the software is supposed to do but is not aware of how it does it.

### Volume Testing

**Volume testing** involves evaluating the performance of the information system under varying yet realistic work volume and operating conditions (e.g., database size, number of concurrent users, number of transactions, and number of queries). The goals of volume testing are to determine the work load at which systems performance begins to degrade and to identify and eliminate any issues that prevent the system from reaching its required system-level performance.

### User Acceptance Testing

During **user acceptance testing (UAT)**, trained users test the information system to verify that it can complete required tasks in a real-world operating environment and perform according to the system design specifications. UAT is also known as beta testing, application testing, and end-user testing. Unlike system testing, which ensures that the system itself works, UAT determines whether the system meets its intended business needs.

UAT is a critical activity that must be completed successfully before newly developed software can be rolled out to the market. In the case of implementing a software package or software developed by an outside organization, the customer performs user acceptance testing before accepting transfer of ownership. UAT involves the following steps:

1. The UAT test team is selected from the set of likely users.
2. The UAT test team is trained using the currently available training material.
3. The overall UAT strategy and schedule is defined.
4. The UAT team designs test cases to exercise the functions and features of the information system.
5. The test cases are documented in a clear and simple step-by-step manner to make the tests easy to execute.
6. The UAT team executes the defined test cases and documents the results of each test.
7. The software development team reviews the test results and makes any required changes to the code, so it meets the design specifications.
8. The UAT team retests the information system until all defects have been fixed or it is agreed that certain defects will not be fixed.
9. The UAT team indicates its acceptance or nonacceptance of the information system. If accepted, the information system is ready to be fully implemented.
10. The UAT team provides feedback on the user training material so it can be updated and improved.

Prior to releasing a new software package or a major revision of an existing package, commercial software development organizations conduct alpha and beta testing. Alpha testing is a limited internal acceptance test where employees of the software development organization and a limited number of other “friends” use the software and provide feedback. After fixing problems uncovered in alpha testing, the developer makes a beta test version of the software available to potential users outside the organization. For example, Microsoft might make a free beta test version of software available on the Internet to increase the amount of feedback it receives.

**user acceptance document:** A formal agreement that the organization signs stating that a phase of the installation or the complete system is approved.

Most software manufacturers and third-party software developers have a **user acceptance document**—a formal agreement the end user organization signs stating that a phase of the installation or the complete system is approved. This is a legal document that usually removes or reduces the IS vendor’s liability for problems that occur after the user acceptance document has been signed. Because this document is so important, many companies get legal assistance before they sign it. Stakeholders can also be involved in acceptance testing to make sure that their benefits are indeed realized.

Table 13.10 summarizes five types of testing: unit testing, integration testing, system testing, volume testing, and user acceptance testing.

**TABLE 13.10** Tests conducted on an information system

Form of Test	What Is Tested	Purpose of Test	Who Does It
<b>Unit</b>	Test individual units of the system.	Verify that each unit performs as designed.	Software developers
<b>Integration</b>	Test all the individual units of the information system linked together.	Uncover any defects between individual components of the information system.	Software developers or independent software testers, using black box testing measures
<b>System</b>	Test the complete, integrated system (hardware, software, databases, people, and procedures).	Validate that the information system meets all specified requirements.	Independent test team, separate from the software development team
<b>Volume</b>	Evaluate the performance of the information system under realistic and varying work volume and operating conditions.	Determine the work load at which system performance begins to degrade and identify and eliminate any issues that prevent the system from performing at the required service level.	System development team and members of the operations organization
<b>User Acceptance</b>	Test the complete, integrated system (hardware, software, databases, people, and procedures).	Verify the information system can complete required tasks in a real-world operating environment and do this according to the system design specifications.	Trained users of the system

## Implementation

Several steps are involved in system implementation. These are outlined next and discussed in the following sections.

1. User preparation
2. Site preparation
3. Installation
4. Cutover

### User Preparation

**user preparation:** The process of readying managers, decision makers, employees, other users, and stakeholders to accept and use the new system.

**User preparation** is the process of readying managers, decision makers, employees, system users, and stakeholders to accept and use the new system. Ideally, user preparation begins in the early stages of system investigation and continues through implementation.

The major challenges to successful implementation of an information system are often more behavioral than technical. Successfully introducing an information system into an organization requires a mix of organizational change skills and technical skills. Strong, effective leadership is required to overcome the behavioral resistance to change and achieve a smooth and successful system introduction.

The dynamics of how change is implemented can be viewed in terms of the Lewin and Schein three-stage model for change: (1) ceasing old habits and creating a climate that is receptive to change; (2) learning new work methods, behaviors, and systems; and (3) reinforcing changes to make the new process second nature, accepted, and part of the job.

Leavitt's Diamond is a change model that proposes that every organizational system is made up of people, tasks, structure, and technology—any change in one of these elements will necessitate a change in the other three elements. Thus, to successfully implement a new information system, appropriate changes must be made to the people, structure, and tasks affected by the new system. People must be convinced to take a positive attitude to the change and be willing to exhibit new behaviors consistent with the change. Management might need to modify the reward system to recognize those who exhibit the desired new behaviors. Training in any required new skills is also necessary.

Recall that the technology acceptance model (TAM) specifies the factors that can lead to better attitudes about the use of a new information system, along with its higher acceptance and usage. Perceived usefulness and perceived ease of use strongly influence whether someone will use an information system. Management can improve that perception by demonstrating that others have used the system effectively and by providing user training and support.

The diffusion of innovation theory cautions that adoption of any innovation does not happen all at once for all members of the targeted population. Instead, adoption is a drawn-out process, with some people adopting the innovation more quickly than others. Rogers' diffusion of innovation theory defined five categories of adopters, each with different attitudes toward innovation. This theory can be useful during the user preparation step of system implementation.

Because user training is so important, some companies employ a variety of training approaches including in-house, software, video, Internet, among others. The material used to train the UAT team can serve as a starting point, with changes based on feedback from the test team.

The eventual success of any system depends not only on how users work with it, but how well the IS personnel within the organization can operate and support it. The IS personnel should also attend training sessions similar to those for the users, although their sessions can provide more technical details. Effective training will help IS personnel use the new system to perform their jobs and support other users in the organization. Many companies use online and simulated training programs to cut training costs and improve effectiveness.

## Site Preparation

**site preparation:** Preparation of the location of a new system.

A location for the hardware associated with the new system needs to be prepared, a process called **site preparation**. For a small system, site preparation can be as simple as rearranging the furniture in an office to make room for a computer. The computer and associated hardware in a larger system might require special wiring, air conditioning, or construction. A special floor, for example, might have to be built and cables placed under it to connect the various computer components, and a new security system might be needed to protect the equipment. The project team needs to consider the amount of site preparation that may be necessary and build sufficient lead time into the schedule to allow for it.

Today, most organizations place a priority on developing IS sites that are energy efficient and secure. One company, for example, installed special security kiosks that let company visitors log on and request a meeting with a company employee. The employee can see the visitor on his or her computer screen and accept or reject the visitor. If the visitor is accepted, the kiosk prints a visitor pass, which allows the person access to the building.

Cyxtera, a large infrastructure and data center company with over 3,500 customers, has recently expanded its data centers in five major markets across North America. As part of its expansion, the company has implemented new security measures that include security cabinets, security cages, and updated compliance standards.<sup>28</sup>

## Installation

**installation:** The process of physically placing the computer equipment on the site and making it operational.

**Installation** is the process of physically placing the computer equipment on the site and making it operational. Although the manufacturer is normally responsible for installing computer equipment, someone from the organization (usually the IS manager) should oversee the process, making sure that all equipment specified in the contract is installed at the proper location. After the system is installed, the manufacturer performs several tests to ensure that the equipment is operating as it should.

## Cutover

**cutover:** The process of switching from an old information system to a replacement system.

**Cutover** is the process of switching from an old information system to a replacement system. Cutover is critical to the success of the organization; if not done properly, the results can be disastrous.

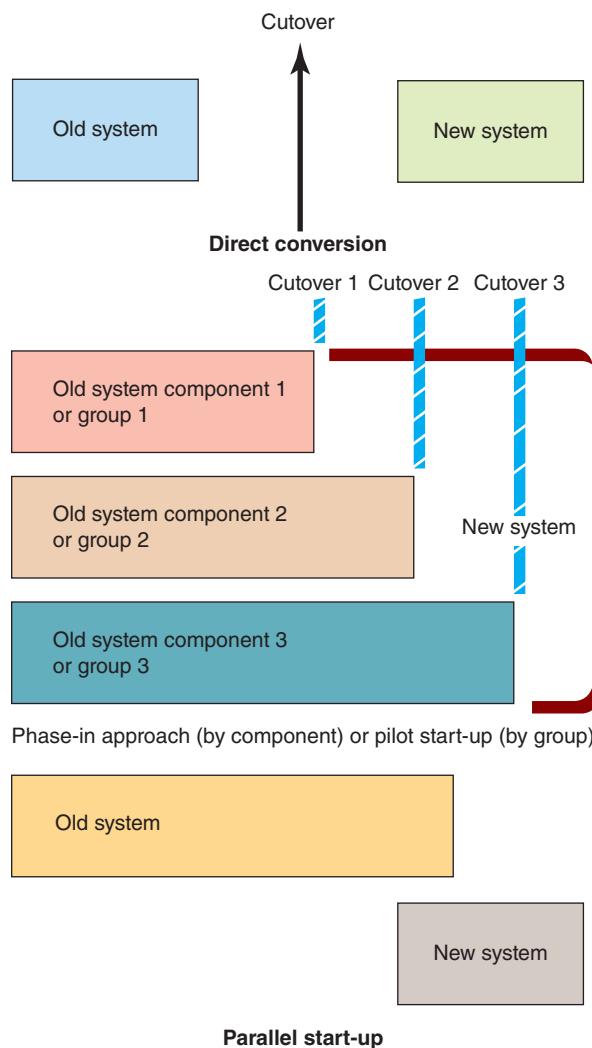
Hershey's, the largest chocolate manufacturer in North America, provides a classic example of a failed system cutover. The company planned to upgrade a mix of older existing, or "legacy," information systems into an integrated environment of the latest software from leading vendors, including SAP for ERP functionality, Manugistics for supply chain management, and Siebel for customer relationship management. The cutover was targeted for July, one of the company's busiest months, when it was shipping orders for Halloween and Christmas. Unfortunately, Hershey's was not well prepared, and the cutover was a fiasco. As a result, Hershey was unable to process over \$100 million worth of orders. The resulting operational paralysis led to nearly a 20 percent drop in quarterly profits and an 8 percent decline in share price.

Organizations can follow one of several cutover strategies. See Figure 13.17. **Direct conversion** (also called plunge or direct cutover) involves stopping the old system and starting the new system on a given date. Direct conversion is high-risk approach because of the potential for problems and errors when the old system is shut off and the new system is turned on at the same instant.

**direct conversion:** A cutover strategy that involves stopping the old system and starting the new system on a given date; also called plunge or direct cutover.

**FIGURE 13.17****System cutover strategies**

Cutover can be through direct conversion, phase-in approach, pilot start-up, or parallel start-up.



**phase-in approach:** A cutover strategy that involves slowly replacing components of the old system with those of the new one; this process is repeated for each application until the new system is running every application and performing as expected; it is also called a piecemeal approach.

**pilot start-up:** A cutover strategy that involves running the complete new system for one group of users rather than for all users.

**parallel start-up:** A cutover strategy that involves running both the old and new systems for a set period of time and closely comparing the output of the new system with the output of the old system; any differences are reconciled. When users are comfortable that the new system is working correctly, the old system is eliminated.

Many organizations follow a **phase-in approach**, where components of the new system are slowly phased in while components of the old one are slowly phased out. When everyone is confident that all components of the new system are performing as expected, the old system is completely phased out. This gradual replacement is repeated for each component until the new system has fully replaced the old system. In some cases, the phase-in approach, also called a piecemeal approach, can take several months.

**Pilot start-up** involves running the complete new system for one group of users rather than for all users. For example, a manufacturing company with many retail outlets throughout the country could use the pilot start-up approach and install a new inventory control system at one of its retail outlets. When the system runs without problems at the pilot location, the new inventory control system can then be implemented at other outlets, one by one.

**Parallel start-up** involves running both the old and new systems for a set period of time. The performance and output of the new system are compared closely with the performance and output of the old system, and any differences are reconciled. When users are comfortable that the new system is working correctly, the old system is eliminated.

The dormakaba Group is a large security and access firm located in Rümlang, Switzerland. With over 16,000 employees and CHF 402 million in revenue, dormakaba is one of the largest providers of access and security solutions for hospitals, airports, and hotels.<sup>29</sup> In January of 2018, dormakaba was

recognized as one of the Top 100 Global Technology Leaders by Thompson Reuters for its complex business strategies.<sup>30</sup> When developing their technology, dormakaba turn to the SAP cloud platform. The dormakaba jay cloud is available using SaaS to allow them to deliver high-quality customer service while maintain their competitive edge.<sup>31</sup>

One of the success stories from the dormakaba Group is from the Südzucker AG company. A combination of cutover strategies was used to implement the new system for recording time attendance and operational data. Südzucker AG is one of the largest sugar producers in Europe and is headquartered in Germany. A phased-in approach was used for the locations in Germany. Once successful, a direct conversion was used for the remaining world-wide locations. Both implementation strategies proved successful.<sup>32</sup>

## System Operation and Maintenance

The steps involved in system operation and maintenance are outlined next and discussed in the following sections:

1. Operation
2. Maintenance
3. Disposal

### *Operation*

**system operation:** The use of a new or modified system under all kinds of operating conditions.

**monitoring:** The process of measuring system performance by tracking the number of errors encountered, the amount of memory required, the amount of processing or CPU time needed, and other performance indicators.

**System operation** involves the use of a new or modified system under all kinds of operating conditions. Getting the most out of a new or modified system during its operation is the most important aspect of system operations for many organizations. To provide adequate user support, many companies establish a formal help desk for their employees and customers. A help desk consists of computer systems, manuals, people with technical expertise, and other resources needed to solve problems and give accurate answers to questions. End users who experience problems accessing or using an information system, can access the help desk's Web site or request support via a call or text to the help desk.

**Monitoring** is the process of measuring system performance by tracking the number of errors encountered, the amount of memory required, the amount of processing or CPU time needed, and other performance indicators. If a system is not performing as expected, it should be modified, or a new system should be developed or acquired.

System performance products can measure all components of an information system, including hardware, software, database, telecommunications, and network systems. Microsoft Visual Studio, for example, has features that allow system developers to monitor and review how applications are running and performing, enabling developers to make changes if needed. IDERA's Precise for Databases is a suite of performance monitors designed for the analysis of enterprise database environments—such as Oracle, SQL, DB2, and Sybase—and various subsystems.<sup>33</sup> Precise Software Solutions has system performance products that provide around-the-clock performance monitoring that provide data analysis and tuning recommendations to provide enhance strategic planning. HP also offers a software tool called Business Technology Optimization (BTO) to help companies analyze the performance of their computer systems, diagnose potential problems, and take corrective action if needed. When properly used, system performance products can quickly and efficiently locate actual or potential problems.

Allscripts is a \$2.1 billion publicly traded company that provides practice management, electronic health care records, and financial software to hundreds of physician practices, hospitals, and other health care organizations. Honeywell has partnered with Allscripts to provide systems monitoring for critical

systems such as those that control patient oxygen flow and air flow for laboratories and pharmacies. With a monitoring system that alerts them before a problem occurs, Allscripts's clients have the assurance that the critical systems they need to deliver high-quality patient care will continue uninterrupted.<sup>34</sup>

**system review:** The process of analyzing a system to make sure it is operating as intended.

**System review** is the process of analyzing a system to make sure it is operating as intended. System review often compares the performance and benefits of the system as it was designed with the actual performance and benefits of the system in operation.

United Airlines launched its Volunteer Solicitation Program in 2017. This software alerted passengers that flight was overbooked and would ask how much compensation they would accept in exchange for accepting a later, or earlier, flight. This information would then be available for use by the gate agents if the need arose. In reviewing the system and the data generated, the software team released a second version of the software in December 2018. This version gave passengers more options up to 24 hours in advance of their flight, so the compensation could be negotiated for a higher amount. The software also had options available based on the airport, customer type, and check-in channel (mobile, ticket counter, terminal). The system was built on gamification, meaning the customers could bid on the options they were viewing, and it gave them more control of their options. Jason Birnbaum, Vice President of Operations and Employee Technology, advises IT leaders to be as close to your team and customers as possible. When reviewing your software, he also advises “One of the key tenets of this project, and many others, has been for us to not iterate much in the conference room around white boards. . . . The information we get in every single one of these iterations is fast feedback.”<sup>35</sup>

Internal employees, external consultants, or both can perform a system review. An organization’s billing application, for example, might be reviewed for errors, inefficiencies, and opportunities to reduce operating costs. In addition, the billing application might be reviewed if corporations merge, if one or more new managers require different information or reports, or if federal laws on bill collecting and privacy change. This is an event-driven approach to system review.

### Maintenance

**system maintenance:** A stage of systems development that involves changing and enhancing the system to make it more useful in achieving user and organizational goals.

**System maintenance** is a stage of system development that involves changing and enhancing the system to make it more useful in achieving user and organizational goals. Reasons for program maintenance include the following:

- Poor system performance, such as slow response time for frequent transactions
- Changes in business processes
- Changes in the needs of system stakeholders, users, and managers
- Bugs or errors in the program
- Technical and hardware problems
- Corporate mergers and acquisitions
- Changes in government regulations
- Changes in the operating system or hardware on which the application runs

Organizations can perform system maintenance in-house, or they can hire outside companies to perform maintenance for them. Many companies that use information systems from Oracle or SAP, for example, hire those companies to maintain their systems. System maintenance is important for individuals, groups, and organizations. Individuals looking to system-maintenance services, for example, can use the Internet, computer vendors, and independent maintenance companies, including Geek Squad ([www.geeksquad.com](http://www.geeksquad.com)) and PC Pinpoint ([www.pcpinpoint.com](http://www.pcpinpoint.com)). Organizations often have personnel dedicated to system maintenance. Software maintenance for purchased software can cost 20 percent or more of the purchase price annually.

The maintenance process can be especially difficult for older software. A legacy system might have cost millions of dollars to develop, patch, and modify over the years. The maintenance costs for legacy systems can become quite expensive, and, at some point, it becomes more cost effective to switch to new programs and applications than to repair and maintain the legacy system.

**slipstream upgrade:** A minor system upgrade—typically a code adjustment or minor bug fix; it usually requires recompiling all the code, and in so doing, it can create entirely new bugs.

**patch:** A minor system change to correct a problem or make a small enhancement; it is usually an addition to an existing program.

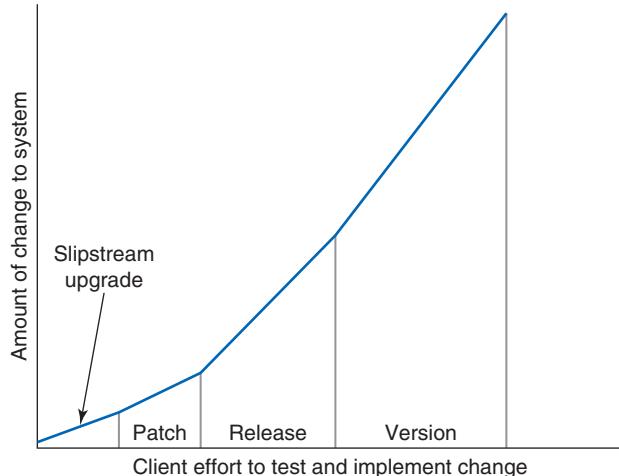
**release:** A significant program change that often requires changes in the documentation of the software.

**version:** A major program change, typically encompassing many new features.

Four generally accepted categories signify the amount of change involved in maintenance. A **slipstream upgrade** is a minor system upgrade—typically a code adjustment or minor bug fix. Many companies don't announce to users that a slipstream upgrade has been made; however, because a slipstream upgrade usually requires recompiling all the code, it can create entirely new bugs. This maintenance practice explains why the same computers sometimes work differently with what is supposedly the same software. A **patch** is a minor change to correct a problem or make a small enhancement. The fix is usually patched into an existing program; that is, the programming code representing the system enhancement is usually added to the existing code. Many patches come from off-the-shelf software vendors. Although slipstream upgrades and patches are minor changes, they can cause users and support personnel big problems if the programs do not run as before. A new **release** is a significant program change that often requires changes in the documentation of the software. Finally, a new **version** is a major program change, typically encompassing many new features. Figure 13.18 shows the relative amount of change and effort required to test and implement these four categories of system maintenance.

**FIGURE 13.18**  
**System maintenance efforts**

This chart shows the relative amount of change and effort associated to test and implement slipstream upgrades, patches, releases, and versions.



Because of the amount of effort that can be spent on maintenance, many organizations require a request for maintenance form to be completed and approved before authorizing the modification of an information system. This form is usually signed by a business manager who documents the need for the change and identifies the priority of the change relative to other work that has been requested. The IS group reviews the form and identifies the programs that need to be changed, determines the programmer to assign to the project, estimates the expected completion date, and develops a technical description of the change. A cost/benefit analysis might be required if the change requires substantial resources. The completed change request is then reviewed and prioritized relative to the other change requests that have been made.

### Disposal

At some point, an existing information system may become obsolete, uneconomical to operate and/or maintain, or unrepairable. Information systems typically evolve to this stage in the life cycle because the system can no longer be

**system disposal:** A stage of system development that involves those activities that ensure the orderly dissolution of the system, including disposing of all equipment in an environmentally friendly manner, closing out contracts, and safely migrating information from the system to another system or archiving it in accordance with applicable records management policies.

modified to keep up with changing user and business requirements, outdated technology causes the system to run slowly or unreliably, or key vendors are no longer able or willing to continue to provide necessary service or support.

**System disposal** is a stage of system development that involves those activities that ensure the orderly dissolution of the system, including disposing of all equipment in an environmentally friendly manner, closing out contracts, and safely migrating information from the system to another system or archiving it in accordance with applicable records management policies. The steps involved in system disposal are outlined and discussed in the following sections:

1. Communicate intent
2. Terminate contracts
3. Make backups of data
4. Delete sensitive data
5. Dispose of hardware

### **Communicate Intent**

A memo communicating the intent to terminate the information system should be distributed to all key stakeholders, months in advance of the actual shutdown. This ensures that everyone is aware of the shutdown and allows time for them to convert to the new system or process replacing the terminated system. Microsoft has announced that extended support for Windows 7 will end on January 14, 2020. Mainstream support for the operating system ended in 2015. When the end of support for an operating system is announced, businesses must begin to plan their strategy, as the end of support means there will no longer be security updates. Despite the risks, an estimated 43 percent of companies are still running the outdated operating system, with an astonishing 16 percent still running Windows XP and Windows Vista, which Microsoft stopped supporting several years ago. Running outdated operating systems leaves a company vulnerable to security threats. However, for a significant fee, an organization can contract with Microsoft for additional extended support.<sup>36</sup>

### **Terminate Contracts**

The various vendors who provide hardware, software, or services associated with the information system must be notified well in advance to avoid any penalty fees associated with abrupt termination of a contract.

### **Make Backups of Data**

Prior to deleting files associated with the system, backup copies of data must be made according to the organization's records-management policies.

### **Delete Sensitive Data**

Extreme care must be taken to remove customer, employee, financial, and company-sensitive data from all computer hardware and storage devices before disposing of it. Otherwise, an organization's discarded equipment could become a treasure trove to competitors or identity thieves. When a file is deleted, the bits and pieces of the file physically stay on a computer hard drive until they are overwritten, and they can be retrieved with a data recovery program. To remove data from a hard drive permanently, the hard drive needs to be wiped clean. The program used should overwrite or wipe the hard drive several times. An alternative is to remove the hard drive and physically destroy it.

### **Dispose of Hardware**

After backing up and then removing data from drives, members of the project team can dispose of obsolete or damaged computer hardware. Governments, environmental agencies, and leading hardware manufacturers are attempting

to reduce hazardous materials in electronic products; however, some hardware components still contain materials that are toxic to the environment. Responsible disposal techniques should be used regardless of whether the hardware is sold, given away, or discarded. Many computer hardware manufacturers, including Dell and HP, have developed programs to assist their customers in disposing of old equipment.



## Critical Thinking Exercise

### User Acceptance Testing for New Accounting System

#### ► TEAMWORK

You are a member of the finance and accounting organization of a midsized sporting goods retailer. You are knowledgeable of all facets of your firm's current accounting systems and procedures and have been working in accounts receivable for the past three years. The firm is implementing a new cloud-based accounting system to handle general ledger, accounts payable, accounts receivable, and payroll tasks. You have been selected to plan and lead the user acceptance testing for the accounts receivable portion of the system. This will be a full-time activity for you over the next two-to-three months, and during that time, other employees will fill in to take care of most of your day-to-day responsibilities.

#### Review Questions

1. Outline the tasks that must be accomplished to successfully complete user acceptance testing.
2. Your normal work activities and responsibilities have not allowed you time to become familiar with this project and the new system and its capabilities. What actions would you take to get caught up quickly?

#### Critical Thinking Questions

1. How would you go about selecting and recruiting end users to participate in the user acceptance testing? How would you determine how many end users are needed for testing?
2. What do you think might be the biggest barriers to completion of the user acceptance testing in a timely manner?

## Agile Development

**Agile development:** An iterative system development process that develops the system in “sprint” increments lasting from two weeks to two months.

**Scrum:** An Agile development framework that emphasizes a team-based approach in order to keep the development effort focused and moving quickly.

**Agile development** is an iterative system development process that develops a system in “sprint” increments lasting from two weeks to two months. Unlike the Waterfall system development process, Agile development accepts the fact that system requirements are evolving and cannot be fully understood or defined at the start of the project. Agile development concentrates instead on maximizing the team’s ability to deliver quickly and respond to emerging requirements—hence the name Agile. In an Agile development project, the team stops and reevaluates the system every two weeks to two months, giving it ample opportunity to identify and implement new or changed system requirements.<sup>37</sup>

**Scrum** is an Agile development framework that uses a team-based approach in order to keep the development effort focused and moving quickly. Scrum emphasizes individuals and interactions over processes and tools, working software over comprehensive documentation, customer collaboration over contract negotiation, and responding to change over following a plan.<sup>38</sup>

**Scrum master:** The person who coordinates all the Scrum activities of a team.

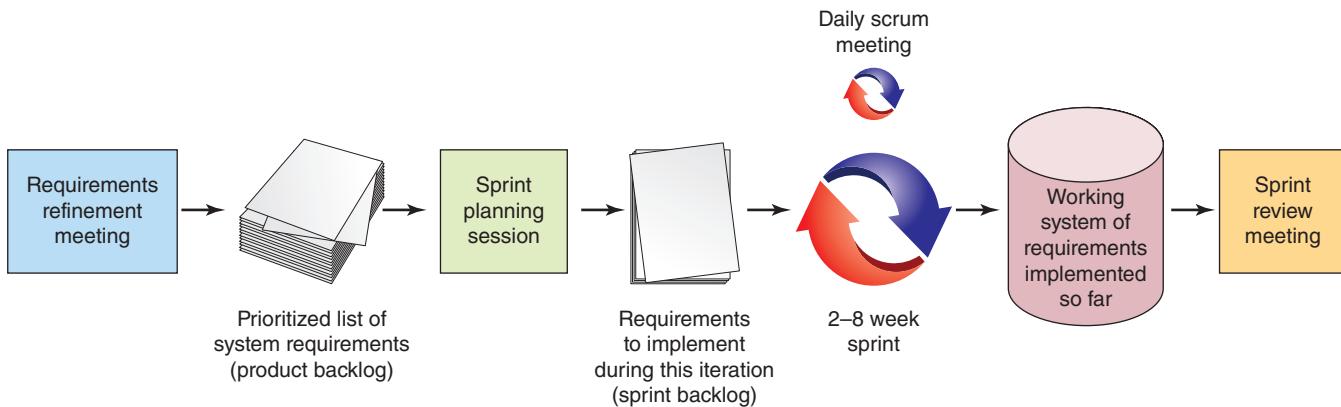
**product owner:** A person who represents the project stakeholders and is responsible for communicating and aligning project priorities between the stakeholders and development team.

**product backlog:** A prioritized list of project requirements created by the stakeholders and project team members; from this list, the team selects the highest priorities.

A **Scrum master** is the person who coordinates all Scrum activities, and a Scrum team consists of a dozen or fewer people who perform all systems development activities from investigation to testing so there is less personnel turnover than on the typical Waterfall system development project. The Scrum master does not fill the role of a traditional project manager and has no people management responsibilities. Instead, the primary responsibility of the Scrum master is to anticipate and remove barriers to the project team producing its deliverables and meeting the project schedule.<sup>39</sup>

The **product owner** is a person who represents the project stakeholders and is responsible for communicating and aligning project priorities between the stakeholders and development team. The product owner holds the product vision; he or she is responsible for describing what should be built and why—but not how.<sup>40</sup>

Using the Scrum method, the product owner works with the stakeholders and team to create a prioritized list of project requirements called a **product backlog**. Next, a sprint planning session is held, during which the team selects the highest priority requirements from the top of the product backlog to create the sprint backlog; they then decide how to implement those requirements. The team sets a certain amount of time—typically two to eight weeks—to complete its work. During the sprint, each day at the same time, the team meets briefly (15 minutes at most) to share information necessary for coordination. At this meeting, team members describe what they completed the previous day and identify any obstacles that stand in the way of them completing this day's activities. The sprint is complete when the team presents a working system that incorporates the new requirements, and it can be used and evaluated. During the sprint review meeting, the team shares what it learned from the current sprint iteration so that knowledge can be applied in the next sprint iteration. See Figure 13.19. Along the way, the Scrum master keeps the team focused on its goals.<sup>41</sup>



**FIGURE 13.19**

### The Scrum Agile software development process

The Scrum Agile approach develops a system in sprint increments lasting from two weeks to two months.

Agile development requires cooperation and frequent face-to-face meetings with all participants, including system developers and users, as they modify, refine, and test the system's capabilities and how it meets users' needs. Organizations are using Agile development to a greater extent today to improve the results of system development, including global projects requiring IS resources distributed in many locations. Agile is often better suited for developing smaller information systems than larger ones. During an Agile

project, the level of participation of stakeholders and users is much higher than in other approaches. Table 13.11 lists advantages and disadvantages of Agile development.<sup>42</sup>

**TABLE 13.11** Advantages and disadvantages of Agile development

Advantages	Disadvantages
For appropriate projects, this approach puts an application into production sooner than any other approach.	It is an intense process that can burn out system developers and other project participants.
Documentation is produced as a by-product of completing project tasks.	This approach requires system analysts and users to be skilled in Agile system development tools and Agile techniques.
Agile forces teamwork and lots of interaction between users and stakeholders.	Agile requires a larger percentage of stakeholders' and users' time than other approaches.

**extreme programming (XP):** A form of Agile software development that promotes incremental development of a system using short development cycles to improve productivity and to accommodate new customer requirements.

**DevOps:** The practice of blending the tasks performed by the development and IT operations groups to enable faster and more reliable software releases.

**Extreme programming (XP)** is a form of Agile software development that promotes incremental development of a system using short development cycles to improve productivity and to accommodate new customer requirements. Other essentials of extreme programming include programming in pairs, performing extensive code review, unit testing of all code, putting off the programming of system features until they are actually needed, use of a flat project management structure, simplicity and clarity in code, expecting changes in system requirements as the project progresses and the desired solution is better understood, and frequent communication with the customer and among programmers. These qualities make extreme programming compatible with Agile software development.<sup>43</sup>

**DevOps** is the practice of blending of the tasks performed by the development staff (who are typically responsible for design, coding, and testing) and the IT operations groups (who typically handle operational deployment tasks, such as server provisioning and job scheduling) to enable faster and more reliable software releases.<sup>44</sup> This approach is key to successful Agile development environments where organizations go live with new software releases every two to four weeks. And in many organizations, DevOps is being used as part of a continuous deployment strategy, in which releases are launched daily—and in some cases, multiple times a day. Many industry experts view DevOps as an outgrowth of the Agile development movement, with an extension of Agile development principles to include systems and operations rather than just code.

Under traditional software development approaches, the application development team gathers business requirements, writes code, and tests programs in an isolated development environment. The code is then released to the IT operations group to deploy in the real-world operational environment of end users. This involves gluing together all the components of an application, including databases, messaging infrastructure, external services, the passing and receiving of data to and from other systems, and third-party dependencies.

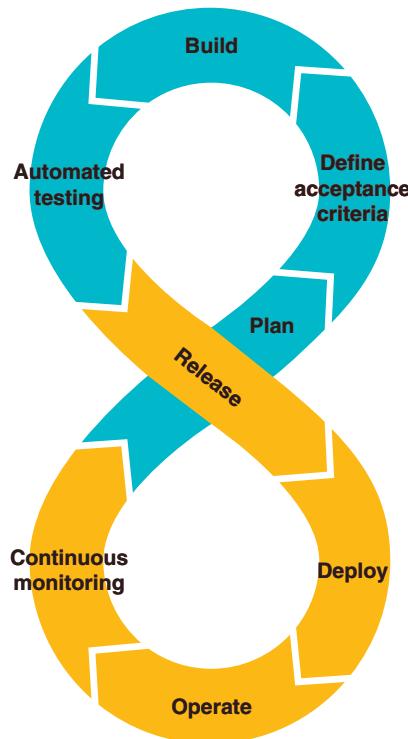
DevOps principles reshape all the move-into-production activities so that they become automated, collaborative, continuous, incremental, iterative, and self-service. Responsive teams adopt DevOps practices of self-service configuration, automated provisioning (using predefined procedures that are carried out electronically without requiring human intervention), continuous build, continuous integration, continuous delivery, automated release management, and incremental testing, as shown in Figure 13.20.

**FIGURE 13.20**

**DevOps is part of a continuous deployment strategy in which releases can be launched daily**

DevOps blends the tasks performed by the development and operations groups to enable faster and more reliable software releases.

Source: Chris Haddad, "Overcome DevOps Adoption Barriers to Accelerate Software Delivery," Tech Well Insights, May 8, 2015, [www.techwell.com/techwell-insights/2015/05/overcome-devops-adoption-barriers-accelerate-software-delivery](http://www.techwell.com/techwell-insights/2015/05/overcome-devops-adoption-barriers-accelerate-software-delivery).



Although DevOps can mean slightly different things depending on how it is deployed at different companies, at its core, DevOps places a priority on collaboration, with operations staff and development engineers participating together, over the entire system's lifecycle—from design and development through testing and implementation.<sup>45</sup>

Etsy is an online shopping site that sells everything from clothing to musical instruments to vintage collectibles. Etsy connects buyers and sellers through its Web site, which means the site needs to be up and running consistently. When Etsy first began developing its systems, the IT staff used the Waterfall method of development. The process was slow, however, and the updates were causing too much downtime with the Web site. Etsy has now adopted a DevOps framework, which allows it to deploy more than 50 updates per day, with much less disruption on its site.<sup>46</sup>

Table 13.12 compares the key features of the Agile and Waterfall system development processes.

**TABLE 13.12** Comparison of approaches to system development

Characteristic	Software Development Approach	
	Agile	Waterfall
<b>Description</b>	An iterative process that develops the system in sprint increments lasting 2–8 weeks; each increment focuses on implementing the highest priority requirements that can be completed in the allotted time	A sequential multistage process where work on the next stage cannot begin until the results of the previous stage are reviewed and approved or modified as necessary
<b>Basic assumption</b>	System requirements cannot be fully defined at start of project	All critical system requirements must be fully defined before any coding begins
<b>How requirements and design are defined</b>	Users interacting with system analysts and working software	Users interacting with system analysts and system documentation and/or models
<b>Associated processes</b>	Scrum	Structured system analysis and design



## Critical Thinking Exercise

### Firm's First Agile Project

#### ► WRITTEN AND ORAL COMMUNICATION

You were hired into a new company that was impressed with your two years of experience as a Scrum master on a variety of information systems projects. Your new firm has a large in-house information system development staff that is trained and experienced in the use of the Waterfall software development process. You have been assigned responsibility as a Scrum master for a key project that will be the firm's first Agile project. You have also been asked to train the project manager, team, and newly appointed product owner in the Agile process and their associated roles and responsibilities.

#### Review Questions

- As part of the team's initial project kickoff meeting, you have been asked to briefly summarize the differences between the Waterfall and Agile software development process. What would you say?
- Following your discussion, one of the team members asks, "so why are we changing to a new software development process? We are all comfortable with the way we do things now." What do you say?

#### Critical Thinking Questions

- There is likely to be some confusion over the role of project manager, Scrum master, and product owner. What can you do to avoid this potential problem?
- What other potential problems can you anticipate as the team moves forward with its first Agile project? What can be done to avoid these potential issues?

## Summary

### Principle:

**Organizations can obtain software using one of three basic approaches: subscribe, buy, or build.**

Buying off-the-shelf software is less risky and leads to quicker deployment; however, maintenance and support costs may become expensive with this approach, and the software may not be an exact match to the needs and work processes of the organization.

Building custom software can provide a better match to the current work processes of the organization and provide a potential competitive advantage; however, the cost can become extremely high, and it can take months or even years to develop the software.

### Principle:

**When evaluating and purchasing off-the-shelf software, an organization must consider the effort required to modify both the new software package and the existing software so that they work well together.**

A preliminary evaluation of software packages and vendors begins during system analysis when the two or three strongest contenders are identified. The final evaluation begins with a detailed investigation of the contenders' proposals as well as discussions with two or three customers of each vendor.

## Principle:

**A system developed following the Waterfall approach moves from one phase to the next, with a management review at the end of each phase.**

The set of activities involved in building information systems to meet users' needs is called system development.

The Waterfall system development process cycle is a sequential, multistage system development process in which work on the next stage cannot begin until the results of the current stage are reviewed and approved or modified as necessary. It is referred to as a Waterfall process because progress is seen as flowing steadily downwards (like a Waterfall) through the various phases of development.

The phases of the Waterfall system development process can vary from one company to the next, but many organizations use an approach with six phases: investigation, analysis, design, construction, integration and testing, and implementation. Once the system is built, organizations complete the additional steps of operation and maintenance and disposition.

At the end of each phase, a review is conducted to ensure that all tasks and deliverables associated with that phase were produced and that they are of good quality. In addition, at the end of each phase, the overall project scope, costs, schedule, and benefits associated with the project are reviewed to ensure that the project is on track and worth completing. As a result, the Waterfall system development process allows for a high degree of management control.

System investigation is the key initial phase in the development of a new or modified business information system. The purpose of this phase is to gain a clear understanding of the specifics of the problem to solve or the opportunity to address.

Joint application development (JAD) is a structured meeting process that can accelerate and improve the efficiency and effectiveness of not only the investigation phase, but also the analysis and design phases of a system development project.

Functional decomposition is a technique used primarily during the investigation phase to define the business processes included within the scope of the system.

The technical, economic, legal, operational, and schedule feasibility are assessed during the feasibility analysis.

After a project has completed the investigation phase and been approved for further study, the next step is system analysis, which answers the question, "What must the information system do to solve the problem or capitalize on the opportunity?"

The overall emphasis of analysis is gathering data on the existing system, determining the requirements for the new system, considering alternatives within identified constraints, and investigating the feasibility of alternative solutions.

Identifying, confirming, and prioritizing system requirements is perhaps the single most critical step in the entire Waterfall system development process because failure to identify a requirement or an incorrect definition of a requirement may not be discovered until much later in the project, causing much rework, additional costs, and delay in the systems effort.

A data-flow diagram (DFD) is a diagram used during both the analysis and design phases to document the processes of the current system or to provide a model of a proposed new system. A DFD shows not only the various processes within the system but also where the data needed for each process comes from, where the output of each process will be sent, and what data will be stored and where.

The analysis team should make a preliminary assessment of the software marketplace to determine whether existing packages can meet the organization's needs. The primary tool for doing this is the request for information (RFI), a document that outlines an organization's hardware or software needs and requests vendors to respond with information about if and how they can meet those needs and the time and resources required.

The purpose of system design phase is to answer the question, “How will the information system solve this problem?” The primary result of the system design phase is a technical design that details system outputs, inputs, controls, and user interfaces; specifies hardware, software, databases, telecommunications, personnel, and procedures; and shows how these components are interrelated. In other words, system design creates a complete set of technical specifications that can be used to construct the information system.

During the design phase, designers must develop specific system security and controls for all aspects of the information system, including hardware, software, database systems, telecommunications, and Internet operations.

System construction converts the system design into an operational system by coding and testing software programs, creating and loading data into databases, and performing initial program testing.

Several types of testing must be conducted before a new or modified information system is ready to be put into production, including unit testing, integration testing, system testing, volume testing, and user acceptance testing.

System implementation includes the following activities: user preparation, site preparation, installation, and cutover.

System operation involves using the new or modified system under all kinds of operating conditions. Getting the most out of a new or modified system during its operation is the most important aspect of system operations for many organizations.

System maintenance involves changing and enhancing the system to make it more useful in achieving user and organizational goals. There are many reasons why system maintenance is required.

System disposal involves those activities that ensure the orderly dissolution of the system, including disposing of all equipment in an environmentally friendly manner, closing out contracts, and safely migrating information from the system to another system or archiving it in accordance with applicable records management policies.

## Principle:

**Agile development is an iterative system development process that develops a system in “sprint” increments lasting from two weeks to two months.**

Unlike the Waterfall system development process, Agile development accepts the fact that system requirements are evolving and cannot be fully understood or defined at the start of the project. Agile development concentrates instead on maximizing the team’s ability to deliver quickly and respond to emerging requirements—hence the name Agile.

Scrum is an Agile development framework that uses a team-based approach in order to keep the development effort focused and moving quickly. Scrum emphasizes individuals and interactions over processes and tools, working software over comprehensive documentation, customer collaboration over contract negotiation, and responding to change over following a plan.

A Scrum master is the person who coordinates all Scrum activities, and a Scrum team consists of a dozen or fewer people who perform all system development activities from investigation to testing.

The product owner is a person who represents the project stakeholders and is responsible for communicating and aligning project priorities between the stakeholders and development team. The product owner holds the product vision; he or she is responsible for describing what should be built and why—but not how.

Extreme programming (XP), another Agile software development approach, promotes incremental development of a system using short development cycles to improve productivity and to accommodate new customer requirements.

DevOps is the practice of blending the tasks performed by the development and IT operations groups to enable faster and more reliable software releases. This approach is key to successful Agile development.

## Key Terms

- |                                     |                                      |
|-------------------------------------|--------------------------------------|
| Agile development                   | release                              |
| cold site                           | request for information (RFI)        |
| cutover                             | schedule feasibility                 |
| data-flow diagram (DFD)             | Scrum                                |
| DevOps                              | Scrum master                         |
| direct conversion                   | site preparation                     |
| disaster recovery plan              | slipstream upgrade                   |
| economic feasibility                | system analysis                      |
| extreme programming (XP)            | system construction                  |
| failover                            | system design                        |
| feasibility analysis                | system development                   |
| functional decomposition            | system disposal                      |
| hot site                            | system investigation                 |
| installation                        | system investigation report          |
| integration testing                 | system maintenance                   |
| joint application development (JAD) | system operation                     |
| legal feasibility                   | system review                        |
| mission-critical processes          | system testing                       |
| monitoring                          | technical documentation              |
| operational feasibility             | technical feasibility                |
| parallel start-up                   | unit testing                         |
| Pareto principle (80–20 rule)       | user acceptance document             |
| patch                               | user acceptance testing (UAT)        |
| performance evaluation test         | user documentation                   |
| perpetual license                   | user preparation                     |
| phase-in approach                   | version                              |
| pilot start-up                      | volume testing                       |
| product backlog                     | Waterfall system development process |
| product owner                       |                                      |

## Self-Assessment Test

Organizations can obtain software using one of three basic approaches: subscribe, buy, or build.

1. \_\_\_\_\_ software is less risky and leads to quicker deployment; however, maintenance and support costs may become expensive.
  - a. Custom
  - b. Enterprise
  - c. Off-the-shelf
  - d. Personal productivity
2. \_\_\_\_\_ software can provide a better match to the current work processes of the organization and may provide a potential competitive advantage; however, software development can be extremely costly, and it can take months or even years to complete.
  - a. Custom
  - b. Enterprise
  - c. Off-the-shelf
  - d. Personal productivity
3. Which of the following is not a reason to subscribe to on-demand software?
  - a. The software does not need to be scalable.
  - b. Specialized software is needed in a timely fashion.
  - c. The IT staff does not include developers.
  - d. The company has limited storage capacity.

**When evaluating and purchasing off-the-shelf software, an organization must consider the effort required to modify both the new software package and the existing software so that they work well together.**

4. A preliminary evaluation of software packages and vendors begins during the \_\_\_\_\_ phase when the two or three strongest contenders are identified.
  - a. system investigation
  - b. system design
  - c. system analysis
  - d. feasibility analysis

**A system developed using the Waterfall approach moves from one phase to the next, with a management review at the end of each phase.**

5. Many organizations use a Waterfall approach with six phases, including investigation, analysis, design, \_\_\_\_\_, integration and testing, and implementation.
6. The Waterfall approach allows for a high degree of management control, but it does not allow for user interaction with the system until the integration and testing phase, when the system is nearly complete. True or False?
7. The purpose of the system investigation phase is to \_\_\_\_\_.
  - a. define what the information system must do to solve the problem or capitalize on the opportunity
  - b. gain a clear understanding of the specifics of the problem to solve or the opportunity to address
  - c. gather data on the existing system and determine the requirements for the new system
  - d. identify, confirm, and prioritize system requirements
8. \_\_\_\_\_ is a diagram used to document the processes of the current system or to provide a model of a proposed new system.
9. The overall emphasis of the \_\_\_\_\_ phase is on gathering data on the existing system, determining the requirements of the new system, considering alternatives within identified constraints, and investigating the feasibility of alternative solutions.

- a. investigation
- b. analysis
- c. design
- d. construction
10. The primary tool for assessing the software marketplace to determine whether existing packages can meet the organization's needs is the \_\_\_\_\_.
  - a. system investigation report
  - b. request for quotation
  - c. RFI
  - d. system design report
11. The \_\_\_\_\_ phase converts the system design into an operational system by coding and testing software programs, creating and loading data into databases, and performing initial program testing.
  - a. system analysis
  - b. system construction
  - c. system implementation
  - d. system testing and integration
12. \_\_\_\_\_ is an Agile development framework that uses a team-based approach in order to keep the development effort focused and moving quickly.
13. In the Scrum framework, the \_\_\_\_\_ is a person who represents the project stakeholders and is responsible for communicating and aligning project priorities between stakeholders and the development team.
  - a. project manager
  - b. Scrum master
  - c. product owner
  - d. project sponsor
14. \_\_\_\_\_ is the practice of blending the tasks performed by the development and IT operations groups to enable faster and more reliable software releases.
  - a. Scrum
  - b. Extreme programming
  - c. JAD
  - d. DevOps

## Self-Assessment Test Answers

1. c
2. a
3. a
4. c
5. construction
6. True
7. b

8. Data-flow diagram
9. b
10. c
11. b
12. Scrum
13. c
14. d

## Review and Discussion Questions

- What are primary characteristics of the Waterfall system development process? What is the rationale for using the term “Waterfall” to describe it?
- Identify and state the purpose of each of the six phases of the Waterfall system development process.
- Identify and briefly describe at least three advantages of SaaS and how these advantages can help an organization as they grow.
- Provide two examples of opportunities or problems that are likely to trigger the need for an information system project.
- What are the four different kinds of feasibility that must be assessed? Why is the feasibility of a system reviewed during both the analysis and design phases?
- Thoroughly discuss the pros and cons of buying versus building software.
- Outline the steps necessary to conduct an effective joint application development (JAD) session. Who should participate in such a session? What is the role of the JAD facilitator?
- Why is it important for business managers to have a basic understanding of the system development process?
- Identify several areas for which system security and control requirements need to be defined.
- Identify and briefly describe six system performance factors.
- How does DevOps support the Agile system development process?
- What is extreme programming (XP)? What is its goal?
- An organization has selected and is now implementing a software package. Identify three key factors that will determine the cost and time required for implementation.

## Business-Driven Decision-Making Exercises

- You are acquiring a new information system for The Fitness Center, a company with three fitness centers in your metropolitan area, with a total of 1200 members and 20 to 30 full and part-time employees in each location. Through previous research efforts, the director of marketing has determined that your clientele is interested in a state-of-the-art software system to track all their fitness and health-related activities. Each piece of equipment in the gym will be modified to allow entry of the member's ID number, recording the date, time of day, weight used, and number of reps or workout length. Members and fitness consultants want to be able to log in to the system from any computer or mobile device and see displays of various reports (calories burned, muscle groups worked, blood pressure, distance run, steps taken, etc.) for a user-specified time period. Use word-processing software to identify at least six high-priority requirements for such a system. Use a spreadsheet or project management program to identify and schedule the tasks that must be performed in order to choose the best software package and implement it.
- The preliminary investigation of a software project has been completed. Two different project teams have estimated the costs associated with the development and maintenance of a new system. One team based their estimates on the assumption that the Waterfall system development

process would be used for the project; the other team plans to follow the Agile approach. A third option is to purchase off-the-shelf software that provides nearly all the benefits of a custom-built solution. Review the estimates below and choose the best approach for the project: Waterfall development, Agile development, or off-the-shelf software implementation. Provide a solid rational for your choice. Identify any assumptions you must make in reaching your decision.

	Waterfall	Agile	Off-the-Shelf Software
Total effort months to complete the system	45	38	6
Cost per effort month	\$10k	\$10k	\$10k
Cost of software package			\$350k
Elapsed time until a partial working version is available (months)	Not applicable	2	Not applicable
Elapsed time until all currently envisioned features are available (months)	8	5	3
Annual savings generated by the complete system	\$180k	\$180k	\$160k

## Teamwork and Collaboration Activities

- Your team has been hired to define the scope and feasibility of project to create a database of job openings and descriptions for the companies visiting your campus each term. Students would be able to log on to the system and request an appointment with each company's recruiter. Recruiters would be granted access to each student's summary transcript (courses taken, but no grades shown) and resume. Describe the tasks your team would perform to complete the system investigation phase. Who else needs to be involved in the system investigation? Develop a data-flow diagram that defines the scope of this system.
- Your team has been selected to monitor the disposal of your school's 10-year old student-registration system. Develop a list of the activities that need to be completed to complete this task. Which activities are of most concern?

## Career Exercises

- Perform research to learn what is required to have a successful career as a software developer for smartphones. What sort of education and experience is needed? What personal characteristics would be helpful in such a career? How would one get started in such a career, and what are starting salaries?
- Identify an information system frequently employed by people in a career field you

are interested in. Discuss how you might be involved as a user in the development or acquisition of such a system for your future company. Identify three things that you could do as a project participant that would greatly improve the likelihood of successful project. Now, identify three things that you could do (or fail to do) that could greatly diminish the probability of success of such a project.

## Case Studies

### ► GLOBAL

#### Case Study

##### **Intel Uses Agile and DevOps to Transform Its Business Operations**

To be a leader in technology, you have to be able to adapt to change, and in today's world, change comes quickly. Intel, one of the world's largest semiconductor companies, has a supply chain that includes 19,000 suppliers, 2,000 customers, and facilities in 63 countries. Each year, the company fulfills over a million orders and ships over a billion units. To sustain this level of business and adapt to a constantly changing market, Intel brought machine learning into its operations by utilizing DevOps and Agile practices.

According to Aziz Safa, Intel's chief data officer, "Twenty years ago, we would not make a major change in the enterprise for years. Whereas today you are seeing new offerings come very fast." According to Safa, developing that agility in Intel's operations required a shift in thinking across the company.

Starting in 2017, Intel jump-started that shift by training 4,700 employees on the Agile methodology. After seeing success with the Agile approach, the company trained another 3,000 employees. According to the company's

2018–2019 IT performance report, Intel's "new scaling framework has created a significant pull in the organization to fully commit to the Agile and DevOps transformation." The goal is to have a 60 percent testing automation and a 50 percent reduction in time to delivery. To achieve this goal, the DevOps team identified the applications that interoperate and the areas that must operate efficiently to reduce the time to delivery. Using the Agile framework, they are working toward the goal of introducing new systems and applications that will utilize the automated testing process and increase the delivery time for its customers.

Now that the move to Agile and DevOps is underway at Intel, the focus is shifting to better utilizing the data from the systems to make applications operate more efficiently across different platforms. Intel is basing more of their success on cloud and automation platforms. DevOps has paved the way for what is being called the "Common Cloud Core" (C3) and the ability to use PaaS (discussed earlier in the chapter) to enhance the delivery of new systems and increase the scalability of the current systems. Traditionally, systems were designed to run for several years before updates

were planned. Intel recognizes that it is “fundamental to any organization that wants to innovate based on technology: digital transformation and DevOps go hand in hand.” A business must be able to move quickly in the ever-changing technology world, and Intel is at the center of this market. Applications must move from the idea state to production in a consistent manner, versus the traditional method that would take months of planning and development. Feedback must be continuous from users to developers to allow for continuous improvements.

By combining DevOps, PaaS, and C3, Intel has automated many of its systems. This automation has allowed for more efficient processing and a cost savings for both company and customers. Intel has taken advantage of release planning, which allows developers to release smaller portions of the system on a more frequent basis. Utilizing the cloud infrastructure, there is no downtime, and end users can provide feedback on a manageable scale. DevOps allows for continuous testing as the development cycle is shorter, and the feedback is faster and on a targeted part of the system. With the tools available through PaaS, there is continuous monitoring of the system to keep applications running at optimum levels. These tools provide developers with performance data so they can improve on any areas that may be under-performing. Intel has been successful in implementing Agile and DevOps. What will be next for this technology giant?

## Notes

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## Critical Thinking Questions

1. Intel has been a technology leader for decades. Why do you think it took the company so long to make major changes in the past? Why do you think it has taken them so long to make the move to an Agile development method for faster processes?
2. Intel uses a combination of DevOps, C3, and PaaS for development. Do you think PaaS is necessary for DevOps to be successful? Why do you think Intel is using PaaS along with DevOps in the Agile development process? What advantage, or disadvantage, do you think PaaS could have for Intel in the future?
3. What would be some of the criteria you would use to measure the success of a shift to DevOps practices within a company?

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# Glossary

## #

**5G (5th generation)** The latest generation of mobile communications, featuring high data transfer speeds over high frequencies with minimal latency and requiring low energy.

## A

**acid properties** Properties (atomicity, consistency, isolation, durability) that guarantee relational database transactions are processed reliably and ensure the integrity of data in the database.

**Agile development** An iterative system development process that develops the system in “sprint” increments lasting from two weeks to two months.

**American Recovery and Reinvestment**

**Act Title xiii** Includes strong privacy provisions for electronic health records (EHRs), including banning the sale of health information, promoting the use of audit trails and encryption, providing rights of access for patients, and mandating that each individual whose health information has been exposed be notified within 60 days after discovery of a data breach.

**analytics** The extensive use of data and quantitative analysis to support fact-based decision making within organizations.

**anonymous expression** The expression of opinions by people who do not reveal their identity.

**antivirus software** Should be installed on each user's personal computer to scan a computer's memory and disk drives regularly for viruses.

**application programming interfaces (API)** A set of programming instructions and standards that enable one microservice to access and use the services of another microservice.

**application software** Programs that help users solve particular computing problems.

**artificial intelligence (AI)** The ability to mimic or duplicate the functions of the human brain.

**artificial intelligence (AI) system** The people, procedures, hardware, software, data, and knowledge needed to develop computer systems and machines that can simulate human intelligence processes, including learning (the acquisition of

information and rules for using the information), reasoning (using rules to reach conclusions), and self-correction (using the outcome from one scenario to improve its performance on future scenarios).

**artificial neural network** A computer system that can recognize and act on patterns or trends that it detects in large sets of data; developed to operate like the human brain.

**attack vector** The technique used to gain unauthorized access to a device or a network.

**attribute** A characteristic of an entity.

**augmented reality (AR)** Vision system software that takes computer-generated images and superimposes them on a user's view of the world through the use of specialized glasses or goggles.

**autonomic computing** The ability of IT systems to manage themselves and adapt to changes in the computing environment, business policies, and operating objectives.

## B

**backward chaining** A strategy used by the inference engine to determine how a decision was made.

**backward compatibility** The ability of current mainframes to run software created decades ago.

**batch processing system** A form of data processing whereby business transactions are accumulated over a period of time and are processed as a single unit or batch.

**best practices** The most efficient and effective ways to complete a business process.

**big data** The term used to describe data collections that are so enormous (terabytes or more) and complex (from sensor data to social media data) that traditional data management software, hardware, and analysis processes are incapable of dealing with them.

**biometric authentication** The process of verifying your identity using your physiological measurements (fingerprint, shape of your face, shape of your hand, vein pattern, your iris, or retina) or behavioral measurements (voice recognition, gait, gesture, or other unique behaviors).

**bioprinting** The use of 3D printers to build human parts and organs from actual human cells.

**blade server** A server that houses many individual computer motherboards that include one or more processors, computer memory, computer storage, and computer network connections.

**blog** A Web site that people and businesses use to share their observations, experiences, and opinions on a wide range of topics.

**Bluetooth** A wireless communications specification that describes how cell phones, computers, faxes, printers, and other electronic devices can be interconnected over distances of 10 to 30 feet at a rate of about 2 Mbps.

**botnet** A large group of computers controlled from one or more remote locations by hackers without the knowledge or consent of their owners.

**brain computer interface (BCI)** Technology that interacts with a human's neural structure (brain) and translates the information (thoughts) into activity (actions).

**bring your own device (BYOD)** A business policy that permits, and in some cases encourages, employees to use their own mobile devices (smartphones, tablets, or laptops) to access company computing resources and applications.

**bus** A set of electronic circuits used to route data and instructions to and from the various components of a computer.

**bus network** A network in which all network devices are connected to a common backbone that serves as a shared communications medium.

**business continuity plan** A document that includes an organization's disaster recovery plan, occupant emergency evacuation plan, continuity of operations plan, and an incident management plan.

**business intelligence (BI)** A wide range of applications, practices, and technologies for the extraction, transformation, integration, visualization, analysis, interpretation, and presentation of data to support improved decision making.

**business-to-consumer (B2C) e-commerce** A form of e-commerce in which customers deal directly with an organization and avoid intermediaries.

**business-to-business (B2B) e-commerce** A subset of e-commerce in which all the participants are organizations.

**byte (b)** Eight bits that together represent a single character of data.

## C

**cache memory** A type of highspeed memory that a processor can access more rapidly than main memory.

**Cascading Style Sheet (CSS)** A markup language for defining the visual design of a Web page or group of pages.

**certification** A process for testing skills and knowledge.

**certificate authority (CA)** A trusted third-party organization or company that issues digital certificates.

**change model** A representation of change theories that identifies the phases of change and the best way to implement them.

**channel bandwidth** The capacity of a communications channel to carry traffic, usually measured in megabits bits per second (Gbps).

**Children's Online Privacy Protection Act (COPPA)** States that any Web site that caters to children must offer comprehensive privacy policies, notify parents or guardians about its data collection practices, and receive parental consent before collecting any personal information from children under 13 years of age.

**CIA security triad** Confidentiality, integrity, and availability form the basis of the CIA security triad.

**client/server architecture** This is a networking approach wherein many clients (end-user computing devices) request and receive services from servers (host computers) on the network.

**clock speed** A series of electronic pulses produced at a predetermined rate that affects machine cycle time.

**cloud computing** A computing environment where software and storage are provided as an Internet service and are accessed with a Web browser.

**cold site** A computer environment that includes rooms, electrical service, telecommunications links, data storage devices, and the like.

**communications management** The generation, collection, dissemination, and storage of project information in a timely and effective manner.

**communications medium** Any material substance that carries an electronic signal to support communications between a sending and a receiving device.

**compiler** A special software program that converts the programmer's source code into the machine-language instructions, which consist of binary digits.

**computer forensics** A discipline that combines elements of law and computer

science to identify, collect, examine, and preserve data from computer systems, networks, and storage devices in a manner that preserves the integrity of the data gathered so that it is admissible as evidence in a court of law.

**computer graphics card** A component of a computer that takes binary data from the CPU and translates it into an image you see on your display device.

**computer network** The communications media, devices, and software connecting two or more computer systems or devices.

**computer-aided design (CAD)** The use of software to assist in the creation, analysis, and modification of the design of a component or product.

**computer-aided engineering (CAE)** The use of software to analyze the robustness and performance of components and assemblies.

**computer-aided manufacturing (CAM)** The use of software to control machine tools and related machinery in the manufacture of components and products.

**concurrency control** A method of dealing with a situation in which two or more users or applications need to access the same record at the same time.

**consumer-to-consumer (C2C) e-commerce** A subset of e-commerce that involves electronic transactions between consumers using a third party to facilitate the process.

**content streaming** A method for transferring large media files over the Internet so that the data stream of voice and pictures plays more or less continuously as the file is being downloaded.

**continuous improvement** A form of innovation that involves constantly seeking ways to improve business processes and add value to products and services.

**conversion funnel** A graphical representation that summarizes the steps a consumer takes in making the decision to buy your product and become a customer.

**coprocessor** The part of the computer that speeds processing by executing specific types of instructions while the CPU works on another processing activity.

**core** Receives instructions and performs calculations, or actions, based on those instructions.

**core competency** Something that a firm can do well and that provides customer benefits, is hard for competitors to imitate, and can be leveraged widely to many products and markets.

**core value** A widely accepted principle that guides how people behave and make decisions in the organization.

**cost management** A set of activities that includes the development and management of the project budget.

**cost-reimbursable contract** A contract that requires the buyer to pay the provider an amount that covers the provider's actual costs plus an additional amount or percentage for profit.

**critical path** All project activities that, if delayed, would delay the entire project.

**Cross-Industry Process for Data Mining (CRISP-DM)** A six-phase structured approach for the planning and execution of a data mining project.

**cryptocurrency** A digital currency, such as Bitcoin, used for financial transactions.

**culture** A set of major understandings and assumptions shared by a group, such as within an ethnic group or a country.

**customer relationship management (CRM) system** A system that helps a company manage all aspects of customer encounters, including marketing, sales, distribution, accounting, and customer service.

**cutover** The process of switching from an old information system to a replacement system.

**cyberespionage** The deployment of malware that secretly steals data in the computer systems of organizations.

**cyberterrorism** The intimidation of government or civilian population by using information technology to disable critical national infrastructure (e.g., energy, transportation, financial, law enforcement, emergency response) to achieve political, religious, or ideological goals.

## D

**data** Raw facts such as an employee number or total hours worked in a week.

**data breach** The unintended release of sensitive data or the access of sensitive data by unauthorized individuals.

**data center** A climate-and-access-controlled building or a set of buildings that houses the computer hardware that delivers an organization's data and information services.

**data cleansing** The process of detecting and then correcting or deleting incomplete, incorrect, inaccurate, or irrelevant records that reside in a database.

**data collection** Capturing and gathering all data necessary to complete the processing of transactions.

**data correction** Reentering data that was not typed or scanned properly.

**data definition language (DDL)** A collection of instructions and commands used to define and describe data and relationships in a specific database.

**data dictionary** A detailed description of the data stored in the database.

**data editing** Checking data for validity and completeness to detect any problems.

**data governance** The core component of data management; it defines the roles, responsibilities, and processes for ensuring that data can be trusted and used by the entire organization, with people identified and in place who are responsible for fixing and preventing issues with data.

**data item** The specific value of an attribute.

**data lake** A “store everything” approach to big data that saves all the data in its raw and unaltered form.

**data lifecycle management (DLM)** A policy-based approach to managing the flow of an enterprise’s data, from its initial acquisition or creation and storage to the time when it becomes outdated and is deleted.

**data management** An integrated set of functions that defines the processes by which data is obtained, certified fit for use, stored, secured, and processed in such a way as to ensure that the accessibility, reliability, and timeliness of the data meet the needs of the data users within an organization.

**data manipulation language (DML)** A specific language, provided with a DBMS, which allows users to access and modify the data, to make queries, and to generate reports.

**data mart** A subset of a data warehouse that is used by small and medium-sized businesses and departments within large companies to support decision making.

**data mining** A BI analytics tool used to explore large amounts of data for hidden patterns to predict future trends and behaviors for use in decision making.

**data normalization** The process of organizing the data in a relational database to eliminate data redundancy (all data is stored in only one place) and ensure data dependencies make sense (only storing related data in a table).

**data processing** Performing calculations and other data transformations related to business transactions.

**data scientist** An individual who combines strong business acumen, a deep understanding of analytics, and a healthy appreciation of the limitations of data, tools, and techniques to deliver real improvements in decision making.

**data steward** An individual responsible for the management of critical data elements, including identifying and acquiring new data sources; creating and maintaining consistent reference data and master data definitions; and analyzing data for quality and reconciling data issues.

**data storage** Updating one or more databases with new transactions.

**data warehouse** A large database that holds business information from many sources in the enterprise, covering all aspects of the company’s processes, products, and customers.

**database** A well-designed, organized, and carefully managed collection of data.

**database administrator (DBA)** A skilled and trained IS professional who holds discussions with business users to define their data needs; applies database programming languages to craft a set of databases to meet those needs; tests and evaluates databases; implements changes to improve the performance of databases; and assures that data is secure from unauthorized access.

**database approach to data management** An approach to data management where multiple information systems share a pool of related data.

**database management system (DBMS)** A group of programs used to access and manage a database as well as provide an interface between the database and its users and other application programs.

**database as a service (DaaS)** An arrangement where the database is stored on a service provider’s servers and accessed by the service subscriber over a network, typically the Internet, with the database administration handled by the service provider.

**data-flow diagram (DFD)** A diagram used during both the analysis and design phases to document the processes of the current system or to provide a model of a proposed new system.

**deep learning** Allows programs to grow and learn from examples provided users, either typed or spoken.

**defamation** The making of either an oral or a written statement of alleged fact that is false and that harms another person.

**Department of Homeland Security (DHS)**

A large federal agency with more than 240,000 employees and a budget of almost \$65 billion whose goal is to provide for a “safer, more secure America, which is resilient against terrorism and other potential threats.”

**descriptive analysis** A preliminary data processing stage used to identify patterns in the data and answer questions about who, what, where, when, and to what extent.

**desktop computers** A nonportable computer that fits on a desktop and can provide sufficient computing power, memory, and storage for most business computing tasks.

**development engine** Engine that builds the sets of rules and processes used by AI systems.

**DevOps** The practice of blending the tasks performed by the development and IT operations groups to enable faster and more reliable software releases.

**diffusion of information theory** A theory developed by E.M. Rogers to explain how a new idea or product gains acceptance and diffuses (or spreads) through a specific population or subset of an organization.

**digital certificate** An attachment to an email message or data embedded in a Web site that verifies the identity of a sender or Web site.

**direct conversion** A cutover strategy that involves stopping the old system and starting the new system on a given date; also called plunge or direct cutover.

**disaster recovery plan** A documented process for recovering an organization’s business information system assets—including hardware, software, data, networks, and facilities—in the event of a disaster such as a flood, fire, or electrical outage.

**discrete manufacturing** The production of distinct items such as autos, airplanes, furniture, or toys that can be decomposed into their basic components.

**distributed denial-of-service (DDoS) attack** A cyberattack in which a malicious hacker takes over computers via the Internet and causes them to flood a target site with demands for data and other small tasks.

**document production** Generating output records, documents, and reports.

**domain** The range of allowable values for a data attribute.

**domain expert** The person or group with the expertise or knowledge the expert system is trying to capture (domain).

**domain name system** A system that maps the name people use to locate a website to the IP address that a computer uses to locate a Web site.

## E

**economic feasibility** The process of determining whether the project makes financial sense and whether predicted benefits offset the cost and time needed to obtain them.

**e-discovery (electronic discovery)** The process of identifying, collecting, and producing electronically stored information for use in legal cases.

**e-government (electronic government)** The use of information and communications technology to simplify the sharing of information, speed formerly paper-based processes, and improve the relationship between citizens and government.

**electronic cash** An amount of money that is computerized, stored, and used as cash for e-commerce transactions.

**electronic exchange** An electronic forum where manufacturers, suppliers, and competitors buy and sell goods, trade market information, and run back-office operations.

**Electronic Product Environmental Assessment Tool (EPEAT)**

A system that enables purchasers to evaluate, compare, and select electronic products based on a total of 51 environmental criteria.

**encryption** The process of scrambling messages or data in such a way that only authorized parties can read it.

**encryption key** A value that is applied (using an algorithm) to a set of unencrypted text (plaintext) to produce encrypted text that appears as a series of seemingly random characters (ciphertext) that is unreadable by those without the encryption key needed to decipher it.

**end user license agreement (EULA)** The legal agreement between the software manufacturer and the user of the software that stipulates the terms of usage.

**enterprise application** Software used to meet organization-wide business needs and typically shares data with other enterprise applications used within the organization.

**enterprise data model** A data model that identifies the data entities and data attributes of greatest interest to the organization along with their associated standard data definitions, data length and format, domain of valid values, and any business rules for their use.

**enterprise information system** An information system that an organization uses to define structured interactions among its own employees and/or with external customers, suppliers, government agencies, and other business partners.

**enterprise system** A system central to the organization that ensures information can be shared with authorized users across all business functions and at all levels of management to support the running and managing of a business.

**entity** A person, place, or thing for which data is collected, stored, and maintained.

**entity-relationship (ER) diagram** A data model that uses basic graphical symbols to show the organization of and relationships between data.

**embedded system** A computer system (including some sort of processor) that is implanted in and dedicated to the control of another device.

**ethics** The set of principles about what is right and wrong that individuals use to make choices to guide their decisions.

**expert systems** The decision-making computer systems in AI, designed to be the most advanced and most reliable in solving complex problems.

**explanation facility** Component of an expert system that allows a user or decision maker to understand how the expert system arrived at certain conclusions or results.

**exploit** An attack on an information system that takes advantage of a particular system vulnerability.

**Extensible Markup Language (XML)** The markup language designed to transport and store data on the Web.

**Extract Transform Load (ETL) process** A data handling process that takes data from a variety of sources, edits and transforms it into the format used in the data warehouse, and then loads this data into the warehouse.

**extranet** A network built using Web technologies that links selected resources of the intranet of a company with its customers, suppliers, or other business partners.

**extreme programming (XP)** A form of Agile software development that promotes incremental development of a system using short development cycles to improve productivity and to accommodate new customer requirements.

**F**

**failover** A backup technique that involves automatically switching applications and programs to a redundant or replicated server, network, or database to prevent interruption of service.

**Fair and Accurate Credit Transactions Act** Allows consumers to request and obtain a free credit report once each year from each of the three primary consumer credit reporting companies (Equifax, Experian, and TransUnion).

**Fair Credit Reporting Act** Regulates the operations of credit-reporting bureaus, including how they collect, store, and use credit information.

**fair information practices** A term for a set of guidelines that govern the collection and use of personal data.

**false news** A false story that is presented as being factually accurate and appears to be news.

**Family Educational Rights and Privacy Act (FERPA)** Assigns certain rights to parents regarding their children's educational records.

**feasibility analysis** An assessment of the technical, economic, legal, operational, and schedule feasibility of a project.

**file** A collection of similar entities.

**firewall** A system of software, hardware, or a combination of both that stands guard between an organization's internal network and the Internet, and limits network access based on the organization's access policy.

**First Amendment** Protects Americans' rights to freedom of religion, freedom of expression, and freedom to assemble peacefully.

**fixed-price contract** A contract in which the buyer and provider agree to a total fixed price for a well-defined product or service.

**foreign key** An attribute in one table that refers to the primary key in another table.

**forming-storming-norming performing adjourning model** A model that describes how teams develop and evolve.

**forward chaining** A strategy used by the inference engine to process data using a set of known facts to make decisions.

**four tiers of data center classification** A system that enables organizations to quantify and qualify their ability to provide a predictable level of performance.

**Fourth Amendment** Protects us from illegal searches and seizures.

**functional decomposition** A technique that involves breaking down complex problems or systems into smaller parts, making them easier to manage and understand.

**G**

**Gantt chart** A graphical tool used for planning, monitoring, and coordinating projects; it is essentially a grid drawn on a timescale that lists activities and deadlines.

**General Data Protection Regulation (GDPR)** A set of data privacy requirements that apply across the European Union and apply as well to organizations that market to or process information of EU end users, customers, or employees.

**genetic algorithm** An approach to solving problems based on the theory of evolution; uses the concept of survival of the fittest to find *approximate* solutions to optimization and search problems.

**gigahertz (GHz)** A unit of frequency that is equal to one billion cycles per second; a measure of clock speed.

**goal** A specific result that must be achieved to reach an objective.

**goals-based strategic planning** A multiphase strategic planning process that involves analyzing an organization and its environment, defining strategies, and executing initiatives to help an organization meet its long-term goals and objectives.

**graphics processing unit (GPU)** A powerful processing chip that renders images on the screen display.

**green computing** Concerned with the efficient and environmentally responsible design, manufacture, operation, and disposal of IT-related products, including all types of computing devices (from smartphones to supercomputers), printers, printer materials such as cartridges and toner, and storage devices.

**grid computing** The use of a collection of computers, often owned by multiple

individuals or organizations, that work in a coordinated manner to solve a common problem.

## H

**Hadoop** An open-source software framework including several software modules that provide a means for storing and processing extremely large data sets.

**Hadoop Distributed File System (HDFS)** A system used for data storage that divides the data into subsets and distributes the subsets onto different servers for processing.

**hard disk drive (HDD)** A direct access storage device used to store and retrieve data from rapidly rotating disks coated with magnetic material.

**hate speech** Persistent or malicious harassment aimed at a specific person.

**hybrid cloud computing environment** A cloud computing environment is composed of both private and public clouds integrated through networking.

**Health Insurance Portability and Accountability Act (HIPAA) (Public Law 104-191)** Requires health care organizations to employ standardized electronic transactions, codes, and identifiers to enable them to fully digitize medical records, thus making it possible to exchange medical data over the Internet.

**heuristics** A trial-and-error method of problem solving used when an algorithmic or mathematical approach is not practical.

**high-quality software systems** Systems that are easy to learn and use because they perform quickly and efficiently; they meet their users' needs; and they operate safely and reliably so that system downtime is kept to a minimum.

**hot site** A duplicate, operational hardware system that is ready for use (or immediate access to one through a specialized vendor).

**HTML tag** A code that tells the Web browser how to format text—as a heading, as a list, or as body text—and whether images, sound, and other elements should be inserted.

**hyperlink** Highlighted text or graphics in a Web document that, when clicked, opens a new Web page containing related content.

**Hypertext Markup Language (HTML)** The standard page description language for Web pages.

**hypervisor** A virtual server program that controls the host processor and resources, allocates the necessary resources to each virtual system, and ensures that they do not disrupt each other.

## I

**identity theft** The use of someone's personal identification information without his or her permission, often to commit fraud or other crimes.

**if-then statements** A rule that suggests certain conclusions.

**inference engine** Part of the expert system that seeks information and relationships from the knowledge base and provides answers, predictions, and suggestions, often taking the place of the human experts.

**information** A collection of data organized and processed so that it has additional value beyond the value of the individual facts.

**information system** A set of interrelated components that work together to support fundamental business operations, data reporting and visualization, data analysis, decision making, communications, and coordination within an organization.

**infrastructure as a service (IaaS)** An information systems model in which an organization outsources the equipment used to support its data processing operations, including servers, storage devices, and networking components.

**in-memory database (IMDB)** A database management system that stores the entire database in random access memory (RAM).

**innovation** The application of new ideas to the products, processes, and activities of a firm, leading to increased value.

**input/output devices** A computer component that provides data and instructions to the computer and receives results from it.

**installation** The process of physically placing the computer equipment on the site and making it operational.

**instant messaging** The online, real-time communication between two or more people who are connected via the Internet.

**intangible benefit** A benefit that cannot directly be measured and cannot easily be quantified in monetary terms.

**integrated circuit (IC)** A set of electronic circuits on one small piece of semiconductor material, normally silicon.

**integration testing** Testing that involves linking all the individual components together and testing them as a group to uncover any defects in the interfaces between individual components.

**intelligent agent** Programs and a knowledge base used to perform a specific task for a person, a process, or another program; also called an intelligent robot or bot.

**intelligent behavior** The ability to learn from experiences and apply knowledge acquired from those experiences; to handle complex situations; to solve problems when important information is missing; to

determine what is important and to react quickly and correctly to a new situation; to understand visual images, process and manipulate symbols, and be creative and imaginative; and to use heuristics.

**Internet backbone** One of the Internet's high-speed, long-distance communications links.

**Internet censorship** The control or suppression of the publishing or accessing of information on the Internet.

**Internet filter** Software that can be used to block access to certain websites that contain material deemed inappropriate or offensive.

**Internet service provider (ISP)** Any organization that provides Internet access to people.

**interorganizational IS** An information system that enables sharing of information and conducting business electronically across organizational boundaries.

**intranet** An internal corporate network built using Internet and World Wide Web standards and products.

**intrusion detection system (IDS)** Software and/or hardware that monitors system and network resources and activities and notifies network security personnel when it detects network traffic that attempts to circumvent the security measures of a networked computer environment.

**IP address** A 64-bit number that identifies a computer on the Internet.

**issues-based strategic planning** A strategic planning process that begins by identifying and analyzing key issues facing the organization, setting strategies to address those issues, and identifying projects and initiatives that are consistent with those strategies.

## J

**joining** The combining of two or more tables through common data attributes to form a new table with only the unique data attributes.

**joint application development (JAD)**

A structured meeting process that can accelerate and improve the efficiency and effectiveness of the investigation, analysis, and design phases of a system development project.

## K

**kernel** The heart of the operating system that controls the most critical processes of the OS.

**knowledge** The awareness and understanding of a set of information and the ways that information can be made useful to support a specific task or reach a decision.

**knowledge acquisition facility** Part of the expert system that provides a convenient and efficient means of capturing and storing all the components of the knowledge base.

**knowledge base** A component of an expert system that stores all relevant information, data, rules, cases and relationships used by the expert system.

**knowledge engineer** A person who has training or experience in the design, development, implementation, and maintenance of an expert system.

**knowledge user** The person or group who uses and benefits from the expert system.

## L

**laptop** A personal computer designed for use by mobile users, being small and light enough to sit comfortably on a user's lap.

**Leavitt's Diamond** A model that states an organization's information systems operate within a context of people, technology infrastructure, processes, and structure.

**legal feasibility** The process of determining whether laws or regulations may prevent or limit a system development project.

**linear programming** A technique for finding the optimum value (largest or smallest, depending on the problem) of a linear expression (called the objective function) that is calculated based on the value of a set of decision variables that are subject to a set of constraints.

**local area network (LAN)** A network that connects computer systems and devices within a small area, such as an office, home, or several floors in a building.

**Long Term Evolution (LTE)** A standard for wireless communications for mobile phones based on packet switching.

## M

**machine learning** The ability of a computer to learn without having a programmer change the software for every scenario it encounters.

**magnetic tape** A type of sequential secondary storage medium, now used primarily for storing backups of critical organizational data in the event of a disaster.

**main memory** The component of a computer that provides the CPU with a working storage area for program instructions and data.

### managed security service provider

**(MSSP)** A company that monitors, manages, and maintains computer and network security for other organizations.

**mainframe computer** A large, powerful computer often shared by hundreds of concurrent users connected to the machine over a network.

**make-or-buy decision** The act of comparing the pros and cons of in-house production versus outsourcing of a given product or service.

**MapReduce program** A composite program that consists of a Map procedure that performs filtering and sorting and a Reduce method that performs a summary operation.

**market segmentation** The identification of specific markets to target them with tailored advertising messages.

**massively parallel processing systems** A system that speeds processing by linking hundreds or thousands of processors to operate at the same time, or in parallel, with each processor having its own bus, memory, disks, copy of the operating system, and applications.

**memory** A component of the computer that provides the processor with a working storage area to hold program instructions and data.

**mesh network** A network that uses multiple access points to link a series of devices that speak to each other to form a network connection across a large area.

**metropolitan area network (MAN)** A network that connects users and their computers in a geographical area that spans a campus or city.

**Michael Porter's Five Forces Model** A model that identifies the bargaining power of suppliers and buyers, the threat of new entrants and substitute products, and the existing industry competitors, which determine the level of competition and long-term profitability of an industry.

**middleware** Software that allows various systems to communicate and exchange data.

**mission statement** A statement that concisely defines an organization's fundamental purpose for existing.

**mission-critical process** A process that plays a pivotal role in an organization's continued operations and goal attainment.

**mobile device management (MDM) software** Software that manages and troubleshoots mobile devices remotely, pushing out applications, data, patches, and settings while enforcing group policies for security.

**monitoring** The process of measuring system performance by tracking the number of errors encountered, the amount of memory required, the amount of processing or CPU time needed, and other performance indicators.

**Monte Carlo simulation** A simulation that enables you to see a spectrum of thousands of possible outcomes, considering not only the many variables involved, but also the range of potential values for each of those variables.

**multicore processor** A processor that has two or more independent processing units, called cores, that are capable of sequencing and executing instructions.

**multiprocessing** The simultaneous execution of two or more instructions at the same time.

## N

**natural language processing (NLP)** The part of machine language that allows computers to understand, analyze, manipulate, and generate natural language for processing.

**near field communication (NFC)** A very short-range wireless connectivity technology that enables two devices placed within a few inches of each other to exchange data.

**nettop computers** A very small, inexpensive desktop computer typically used for Internet access, email, accessing Web-based applications, document processing, and audio/video playback.

**network latency** A measurement of how long it takes for a unit of data to get to its destination and back again.

**network-management software** Software that enables a manager on a networked desktop to monitor the use of individual computers and shared hardware (such as printers), scan for viruses, and ensure compliance with software licenses.

**network operating system (NOS)** Systems software that controls the computer systems and devices on a network and allows them to communicate with each other.

**network topology** The shape or structure of a network, including the arrangement of the communication links and hardware devices on the network.

**next-generation firewall (NGFW)** A hardware- or software-based network security system that can detect and block sophisticated attacks by filtering network traffic dependent on the packet contents.

**NoSQL database** A way to store and retrieve data that is modeled using some means other than the simple two-dimensional tabular relations used in relational databases.

## O

**objective** A statement of a compelling business need that an organization must meet to achieve its vision and mission.

**off-the-shelf software** Software produced by software vendors to address needs that are common across businesses, organizations, or individuals.

**omnichannel** An integrated strategy for engaging customers (and potential customers) across multiple platforms and channels of communication to provide a seamless experience.

**online transaction processing (OLTP)** A form of data processing where each transaction is processed immediately without the delay of accumulating transactions into a batch.

**open-source software** Software that is distributed, typically for free, with the source code also available so that it can be studied, changed, and improved by its users.

**operating system (OS)** A set of computer programs that controls the computer hardware and acts as an interface to application software.

**operational feasibility** The process of determining how a system will be accepted by people and how well it will meet various system performance expectations.

#### **optical character recognition (OCR)**

Technology that distinguishes printed or handwritten text in a digital image, such as a scanned document, that is converted into a computer-generated document, such as a PDF.

**organic strategic planning** A strategic planning process that defines the organization's vision and values and then identifies projects and initiatives to achieve the vision while adhering to the values.

**organizational change** The way in which for-profit and nonprofit organizations plan for, implement, and handle change.

**organizational culture** The major understandings and assumptions for a business, corporation, or other organization.

## P

**Pareto principle** An observation that for many events, roughly 80 percent of the effects come from 20 percent of the causes.

**parallel processing** The simultaneous execution of the same task on multiple processors to obtain results faster.

**parallel start-up** A cutover strategy that involves running both the old and new systems for a set period of time and closely comparing the output of the new system with the output of the old system; any differences are reconciled. When users are comfortable that the new system is working correctly, the old system is eliminated.

**patch** A minor system change to correct a problem or make a small enhancement; it is usually an addition to an existing program.

**perceptive system** A system that approximates the way a person sees, hears, and feels objects.

**performance evaluation test** A comparison of vendor options conducted in a computing environment (e.g., computing hardware, operating system software, database management system) and with a workload (e.g., number of concurrent users, database size, and number of transactions) that matches its intended operating conditions.

**perpetual license** A license provided for one installation, with new software editions requiring new licenses; usually purchased by the bundle, called seats, and loaded on individual computers.

**personal area network (PAN)** A network that supports the interconnection of information technology devices close to one person.

**personal information system** An information system that improves the productivity of individual users in performing stand-alone tasks.

**personalization** The process of tailoring Web pages to specifically target individual consumers.

**phase-in approach** A cutover strategy that involves slowly replacing components of the old system with those of the new one; this process is repeated for each application until the new system is running every application and performing as expected; it is also called a piecemeal approach.

**pilot start-up** A cutover strategy that involves running the complete new system for one group of users rather than for all users.

**platform as a service (PaaS)** An information systems model in which users are provided with a computing platform, typically including operating system, programming language execution environment, database services, and Web server.

**podcast** An audio broadcast you can listen to over the Internet.

**portable computers** A computer small enough to carry easily.

**predecessor task** A task that must be completed before a later task can begin.

**predictive analytics** A set of techniques used to analyze current data to identify future probabilities and trends, as well make predictions about the future.

**primary key** An attribute or set of attributes that uniquely identifies the record.

**private cloud computing environment** A single-tenant cloud.

**problem statement** A clear, concise description of the issue that needs to be addressed.

**procedure** A set of steps that need to be followed to achieve a specific end result, such as entering a customer order, paying a supplier invoice, or requesting a current inventory report.

**process** A structured set of related activities that takes input, adds value, and creates an output for the customer of that process.

**process manufacturing** The production of products—such as soda, laundry detergent, gasoline, and pharmaceutical drugs—that are the result of a chemical process; these products cannot be easily decomposed into their basic components.

**procurement management** A set of activities related to the acquisition of goods and/or services for the project from sources outside the performing organization.

**product backlog** A prioritized list of project requirements created by the stakeholders and project team members; from this list, the team selects the highest priorities.

**product lifecycle management (PLM)** An enterprise business strategy that creates a common repository of product information and processes to support the collaborative creation, management, dissemination, and use of product and packaging definition information.

**product lifecycle management (PLM) software** Software that provides a means for managing the data and processes associated with the various phases of the product lifecycle, including sales and marketing, research and development, concept development, product design, prototyping and testing, process design, production and assembly, delivery and product installation, service and support, and product retirement and replacement.

**product owner** A person who represents the project stakeholders and is responsible for communicating and aligning project priorities between the stakeholders and development team.

**professional code of ethics** A statement of the principles and core values that an organization wishes to develop in its leaders and members.

**programming languages** Sets of keywords, commands, symbols, and rules for constructing statements by which humans can communicate instructions to a computer.

**project** A temporary endeavor that creates an actionable plan, allowing organizations to achieve their goals and objectives—often the creation of a unique product, service, or result.

**project champion** A well-respected manager with a passion to see a project succeed and who removes barriers to the success of the project.

**project deadline** The date the entire project should be completed and operational—when the organization can expect to begin to reap the benefits of the project.

**project integration management** The coordination of all appropriate people, resources, plans, knowledge, and efforts to complete a project successfully.

**project management** The application of knowledge, skills, and techniques to project activities to meet project requirements.

**project milestone** A critical date for completing a major part of the project, such as program design, coding, testing, and release (for a programming project).

**project resource management** A set of activities designed to identify, acquire, and manage resources for a project.

**project risk** An uncertain event or condition that, if it occurs, has a positive or a negative effect on a project objective.

**project schedule** A plan that identifies the project activities that must be completed, the expected start and end dates, and what resources are assigned to each task.

**project scope** A definition of which tasks are and which tasks are not included in a project.

**project sponsor** A senior manager from the business unit most affected by a project and who ensures the project will indeed meet the needs of his or her organization.

**project stakeholders** The people involved in the project or those affected by its outcome.

**project steering team** A group of senior managers representing the business and IS organizations that provide guidance and support to a project.

**projecting** Manipulating data to eliminate columns in a table.

**proprietary software** One-of-a-kind software designed for a specific application and for an individual company, organization, or person that uses it.

**public cloud computing environment** A computing environment in which a service provider organization owns and manages the infrastructure (including computing, networking, storage devices, and support personnel) with cloud user organizations (called tenants) accessing slices of shared resources via the Internet.

## Q

**quality** The degree to which a project meets the needs of its users.

**quality assurance** The evaluation of the progress of the project on an ongoing basis to ensure that it meets the identified quality standards.

**quality control** The checking of project results to ensure that they meet identified quality standards.

**quality management** A set of activities designed to ensure that a project will meet the needs for which it was undertaken.

**quality planning** The determination of which quality standards are relevant to the project and determining how they will be met.

## R

**radio frequency identification (RFID)** A technology that employs a microchip with an antenna to broadcast its unique identifier and location to receivers.

**random access memory (RAM)** A form of memory in which instructions or data can be temporarily stored.

**ransomware** Malware that stops you from using your computer or accessing your data until you meet certain demands.

**read-only memory (rom)** A nonvolatile form of memory.

**reasonable assurance** The recognition that managers must use their judgment to ensure that the cost of control does not exceed the system's benefits or the risks involved.

**record** A collection of attributes about a specific entity.

**redundant array of independent/inexpensive disks (RAID)** A method of storing data that generates extra bits of data from existing data, allowing the system to create a “reconstruction map” so that if a hard drive fails, the system can rebuild lost data.

**reengineering (process redesign/business process reengineering [BPR])** The radical redesign of business processes, organizational structures, information systems, and values of the organization to achieve a breakthrough in business results.

**regression analysis** A method for determining the relationship between a dependent variable and one or more independent variables.

**reinforced learning** Machine learning using trial and error on an unlabeled data set. Learning is gained through positive and negative feedback.

**relational database model** A simple but highly useful way to organize data into collections of two-dimensional tables called relations.

**release** A significant program change that often requires changes in the documentation of the software.

**request for information (RFI)** A document that outlines an organization's hardware or software needs and requests information from vendors about if and how they can meet those needs and the time and resources required.

**Right to Financial Privacy Act** Protects the records of financial institutions' customers from unauthorized scrutiny by the federal government.

**risk assessment** The process of assessing security-related risks to an organization's computers and networks from both internal and external threats.

**risk management** A deliberate and systematic process designed to identify, analyze, and manage project risks.

**risk owner** The individual responsible for developing a risk management strategy and monitoring the project to determine if the risk is about to occur or has occurred.

**robotics** Technology using a combination of mechanical engineering, computer science, and machine learning to create a device that can perform tasks with a high degree of precision.

**router** A network device that directs data packets to other networks until each packet reaches its destination.

**rule** A conditional statement that links conditions to actions or outcomes.

## S

**safety-critical system** A system whose failure may cause human injury or death.

**scalability** The ability to increase the processing capability of a computer system so that it can handle more users, more data, or more transactions in a given period.

**schedule feasibility** The process of determining whether the project can be completed within a desired time frame.

**schedule management** A set of activities that includes defining an achievable completion date that is acceptable to the project stakeholders, developing a workable project schedule, and ensuring the timely completion of the project.

**scenario analysis** A process for predicting future values based on certain potential events.

**schema** A description that defines the logical and physical structure of the database by identifying the tables, the attributes in each table, and the relationships between attributes and tables.

**scope management** A set of activities that include defining the work that must be done as part of a project and then controlling the work to stay within the agreed-upon scope.

**Scrum** An Agile development framework that emphasizes a team-based approach in order to keep the development effort focused and moving quickly.

**Scrum master** The person who coordinates all the Scrum activities of a team.

**search engine** A valuable tool that enables you to find information on the Web by specifying words that are key to a topic of interest, known as keywords.

**search engine optimization (SEO)** A process for driving traffic to a Web site by using techniques that improve the site's ranking in search results.

**secondary storage** A device that stores large amounts of data, instructions, and information more permanently than allowed with main memory.

**Section 230 of the CDA** Provides immunity to an Internet service provider (ISP) that publishes user-generated content, provided its actions do not rise to the level of a content provider.

**security audit** A process that enables the organization to identify its potential threats, establish a benchmark of where it is, determine where it needs to be, and develop a plan to meet those needs.

**security policy** Defines an organization's security requirements, as well as the controls and sanctions needed to meet those requirements.

**self-service analytics** Training, techniques, and processes that empower end users to work independently to access data from approved sources to perform their own analyses using an endorsed set of tools.

**Selecting** Manipulating data to eliminate rows according to certain criteria.

**semiconductor fabrication plant** A factory where integrated circuits are manufactured; also called a fab or a foundry.

**semi-supervised learning** Machine learning using a combination of supervised and unsupervised learning techniques.

**server** A computer employed by many users to perform a specific task, such as running network or Internet applications.

**server farm** A facility that houses a large number of servers in the same room, where access to the machines can be controlled and authorized support personnel can more easily manage and maintain the servers.

**server virtualization** A method of logically dividing the resources of a single physical server to create multiple logical servers, each acting as its own dedicated machine.

**service-oriented architecture (SOA)** A software design approach based on the use of discrete pieces of software (modules) to provide specific functions as services to other applications.

**shadow IT** The information systems and solutions built and deployed by departments other than the information systems department.

**site preparation** Preparation of the location of a new system.

**slack time** The amount of time an activity can be delayed without delaying the entire project.

**slipstream upgrade** A minor system upgrade—typically a code adjustment or minor bug fix; it usually requires recompiling all the code, and in so doing, it can create entirely new bugs.

**smart city** Cities that make use of data from sensors combined with artificial intelligence to improve infrastructure and efficiently manage traffic lights, power plants, water supplies, networks, energy usage, and other resources.

**soft side of implementing change** The work designed to help employees embrace a new information system and way of working.

**software defect** Any error that, if not removed, could cause a software system to fail to meet its users' needs or open a door for a cyberattacker.

**software as a service (SaaS)** A software distribution model under which a third-party provider hosts applications and makes them available to subscribers over the Internet.

**software suite** A collection of programs packaged together and sold in a bundle.

**software-defined networking (SDN)** An emerging approach to networking that allows network administrators to have programmable central control of the network via a controller without requiring physical access to all the network devices.

**solid state storage device (SSD)** A storage device that stores data in memory chips rather than on hard disk drives or optical media.

**source data automation** Capturing data at its source and recording it accurately in a timely fashion, with minimal manual effort and in an electronic or digital form so that it can be directly entered into the computer.

**sponsoring business unit** The business unit most affected by the project and the one whose budget will cover the project costs.

**SQL** A special-purpose programming language for accessing and manipulating data stored in a relational database.

**stakeholder management** A set of activities that involves identifying, engaging, communicating with all the people, groups, or organizations who are or could be impacted by a project.

**star network** A network in which all network devices connect to one another through a single central device called the hub node.

**storefront broker** A company that acts as an intermediary between your Web site and online merchants who have the products and retail expertise.

**strategic planning** A process that helps managers identify desired outcomes and formulate feasible plans to achieve their objectives by using available resources and capabilities.

**strategy** A plan that describes how an organization will achieve its vision, mission, objectives, and goals.

**streaming** A form of data collection, where data is available through a continuous feed.

**Strengths, Weaknesses, Opportunities, Threats (SWOT) matrix** A simple way to illustrate what a company is doing well, where it can improve, what opportunities are available, and what environmental factors threaten the future of the organization.

**structure** A definition of the relationships among the members of an organization including their roles, responsibilities, and lines of authority necessary to complete various activities.

**subject matter expert** someone who provides knowledge and expertise in a particular aspect important to the project.

**supercomputers** One of the most powerful computer systems with the fastest processing speeds.

**supervised learning** Machine learning using a labeled data set and examples to produce output that is compared to a predefined correct output.

**supply chain** A key value chain whose primary processes include inbound logistics, operations, outbound logistics, marketing and sales, and service.

**supply chain management (SCM)** A system that includes planning, executing, and controlling all activities involved in raw material sourcing and procurement, the conversion of raw materials to finished products, and the warehousing and delivery of finished products to customers.

**switch** is a network device that keeps a record of the MAC (Media Access Control) address of all the devices connected to it and uses this information to determine to which port a frame of data should be directed.

**system analysis** The phase of system development that focuses on gathering data on the existing system, determining the requirements for the new system, considering alternatives within identified constraints, and investigating the feasibility of alternative solutions.

**system construction** The phase of system development that converts the system design into an operational system by acquiring and installing hardware and software, coding and testing software programs, creating and loading data into databases, and performing initial program testing.

**system development** The set of activities involved in building information systems to meet users' needs.

**system design** The stage of system development that answers the question, "How will the information system solve a problem?"

**system disposal** A stage of system development that involves those activities that ensure the orderly dissolution of the system, including disposing of all equipment in an environmentally friendly manner, closing out contracts, and safely migrating information from the system to another system or archiving it in accordance with applicable records management policies.

**system investigation** The initial phase in the development of a new or modified business information system whose purpose is to gain a clear understanding of the specifics of the problem to solve or the opportunity to address.

**system investigation report** A summary of the results of the system investigation, with a recommendation of a course of action.

**system maintenance** A stage of systems development that involves changing and enhancing the system to make it more useful in achieving user and organizational goals.

**system operation** The use of a new or modified system under all kinds of operating conditions.

**system review** The process of analyzing a system to make sure it is operating as intended.

**system software** Software that includes operating systems, utilities, and middleware that coordinate the activities and functions of the hardware and other programs throughout the computer system.

**system testing** Testing the complete, integrated system (hardware, software, databases, people, and procedures) to validate that the information system meets all specified requirements.

## T

**tablet** A portable, lightweight computer with no keyboard that allows you to roam the office, home, or factory floor carrying the device like a clipboard.

**tangible benefit** A benefit that can be measured directly and assigned a monetary value.

**technical documentation** Written details used by computer operators to execute the program and by analysts and programmers to solve problems or modify the program.

**technical feasibility** The process of determining whether a project is feasible within the current limits of available technology.

**technical resource** A subject matter expert in an IS topic of value to the project.

**technology acceptance model (TAM)** A model that specifies the factors that can lead to better attitudes about an information system, along with higher acceptance and usage of it.

**technology infrastructure** All the hardware, software, databases, networks, facilities, and services used to develop, test, deliver, control, or support the information technology applications and services an organization requires to meet the needs of its customers, suppliers, key business partners, regulatory agencies, and employees.

**text analysis** A process for extracting value from large quantities of unstructured text data.

**thin client** A low-cost, centrally managed computer with no internal or external attached drives for data storage.

**time and material contract** A contract that requires the buyer to pay the provider for both the time and materials required to complete the contract.

**time series analysis** The use of statistical methods to analyze time series data and determine useful statistics and characteristics about the data.

**transaction processing cycle** The process of data collection, data editing, data correction, data processing, data storage, and document production.

**Transmission Control Protocol/Internet Protocol (TCP/IP)** A collection of communication protocols used to interconnect network devices on packet switching networks such as the Internet.

**Transport Layer Security (TLS)** A communications protocol or system of rules that ensures privacy between communicating applications and their users on the Internet.

## U

**Uniform Resource Locator (URL)** A Web address that specifies the exact location of a Web page using letters and words that map to an IP address and a location on the host.

**unit testing** Testing of individual components of code (subroutines, modules, and programs) to verify that each unit performs as designed.

**unsupervised learning** Machine learning using an unlabeled data set and no examples. The data is labeled through observations, and learning is through observation.

**upskill** The practice of training a workforce to perform higher-skilled roles to ensure they meet their full potential.

### U.S. Computer Emergency Readiness Team (US-CERT)

A partnership between the Department of Homeland Security and the public and private sectors; established to provide timely handling of security incidents as well as conducting improved analysis of such incidents.

**user acceptance document** A formal agreement that the organization signs stating that a phase of the installation or the complete system is approved.

**user acceptance testing (UAT)** Testing performed by trained system users to verify that the system can complete required tasks in a real-world operating environment and perform according to the system design specifications.

**user documentation** Written descriptions developed for people who use a program; in easy-to-understand language, it shows how the program can and should be used to meet the needs of its various users.

**user preparation** The process of readying managers, decision makers, employees, other users, and stakeholders to accept and use the new system.

**utility programs** A program that helps to perform maintenance or correct problems with a computer system.

## V

**version** A major program change, typically encompassing many new features.

**video analysis** The process of obtaining information or insights from video footage.

**virtual private network (VPN)** A secure connection between two points on the Internet; VPNs transfer information by encapsulating traffic in IP packets and sending the packets over the Internet.

**virtual tape** A storage device for less frequently needed data. With virtual tape systems, data appears to be stored entirely on tape cartridges, although some parts of it might actually be located on faster hard disks.

**virtualization tools** A set of tools that allow users to access their desktop operating system hosted in the cloud on a centralized server—meaning users can interact with files and applications as if they were stored on a local device.

**virus signature** Code that indicates the presence of a specific virus.

**vision** A concise statement of what an organization intends to achieve in the future.

**vision statement** A statement that communicates an organization's overarching aspirations to guide it through changing objectives, goals, and strategies (see also mission statement).

**vision systems** The hardware and software that permit computers to capture, store, and manipulate visual images.

**visual analytics** The presentation of data in a pictorial or graphical format.

**volume testing** Testing to evaluate the performance of the information system under varying yet realistic work volume and operating conditions to determine the work load at which system performance begins to degrade and to identify and eliminate any issues that prevent the system from reaching its required service-level performance.

## W

**waterfall system development process** A sequential, multistage system development process in which work on the next stage cannot begin until the results of the current stage are reviewed and approved or modified as necessary.

**Web 2.0** The Web as a computing platform that supports software applications and the sharing of information among users.

**Web browser** Web client software—such as Chrome, Edge, Firefox, Internet Explorer, and Safari—used to view Web pages.

**wide area network (WAN)** A network that connects large geographic regions.

**Wi-Fi** A medium-range wireless communications technology brand owned by the Wi-Fi Alliance.

**wireless communication** The transfer of information between two or more points that are not connected by an electrical conductor.

**word cloud** A visual depiction of a set of words that have been grouped together because of the frequency of their occurrence.

**work breakdown structure (WBS)** An outline of the work to be done to complete the project.

**workgroup application software** Software designed to support teamwork, whether team members are in the same location or dispersed around the world.

**workgroup information system** Systems that support teamwork and enable people to work together effectively, whether

team members are in the same location or dispersed around the world.

**workstations** A more powerful personal computer used for mathematical computing, computer-assisted design, and other high-end processing but still small enough to fit on a desktop.

## Z

**zero-day attack** An attack that takes place before the security community becomes aware of and fixes a security vulnerability.

# Subject Index

Note: A *boldface* page number indicates a key term and the location of its definition in the text.

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