

# Learner Guide

## Faculty of Information Technology

*Information Systems 621*

*Year 2*

*Semester 1*



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# **FACULTY OF INFORMATION TECHNOLOGY**

## **LEARNER GUIDE**

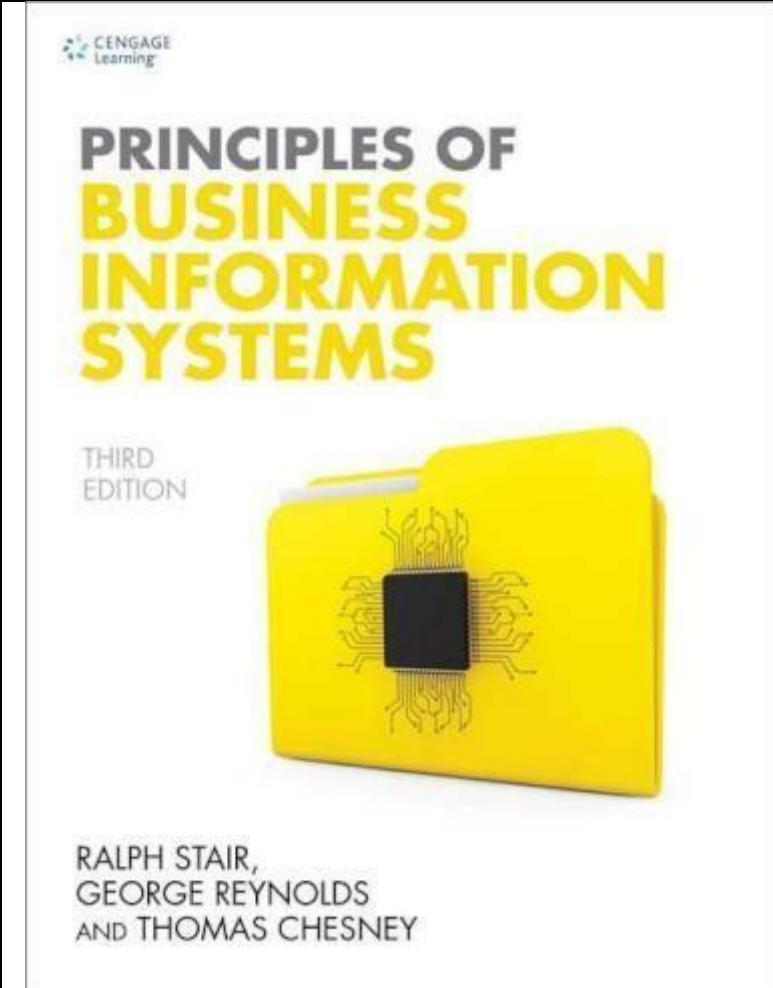
**MODULE: INFORMATION SYSTEMS 621 (1ST SEMESTER)**

**PREPARED ON BEHALF OF  
RICHFIELD GRADUATE INSTITUTE OF TECHNOLOGY (PTY) LTD**

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## PREScribed OR RECOMMENDED BOOKS

 <p>The book cover for "Principles of Business Information Systems" shows the title in large, bold, yellow and grey letters. Below the title is a yellow folder icon with a black microchip and circuit board graphic. The text "THIRD EDITION" is in the bottom left corner. At the bottom, the authors' names are listed: RALPH STAIR, GEORGE REYNOLDS AND THOMAS CHESNEY.</p>	<p><b>Principles of Business Information Systems</b></p> <p><b>Ralph Stair, George Reynolds and Thomas Chesney</b></p> <p><b>Third Edition</b></p> <p>© 2018 Cengage Learning®</p> <p><b>ISBN: 978-1-4737-4841-5</b></p>
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**Chapter 1: An Introduction to Information Systems**

**Chapter 2: Information System in Organisations**

**Chapter 3: Hardware: Input, Processing, Output and Storage Devices**

**Chapter 4: Software: System and Application Software**

**Chapter 5: Organising and Storing Data**

**Chapter 6: Computer Network**

## Table of Contents

<b>Chapter 1: An Introduction to Information Systems .....</b>	<b>3</b>
<b>1.1 What is an Information System? .....</b>	<b>6</b>
<b>1.2 Business Information Systems .....</b>	<b>14</b>
<b>1.3 Systems Development .....</b>	<b>22</b>
<b>1.4 Information Systems in Society, Business and Industry .....</b>	<b>24</b>
<b>1.5 Global Challenges in Information Systems .....</b>	<b>25</b>
<b>Chapter 2: Information System In Organisations.....</b>	<b>33</b>
<b>2.1 An Introduction to Organizations .....</b>	<b>34</b>
<b>2.2 Competitive Advantage .....</b>	<b>45</b>
<b>2.3 Evaluating IS .....</b>	<b>47</b>
<b>2.4 Careers in Information Systems .....</b>	<b>48</b>
<b>Chapter 3: Hardware: Input, Processing, Output and Storage Devices .....</b>	<b>58</b>
<b>3.1 Computer Systems: Integrating the Power of Technology .....</b>	<b>58</b>
<b>3.2 Processing and Memory Devices: Power, Speed and Capacity .....</b>	<b>61</b>
<b>3.3 Secondary Storage .....</b>	<b>68</b>
<b>3.4 Input and Output Devices: The Gateway to Computer Systems .....</b>	<b>75</b>
<b>3.5 Computer System Types .....</b>	<b>86</b>
<b>3.6 Green Computing .....</b>	<b>96</b>
<b>Chapter 4: Software: System and Application Software.....</b>	<b>103</b>
<b>4.1 An Overview of Software .....</b>	<b>104</b>
<b>4.2 Systems Software .....</b>	<b>106</b>
<b>4.3 Application Software .....</b>	<b>116</b>
<b>4.4 Programming Languages .....</b>	<b>127</b>
<b>4.5 Software Issues and Trends .....</b>	<b>130</b>
<b>Chapter 5: Organising and Storing Data .....</b>	<b>140</b>
<b>5.1 Data Management and Data Modelling .....</b>	<b>140</b>
<b>5.2 Database Management Systems .....</b>	<b>148</b>
<b>5.3 Database Applications .....</b>	<b>154</b>
<b>Chapter 6: Computer Network.....</b>	<b>167</b>
<b>6.1 Telecommunications .....</b>	<b>167</b>
<b>6.2 Networks and Distributed Processing .....</b>	<b>178</b>
<b>6.3 The Internet.....</b>	<b>189</b>
<b>6.5 Intranets and Extranets .....</b>	<b>199</b>

## Chapter 1: An Introduction to Information Systems



### LEARNING OUTCOMES

After reading this Section of the guide, the learner should be able to:

#### Learning Objectives

- Discuss why it is important to study and understand information systems.
- Describe the characteristics used to evaluate the quality of data.
- Name the components of an information system and describe several system characteristics.
- Identify the basic types of business information systems and discuss who uses them, how they are used and what kinds of benefits they deliver.
- Identify the major steps of the systems development process and state the goal of each.
- Describe some of the threats to security and privacy that information systems and the Internet can pose.
- Discuss the expanding role and benefits of information systems in business and industry.

### Introduction

Information systems are used in almost every imaginable profession. Sales representatives use information systems to advertise products, communicate with customers and analyse sales trends. Managers use them to make major decisions, such as whether to build a manufacturing plant or research a cancer drug. From a small music store to huge multinational companies, businesses of all sizes could not survive without information systems to perform accounting and finance operations. Regardless of your chosen career, you will use information systems to help you achieve goals. This chapter presents an overview of information systems. The sections on hardware, software, data- bases, telecommunications, e-commerce and m-commerce, transaction processing and enterprise resource planning, information and decision support, special purpose systems, systems development, and ethical and societal issues are expanded to full chapters in the rest of the book. We will start by exploring the basics of information systems.

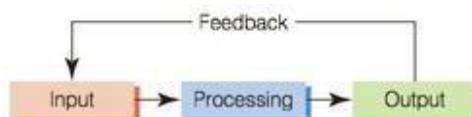
## 1.1 What is an Information System?

People and organizations use information every day. Many retail chains, for example, collect data from their shops to help them stock what customers want and to reduce costs. Businesses use information systems to increase revenues and reduce costs. We use automated teller machines outside banks and access information over the Internet. Information systems usually involve computers, and, together, they are constantly changing the way organizations conduct business. Today we live in an information economy. Information itself has value, and commerce often involves the exchange of information rather than tangible goods. Systems based on computers are increasingly being used to create, store and transfer information. Using information systems, investors make multimillion-euro decisions, financial institutions transfer billions of euros around the world electronically, and manufacturers order supplies and distribute goods faster than ever before. Computers and information systems will continue to change businesses and the way we live. To define an information system, we will start by examining what a system

### What is a System?

A central concept of this book is that of a system. A **system** is a set of elements or components that interact to accomplish goals. The elements themselves and the relationships among them determine how the system works. Systems have inputs, processing mechanisms, outputs and feedback (see Figure 1.1). A system processes the input to create the output. For example, consider an automatic car wash. Tangible inputs for the process are a dirty car, water and various cleaning ingredients. Time, energy, skill and knowledge also serve as inputs to the system because they are needed to operate it.

**Figure 1.1 Components of a System** A system's four components consist of input, processing, output and feedback.



The processing mechanisms consist of first selecting which cleaning option you want (wash only, wash with wax, wash with wax and hand dry, etc.) and communicating that to the operator of the car wash. Liquid sprayers shoot clear water, liquid soap or car wax depending on where your car is.

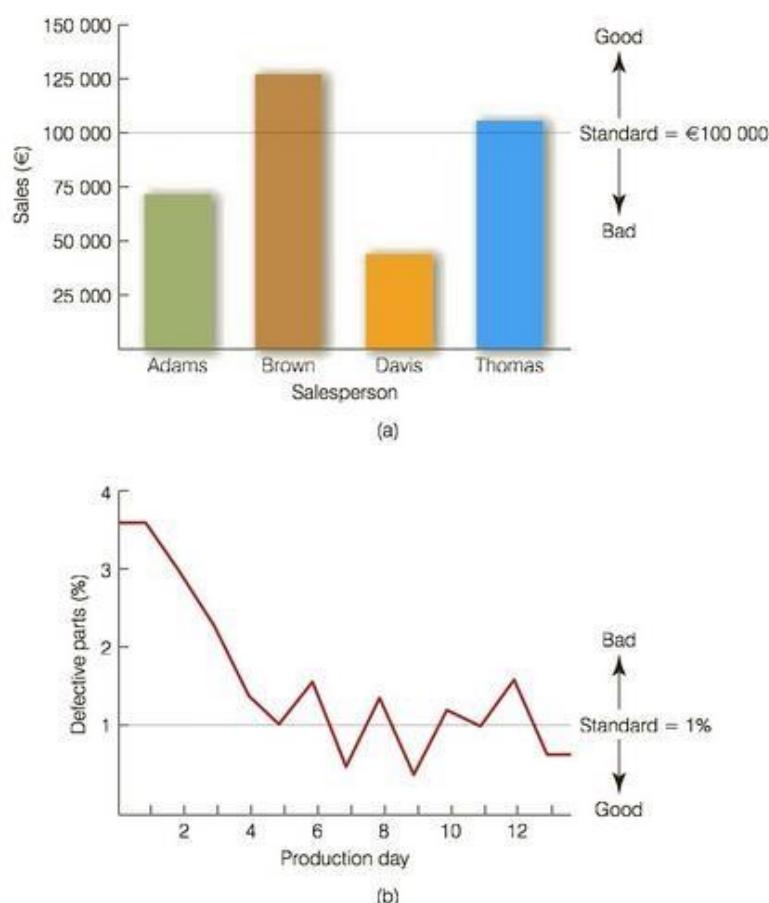


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In the process and which options you selected. The output is a clean car. As in all systems, independent elements or components (the liquid sprayer, foaming brush and air dryer) interact to create a clean car. A feedback mechanism is your assessment of how clean the car is. System

performance can be measured in various ways. **Efficiency** is a measure of what is produced divided by what is consumed. For example, the efficiency of a motor is the energy produced (in terms of work done) divided by the energy consumed (in terms of electricity or fuel). Some motors have an efficiency of 50 per cent or less because of the energy lost to friction and heat generation. **Effectiveness** is a measure of the extent to which a system achieves its goals. It can be computed by dividing the goals actually achieved by the total of the stated goals. For example, a company might want to achieve a net profit of €100 million for the year with a new information system. Actual profits, however, might only be €85 million for the year. In this case, the effectiveness is 85 per cent ( $85/100 = 85$  per cent).

A system performance standard is a specific objective of the system. For example, a system performance standard for a marketing campaign might be to have each sales representative sell €100 000 of a certain type of product each year (see Figure 1.2a). A **system performance standard** for a manufacturing process might be to provide no more than 1 per cent defective parts (see Figure 1.2b). After standards are established, system performance is measured and compared with the standard. Variances from the standard are determinants of system performance.



**Figure 1.2 System Performance Standards**

(a) Sales broken down by sales person

(b) Percentage of defective parts

## What is Information?

Information is one of those concepts that we all seem intuitively able to grasp, but find tricky to define. In the 1940s, mathematician Claude Shannon defined it as: information is that which reduces uncertainty. Shannon was working on the technical problems involved in sending messages over communication networks, and his concept of information is actually quite different from what we in business information systems mean by ‘information’. Nevertheless, we can use his definition as a starting point. Imagine you are unsure of what today’s weather will be like. Getting out of bed you open the curtains to see that the sun is shining. You now know a bit more about what’s it’s going to be like: your uncertainty about the weather has been reduced. Therefore looking out the window gave you information. When you turn on your radio and hear a detailed weather report, your uncertainty has been reduced further. When you look at the temperature gauge in your car, again your uncertainty has gone down. According to Shannon’s definition, each of these events has therefore given you information. However his definition does not really capture what we would think of when we consider the information in, say, a management report. Therefore we simply define information as a collection of facts. These facts can take many forms. The temperature gauge in the car gives information in the form of a number. The radio gives audio information. Looking out of the window gives visual information. Other forms of information include text, images and video clips. Another term that is closely related to information is ‘data’. It’s not intuitive but a philosopher might define data as ‘variation’. To explain this: a blank page contains no data, but as soon as there is a mark on the page, that is, as soon as there is variation in the blankness, then data exist. Again this doesn’t really capture what we mean by data in the context of business information systems. The traditional information systems view is that the input to an information system is data, and the output from the system is information. This means therefore that the difference between them is to do with how much processing has been done: unprocessed facts are data, processed facts are information. Unfortunately, however, this distinction is of little practical use. Therefore we will simply use the terms ‘information’ and ‘data’ interchangeably and define them as a collection of facts which can come in a variety of formats. Incidentally, strictly speaking, the term data is plural, so we would say ‘data are used’ rather than ‘data is used’. However this is often not adhered to and we won’t worry too much about it here.

## What Is An Information System

Now that we have defined the terms ‘system’ and ‘information’, we can define an information system: an **information system (IS)** is a set of interrelated components that collect, manipulate, store and disseminate information and provide a feedback mechanism to meet an objective. It is the feedback mechanism that helps organizations achieve their goals, such as increasing profits or improving customer service.

In information systems, **input** is the activity of gathering and capturing data. In producing paycheques, for example, the number of hours every employee works must be collected before the cheques can be calculated or printed. In a university grading system, instructors must submit student grades before a summary of grades for the semester can be compiled and sent to the students. Processing means converting or transforming this input into useful outputs. **Processing** can involve making calculations, comparing data and taking alternative actions, and storing data for future use. In a payroll application, the number of hours each employee worked must be converted into net, or take-home, pay. Other inputs often include employee ID number and department. The required processing can first involve multiplying the number of hours worked by the employee’s hourly pay rate to get gross pay. If weekly hours worked exceed basic hours, overtime pay might also be included. Then tax must be deducted along

with contributions to health and life insurance or savings plans to get net pay. After these calculations and comparisons are performed, the results are typically stored. Storage involves keeping data and information available for future use, including output.

**Output** involves producing useful information, usually in the form of documents and reports. Outputs can include paycheques for employees, reports for managers, and information supplied to stockholders, banks, government agencies and other groups. In addition, output from one system can become input for another. For example, output from a system that processes sales orders can be used as input to a customer billing system. Computers typically produce output on printers and display screens. Output can also be handwritten or manually produced reports, although this is not common.

Lastly, **feedback** is information from the system that is used to make changes to input or processing activities. For example, errors or problems might make it necessary to correct input data or change a process. Consider a payroll example. Perhaps the number of hours an employee worked was entered as 400 instead of 40 hours. Fortunately, most information systems check to make sure that data falls within certain ranges. For number of hours worked, the range might be from 0 to 100 hours because it is unlikely that an employee would work more than 100 hours in a week. The information system would determine that 400 hours is out of range and provide feedback. The feedback is used to check and correct the input on the number of hours worked to 40. Feedback is also important for managers and decision makers. For example, a furniture maker could use a computerized feedback system to link its suppliers and manufacturing plants. The output from an information system might indicate that inventory levels for mahogany and oak are getting low – a potential problem. A manager could use this feedback to decide to order more wood from a supplier. These new inventory orders then become input to the system. In addition to this reactive approach, a computer system can also be proactive – predicting future events to avoid problems. This concept, often called forecasting, can be used to estimate future sales and order more inventory before a shortage occurs. **Forecasting** is also used to predict the strength of hurricanes and possible landing sites, future stock-market values and who will win a political election.

### The Characteristics of Valuable Information events.

To be valuable to managers and decision makers, information should have some and possibly all of the characteristics described in Table 1.1. Many shipping companies, for example, can determine the exact location of inventory items and packages in their systems, and this information makes them responsive to their customers. In contrast, if an organization's information is not accurate or complete, people can make poor decisions costing thousands, or even millions, of euros. Many claim, for example, that the collapse and bankruptcy of some companies, such as drug companies and energy-trading firms, was a result of inaccurate accounting and reporting information, which led investors and employees alike to misjudge the actual state of the company's finances and suffer huge personal losses. As another example, if an inaccurate forecast of future demand indicates that sales will be very high when the opposite is true, an organization can invest millions of euros in a new plant that is not needed. Furthermore, if information is not relevant, not delivered to decision makers in a timely fashion, or too complex to understand, it can be of little value to the organization. The value of information is directly linked to how it helps decision makers achieve their organization's goals. For example, the value of information might be measured in the time required to make a decision or in increased profits to the company. Consider a market forecast that predicts a high demand for a new product. If you use this information to develop the new product and your company makes an additional profit of €10 000, the value of this information to the company is €10 000 minus the cost of the information.

**Table 1.1** Characteristics of Valuable Information

Characteristics	Definitions
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
Complete	Complete information contains all the important facts, but not more facts than are necessary (see the Simple characteristic below)
Economical	Information should also be relatively economical to produce. Decision makers must always balance the value of information with the cost of producing it
Flexible	Flexible information can be used for a variety of purposes. For example, information on how much inventory is on hand for a particular part can be used by a sales representative in closing a sale, by a production manager to determine whether more inventory is needed, and by a financial executive to determine the total value the company has invested in inventory
Relevant	Relevant information is important to the decision maker
Reliable	Reliable information can be depended on. 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 rumour from an unknown source that oil prices might go up may soon not be reliable (even though it might be useful)
Secure	Information should be secure from access by unauthorized users
Simple	Information should be simple, not overly complex. Sophisticated and detailed information might not be needed. In fact, too much information can cause information overload, whereby a decision maker has too much information and is unable to determine what is really important
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

## Manual and Computerized Information Systems

An information system can be manual or computerized. For example, some investment analysts manually draw charts and trend lines to assist them in making investment decisions. Tracking data on stock prices (input) over the last few months or years, these analysts develop patterns on graph paper (processing) that help them determine what stock prices are likely to do in the next few days or weeks (output). Some investors have made millions of euros using manual stock analysis information systems. Of course, today, many excellent computerized information systems follow stock indexes and markets and suggest when large blocks of stocks should be purchased or sold to take advantage of market discrepancies. A **computer-based information system (CBIS)** is a single set of hardware, software, databases, telecommunications, people and procedures that is configured to collect, manipulate, store and process data into information. For example, a company's payroll, order entry or inventory control system are examples of a CBIS. CBISs can also be embedded into products. Some new cars and home appliances include computer hardware, software, databases and even telecommunications to control their operations and make them more useful. This is often called 'embedded', 'pervasive' or 'ubiquitous' computing. CBISs have evolved into sophisticated

analysis tools. The components of a CBIS are illustrated in Figure 1.3. Information technology (IT) refers to hardware, software, databases and telecommunications. A business's **technology infrastructure** includes all the hardware, software, data- bases, telecommunications, people and procedures that are configured to collect, manipulate, store and process data into information. The technology infrastructure is a set of shared IS resources that form the foundation of each computer-based information system.



**Figure 1.3** The Components of a Computer-Based Information System



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## Hardware

**Hardware** consists of computer equipment used to perform input, processing and output activities. Input devices include keyboards, mice and other pointing devices, automatic scanning devices and equipment that can read magnetic ink characters. Investment firms often use voice-response technology to allow customers to access their balances and other information with spoken commands. Processing devices include computer chips that contain the central processing unit and main memory. One processor chip, called the 'Bunny Chip' by some, mimics living organisms and can be used by the drug industry to test drugs instead of using animals, such as rats or bunnies.<sup>1</sup> The experimental chip could save millions of euros

and months of time in drug research costs. Processor speed is also important. The TOP500 project ([www.top500.org](http://www.top500.org)) has collected statistics on the world's fastest computers since 1993. Currently the fastest is Tianhe-2, a supercomputer developed by China's National University of Defense Technology (NUDT) which is capable of performing 33.86 petaflop/s (quadrillions of calculations per second). NUDT say it will be used for business opinion analysis, government security and nuclear fusion research. The many types of output devices include printers and computer screens. Bond traders, for example, often use an array of six or more computer screens to monitor bond prices and make split-second trades throughout each day. Another type of output device is a printer to print photos from a digital camera. Such printers accept the memory card direct from the camera. There are also many special-purpose hardware devices. Computerized event data recorders (EDRs) are now being placed into vehicles. Like an aeroplane black box, EDRs record a vehicle's speed, possible engine problems, a driver's performance and more. The technology is being used to monitor vehicle operation, determine the cause of accidents and investigate whether truck drivers are taking required breaks.

## Software

**Software** consists of the computer programs that govern the operation of the computer. These programs allow a computer to process payroll, send bills to customers and provide managers with information to increase profits, reduce costs and provide better customer service. With software, people can work anytime at any place. Software, along with manufacturing tools, for example, can be used to fabricate parts almost anywhere in the world. Software called 'Fab Lab' controls tools, such as cutters, milling machines and other devices. A Fab Lab system, which costs about €15 000, has been used to make radio frequency tags to track animals in Norway, engine parts to allow tractors to run on processed castor beans in India and many other fabrication applications. The two types of software are system software, such as Microsoft Windows, which controls basic computer operations, including start-up and printing; and applications software, such as Microsoft Office, which allows you to accomplish specific tasks, including word processing and drawing charts. Sophisticated application software, such as Adobe Creative Suite, can be used to design, develop, print and place professional-quality advertising, brochures, posters, prints and videos on the Internet.

## Databases

A **database** is an organized collection of facts and information, typically consisting of two or more related data files. An organization's database can contain information on customers, employees, inventory, competitors' sales, online purchases and much more. Most managers and executives consider a database mimics living organisms and can be used by the drug industry to test drugs instead of using animals, such as rats or bunnies. The experimental chip could save millions of euros and months of time in drug research costs. Processor speed is also important. The TOP500 project ([www.top500.org](http://www.top500.org)) has collected statistics on the world's fastest computers since 1993. Currently the fastest is Tianhe-2, a supercomputer developed by China's National University of Defense Technology (NUDT) which is capable of performing 33.86 petaflop/s (quadrillions of calculations per second). NUDT say it will be used for business opinion analysis, government security and nuclear fusion research. The many types of output devices include printers and computer screens. Bond traders, for example, often use an array of six or more computer screens to monitor bond prices and make split-second trades throughout each day. Another type of output device is a printer to print photos from a digital camera. Such printers accept the memory card direct from the camera. There are also many

special-purpose hardware devices. Computerized event data recorders (EDRs) are now being placed into vehicles. Like an aeroplane black box, EDRs record a vehicle's speed, possible engine problems, a driver's performance and more. The technology is being used to monitor vehicle operation, determine the cause of accidents and investigate whether truck drivers are taking required breaks. Base to be one of the most valuable parts of a computer-based information system. One California real estate development company uses databases to search for homes that are undervalued and purchase them at bargain prices. It uses the database to analyse crime statistics, prices, local weather reports, school districts and more to find homes whose values are likely to increase. The database has helped the company realize an average 50 per cent return on investment. Increasingly, organizations are placing important databases on the Internet, which makes them accessible to many, including unauthorized users.

### Telecommunications, Networks, and the Internet

**Telecommunications** is the electronic transmission of signals for communications, which enables organizations to carry out their processes and tasks through computer networks. Large restaurant chains, for example, can use telecommunications systems and satellites to link hundreds of restaurants to plants and headquarters to speed credit card authorization and report sales and payroll data

**Networks** connect computers and equipment in a building, around the country or around the world to enable electronic communication. Investment firms can use wireless networks to connect thousands of investors with brokers or traders. Many hotels use wireless telecommunications to allow guests to connect to the Internet, retrieve voice messages and exchange email without plugging their computers or mobile devices into a phone socket. Wireless transmission also allows drones, such as Boeing's Scan Eagle, to fly using a remote control system and monitor buildings and other areas.

The **Internet** is the world's largest computer network, actually consisting of thousands of interconnected networks, all freely exchanging information. Research firms, colleges, universities, schools and businesses are just a few examples of organizations using the Internet. People use the Internet to research information, buy and sell products and services, make travel arrangements, conduct banking, and download music and videos, among other activities. After downloading music, you can use audio software to change a song's tempo, create mixes of your favourite tunes and modify sound tracks to suit your personal taste. You can even mix two or more songs simultaneously, which is called 'mashing'. You can also use many of today's mobile phones to connect to the Internet from around the world and at high speeds. This not only speeds communications, but allows you to conduct business electronically.

Some airline companies are providing Internet service on their flights so that travellers can send and receive email, check investments and browse the Internet. Internet users can create blogs (weblogs) to store and share their thoughts and ideas with others around the world. You can also record and store TV programmes on computers or special viewing devices and watch them later. Often called 'place shifting', this technology allows you to record TV programmes at home and watch them at a different place when it's convenient. The World Wide Web (WWW), or the web, is a network of links on the Internet to documents. Containing text, graphics, video and sound. Information about the documents and access to them are controlled and provided by tens of thousands of special computers called 'web servers'. The web is one of many services

available over the Internet and provides access to many hundreds of millions of documents. Widely available Internet access has allowed the development of **cloud computing**, where software and data storage are provided as an Internet service and are accessed via a web browser. The technology used to create the Internet is also being applied within companies and organizations to create intranets, which allow people within an organization to exchange information and work on projects. One company, for example, uses an **intranet** to connect its 200 global operating companies and 20 000 employees. An extranet is a network based on web technologies that allows selected outsiders, such as business partners and customers, to access authorized resources of a company's intranet. Companies can move all or most of their business activities to an extranet site for corporate customers. Many people use **extranets** every day without realizing it – to track shipped goods, order products from their suppliers or access customer assistance from other companies. If you log on to the FedEx site ([www.fedex.com](http://www.fedex.com)) to check the status of a package, for example, you are using an extranet.

## People

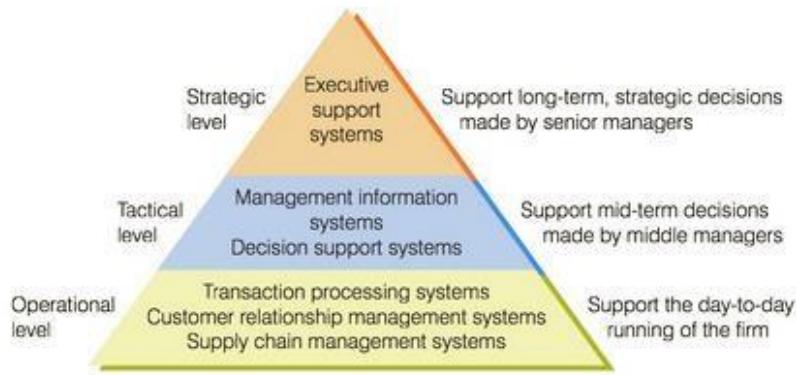
People are the most important element in most computer-based information systems. The people involved include users of the system and information systems personnel, including all the people who manage, run, and program and maintain the system.

## Procedures

**Procedures** include the strategies, policies, methods and rules for using the CBIS, including the operation, maintenance and security of the computer. For example, some procedures describe when each program should be run. Others describe who can access facts in the database, or what to do if a disaster, such as a fire, earthquake or hurricane, renders the CBIS unusable. Good procedures can help companies take advantage of new opportunities and avoid potential disasters. Poorly developed and inadequately implemented procedures, however, can cause people to waste their time on useless rules or result in inadequate responses to disasters, such as hurricanes or tornadoes.

## 1.2 Business Information Systems

The most common types of information systems used in business organizations are those designed for electronic and mobile commerce, transaction processing, management information and decision support. In addition, some organizations employ special-purpose systems, such as virtual reality, that not every organization uses. Together, these systems help employees in organizations accomplish routine and special tasks – from recording sales, processing payrolls and supporting decisions in various departments, to examining alternatives for large-scale projects and opportunities. Often in large organizations one information system is used to accomplish all of these tasks. In others, separate systems are used. When one system is used it is called an Enterprise System, and it does most if not all of the tasks of the other systems shown in Figure 1.4. These systems are discussed next and each one is treated separately but you should be aware that they can be combined together to form an enterprise system. You should also be aware that there is no agreed definition on the minimum set of tasks that a system has to do in order for it to be considered an enterprise system but the expectation is that it must do more than any one of the following.



**Figure 1.4 Business Information Systems**

*The triangle shows the main types of information system used in businesses and the level within the business where they tend to be used.*

## Enterprise Systems: Transaction Processing Systems and Enterprise Resource Planning Transaction Processing Systems

Since the 1950s, computers have been used to perform common business applications. Many of these early systems were designed to reduce costs by automating routine, labour-intensive business transactions. A transaction is any business-related exchange, such as payments to employees, sales to customers or payments to suppliers. Thus, processing business transactions was the first computer application developed for most organizations. A **transaction processing system (TPS)** is an organized collection of people, procedures, software, databases and devices used to record completed business transactions. If you understand a transaction processing system, you understand basic business operations and functions. Enterprise systems help organizations perform and integrate important tasks, such as paying employees and suppliers, controlling inventory, sending out invoices and ordering supplies. In the past, companies accomplished these tasks using traditional transaction processing systems. Today, they are increasingly being performed by enterprise resource planning systems. For example, Whirlpool Corporation, the large appliance maker, used enterprise resource planning to reduce inventory levels by 20 per cent and cut about 5 per cent from its freight and warehousing costs by providing managers with information about inventory levels and costs. The new system may have also helped the company increase its revenues by about €0.7 billion. One of the first business systems to be computerized was the payroll system. The primary inputs for a payroll TPS are the number of employee hours worked during the week and the pay rate. The primary output consists of paycheques. Early payroll systems produced employee paycheques and related reports required by tax authorities. Other routine applications include sales ordering, customer billing and customer relationship management, and inventory control. Some car companies, for example, use their TPSs to buy billions of euros of needed parts each year through websites. Because these systems handle and process daily business exchanges or transactions, they are all classified as TPS

## Enterprise Resource Planning

An **enterprise resource planning (ERP) system** is a set of integrated programs that manages the vital business operations for an entire multisite, global organization. An ERP system can replace many applications with one unified set of programs, making the system easier to use and more effective. Although the scope of an ERP system might vary from company to company, most ERP systems provide integrated software to support manufacturing and finance. In such an environment, a forecast is prepared that estimates customer demand for several weeks. The ERP system checks what is already available in finished product inventory to meet the projected demand. Manufacturing must then produce inventory to eliminate any shortfalls. In developing the production schedule, the ERP system checks the raw materials and packing materials inventories and determines what needs to be ordered to meet the schedule. Most ERP systems also have a purchasing subsystem that orders the needed items. In addition to these core business processes, some ERP systems can support functions such as human resources, sales and distribution. The primary benefits of implementing an ERP system include easing adoption of improved work processes and increasing access to timely data for decision making.

An important type of transaction processing system handles transactions made electronically over the web. **E-commerce** involves any business transaction executed electronically between companies (business-to-business, 'B2B'), companies and consumers (business-to-consumer, 'B2C'), consumers and other consumers (consumer-to-consumer, 'C2C'), business and the public sector, and consumers and the public sector. You might assume that e-commerce is reserved mainly for consumers visiting websites for online shopping, but web shopping is only a small part of the e-commerce picture; the major volume of e-commerce – and its fastest growing segment – is business-to-business (B2B) transactions that make purchasing easier for corporations. This growth is being stimulated by increased Internet access, growing user confidence, better payment systems and rapidly improving Internet and web security. Ecommerce also offers opportunities for small businesses to market and sell at a low cost worldwide, allowing them to enter the global market. **Mobile commerce (m-commerce)** refers to transactions conducted anywhere, anytime. M-commerce relies on wireless communications that managers and corporations use to place orders and conduct business with handheld computers, portable phones, laptop computers connected to a network and other mobile devices (see Figure 1.5 which shows a mobile phone being used to make a contact-less payment).



**Figure 1.5** Contactless payment M-commerce means that it is possible to pay for items using a smartphone or other mobile device.



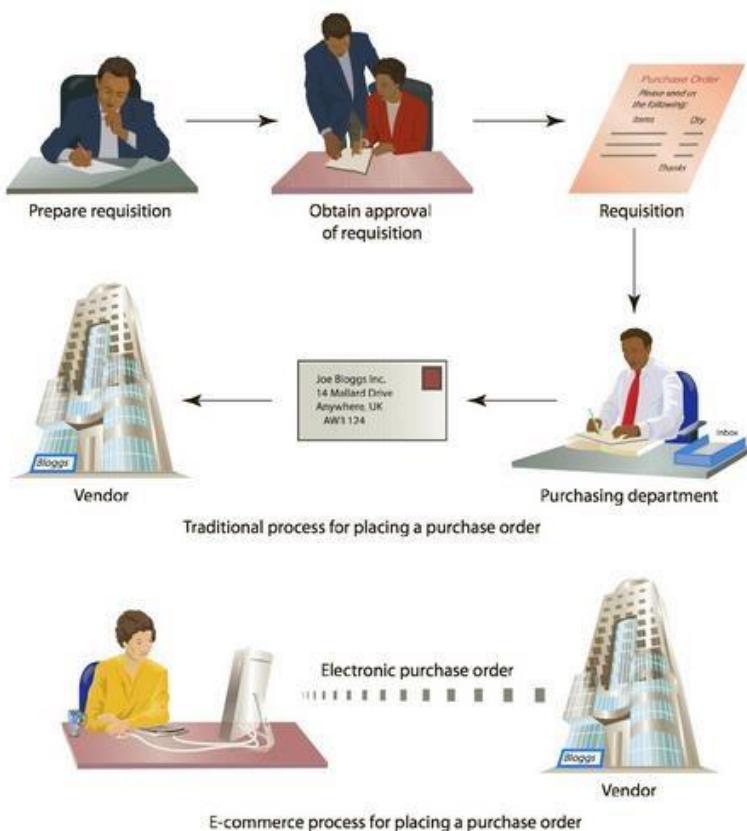
**Principles Of Business Information Systems 3<sup>rd</sup> Edition, Ralph Stair, George Reynolds and Thomas Chesney Chapter 1 Page Number 15**

E-commerce offers many advantages for streamlining work activities. Figure 1.6 (overleaf) provides a brief example of how e-commerce can simplify the process of purchasing new office furniture from an office-supply company. In the manual system, a corporate office worker must get approval for a purchase that exceeds a certain amount. That request goes to the purchasing department, which generates a formal purchase order to procure the goods from the approved vendor. Business-to-business e-commerce automates the entire process. Employees go directly to the supplier's website, find the item in a catalogue and order what they need at a price set by their company. If approval is required, the approver is notified automatically. As the use of e-commerce systems grows, companies are phasing out their traditional systems. The resulting growth of e-commerce is creating many new business opportunities. E-commerce can enhance a company's stock prices and market value. Today, several e-commerce firms have teamed up with more traditional brick-and-mortar businesses to draw from each other's strengths. For example, e-commerce customers can order products on a website and pick them up at a nearby store.

In addition to e-commerce, business information systems use telecommunications and the Internet to perform many related tasks. Electronic procurement (e-procurement), for example, involves using information systems and the Internet to acquire parts and supplies. **Electronic business (e-business)** goes beyond e-commerce and e-procurement by using information systems and the Internet to perform all business-related tasks and functions, such as accounting,

finance, marketing, manufacturing and human resource activities. E-business also includes working with customers, suppliers, strategic partners and stakeholders. Compared with traditional business strategy, e-business strategy is flexible and adaptable.

**Figure 1.6**  
E-Commerce Greatly Simplifies Purchasing



## MIS and DSS

The benefits provided by an effective TPS are tangible and justify their associated costs in computing equipment, computer programs, and specialized personnel and supplies. A TPS can speed business activities and reduce clerical costs. Although early accounting and financial TPSs were already valuable, companies soon realized that they could use the data stored in these systems to help managers make better decisions, whether in human resource management, marketing or administration. Satisfying the needs of managers and decision makers continues to be a major factor in developing information system

## Management Information Systems

A **management information system (MIS)** is an organized collection of people, procedures, software, databases and devices that provides routine information to managers and decision makers. An MIS focuses on operational efficiency. Marketing, production, finance and other functional areas are supported by MISs and linked through a common database. MISs typically provide standard reports generated with data and information from the TPS, meaning the output of a TPS is the input to an MIS. Producing a report that describes inventory that should be ordered is an example of an MIS. Prepare requisition Obtain approval of requisition Joe Bloggs Inc. 14 Mallard Drive Anywhere, UK AW3 124 Requisition Bloggs Traditional process for placing a purchase order Electronic purchase order MISs were first developed in the 1960s and

typically used information systems to produce managerial reports. In many cases, these early reports were produced periodically – daily weekly, monthly or yearly. Because of their value to managers, MISs have proliferated throughout the management ranks. For instance, the total payroll summary report produced initially for an accounting manager might also be useful to a production manager to help monitor and control labour and job cost.

## Decision Support Systems

By the 1980s, dramatic improvements in technology resulted in information systems that were less expensive but more powerful than earlier systems. People at all levels of organizations began using personal computers to do a variety of tasks; they were no longer solely dependent on the IS department for all their information needs. People quickly recognized that computer systems could support additional decision-making activities. A **decision support** system (DSS) is an organized collection of people, procedures, software, data-bases and devices that support problem-specific decision making. The focus of a DSS is on making effective decisions.

Whereas an MIS helps an organization ‘do things right’, a DSS helps a manager ‘do the right thing’.

In addition to assisting in all aspects of problem-specific decision making, a DSS can support customers by rapidly responding to their phone and email enquiries. A DSS goes beyond a traditional MIS by providing immediate assistance in solving problems. Many of these problems are unique and complex, and information is often difficult to obtain. For instance, a car manufacturer might try to determine the layout for its new manufacturing facility. Traditional MISs are seldom used to solve these types of problems; a DSS can help by suggesting alternatives and assisting in final decision making.

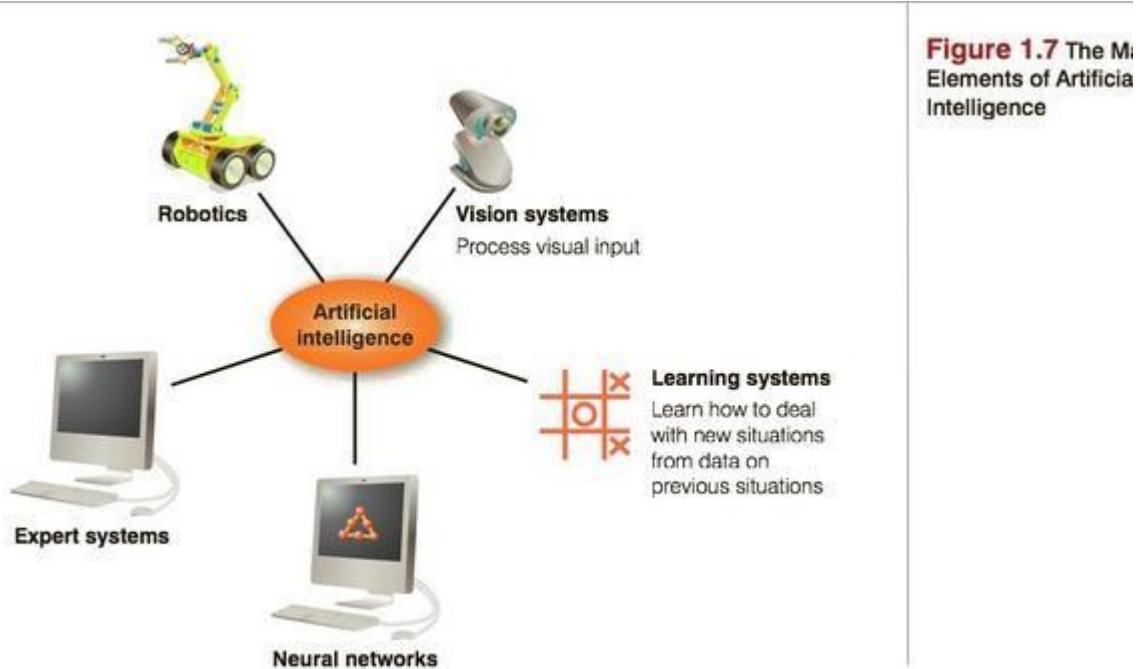
Decision support systems are used when the problem is complex and the information needed to make the best decision is difficult to obtain and use. So a DSS also involves managerial judgment and perspective. Managers often play an active role in developing and implementing the DSS. A DSS recognizes that different managerial styles and decision types require different systems. For example, two production managers in the same position trying to solve the same problem might require different information and support. The overall emphasis is to support, rather than replace, managerial decision making.

The essential elements of a DSS include a collection of models used to support a decision maker or user (model base), a collection of facts and information to assist in decision making (database), and systems and procedures (dialogue manager or user interface) that help decision makers and other users interact with the DSS. Software is often used to manage the database – the database management system (DBMS) – and the model base – the model management system (MMS). In addition to DSSs for managers, group decision support systems and executive support systems use the same approach to support groups and executives. A group decision support system, also called a group support system, includes the DSS elements just described and software, called group-ware, to help groups make effective decisions. An executive support system, also called an executive information system, helps top-level managers, including a firm’s CEO, divisional directors and members of the board of directors, make better decisions. An executive support system can assist with strategic planning, top-level organizing and staffing, strategic control and crisis management.

## Knowledge Management, Artificial Intelligence, Expert Systems and Virtual Reality

In addition to TPSs, MISs and DSSs, organizations often rely on specialized systems. Many use knowledge management systems (KMSs), an organized collection of people, procedures, software, databases and devices to create, store, share and use the organization's knowledge and experience. According to a survey of CEOs, firms that use KMSs are more likely to innovate and perform better.

In addition to knowledge management, companies use other types of specialized systems. The Nissan Motor Company, for example, has developed a specialized system for their vehicles called 'Lane Departure Prevention' that nudges a car back into the correct lane if it veers off course. The system uses cameras and computers to adjust braking to get the vehicle back on course. The system switches off when the driver uses turn signals to change lanes. Other specialized systems are based on the notion of **artificial intelligence (AI)**, in which the computer system takes on the characteristics of human intelligence. The field of artificial intelligence includes several sub-fields (see Figure 1.7). Some people predict that in the future, we will have nanobots, small molecular-sized robots, travelling throughout our bodies and in our bloodstream, keeping us healthy. Other nanobots will be embedded in products and services, making our lives easier and creating new business opportunities.



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## Artificial Intelligence

Robotics is an area of AI in which machines take over complex, dangerous, routine or boring tasks, such as welding car frames or assembling computer systems and components. Vision systems allow robots and other devices to ‘see’, store and process visual images. Natural language processing involves computers understanding and acting on verbal or written commands in English, Spanish or other human languages. Learning systems allow computers to learn from past mistakes or experiences, such as playing games or making business decisions, and neural networks is a branch of AI that allows computers to recognize and act on patterns or trends. Some successful stock, options and futures traders use neural networks to spot trends and make them more profitable with their investments. State of the art AI is impressive. In 2011 the IBM supercomputer Watson competed against and beat two human champions in the game show Jeopardy. By the end of 2018, Google expects to be selling cars with ‘driverless’ features, using AI in the vehicles to avoid passenger injuries.

## Expert Systems

**Expert systems** give the computer the ability to make suggestions and act like an expert in a particular field. It can help the novice user perform at the level of an expert. The unique value of expert systems is that they allow organizations to capture and use the wisdom of experts and specialists. Therefore, years of experience and specific skills are not completely lost when a human expert dies, retires or leaves for another job. Expert systems can be applied to almost any field or discipline. They have been used to monitor nuclear reactors, perform medical diagnoses, locate possible repair problems, design and configure IS components, perform credit evaluations and develop marketing plans for a new product or new investment strategy. The collection of data, rules, procedures and relationships that must be followed to achieve value or the proper outcome is contained in the expert system’s **knowledge base**.

## Virtual Reality

**Virtual reality** is the simulation of a real or imagined environment that can be experienced visually in three dimensions. Originally, virtual reality referred to immersive virtual reality, which means the user becomes fully immersed in an artificial, computer-generated 3D world. The virtual world is presented in full scale and relates properly to the human size. It can represent any 3D setting, real or abstract, such as a building, an archaeological excavation site, the human anatomy, a sculpture or a crime scene reconstruction. Virtual worlds can be animated, interactive and shared. Through immersion, the user can gain a deeper understanding of the virtual world’s behaviour and functionality. Virtual reality can also refer to applications that are not fully immersive such as mouse-controlled navigation through a 3D environment on a graphics monitor, stereo viewing from the monitor via stereo glasses, stereo projection systems and others.

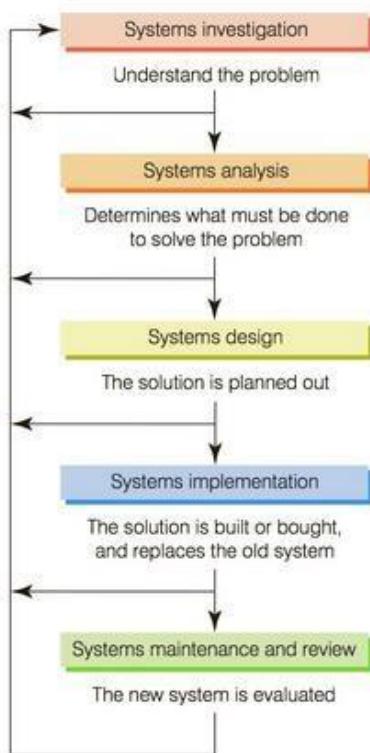
A variety of input devices, such as head-mounted displays, data gloves, joysticks and hand-held wands, allow the user to navigate through a virtual environment and to interact with virtual objects. Directional sound, tactile and force feedback devices, voice recognition and other technologies enrich the immersive experience. Because several people can share and interact in the same environment, virtual reality can be a powerful medium for communication, entertainment and learning.

It is difficult to predict where information systems and technology will be in 10 to 20 years. It seems, however, that we are just beginning to discover the full range of their usefulness.

Technology has been improving and expanding at an increasing rate; dramatic growth and change are expected for years to come. Without question, a knowledge of the effective use of information systems will be critical for managers both now and in the long term. But how are these information systems created?

### 1.3 Systems Development

**Systems development** is the activity of creating or modifying business systems. Systems development projects can range from small to very large in fields as diverse as stock analysis and video game development. People inside a company can develop systems or companies can use outsourcing, hiring an outside company to perform some or all of a systems development project. Outsourcing allows a company to focus on what it does best and delegate other functions to companies with expertise in systems development. Outsourcing, however, is not the best alternative for all companies. An alternative is agile systems development where systems are developed rapidly in close partnership with users. Working together, parts of the system are developed, tested, modified and refined over and over again until a usable system emerges. Developing information systems to meet business needs is highly complex and difficult – so much so that it is common for IS projects to overrun budgets and exceed scheduled completion dates. Her Majesty's Revenue and Customs (HMRC), which collects taxes in the UK, settled out of court with an outsourcing company to recover funds lost due to a tax-related mistake caused by a failed systems development project. The failed project overpaid about €2.5 billion to some families with children or taxpayers in a low-income tax bracket. One strategy for improving the results of a systems development project is to divide it into several steps, each with a well-defined goal and set of tasks to accomplish (see Figure 1.8). These steps are summarized next



**Figure 1.8** An Overview of Systems Development

## Systems Investigation and Analysis

Figure 1.8 An Overview of Systems Development Systems analysis Systems design Systems implementation Systems maintenance and review The first two steps of systems development are systems investigation and analysis. The goal of the systems investigation is to gain a clear understanding of the problem to be solved or opportunity to be addressed. A cruise line company, for example, might launch a systems investigation to determine whether a development project is feasible to automate purchasing at ports around the world. After an organization understands the problem, the next question is, ‘Is the problem worth solving?’ Given that organizations have limited resources – people and money – this question deserves careful consideration. If the decision is to continue with the solution, the next step, systems analysis, defines the problems and opportunities of the existing system. During systems investigation and analysis, as well as design maintenance and review, discussed next, the project must have the complete support of top-level managers and focus on developing systems that achieve business goals.

## Systems Design, Implementation, and Maintenance And Review

Systems design determines how the new system will work to meet the business needs defined during systems analysis. Systems implementation involves creating or acquiring the various system components (hardware, software, databases, etc.) defined in the design step, assembling them and putting the new system into operation. The purpose of systems maintenance and review is to check and modify the system so that it continues to meet changing business needs.

Information systems have been developed to meet the needs of all types of organizations and people, and their use is spreading throughout the world to improve the lives and business activities of many citizens. To provide their enormous benefits, however, information systems must be implemented with thought and care. The speed and widespread use of information systems opens users to a variety of threats from unethical people.

### Computer and Information Systems Literacy

In the twenty-first century, business survival and prosperity have continued to become more difficult. For example, increased mergers among former competitors to create global conglomerates, continued downsizing of corporations to focus on their core businesses and to improve efficiencies, efforts to reduce trade barriers, and the globalization of capital all point to the increased internationalization of business organizations and markets. In addition, business issues and decisions are becoming more complex and must be made faster. Whatever career path you take, understanding information systems will help you cope, adapt and prosper in this challenging environment. A knowledge of information systems will help you make a significant contribution to the job. It will also help you advance in your chosen career or field. Managers are expected to identify opportunities to implement information systems to improve their business. They are also expected to lead IS projects in their areas of expertise. To meet these personal and organizational goals, you must acquire both computer literacy and information systems literacy. **Computer literacy** is a knowledge of computer systems and equipment and the ways they function. It stresses equipment and devices (hardware), programs and instructions (software), databases and telecommunications. Information systems literacy goes beyond knowing the fundamentals of computer systems and equipment. Information systems literacy is the knowledge of how data and information are used by individuals, groups and organizations. It includes knowledge of computer technology and the broader range of information systems. Most important, however, it encompasses how and why this technology is applied in business. Knowing about various types of hardware and software is an example of computer literacy. Knowing how to use hardware and software to increase profits, cut costs, improve productivity and increase customer satisfaction is an example of information systems literacy. **Information systems literacy** can involve recognizing how and why people (managers, employees, stockholders and others) use information systems; being familiar with organizations, decision-making approaches, management levels and information needs; and understanding how organizations can use computers and information systems to achieve their goals. Knowing how to deploy transaction processing, management information, decision support and expert systems to help an organization achieve its goals is a key aspect of information systems literacy.

### Information Systems in the Functional Areas of Business

Information systems are used in all functional areas and operating divisions of business. In finance and accounting, information systems forecast revenues and business activity, determine the best sources and uses of funds, manage cash and other financial resources, analyse investments and perform audits to make sure that the organization is financially sound and that all financial reports and documents are accurate. Sales and marketing use information systems to develop new goods and services (product analysis), select the best location for production

and distribution facilities (place or site analysis), determine the best advertising and sales approaches (promotion analysis) and set product prices to get the highest total revenues (price analysis). In manufacturing, information systems process customer orders, develop production schedules, control inventory levels and monitor product quality. In addition, information systems help to design products (computer-assisted design or CAD), manufacture items (computer-assisted manufacturing or CAM), and integrate machines or pieces of equipment (computer-integrated manufacturing or CIM). Human resource management uses information systems to screen applicants, administer performance tests to employees, and monitor employee productivity and more. Legal information systems analyse product liability and warranties and help to develop important legal documents and report

## **Information Systems in Industry**

In addition to being used in every department in a company, information systems are used in almost every industry or field in business. The airline industry develops Internet auction sites to offer discount fares and increase revenue. Investment firms use information systems to analyse stocks, bonds, options, the futures market and other financial instruments, and provide improved services to their customers. Banks use information systems to help make sound loans and good investments, as well as to provide online payment for account holders. The transportation industry uses information systems to schedule trucks and trains to deliver goods and services at the lowest cost. Publishing companies use information systems to analyse markets and to develop and publish newspapers, magazines and books. Private healthcare organizations use information systems to diagnose illnesses, plan medical treatment, track patient records and bill patients. Retail companies are using the web to take orders and provide customer service support. Retail companies also use information systems to help market products and services, manage inventory levels, control the supply chain and forecast demand. Power management and utility companies use information systems to monitor and control power generation and usage. Professional services firms employ information systems to improve the speed and quality of services they provide to customers. Management consulting firms use intranets and extranets to offer information on products, services, skill levels and past engagements to their consultants. These industries are discussed in more detail as we continue through the book.

### **1.5 Global Challenges in Information Systems**

Changes in society as a result of increased international trade and cultural exchange, often called globalization, have always had a big impact on organizations and their information systems. In his book *The World Is Flat*, Thomas Friedman describes three eras of globalization (see Table 1.2). According to Friedman, we have progressed from the globalization of countries to the globalization of multinational corporations and individuals. Today, people in remote areas can use the Internet to compete with, and contribute to, other people, the largest corporations and entire countries. These workers are empowered by high-speed Internet access, making the world seem smaller and effectively levelling the global playing field. In the Globalization 3 era, designing a new aeroplane or computer can be separated into smaller subtasks and then completed by a person or small group that can do the best job. These workers can be located in India, China, Russia, Europe and other areas of the world. The subtasks can then be combined or reassembled into the complete design. This approach can be used to

prepare tax returns, diagnose a patient's medical condition, and fix a broken computer and many other tasks.

**Table 1.2 Eras of Globalization**

Era	Dates	Characterized by
Globalization 1	Late 1400–1800	Countries with the power to explore and influence the world
Globalization 2	1800–2000	Multinational corporations that have plants, warehouses and offices around the world
Globalization 3	2000–today	Individuals from around the world who can compete and influence other people, corporations and countries by using the Internet and powerful technology tools



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Today's information systems have led to greater globalization. High-speed Internet access and networks that can connect individuals and organizations around the world create more international opportunities. Global markets have expanded. People and companies can get products and services from around the world, instead of around the corner or across town. These opportunities, however, introduce numerous obstacles and issues, including challenges involving culture, language and many others.

- Cultural challenges: Countries and regional areas have their own cultures and customs that can significantly affect individuals and organizations involved in global trade.
- Language challenges: Language differences can make it difficult to translate exact meanings from one language to another.
- Time and distance challenges: Time and distance issues can be difficult to overcome for individuals and organizations involved with global trade in remote locations. Large time differences make it difficult to talk to people on the other side of the world. With long distance, it can take days to get a product, a critical part or a piece of equipment from one location to another location.
- Infrastructure challenges: High-quality electricity and water might not be available in certain parts of the world. Telephone services, Internet connections and skilled employees might be expensive or not readily available.
- Currency challenges: The value of different currencies can vary significantly over time, making international trade more difficult and complex.
- Product and service challenges: Traditional products that are physical or tangible, such as a car or bicycle, can be difficult to deliver to the global market. However, electronic products (e-products) and electronic services (e-services) can be delivered to customers electronically,

over the phone, networks, through the Internet or other electronic means. Software, music, books, manuals, and help and advice can all be delivered over the Internet.

- Technology transfer issues: Most governments don't allow certain military-related equipment and systems to be sold to some countries. Even so, some believe that foreign companies are stealing the intellectual property, trade secrets, copyrighted materials and counterfeiting products and services
- National laws: Every country has a set of laws that must be obeyed by citizens and organizations operating in the country. These laws can deal with a variety of issues, including trade secrets, patents, copyrights, protection of personal or financial data, privacy and much more. Laws restricting how data enters or exits a country are often called 'trans-border dataflow laws'. Keeping track of these laws and incorporating them into the procedures and computer systems of multinational and trans-national organizations can be very difficult and time consuming, requiring expert legal advice.
- Trade agreements: Countries often enter into trade agreements with each other. The EU has trade agreements among its members.<sup>20</sup> The North American Free Trade Agreement (NAFTA) and the Central American Free Trade Agreement (CAFTA) are other examples.<sup>21</sup> Others include the Australia–United States Free Trade Agreement and agreements between Bolivia and Mexico, Canada and Costa Rica, Canada and Israel, Chile and Korea, Mexico and Japan, the USA and Jordan and many other.



## Chapter Summary

The value of information is directly linked to how it helps decision makers achieve the organizational goals. Information systems are used in almost every imaginable career area. Regardless of your chosen career, you will find that information systems are indispensable tools to help you achieve your goals. Learning about information systems can help you get your first job, earn promotions and advance your career.

Information is a collection of facts.

Computers and information systems are constantly making it possible for organizations to improve the way they conduct business. A system is a set of elements that interact to accomplish a goal or set of objectives. The components of a system include inputs, processing mechanisms and outputs. A system uses feedback to monitor and control its operation to make sure that it continues to meet its goals and objectives.

Knowing the potential impact of information systems and having the ability to put this knowledge to work can result in a successful personal career, organizations that reach their goals and a society with a higher quality of life. Information systems are sets of interrelated elements that collect (input), manipulate and store (process), and disseminate (output) data and information. Input is the activity of capturing and gathering new data, processing involves converting or transforming data into useful outputs, and output involves producing useful information. Feedback is the output that is used to make adjustments or changes to input or processing activities.



### Review Questions (Short)

1. What is m-commerce?
2. Define telecommunications.
3. What is virtual reality and how could it be used in
4. What are the main steps in systems development?
5. What are some of the global challenges in the field of information systems?



### Review Questions (Long)

1. Describe what an information system is. What are its main elements?
2. Define the word system.
3. What do each of them do?
4. What are the characteristics of good quality information?
5. Describe what a TPS does



### Review Questions (MCQ)

1. Input is \_\_\_\_\_ to produce output.  
A. Processed  
B. System  
C. System Performance standard  
D. Output
  
2. A \_\_\_\_\_ is a specific objective of a system.  
A. Extranet  
B. Telecommunications  
C. System performance standard  
D. Input
  
3. \_\_\_\_\_ Is information from a system that is used to make changes to the input?  
A. Transaction  
B. Feedback  
C. Market Share  
D. Green Computing
  
4. Providing software and data storage via a web browser is usually called  
A. Primary Key  
B. Switch  
C. Antivirus  
D. Cloud computing
  
5. The most important element in an information system is the  
A. People  
B. Secondary Storage  
C. Broadband Communications  
D. Artificial Intelligence



## Case Studies

### Case one -when online survey go awry

#### When online survey go away

Oh dear. It has happened before and it will happen again. A serious organization naively assumes that the Internet-using public will take its survey seriously. Having just spent over 300 million euros on a new Arctic-going research vessel, the Natural Environment Research Council (NERC) thought it would stir up interest in its work by running an online poll to decide what to name it. Perhaps the public would suggest naming it after a famous explorer. Or maybe Sir David Attenborough, a name synonymous in the UK with TV nature programmes. A few and the result were in. the winning suggestion? "Boaty Mcboatface".

The suggestion received 124,109 votes, a massive four times as many as the runner up, Poppy-Mai, named after a 16-month-old girl with incurable cancer. The chief executive of the NERC, Duncan Wingham, was then faced with the dilemma of choosing between a credible name and overwhelming public opinion. As mentioned, this is not the first time this sort of thing has happened. In 2012, soft drinks maker PepsiCo ran a survey to "Dub the Dew" and give their new flavour a brand name. Unfortunately pranksters from the online community 4 Chan stepped in and the name 'Hitler Did Nothing Wrong' rose to the top of the suggestions (although other communities were also blamed for this). The UK government was quick to put the breaks on Boaty McBoatface. Jo Johnson, the science minister said, "the new royal research ship will sailing into the world's iciest waters to address global challenges that affect the lives of hundreds of millions of people, including global warming, the melting of polar ice and rising sea levels. That's why we want a name that lasts longer than a social media news cycle and reflects the serious nature of the science it will be doing. There are many excellent suggestions among the 7 000 names put forward by members of the public.

#### Questions

1. If you were chief executive of the NERC, what?
2. Are online surveys of this kind just too?
3. What are the advantages of this sort of survey? Is there no such thing as bad publicity? Who would have heard of this £300m ship if it had not been for the Boaty McBoat suggestion?



**Principles Of Business Information Systems 3<sup>rd</sup> Edition, Ralph Stair, George Reynolds and Thomas Chesney Chapter 1 Page Number 29**



## Case Studies

### Health Information System In South African

Hospitals and health workers have long recognized the importance of good information. A knowledge of diagnoses made by doctors in the past, and a record of treatments that were given to patients along with the outcomes, all help to create the most promising treatment plans for future patients. Information on the geography of health problems also helps to create a national strategy that can be used to make health-related decisions and plan responses to disease outbreaks. The data may even be used to predict and prevent those outbreaks.

South Africa's Health Program is a not-for-profit non-governmental organization that aims to empower healthcare workers and decision makers to improve the coverage, quality and efficiency of health services through the use of open standards and data exchange mechanisms. They subscribe to an open source philosophy, freely sharing their training materials and software solutions.

Their staff members include nine software developers and ten database administrators who create web-based and mobile solutions. This use of web standards means that their software will run on most operating systems and on most devices, which means there will be few, if any, access problems..

#### Questions

1. What devices could be used to collect health information and what are the advantages and disadvantages of each?
2. What are the advantages of health professionals discussing patients with each other online? Are there any disadvantages?
3. Why do you think the Health Information System program uses an open source philosophy?
4. Why are patients concerned with sharing sensitive data with a private company?



Principles Of Business Information Systems 3<sup>rd</sup> Edition, Ralph Stair,George Reynolds and Thomas Chesney Chapter 1 Page Number 30



### LEARNING OUTCOMES

After reading this Section of the guide, the learner should be able to:

#### Learning Objectives

- Identify the value-adding processes in the supply chain and describe the role of information systems within them.
- Provide a clear definition of ‘organizational structure’ and ‘Organizational change’ and discuss how these affect the Implementation of information systems.

Identify some of the strategies employed to lower costs or improve service.

- Define the term ‘competitive advantage’ and discuss how organizations are using information systems to achieve such an advantage.
- Discuss how organizations justify the need for information systems.
- Define the types of roles, functions and careers available in information systems.

### Introduction

The impact that computers have had in organizations cannot be overstated. Office work has been transformed almost beyond all recognition, and many workers could not operate without their computer. All of this happened before the rise in popularity of the Internet as a channel for sharing information. When that happened, the Internet changed everything all over again! No matter what path your career takes, you will almost certainly come into contact with information systems every day. Marketing departments, accounts departments, order processing, shipping and logistics all rely on information systems. Researchers, medical doctors, and mechanics – it is difficult to think of a profession where the computer does not play a central role. Even musicians use information systems to get the sound they want. In this chapter, you will see how the use of information systems in every part of organizations can help produce higher-quality products and increase their returns on investment.

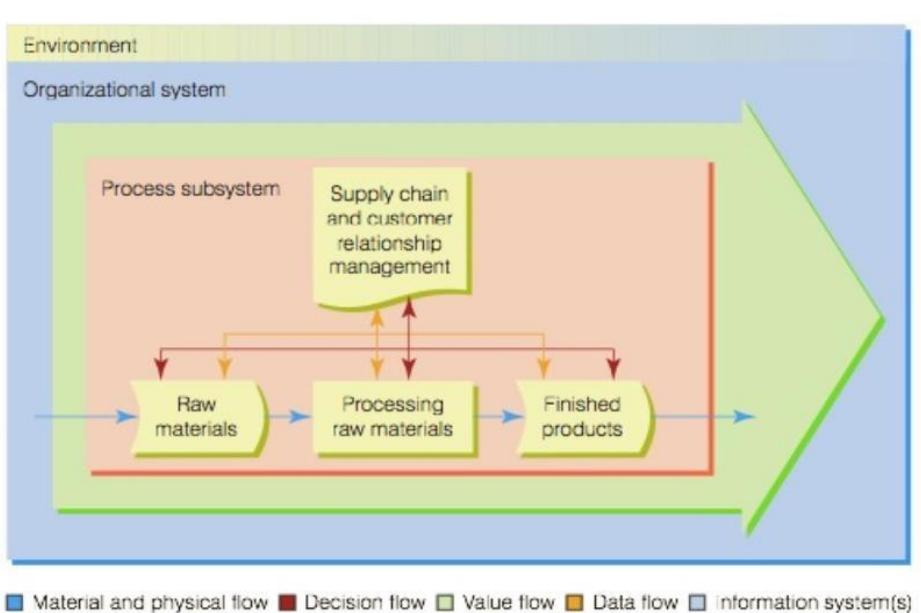
## 2.1 An Introduction to Organizations

An **organization** is a formal collection of people and other resources established to accomplish a set of goals. The primary goal of a for-profit organization is to maximize shareholder value, often measured by the price of the company stock. Non-profit organizations include social groups, religious groups, universities, charities and other organizations that do not have profit as their goal.

An organization is a system, which, as you will recall from Chapter 1, means that it has inputs, processing mechanisms, outputs and feedback. Resources such as materials, people and money serve as inputs to the organizational system from the environment, go through a transformation mechanism and then are produced as outputs to the environment. The outputs from the transformation mechanism are usually goods or services which are of higher relative value than the inputs alone. Through adding value or worth, organizations attempt to achieve their goals.

How does the organizational system increase the value of resources? In the transformation mechanism, subsystems contain processes that help turn inputs into goods or services of increasing value. These processes increase the relative worth of the combined inputs on their way to becoming final outputs. Consider a car maker. Its inputs are the staff it has hired, the assembly equipment it has bought, raw materials such as metal and plastic, and pre-assembled components such car radios. The processing that it does is turning the materials into finished vehicles, which are the output. The finished product is worth more than the cost of the components. This amount is the value that has been added. **The value chain**, popularized by Michael Porter in his book, Competitive Strategy, is a useful tool for analysing where and how this value gets added. The value chain is a series (chain) of activities that includes inbound logistics, warehouse and storage, production, finished product storage, outbound logistics, marketing and sales, and customer service. The value chain of a manufacturing company is shown in Figure 2.1. Analyzing value chains when developing information systems often results in efficient transaction processing systems (explained fully in a later chapter), an expanding market and the sharing of information. The value chain is used to examine what happens to raw materials to add value to them before the finished product is sold to customers. Information systems can be focused on those activities that add the most value. The value chain can also reveal linkages between different activites (say marketing and production) which can be exploited using IS (to increase communication between the two for instance).

The value chain is just as important (although it can be a little more difficult to apply) to companies that don't manufacture products, but provide services, such as tax preparers and legal firms. By adding a significant amount of value to their products and services, companies ensure success.



**Figure 2.1** The Value Chain of a Manufacturing Company Managing raw materials, inbound logistics, and warehouse and storage facilities is called 'upstream management', and managing finished product storage, outbound logistics, marketing and sales, and customer service is called 'downstream management'.

Supply chain management (SCM) and customer relationship management (CRM) are two key parts of managing the value chain. SCM helps determine what supplies are required for the value chain, what quantities are needed to meet customer demand, how the supplies should be processed (manufactured) into finished goods and services, and how the shipment of supplies and products to customers should be scheduled, monitored and controlled.<sup>3</sup> For example, in the car manufacturing company mentioned on page 34, SCM can identify key suppliers and parts, negotiate with vendors for the best prices and support, make sure that all supplies and parts are available to manufacture cars and send finished products to dealerships around the country when they are needed. Increasingly, SCM is accomplished using the Internet and electronic marketplaces (e-marketplaces). When an organization has many suppliers, it can use business-to-business exchanges such as eBay Business (<http://www.ebay.com/rpp/businessindustrial>) to negotiate good prices and service.

CRM programs help a company manage all aspects of customer encounters, including marketing and advertising, sales, customer service after the sale and help retain loyal customers. CRM can assist a company with collecting data on customers, contacting customers, informing them about new products and actively selling products to existing and new customers. Often, CRM software uses a variety of information sources, including sales from retail stores, surveys, email and Internet browsing habits, to compile comprehensive customer profiles. CRM systems can also collect customer feedback which can be used to design new products and services. Tesco, the UK's largest retail operation, encourages its customers to use its Club card, which allows it to collect information on customer transactions. It uses this information to provide outstanding customer service and deliver loyalty rewards and perks to valued customers. In return, customers are rewarded with discounts on Tesco products, holidays and other deals. Figure 2.2 shows the Tesco website which the company uses to help with CRM.

What role does an information system play in these processes? A traditional view of information systems holds that organizations use them to control and monitor processes and ensure effectiveness and efficiency. Under this view, the output from a company's information systems is used to make changes to company processes. These changes could involve using different raw materials (inputs), designing new assembly-line procedures (product

transformation) or developing new products and services (outputs). Here, the information system is external to the process and serves to monitor or control it.

**Figure 2.2 Tesco Website** Tesco uses its website to help with customer relationship management.



**Principles Of Business Information Systems 3<sup>rd</sup> Edition, Ralph Stair, George Reynolds and Thomas Chesney Chapter 2 Page Number 36**

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. Consider a telephone directory business that creates telephone books for international businesses. A customer requests a telephone directory listing all steel suppliers in Western Europe. Using its information system, the directory business can sort files to find the suppliers' names and telephone numbers and organize them into an alphabetical list. The information system itself is an inseparable part of this process. It does not just monitor the process externally but works as part of the process to transform raw data into a product. In this example, the information system turns input (names and telephone numbers) into a sellable output (a telephone directory). The same system might also provide the input (the files storing the data) and output (printed pages for the directory).

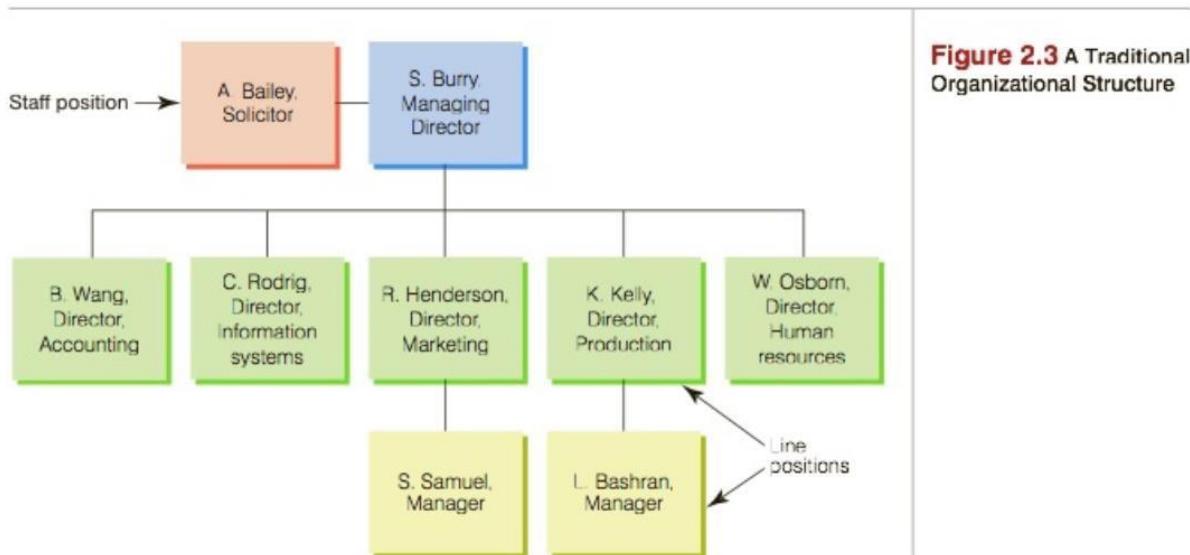
This latter view provides a new perspective on how and why businesses can use information systems. Rather than attempting to understand information systems independently of the organization, we must consider the potential role of information systems within the process itself, often leading to the discovery of new and better ways to accomplish the process.

## Organizational Structures

**Organizational structure** refers to organizational subunits and the way they relate to each other. An organization's structure depends on its approach to management and can affect how it views and uses information systems. The types of organizational structures typically include traditional, project, team and virtual.

### Traditional Organizational Structure

A **traditional organizational structure**, also called a hierarchical structure, is like a managerial pyramid where the hierarchy of decision making and authority flows from the strategic management at the top, down to operational management and non-management employees. Compared to lower levels, the strategic level, including the managing director of the company and directors, has a higher degree of decision authority, more impact on business goals and more unique problems to solve (see Figure 2.3).



In most cases, department heads report to a managing director or top-level manager. The departments are usually divided according to function and can include marketing, production, information systems, finance and accounting, research and development, and so on. The positions or departments that are directly associated with making, packing, or shipping goods are called line positions. A production manager who reports to a director of production is an example of a line position. Other positions might not be directly involved with the formal chain of command but instead assist a department or area. These are staff positions, such as a solicitor, reporting to the managing director.

Today, the trend is to reduce the number of management levels, or layers, in the traditional organizational structure. This type of structure, often called a flat organizational structure, empowers employees at lower levels to make decisions and solve problems without needing permission from mid-level managers. Empowerment gives employees and their managers more responsibility and authority to make decisions, take action and have more control over their jobs. For example, an empowered shop assistant can respond to customer requests and problems without needing permission from a manager. In a factory, empowerment might mean that an assembly-line worker can stop production to correct a problem before the product is passed to the next station.

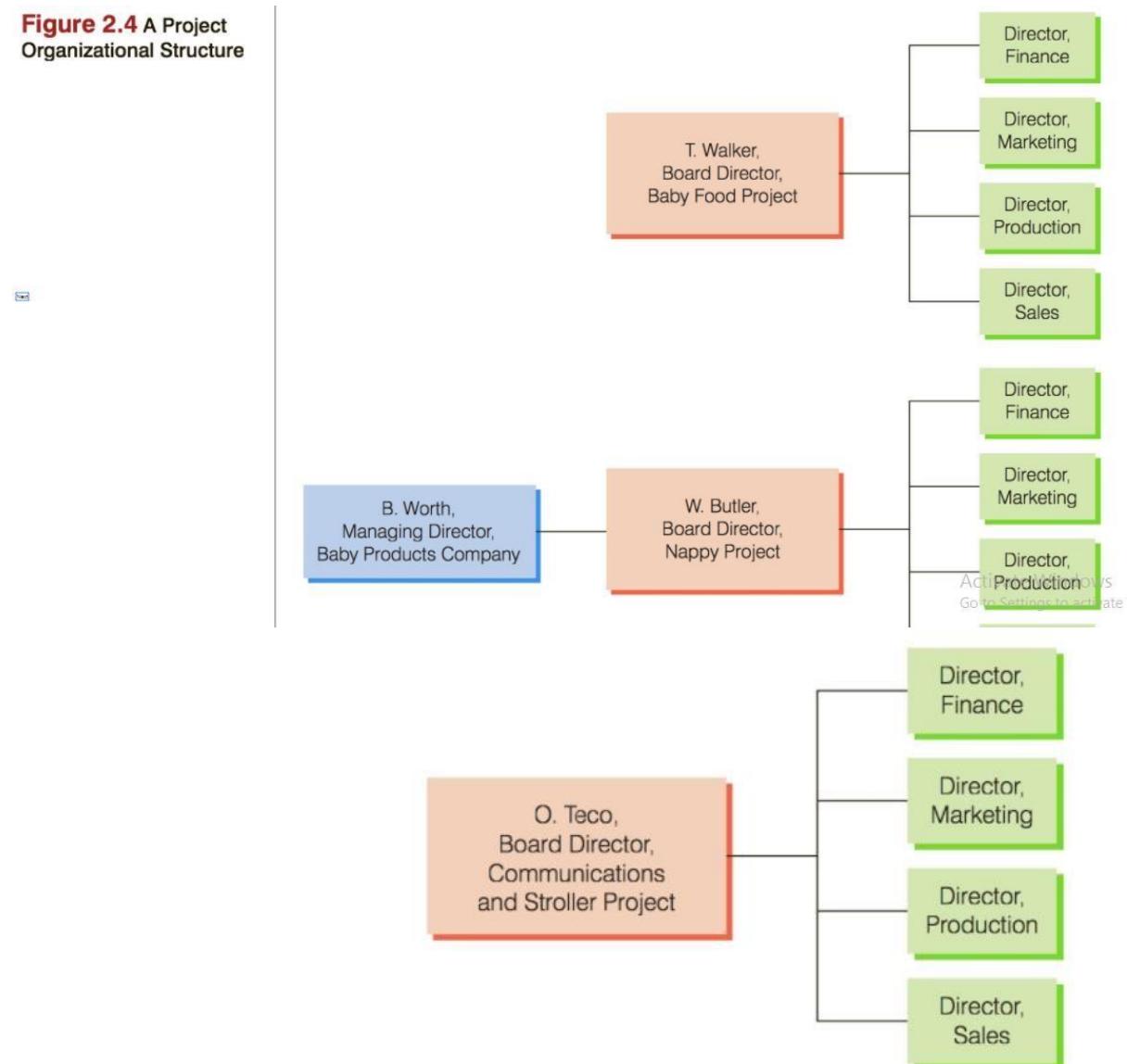
Information systems can be a key element in empowering employees because they provide the information employees need to make decisions. The employees might also be empowered to develop or use their own personal information systems, such as a simple forecasting model or spreadsheet.

## Project and Team Organizational Structures

A **project organizational structure** is centred on major products or services. For example, in a manufacturing firm that produces baby food and other baby products, each line is produced by a separate unit. Traditional functions such as marketing, finance and production are positioned within these major units (see Figure 2.4). Many project teams are temporary – when the project is complete, the members go on to new teams formed for another project.

The **team organizational structure** is centred on work teams or groups. In some cases, these teams are small; in others, they are very large. Typically, each team has a leader who reports to an upper-level manager. Depending on its tasks, the team can be temporary or permanent. A healthcare company, for example, can form small teams to organize its administrators, physicians and others to work with individual patients.

**Figure 2.4** A Project Organizational Structure





**Principles Of Business Information Systems 3<sup>rd</sup> Edition, Ralph Stair,George Reynolds and Thomas Chesney Chapter 2 Page Number 38**

## **Virtual Organizational Structure**

A **virtual organizational structure** is made up of individuals, teams or complete business units that work with other individuals, teams or complete business units in different geographic locations. This almost always requires the use of the Internet (or other telecommunications), and the teams can exist for a few weeks or years. The people involved might be in different countries and operating in different time zones. In other words, virtual organizational structures allow people who work together to be separated by location and time. The people might never meet physically, which explains the use of the word ‘virtual’. In Chapter 10 we will examine some of the technologies that make this form of collaborative work possible. Despite their physical separation, members of a virtual organization can collaborate on any aspect of a project, such as supplying raw materials, producing goods and services, and delivering goods and services to the marketplace.

A company can use a virtual organizational structure with its own dispersed workers who have distinct skills and abilities to reduce costs. Price Waterhouse Coopers, a global accounting giant, uses virtual teams of 5 to 50 people in the learning and education department.<sup>6</sup> According to Peter Nicolas, the company’s Learning Solutions manager, ‘Virtual teaming is the norm for us’. The company takes advantage of software and technology, including Microsoft Live Meeting, Centra Software’s Virtual-Classroom Application and Lotus Notes from IBM, to help the teams work from distant locations.

In addition to reducing costs or increasing revenues, a virtual organizational structure can provide an extra level of security. For instance, dispersing employees and using a virtual structure can provide an ability to deal with a disaster at the primary location. If this happened, the company would still have sufficient employees at other locations to keep the business running. Today’s workers are performing company work at home, at a customer’s location, in coffee shops, on pleasure boats and at convenient work centres in suburbia. People can work at any time. Using the Internet and email, workers can put the finishing touches to a new business proposal in Europe or Asia, while co-workers in North America are sleeping.

Successful virtual organizational structures share key characteristics. One strategy is to have in-house employees concentrate on the firm’s core businesses and use virtual employees, groups or businesses to do everything else. Using information systems to manage the activities

of a virtual structure is essential, often requiring specialized software to coordinate joint work. Even with sophisticated IS tools though, teams may still need face-to-face meetings, especially at the beginning of new projects.

### Organizational Change

Most organizations are constantly undergoing change, both minor and major. The need for **organizational change** can be caused by internal factors, such as those initiated by employees at all levels, or external factors, such as activities wrought by competitors, stockholders, new laws, community regulations, natural occurrences (such as hurricanes) and general economic conditions. In the 1990s, the Internet caused massive changes in the way millions of organizations did business. Change can be sustaining or disruptive. Sustaining change such as new or cheaper production equipment can help an organization improve its operations. For example, many factories are now able to use robots because prices for robots are falling and their useful lifetime is increasing, leading to a big market in second-hand robots.

Disruptive change, on the other hand, often harms an organization's performance or even puts it out of business. In general, disruptive technologies might not originally have good performance, low cost or even strong demand. Over time, however, they often replace existing technologies. They can cause good, stable companies to fail when they don't change or adopt the new technology. VoIP telephone technology is currently disrupting the business models of established companies such as BT ([www.bt.com](http://www.bt.com)) who, in response, are moving towards providing broadband Internet connections as their main product.

Overcoming resistance to change, especially disruptive change, can be the hardest part of bringing information systems into a business. Occasionally, employees even attempt to sabotage a new information system because they do not want to learn the new procedures and commands. The best way to avoid this resistance is to involve the employees in the decision to implement the change, and consult them on the development or purchase of the information system.

When a company introduces a new information system, a few members of the organization must become agents of change – champions of the new system and its benefits. Understanding the dynamics of change can help them confront and overcome resistance so that the new system can be used to maximum efficiency and effectiveness.

A significant portion of an organization's expenses are used to hire, train and compensate talented staff. So organizations try to control costs by determining the number of employees they need to maintain high-quality goods and services. Strategies to contain costs are outsourcing, on-demand computing and downsizing.

**Outsourcing** involves contracting with outside professional services to meet specific business needs. Often, companies outsource a specific business process, such as recruiting and hiring employees, developing advertising materials, promoting product sales or setting up a global telecommunications network. Organizations often outsource a process to focus more closely on their core business and target limited resources to meet strategic goals. Everton Football Club, for example, has outsourced all processing of credit and debit card payments from its stadium shop, online store and call centres because it had become a complex operation that was not part of its core operation. They were able to save time and money by not having to train their staff to do this.

Other reasons for outsourcing are to trim expenses or benefit from the expertise of a service provider. A growing number of organizations, however, are finding that outsourcing does not

necessarily lead to reduced costs. One of the primary reasons for cost increases is poorly written contracts that tack on charges from the outsourcing vendor for each additional task. Other potential drawbacks of outsourcing include loss of control and flexibility, overlooked opportunities to strengthen core competency and low employee morale.

**On-demand computing** is an extension of the outsourcing approach, and many companies offer on-demand computing to business clients and customers. On-demand computing, also called on-demand business and utility computing, involves rapidly responding to the organization's flow of work as the need for computer resources varies. It is often called 'utility computing' because the organization pays for computing resources from a computer or consulting company just as it pays for electricity from a utility. Disruptive change, on the other hand, often harms an organization's performance or even puts it out of business. In general, disruptive technologies might not originally have good performance, low cost or even strong demand. Over time, however, they often replace existing technologies. They can cause good, stable companies to fail when they don't change or adopt the new technology. VoIP telephone technology is currently disrupting the business models of established companies such as BT ([www.bt.com](http://www.bt.com)) who, in response, are moving towards providing broadband Internet connections as their main product. Overcoming resistance to change, especially disruptive change, can be the hardest part of bringing information systems into a business. Occasionally, employees even attempt to sabotage a new information system because they do not want to learn the new procedures and commands. The best way to avoid this resistance is to involve the employees in the decision to implement the change, and consult them on the development or purchase of the information system. When a company introduces a new information system, a few members of the organization must become agents of change – champions of the new system and its benefits. Understanding the dynamics of change can help them confront and overcome resistance so that the new system can be used to maximum efficiency and effectiveness. A significant portion of an organization's expenses are used to hire, train and compensate talented staff. So organizations try to control costs by determining the number of employees they need to maintain high-quality goods and services. Strategies to contain costs are outsourcing, on-demand computing and downsizing its company. This approach treats the information system – including hardware, software, databases, telecommunications, personnel and other components – more as a service than as separate products. In other words, instead of purchasing hardware, software and data-base systems, the organization only pays a fee for the systems it needs at peak times. The approach can save money because the organization does not pay for systems that it doesn't routinely need. It also allows the organization's IS staff to concentrate on more strategic issues.

**Downsizing** involves reducing the number of employees to cut costs. The term 'rightsizing' is also used. Rather than pick a specific business process to downsize, companies usually look to downsize across the entire company. Downsizing clearly reduces total payroll costs, although employee morale can suffer.

Employers need to be open to alternatives to reducing the number of employees and use layoffs as the last resort. It's simpler to encourage people to leave voluntarily through early retirement or other incentives. Voluntary downsizing programmes often include a buyout package offered to certain classes of employees (for example, those over 50 years old). The buyout package offers employees certain benefits and cash incentives if they voluntarily retire from the company. Other options are job sharing and transfers.

**Organizational learning** is closely related to organizational change. According to the concept of organizational learning, organizations adapt to new conditions or alter their practices over time. Assembly-line workers, secretaries, shop assistants, managers and executives all learn better ways of doing business and incorporate them into their day-to-day activities.

Collectively, these adjustments based on experience and ideas are called ‘organizational learning’. In some cases, the adjustments can be a radical redesign of business processes, often called ‘reengineering’. In other cases, these adjustments can be more incremental, a concept called ‘continuous improvement’. Both adjustments reflect an organization’s strategy: the long-term plan of action for achieving their goals.

### Reengineering and Continuous Improvement

To stay competitive, organizations must occasionally make fundamental changes in the way they do business. In other words, they must 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. Reengineering can reduce delivery times, increase product and service quality, and enhance customer satisfaction, and increase revenues and profitability. When Mittal Steel, South Africa’s Vanderbijlpark Plant, reengineered its steelmaking operations, introducing new automated systems, it was able to reduce the amount of raw materials used in its processes and increase its output of steel, which was of a higher quality than before. They were also able to reduce processing time and improve plant availability.

In contrast to simply automating the existing work process, reengineering challenges the fundamental assumptions governing their design. It requires finding and vigorously challenging old rules blocking major business process changes. These rules are like anchors weighing down a firm and keeping it from competing effectively. Table 2.1 provides some examples of such rules.

**Table 2.1** Selected Business Rules that Affect Business Processes

Rule	Original Rationale	Potential Problem
Hold small orders until full lorry load shipments can be assembled	Reduce delivery costs	Customer delivery is slow
Do not accept an order until customer credit is approved	Reduce potential for bad debt	Customer service is poor
Let headquarters make all merchandizing decisions	Reduce number of items carried in inventory	Customers perceive organization has limited product selection



**Principles Of Business Information Systems 3<sup>rd</sup> Edition, Ralph Stair,George Reynolds and Thomas Chesney Chapter 2 Page Number 43**

The Northern Ireland Civil Service is introducing an electronic and document records management system (EDRM) to improve its efficiency. Processes have been reengineered so that instead of records being held in different departments and in different formats (on paper, in databases and even in email), a centralized system will provide access to up-to-date and secure information. It is hoped the system will also reduce the amount of paper the service uses.

In contrast to reengineering, the idea of **continuous improvement** is to constantly seek 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, these companies increase customer loyalty, minimize the chance of customer dissatisfaction and diminish the opportunity for competitive inroads. Table 2.2 compares these two strategies.

**Table 2.2** Comparing Business Process Reengineering and Continuous Improvement

Business Process Reengineering	Continuous Improvement
Strong action taken to solve serious problems	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; focus is on tasks in a given area
Goal is to achieve a major breakthrough	Goal is continuous, gradual improvements
Often led by outsiders	Usually led by workers close to the business
Information system integral to the solution	Information systems provide data to guide the improvement team

## User Satisfaction and Technology Acceptance

To be effective, reengineering and continuous improvement efforts must result in satisfied users and be accepted and used throughout the organization. You can determine the actual usage of an information system by the amount of technology diffusion and infusion. **Technology diffusion** is a measure of how widely technology is spread throughout an organization. An organization has a high level of technology diffusion if computers and information systems are located in most departments. Some online merchants, such as BT ([www.bt.com](http://www.bt.com)), have a high diffusion and use computer systems to perform most of their business functions, including marketing, purchasing and billing.

**Technology infusion**, on the other hand, is the extent to which technology permeates an area or department. In other words, it is a measure of how deeply embedded technology is in an area of the organization. Some architectural firms, for example, use computers in all aspects of designing a building from drafting to final blueprints. The design area, thus, has a high level of infusion. Of course, a firm can have a high level of infusion in one part of its operations and a low level of diffusion overall. The architectural firm might use computers in all aspects of design (high infusion in the design area), but not to perform other business functions, including billing, purchasing and marketing (low diffusion). Diffusion and infusion often depend on the technology available now and in the future, the size and type of the organization, and the environmental factors that include the competition, government regulations, and suppliers and so on. This is often called the ‘technology, organization and environment’ (TOE) framework. An active research area in IS involves identifying why people accept and use one system, but dislike and therefore don’t use another. One early model, the Technology Acceptance Model

(TAM), shows that people will use a system if it is easy to use and useful to them. This in itself is unhelpful to IS developers; however, TAM has been the basis for a large body of research that is ongoing and which hopes to produce more practical results. Although an organization might have a high level of diffusion and infusion with computers throughout the organization, this does not necessarily mean that information systems are being used to their full potential.

## The Applications Portfolio

In Chapter 1 we looked at how information systems can be classified by the management level of the user. The applications portfolio is perhaps a more useful classification scheme. It sorts information systems according to the contribution they make to the business. According to the applications portfolio, there are four types of system:

- 1 Support:** **Support applications** are nice to have, but are not essential. They include things that are convenient, but without them the organization can still conduct business. Typical support applications include electronic diaries and instant messaging software, used to let employees in an office communicate with each other.
- 2 Key operational:** **Key operational applications** are essential. Without them the organization would not be able to do business. Transaction processing systems, mentioned in Chapter 1 and discussed fully in Chapter 8, are an example. If the checkout system at a Tesco shop malfunctions, Tesco would be unable to sell goods until it was repaired. The website of every e-commerce business is key operational.
- 3 Strategic:** A **strategic application** is an information system that gives a business an advantage over some or all of its competitors. Some ideas for what this advantage might be are discussed later in this chapter in the section on Competitive Advantage (page 48). The term ‘strategic’ should not be confused with the same term used to describe senior management in a business. A strategic system could appear anywhere in the company hierarchy.
- 4 Future strategic:** A **future strategic application** (also known as a ‘potential strategic’ or ‘high potential’ application) is an idea for, or a prototype of, an information system which, if developed, might one day become a strategic system. A company may have ten future strategic systems and decide to invest in only one. This decision is often a judgement call made by senior management. It may be that the technology to develop a future strategic system is currently too expensive and the company is waiting for prices to fall.

There is an endless cycle at work with systems starting life in one part of the portfolio and finishing in another. Typically an innovative, leading company will come up with an idea for a potential strategic system. If they invest in it and it is successful, it becomes a strategic system. Their competitors see that they have an advantage and so create their own versions of the system. Eventually, the system will become industry standard and then be key operational. In the meantime, the innovative company will have had more ideas for future strategic systems, and so the cycle starts again. Companies that see themselves as industry followers rather than industry leaders will not have strategic or future strategic systems in their portfolio.

## Success Factors

Many writers have suggested reasons why some information systems are implemented successfully and others are not. It is of vital importance that a company’s information systems are aligned with the company’s goals. Misalignment is a frequently cited reason for information systems failure. The main way of achieving **alignment** is for senior managers to consider the

business processes they have in place to achieve company goals, and ask what information systems are needed to support these business processes. Less frequently, a business, typically a small business or even a single entrepreneur, will consider what technology is available and ask what business goals can be achieved using it. In this case, information technology is dictating business strategy instead of business strategy dictating what information technology is used. Both are valid paths to alignment.

Other common success factors are:

- Senior management must be committed to the development or purchase of the information system and support it fully.
- End-users of the system should be involved as early and as much as possible in the development or purchase of the system.
- Time must be taken to carefully determine what the system must do, something known as **requirements engineering**. Requirements must be clearly stated and understood and accepted by everyone involved.
- Strong project management in the development or purchase of the information system.

Later on in this text we will examine Joint Application Development, a method for creating IS which places users at the centre of the development.

## 2.2 Competitive Advantage

A **competitive advantage** is the ability of a firm to outperform its industry, that is, to earn a higher rate of profit than the industry norm<sup>12</sup> and can result from higher-quality products, better customer service and lower costs. Establishing and maintaining a competitive advantage is complex. An organization often uses its information system to help it do this. Ultimately, it is not how much a company spends on information systems but how it makes and manages investments in technology. Companies can spend less and get more value.

### Factors That Lead Firms to Seek Competitive Advantage

A number of factors can lead a company to seek to attain a competitive advantage. Michael Porter, a prominent management theorist, suggested a simple but widely accepted model of the competitive forces in an industry, also called the **five-forces model**. A strong force can put a business at a disadvantage and lead it to invest in technology that can weaken it. The five forces are: (1) the rivalry among existing competitors, (2) the threat of new entrants, (3) the threat of substitute products and services, (4) the bargaining power of buyers, and (5) the bargaining power of suppliers. The more these forces combine in any instance, the more likely firms will seek competitive advantage and the more dramatic the results of such an advantage will be.

Given the five market forces just mentioned, Porter and others have proposed a number of strategies to attain competitive advantage, including cost leadership, differentiation, niche strategy, altering the industry structure, creating new products and services, and improving existing product lines and services. In some cases, one of these strategies becomes dominant.

For example, with a cost leadership strategy, cost can be the key consideration, at the expense of other factors if needs be.

## Cost Leadership

The intent of a cost leadership strategy is to deliver the lowest possible products and services. In the UK, supermarket Asda has used this strategy for years. Cost leadership is often achieved by reducing the costs of raw materials through aggressive negotiations with suppliers, becoming more efficient with production and manufacturing processes, and reducing warehousing and shipping costs. Some companies use outsourcing to cut costs when making products or completing services.

## Differentiation

The intent of differentiation as a strategy is to deliver different cost of productions and services. This strategy can involve producing a variety of products, giving customers more choices, or delivering higher-quality products and services. Many car companies make different models that use the same basic parts and components, giving customers more options. Other car companies attempt to increase perceived quality and safety to differentiate their products. Some consumers are willing to pay higher prices for vehicles that differentiate on higher quality or better safety.

## Niche Strategy

A niche strategy will deliver to only a small, niche market. Porsche, for example, doesn't produce inexpensive estate cars or saloons. It makes high-performance sports cars and four-wheel drives. Rolex only makes high-quality, expensive watches. It doesn't make inexpensive, plastic watches that can be purchased for €20 or less.

## Altering the Industry Structure

Changing the industry to become more favourable to the company or organization is another strategy company's use. The introduction of low-fare airline carriers, such as EasyJet, has forever changed the airline industry, making it difficult for traditional airlines to make high profit margins. To fight back, airlines such as British Airways cut their flight prices and started to emphasize their strengths over low-cost airlines in their advertising. These include landing in central airports rather than airports many miles out of the city they supposedly serve, and extra staff and resources to cope if there is a fault with an aircraft, or adverse weather grounds all planes. Creating strategic alliances can also alter the industry structure. A **strategic alliance**, also called a 'strategic partnership', is an agreement between two or more companies that involves the joint production and distribution of goods and services.

## Creating New Products and Services

Some companies introduce new products and services periodically or frequently as part of their strategy. This strategy can help a firm gain a competitive advantage, especially in the computer industry and other high-tech businesses. If an organization does not introduce new products and services every few months, the company can quickly stagnate, lose market share and decline. Companies that stay on top are constantly developing new products and services.

## Improving Existing Product Lines and Service

Making real or perceived improvements to existing product lines and services is another strategy. Manufacturers of household products are always advertising 'new and improved' products. In some cases, the improvements are more perceived than real refinements; usually, only minor changes are made to the existing product, such as reducing the amount of sugar in a breakfast cereal. Some mail order companies are improving their service by using Radio Frequency Identification (RFID) tags to identify and track the location of their products as they

are shipped from one location to another. Customers and managers can instantly locate products as they are shipped from suppliers to the company, to warehouses and finally to customers. Other potentially successful strategies include being the first to market, offering customized products and services, and hiring talented staff, the assumption being that the best people will determine the best products and services to deliver to the market and the best approach to deliver these products and services. Companies can also combine one or more of these strategies.

### 2.3 Evaluating IS

Once an information system has been implemented, management will want to assess how successful it has been in achieving its goals. Often this is a difficult thing to do, and many businesses do not attempt to take anything more than an informal approach to evaluation.<sup>14</sup> Business can use measurements of productivity, return on investment (ROI), net present value and other measures of performance to evaluate the contributions their information systems make to their businesses.

#### Productivity

Developing information systems that measure and control productivity is a key element for most organizations. **Productivity** is a measure of the output achieved divided by the input required. A higher level of output for a given level of input means greater productivity; a lower level of output for a given level of input means lower productivity. The numbers assigned to productivity levels are not always based on labour hours – productivity can be based on factors such as the amount of raw materials used, resulting quality, or time to produce the goods or service. The value of the productivity number is not as significant as how it compares with other time periods, settings and organizations.

After a basic level of productivity is measured, an information system can monitor and compare it over time to see whether productivity is increasing. Then a company can take corrective action if productivity drops below certain levels. In addition to measuring productivity, an information system can be used within a process to significantly increase productivity. Thus, improved productivity can result in faster customer response, lower costs and increased customer satisfaction.

In the late 1980s and early 1990s, overall productivity did not seem to improve as a company increased its investments in information systems. Often called the productivity paradox, this situation troubled many economists who were expecting to see dramatic productivity gains. In the early 2000s, however, productivity again seemed to be on the rise.

#### Return on Investment and the Value of Information Systems

One measure of IS value is **return on investment** (ROI). This measure investigates the additional profits or benefits that are generated as a percentage of the investment in IS technology. A small business that generates an additional profit of €20 000 for the year as a result of an investment of €100 000 for additional computer equipment and software would have a return on investment of 20 per cent ( $\text{€}20\,000/\text{€}100\,000$ ). In many cases, however, it can be difficult to accurately measure ROI.

## Earnings Growth

Another measure of IS value is the increase in profit or earnings growth it brings. For instance, a mail-order company might install an order-processing system that generates a 7 per cent earnings growth compared with the previous year.

## Market Share

Market share is the percentage of sales that a product or service has in relation to the total market. If installing a new online catalogue increases sales, it might help a company to increase its market share by 20 per cent. Customer Awareness and Satisfaction Although customer satisfaction can be difficult to quantify, about half of today's best global companies measure the performance of their information systems based on feedback from internal and external users. Some companies use surveys and questionnaires to determine whether the IS investment has increased customer awareness and satisfaction.

## Customer Awareness and Satisfaction

Although customer satisfaction can be difficult to quantify, about half of today's best global companies measure the performance of their information systems based on feedback from internal and external users. Some companies use surveys and questionnaires to determine whether the IS investment has increased customer awareness and satisfaction.

## Total Cost of Ownership

Another way to measure the value of information systems was developed by the Gartner Group and is called the **total cost of ownership** (TCO). This approach breaks total costs into areas such as the cost to acquire the technology, technical support, administrative costs and end-user operations. Other costs in TCO include retooling and training costs. TCO can help to develop a more accurate estimate of the total costs for systems that range from desktop computers to large mainframe systems. Market research groups often use TCO to compare products and services.

ROI, earnings growth, market share, customer satisfaction and TCO are only a few measures that companies use to plan for and maximize the value of their IS investments. Regardless of the difficulties, organizations must attempt to evaluate the contributions that information systems make to assess their progress and plan for the future. Information technology and personnel are too important to leave to chance.

## Risk

In addition to the ROI measures of a new or modified information system, managers should also consider the risks of designing, developing and implementing these systems. Information systems can sometimes be costly failures. Some companies, for example, have attempted to implement enterprise resource planning (ERP) systems and failed, costing them millions of dollars. In other cases, e-commerce applications have been implemented with little success. The costs of development and implementation can be greater than the returns from the new system.

## 2.4 Careers in Information Systems

Realizing the benefits of any information system requires competent and motivated IS personnel, and many companies offer excellent job opportunities. Professionals with careers in information systems typically work in an IS department as web developers, computer programmers, systems analysts, database developers and administrators, computer operators, technical support or in other positions. In addition to technical skills, they 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. Today, many good information, business and computer science schools require these business and communications skills of their graduates.

In general, IS professionals are charged with maintaining the broadest perspective on organizational goals. Most medium to large organizations manage information resources through an IS department. In smaller businesses, one or more people might manage information resources, with support from outsourced services. As shown in Figure 2.5, the IS department has three primary responsibilities: operations, systems development and support.

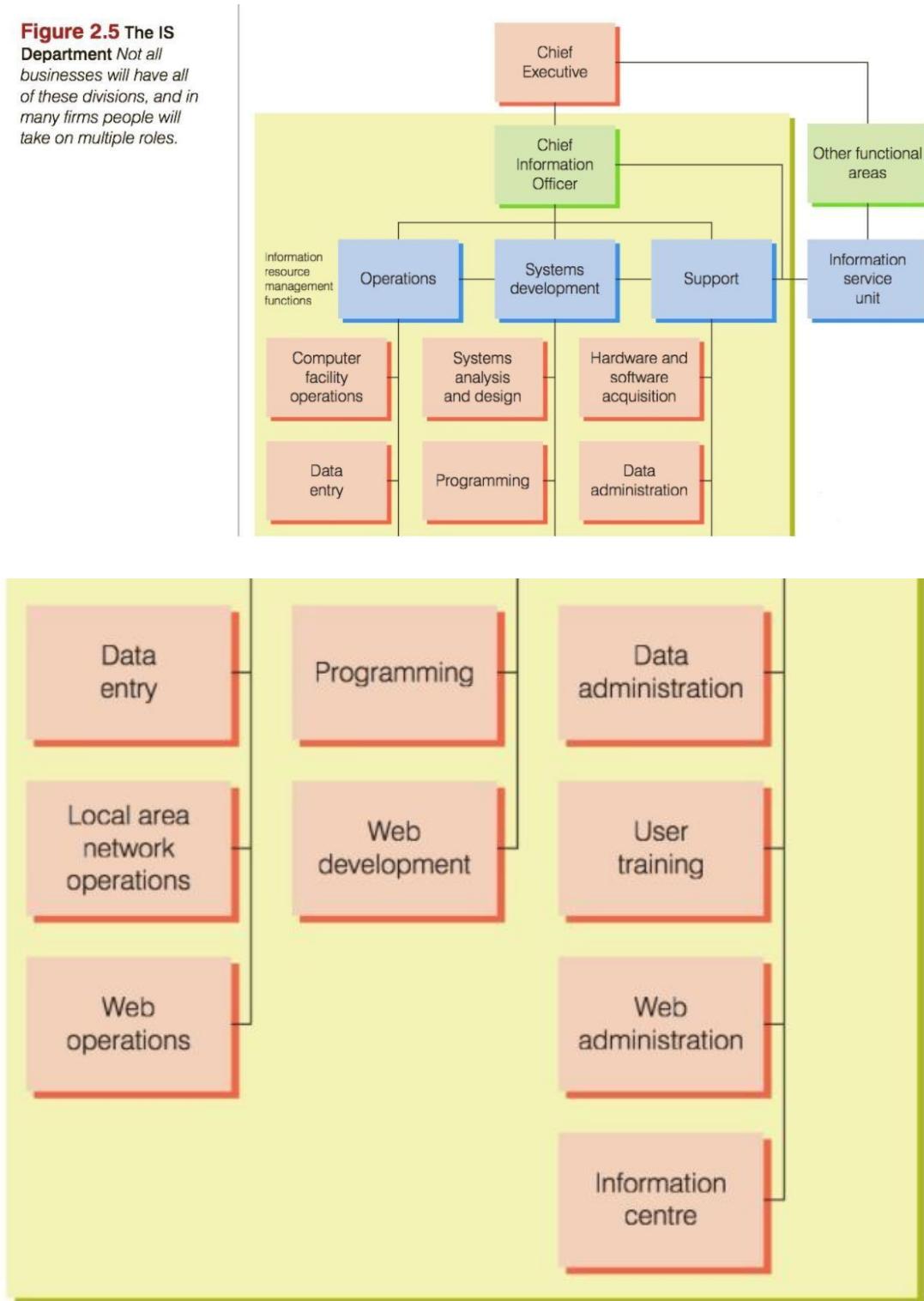
## Operations

People in the operations component of a typical IS department work with information systems in corporate or business unit computer facilities. They tend to focus more on the efficiency of IS functions rather than their effectiveness. System operators primarily run and maintain IS equipment, and are typically trained at technical schools or through on-the-job experience. They are responsible for starting, stopping and correctly operating mainframe systems, networks, back-up drives, disc devices, printers and so on. Other operations include scheduling, hardware maintenance and preparing input and out- put. Data-entry operators convert data into a form the computer system can use. They can use terminals or other devices to enter business transactions, such as sales orders and payroll data. Increasingly, data entry is being automated – captured at the source of the transaction rather than entered later. In addition, companies might have local area network (LAN) and web operators who run the local network and any websites the company has.

## Systems Development

The systems development component of a typical IS department focuses on specific development projects and ongoing maintenance and review. Systems analysts and programmers for example, address these concerns to achieve and maintain IS effectiveness. The role of a systems analyst is multifaceted. Systems analysts help users determine what outputs they need from the system and construct plans for developing the necessary programs that produce these out- puts. Systems analysts then work with one or more programmers to make sure that the appropriate programs are purchased, modified from existing programs or developed. A computer programmer uses the plans the systems analyst created to develop or adapt one or more computer programs that produce the desired outputs. With the dramatic increase in the use of the Internet, intranets and extranets, many companies have web or Internet developers who create effective and attractive websites for customers, internal personnel, suppliers, stockholders and others who have a business relationship with the company.

**Figure 2.5 The IS Department** Not all businesses will have all of these divisions, and in many firms people will take on multiple roles.



## Support

The support component of a typical IS department provides user assistance in hardware and software acquisition and use, data administration, user training and assistance, and web administration. In many cases, support is delivered through an information centre.

Because IS hardware and software are costly, a specialized support group often manages computer hardware and software acquisitions. This group sets guidelines and standards for the

rest of the organization to follow in making purchases. It must gain and maintain an understanding of available technology and develop good relationships with vendors. A database administrator focuses on planning, policies and procedures regarding the use of corporate data and information. For example, database administrators develop and disseminate information about the organization's databases for developers of IS applications. In addition, the database administrator monitors and controls database use. User training is key to getting the most from any information system, and the support area ensures that appropriate training is available. Training can be provided by internal staff or from external sources. For example, internal support staff can train managers and employees in the best way to enter sales orders, to receive computerized inventory reports and to submit expense reports electronically. Companies also hire outside firms to help train users in other areas, including the use of word processing, spreadsheets and database programs. Web administration is another key area for support staff. With the increased use of the Internet, web administrators are sometimes asked to regulate and monitor Internet use by employees and managers to make sure that it is authorized and appropriate. Web administrators also maintain the organization's website to keep it accurate and current, which can require substantial resources. The support component typically operates the helpdesk. A helpdesk provides users with assistance, training, application development, documentation, equipment selection and setup, standards, technical assistance and troubleshooting.

### **Information Service Units**

An information service unit is basically a miniature IS department attached and directly reporting to a functional area in a large organization. Notice the information service unit shown in Figure 2.5. Even though this unit is usually staffed by IS professionals, the project assignments and the resources necessary to accomplish these projects are provided by the functional area to which it reports. Depending on the policies of the organization, the salaries of IS professionals staffing the information service unit might be budgeted to either the IS department or the functional area.

### **Typical IS Titles and Functions**

The organizational chart shown in Figure 2.5 is a simplified model of an IS department in a typical medium or large organization. Many organizations have even larger departments, with increasingly specialized positions such as librarian or quality assurance manager. Smaller firms often combine the roles shown in Figure 2.5 into fewer formal positions.

### **The Chief Information Officer**

The role of the chief information officer (CIO) is to employ an IS department's equipment and personnel to help the organization attain its goals. The CIO is a senior manager concerned with the overall needs of the organization who sets organization-wide policies, and plans, manages and acquires information systems. Some of the CIO's top concerns include integrating IS operations with business strategies, keeping up with the rapid pace of technology, and defining and assessing the value of systems development projects. The high level of the CIO position reflects that information is one of the organization's most important resources. A CIO works with other high-level officers in an organization, including the finance director and the chief executive officer, in managing and controlling total corporate resources. CIOs must also work closely with advisory committees, stressing effectiveness and teamwork and viewing information systems as an integral part of the organization's business processes – not an adjunct to the organization. Thus, CIOs need both technical and business skills.

## LAN Administrator

**Local area network (LAN)** administrators set up and manage the network hardware, software and security processes. They manage the addition of new users, software and devices to the network. They also isolate and fix operational problems. LAN administrators are in high demand and often solve both technical and non-technical problems. Database administrators manage the use, maintenance and security of a company's databases. Often a database administrator will help users extract the data they need in the format they require.



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## Internet Careers

These careers are in the areas of web operations, web development and web administration. As with other areas in IS, many top-level administrative jobs are related to the Internet. These career opportunities are found in both traditional companies and those that specialize in the Internet. Internet jobs within a traditional company include Internet strategists and administrators, Internet systems developers, Internet programmers and Internet or website operators.

### Systems Developers

Systems developers design and write software. Typically, developers will be graduates with degrees in technical subjects such as computer science, mathematics or engineering. However, many big employers have graduate recruitment schemes where degree subject is less important than an ability to learn. On such schemes, graduates are taught the skills they need. The skills needed by developers include the ability to design solutions to problems and communicate these solutions to other developers and to users, and the technical skill to create these solutions. Software development can be extremely challenging and exciting. Often, systems developers are employed to create software to support business goals, such as develop the organization's transaction processing system. Alternatively, systems developers may work in a software house, where the software they write is the product the organization sells. One of the fastest growing areas of software development is the games industry, with many universities now offering degrees in games development.

### Other IS Careers

Other IS career opportunities include technical writing (creating technical manuals and user guides) and user interface design certification. A process for testing skills and knowledge which results in a statement by the certifying authority that an individual is capable of performing a particular kind of job. Often, the people filling IS roles have completed some form of certification. Certification is a process for testing skills and knowledge resulting in an endorsement by the certifying authority that an individual is capable of performing a particular job. Certification frequently involves specific, vendor- provided or vendor-endorsed

coursework. Popular certification programs include Microsoft Certified Systems Engineer, Certified Information Systems Security Professional (CISSP), Oracle Certified Professional and many others.



## Chapter Summary

### Summary

The use of information systems to add value to the organization is strongly influenced by organizational structure and the organization's attitude and ability to change. An organization is a formal collection of people and other resources established to accomplish a set of goals. The primary goal of a for-profit organization is to maximize shareholder value. Non-profit organizations include social groups, religious groups, universities and other organizations that do not have profit as the primary goal.

Because information systems are so important, businesses need to be sure that improvements to existing systems, or completely new systems, help lower costs, increase profits, improve service or achieve a competitive advantage.

Cooperation between business managers and IS personnel is the key to unlocking the potential of any new or modified system. Information systems personnel typically work in an IS department. The chief information officer (CIO) employs an IS department's equipment and personnel to help the organization maintain its goal.



### Review Questions (Short)

1. Describe a virtual organization structure.
2. What is the value chain?
3. What is technology diffusion?
4. Describe on-demand computing.
5. Define continuous improvement and compare it with reengineering.



### Review Questions (Long)

1. Describe some of the ways in which IS can be
2. Why would a company constantly develop new products?
3. What is a support application?
4. Giving employees and their managers more responsibility and authority is known as
5. The head of the information systems department



### Review Questions (MCQ)

1. A minimum number of management layers results in a \_\_\_\_\_ organization structure.
  - A. Flat
  - B. Top
  - C. Middle
  - D. Low
  
2. Giving employees and their managers more responsibility and authority known as
  - A. Disempowerment
  - B. Empowerment
  - C. Promotion
  - D. Salary increase
  
3. Outsourcing computing resources to a third party is known as
  - A. Out-demand computing
  - B. Off-demand computing
  - C. On-demand computing
  - D. In-demand computing
  
4. The radical redesign of business processes is known as
  - A. Redesign
  - B. Strategic alliance
  - C. Development
  - D. Reengineering
  
5. \_\_\_\_\_ are information systems that an organization could not operate without?
  - A. Key operational systems
  - B. System development
  - C. Strategic operational systems
  - D. Small operational systems



### Case Studies

#### **Cloud Computing and Social Media Make Nail Polish Success**

After her graduation in fashion, New Zealand born Anna Ross found herself working in Melbourne in the clothing industry, putting in 90 hour weeks for

a way out, she soon started designing and selling her own silver jewellery. With little start-up capital, it took two years but eventually she noticed a gap in the market and start to manufacture nail polish.

To market her product, Ms Ross used social media, carefully crafting an online presence that made her company seem much larger than it actually was. By publishing beautifully shot photos on Instagram, Ms Ross turned her brand into a life-style product that attracted customers who desired the lifestyle she portrayed in the photos. Nick Bez, a director at Australian market research group Mobium Group, told business reporter Kate Stan the online environment to talk to a wider audience, means you can be a little brand and have a persona of something much bigger<sup>7</sup>.

In an interview with online magazine The Design Files, Ms Ross explained her use of cloud computing. When Kester Black got big enough that an additional employee was needed, she used the cloud to hand over responsibilities to her new administrator\ it is powerful enough to have helped a young company get off the ground.

#### **Questions**

- 1 How can social media change people's
- 2 Are there any dangers with using social media as a platform for promotion?
- 3 What are some of the advantages of using G
- 4 What other cloud based services could small businesses benefit from?



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### Case Studies

### Can You Solve It?

In the 2014 film *The Imitation Game*, Alan Turing is shown recruiting code breakers by publishing a crossword in the *Daily Telegraph* with a message asking people who could solve it in ten minutes or fewer to get in touch. This is based on a real event. The actual crossword used was published on 13 January 1942 and gave readers 12 minutes not 10.

Clues included ‘when hammering take care not to hit this (5,4)’ and ‘those well brought up help these over stiles (4,4)’. It might seem like a strange way to apply for a job, but puzzles are still used by the intelligence community. The current ‘coding challenge’ issued by the British security service MI5 is an image showing pink and blue lines with the instructions:

‘Intelligence isn’t always obvious and our engineers and analysts work hard to unlock it. There’s a clue in the image file below, if you can find it’. Opening the file in a text editor reveals a further Shakespearian sounding clue hidden in a comment. As I read, numbers I see. Would be a shame not to count this art among the great texts of our time.’ You can use a search engine to find the image using this line if you want to see it. The important part of the message seems to be ‘count this art’.

### Questions

- 1 How could children at school be encouraged to consider a career in cybersecurity?
- 2 How could job recruitment be made to be “future proof”?
3. Should governments rely on private firms for their nation’s cybersecurity?
- 4 How could this same approach be used by Reference organizations to hire IT professionals?



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### LEARNING OUTCOMES

After reading this Section of the guide, the learner should be able to:

#### Learning Objectives

- Describe the role of the central processing unit and main memory.
- State the advantages of multiprocessing and parallel computing systems and provide examples of the types of problems they address.
- Describe the access methods, capacity and portability of various secondary storage devices.
- Identify and discuss the speed, functionality and importance of various input and output devices.
- Identify the characteristics and discuss the usage of various classes of single user and multiuser computer systems.
- Describe Moore's Law and discuss its implications for future computer hardware developments.
- Give an example of recent innovations in computer CPU chips, memory devices and input/output devices.
- Define the term green computing and identify the primary goals of this program.
- Identify several benefits of green computing initiatives that have been broadly adopted.

## Introduction

Today's use of technology is practical – it's intended to yield real business benefits. Using the latest information technology and providing additional processing capabilities can increase employee productivity, expand business opportunities and allow for more flexibility. This chapter concentrates on the hardware component of a computer-based information system (CBIS). Recall that hardware refers to the physical components of a computer that perform the input, processing, output and storage activities of the computer. When making hardware decisions, the overriding consideration of a business should be how hardware can support the objectives of the information system and the goals of the organization.

### 3.1 Computer Systems: Integrating the Power of Technology

People involved in selecting their organization's computer hardware must clearly understand current and future business requirements so that they can make informed acquisition decisions.

Consider the following examples of applying business knowledge to reach sound decisions on acquiring hardware:

■ When Facebook needed to add two new data centres, it elected to build its own custom computers rather than buy off-the-shelf computers from traditional manufacturers such as Dell or HP. The computers installed had only the minimum components needed to perform their specific task and did not include expensive manufacturer upgrade and backup services. As a result, the cost of building and outfitting the data centre was reduced by 24 per cent. ■ The Air Force Information Technology Commodity Council, composed of top United States Air Force (USAF) officials, selects the computer hardware vendors that provide wares to the service agency. Recently this group chose a vendor to provide new workstations and desktop personal computers based on a number of criteria, but primarily on their performance in environmental extremes of heat, humidity, cold, dryness and air pollutants including dust and sand. The equipment has to perform reliably in the extremes in which USAF must carry out its missions.

■ Russell's Convenience Stores operates convenience stores across the US western states and Hawaii. Russell's converted to cloud computing technology, where hardware and software resources are provided by a third party over the Internet, to improve how its employees collaborate with one another and with their licences, vendors and other business partners. It also believes that cloud computing will provide more flexibility

And reduce computing costs over a five-year hardware planning horizon. According to Raymond Huff, president of HJB Convenience Corporation/Russell's Convenience, cloud computing 'is helping our licences to operate as one business – one that is connected, informed, and cohesive'.

As these examples demonstrate, choosing the right computer hardware requires understanding its relationship to the information systems and the needs of an organization.

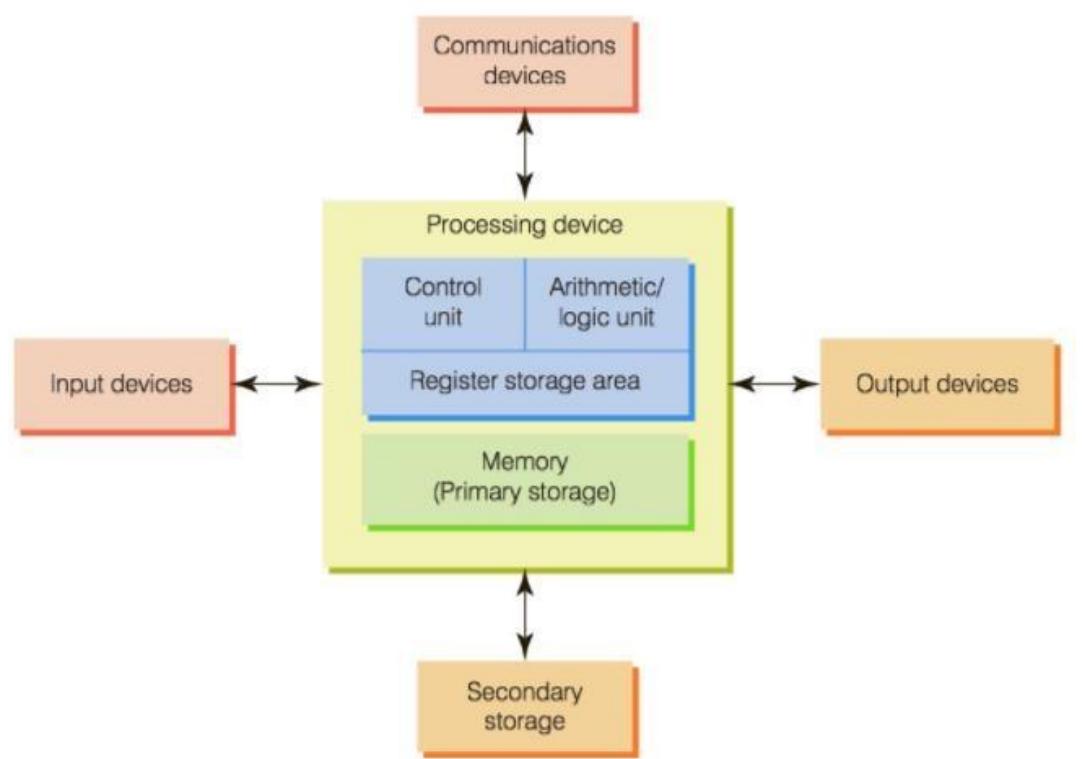
■ Russell's Convenience Stores operates convenience stores across the US western states and Hawaii. Russell's converted to cloud computing technology, where hardware and software resources are provided by a third party over the Internet, to improve how its employees collaborate with one another and with their licences, vendors and other business partners. It also believes that cloud computing will provide more flexibility and reduce computing costs over a five-year hardware planning horizon. According to Raymond Huff, president of HJB Convenience Corporation/Russell's Convenience, cloud computing 'is helping our licences to operate as one business – one that is connected, informed, and cohesive'.

## **Hardware Components**

Computer system hardware components include devices that perform input, processing, data storage and output, as shown in Figure 3.1.

Recall that any system must be able to process (organize and manipulate) data, and a computer system does so through an interplay between one or more central processing units and primary storage. Each **central processing unit (CPU)** consists of three associated elements: the arithmetic/logic unit, the control unit and the register areas. The **arithmetic/logic unit (ALU)** performs mathematical calculations and makes logical comparisons. The **control unit** sequentially accesses program instructions, decodes them and coordinates the flow of data in and out of the ALU, the registers, the primary storage and even secondary storage and various output devices. **Registers** are high-speed storage areas used to temporarily hold small units of program instructions and data immediately before, during and after execution by the CPU

Figure 3.1



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## Hardware Components in Action

- Step 1: Fetch instruction. The computer reads the next program instruction to be executed and any necessary data into the processor.
- Step 2: Decode instruction. The instruction is decoded and passed to the appropriate processor execution unit. Each execution unit plays a different role. The arithmetic/ logic unit performs all arithmetic operations; the floating-point unit deals with no integer operations; the load/store unit manages the instructions that read or write to memory; the branch processing unit predicts the outcome of a branch instruction in an attempt to reduce disruptions in the flow of

instructions and data into the processor; the memory-management unit translates an application's addresses into physical memory addresses; and the vector-processing unit handles vector-based instructions that accelerate graphics operations

- Step 3: Execute instruction. The hardware element, now freshly fed with an instruction and data, carries out the instruction. This process could involve making an arithmetic computation, logical comparison, bit shift or vector operation.
- Step 4: Store results. The results are stored in registers or memory.

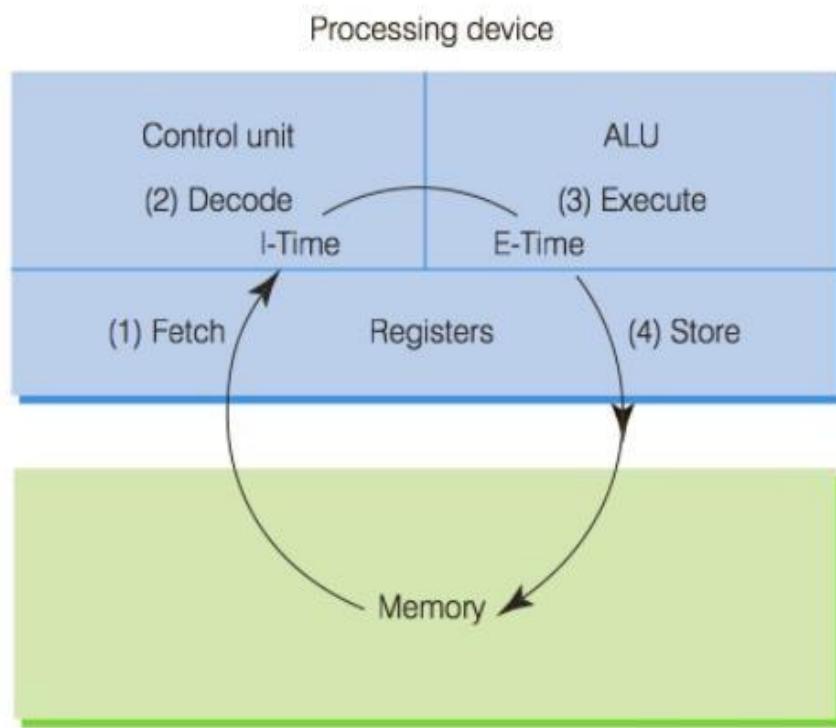
### 3.2 Processing and Memory Devices: Power, Speed and Capacity

The components responsible for processing – the CPU and memory – are housed together in the same box or cabinet, called the system unit. All other computer system devices, such as the monitor, secondary storage and keyboard, are linked directly or indirectly into the system unit housing. In this section we investigate the characteristics of these important devices.



**Principles of Business Information Systems 3<sup>rd</sup> Edition, Ralph Stair, George Reynolds and Thomas Chesney Chapter 3 Page 68**

Figure 3.2



## Processing Characteristics and Functions

Because organizations want efficient processing and timely output, they use a variety of measures to gauge processing speed. These measures include the time it takes to complete a machine cycle and clock speed.

### Machine Cycle Time

As you've seen, a computer executes an instruction during a machine cycle. The time in which a machine cycle occurs is measured in nanoseconds (one-billionth of one second) and picoseconds (one-trillionth of one second). Machine cycle time also can be measured by how many instructions are executed in one second. This measure, called

**MIPS**, stands for millions of instructions per second. **MIPS** is another measure of speed for computer systems of all sizes.

## Clock Speed

Each CPU produces a series of electronic pulses at a predetermined rate, called the **clock speed**, which affects machine cycle time. The control unit executes instructions in accordance with the electronic cycle or pulses of the CPU ‘clock’. Each instruction takes at least the same amount of time as the interval between pulses. The shorter the interval between pulses, the faster each instruction can be executed

Clock speed is often measured in **megahertz** (MHz, millions of cycles per second) or **gigahertz** (GHz, billions of cycles per second). Unfortunately, the faster the clock speed of the CPU, the more heat the processor generates. This heat must be dissipated to avoid corrupting the data and instructions the computer is trying to process. Also, chips that run at higher temperatures need bigger heat sinks, fans and other components to eliminate the excess heat. This increases the size of the computing device whether it is a desktop computer, tablet computer or smartphone, which increases the cost of materials and makes the device heavier counter to what manufacturers and customer’s desire.

Chip designers and manufacturers are exploring various means to avoid heat problems in their new designs. ARM is a computer chip design company whose energy-efficient chip architecture is broadly used in smartphones and tablet computers. Its Cortex-A7 chip design is expected to lead to much cheaper smartphones with a battery life five times longer than in current devices. Its more powerful Cortex-A15 processor can be used for processing-intensive tasks such as navigation or video playback. Intel expects to begin producing computer processor chips based on a new 3D technology that it has been developing for over a decade. Traditionally, transistors, the basic elements of computer chips, are produced in flat 2D structures. The new 3D transistors will cut chip power consumption in half, making the chips ideal for use in the rapidly growing smartphone and tablet computer market.

Manufacturers are also seeking more effective sources of energy as portable devices grow increasingly power hungry. A number of companies are exploring the substitution of fuel cells for lithium ion batteries to provide additional, longer-lasting power. Fuel cells generate electricity by consuming fuel (often methanol), while traditional batteries store electricity and release it through a chemical reaction. A spent fuel cell is replenished in moments by simply refilling its reservoir or by replacing the spent fuel cartridge with a fresh one.

## Physical Characteristics of the CPU

Most CPUs are collections of digital circuits imprinted on silicon wafers or chips, each no bigger than the tip of a pencil eraser. To turn a digital circuit on or off within the CPU, electrical current must flow through a medium (usually silicon) from point A to point B. The speed the current travels between points can be increased by either reducing the distance between the points or reducing the resistance of the medium to the electrical current.

Reducing the distance between points has resulted in ever smaller chips, with the circuits packed closer together. Gordon Moore, who would cofound Intel (the largest maker of micro-processor chips) and become its chairman of the board, hypothesized that progress in chip manufacturing ought to make it possible to double the number of transistors (the microscopic on off switches) on a single chip every two years. The hypothesis became known as **Moore’s Law**, and this ‘rule of thumb’ has become a goal that chip manufacturers have met more or less

for more than four decades. Chip manufacturers have been able to improve productivity and performance by putting more transistors on the same size chip while reducing the amount of power required to perform tasks. Furthermore, because the chips are smaller, chip manufacturers can cut more chips from a single silicon wafer and thus reduce the cost per chip. As silicon-based components and computers perform better, they become cheaper to produce and therefore more plentiful, more powerful and more a part of our everyday lives. This process makes computing devices affordable for an increasing number of people around the world and makes it practical to pack tremendous computing power into the tiniest of devices.

### **Memory Characteristics and Functions**

Main memory is located physically close to the CPU, although not on the CPU chip itself. It provides the CPU with a working storage area for program instructions and data. The chief feature of memory is that it rapidly provides the data and instructions to the CPU.

### **Storage Capacity**

Like the CPU, memory devices contain thousands of circuits imprinted on a silicon chip. Each circuit is either conducting electrical current (on) or not conducting (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. It is estimated that all the words ever spoken represented in text form would equal about 5 Exabyte's of information. Table 3.1 lists units for measuring computer storage

Table 3.1

Name	Abbreviation	Number of Bytes
Byte	B	1
Kilobyte	KB	$2^{10}$ or approximately 1024 bytes
Megabyte	MB	$2^{20}$ or 1024 kilobytes (about 1 million)
Gigabyte	GB	$2^{30}$ or 1024 megabytes (about 1 billion)
Terabyte	TB	$2^{40}$ or 1024 gigabytes (about 1 trillion)
Petabyte	PB	$2^{50}$ or 1024 terabytes (about 1 quadrillion)
Exabyte	EB	$2^{60}$ or 1024 petabytes (about 1 quintillion)



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## Types of Memory

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 (as happens in a power surge, blackout 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 electrical current. Table 3.1 Computer Storage Units Name Abbreviation Number of Bytes Byte B 1 Kilobyte KB 210 or approximately 1024 bytes Megabyte MB 220 or 1024 kilobytes (about 1 million) Gigabyte GB 230 or 1024 megabytes (about 1 billion) Terabyte TB 240 or 1024 gigabytes (about 1 trillion) Petabyte PB 250 or 1024 terabytes (about 1 quadrillion) Exabyte EB 260 or 1024 petabytes (about 1 quintillion) random access memory (RAM)

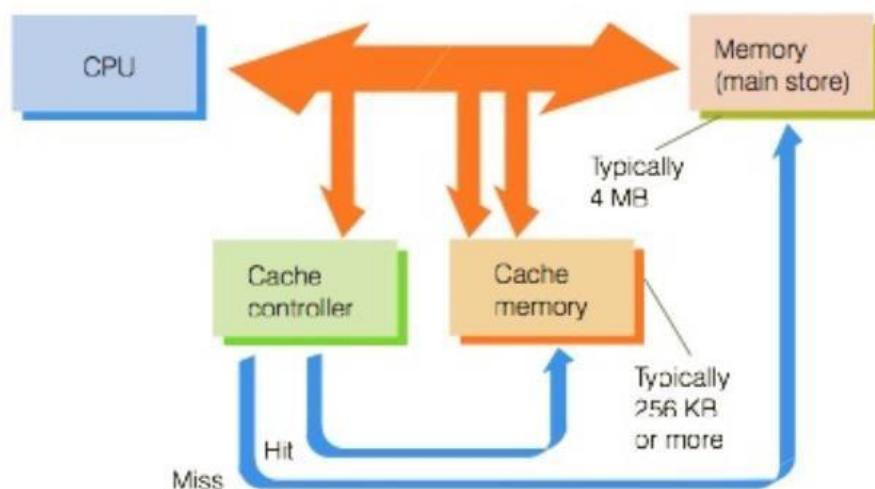
RAM comes in many varieties: static random access memory (SRAM) is byte-addressable storage used for high-speed registers and caches; dynamic random access memory (DRAM) is byte-addressable storage used for the main memory in a computer; and double data rate synchronous dynamic random access memory (DDR SDRAM) is an improved form of DRAM that effectively doubles the rate at which data can be moved in and out of main memory. Other forms of RAM memory include DDR2 SDRAM and DDR3 SDRAM.

**Read-only memory (ROM)**, another type of memory, is non-volatile, 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 many varieties: programmable read-only memory (PROM), which is used to hold data and instructions that can never be changed; erasable programmable read-only memory (EPROM), which is programmable ROM that can be erased and reused; and electrically erasable programmable read-only memory (EEPROM), which is user-modifiable read-only memory that can be erased and reprogrammed repeatedly through the application of higher than normal electrical voltage. Chip manufacturers are competing to develop a non-volatile memory chip that requires minimal power, offers extremely fast write speed and can store data accurately even after a large number of write-erase cycles. Such a chip could eliminate the need for RAM and simplify and Speed up memory processing. Phase change memory (PCM) is one potential approach to provide such a memory device. PCM employs a specialized glass-like material that can change its physical state, shifting between a low-resistance crystalline states to a high-resistance gaseous state by applying voltage to rearrange the atoms of the material. This technology is expected to perform 100 times faster than flash memory and should be available soon.

Although microprocessor speed has roughly doubled every 24 months over the past 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 (see Figure 3.3). 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 main memory. 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 and place the L2 cache directly on the CPU chip itself and provide high-speed support for a tertiary level 3 (L3) external cache

Figure 3.3 Cache Memory



Memory capacity contributes to the effectiveness of a computer. For example, complex processing problems, such as computer-assisted product design, require more memory than simpler tasks such as word processing. Also, because computer systems have different types of memory, they might need other programs to control how memory is accessed and used. In other cases, the computer system can be configured to maximize memory usage. Before purchasing additional memory, an organization should address all these considerations.

## Multiprocessing

Generally, **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 may have different clock speeds than the CPU. Each type of coprocessor performs a specific function.

For example, a maths coprocessor chip speeds up mathematical calculations, while a graphics coprocessor chip decreases the time it takes to manipulate graphics. A **multicore microprocessor** combines two or more independent processors into a single computer so that they share the workload and boost processing capacity. In addition, a dual-core processor enables people to perform multiple tasks simultaneously, such as playing a game and burning a CD.

AMD and Intel are battling for leadership in the multicore processor market- place, with both companies offering quad-core, six-core and eight-core CPU chips that can be used to build powerful desktop computers. AMD announced that its eight-core desktop processors based on its so-called Bulldozer architecture broke the world record for clock speed by running at 8.5 GHz.<sup>8</sup> You need to use multithreaded software designed to take full advantage of the computing power of multicore processors. Scientists at the Jet Propulsion Laboratory are planning to take advantage of the full capabilities of multicore processors to perform image analysis and other tasks on future space missions. When selecting a CPU, organizations must balance the benefits of processing speed with energy requirements and cost. CPUs with faster clock speeds and shorter machine cycle times require more energy to dissipate the heat generated by the CPU, and are bulkier and more expensive than slower ones

## Parallel Computing

**Parallel computing** is the simultaneous execution of the same task on multiple processors to obtain results faster. Systems with thousands of such processors are known as **massively parallel processing systems**, a form of multiprocessing 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, discs, 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 but under the direction of another processor that distributes the work to the other processors and collects their results. The dualcore processors mentioned earlier are a simple form of parallel computing.

The most frequent uses for parallel computing include modelling, simulation and analysing large amounts of data. Parallel computing is used in medicine to develop new imaging systems to complete ultrasound scans in less time with greater accuracy, enabling doctors to provide better diagnoses to patients, for example. Instead of building physical models of new products, engineers can create a virtual model of them and use parallel computing to test how the products work and then change design elements and materials as needed. Astrophysicists at the

University of Nottingham in the United Kingdom are using parallel computing to build a simulation of the early universe. The computer they are using, called Curie, is based in France and has more than 92 000 computer units and offers 2 petaflops of power – the equivalent of 2 million billion operations per second. Grid computing is the use of a collection of computers, often owned by multiple individuals or organizations, to work in a coordinated manner to solve a common problem.

**Grid computing** is a low-cost approach to parallel computing. 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, it 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. CERN is the European Organization for Nuclear Research and its main area of research is the study of the fundamental constituents of matter and the forces acting between them.<sup>11</sup> CERN uses grid computing with the processing power of over 300 000 high-end personal computers. This computing power is needed to process some 25 petabytes of data generated each year by the Large Hadron Collider (LHC) particle accelerator looking for evidence of new particles that can provide clues to the origins of our universe.

### 3.3 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 estimated amount of data that companies store digitally is growing so rapidly that by 2020 storage requirements will be 44 times what they were in 2009 (an average compounded growth rate of 42 per cent per year).<sup>13</sup> International Data Corporation (IDC) estimates that more than 1.8 zettabytes (10<sup>21</sup> bytes) of information was created and stored in 2011 alone.<sup>14</sup> The Indian government is undertaking a massive effort (estimated cost is more than €3 billion) to register its 1.2 billion residents in a universal citizen ID system. When complete, the result will be the world's largest database of biometric data including retina scans, fingerprints and multiple facial images of each individual. The database will have many applications including use at India's borders to recognize travellers and to identify people who should not be in controlled areas such as the hangar area of an airport. The system can also be used in crowd control to recognize the gender and age of a crowd of people and identify where security personnel might be most needed.<sup>15</sup> Advanced data storage technologies will be required to store the large quantity of data and enable users to gain quick access to the information. For most organizations, the best overall data storage solution is probably 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 no volatility, greater capacity and greater economy. On a cost- per-megabyte basis, secondary storage is considerably less expensive than primary memory (see Table 3.2).

The selection of **secondary storage** media and devices requires understanding their primary characteristics: access method, capacity and portability. An objective of a credit card company's information system might be to rapidly retrieve stored customer data to approve customer purchases. In this case, a fast access method is critical. In other cases, such as

equipping the Coca-Cola field sales force with pocket-sized personal computers, portability and storage capacity might be major considerations in selecting and using secondary storage media and devices. In addition to cost, capacity and portability, organizations must address security issues to allow only authorized people to access 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.

Table 3.2 Cost Comparison for Various Forms of Storage All forms of secondary storage cost considerably less per gigabyte of capacity than SDRAM, although they have slower access times. A data cartridge costs about €0.015 per gigabyte, while SDRAM can cost around €12 per gigabyte – 800 times more expensive.

Description	Cost	Storage Capacity GB)	Cost Per GB
1.6 TB 4 mm backup data tape cartridge	€30.17	1600	€0.02
1 TB desktop external hard drive	€68.71	1000	€0.07
25 GB rewritable Blu-ray disc	€2.17	25	€0.09
500 GB portable hard drive	€58.89	500	€0.11
72 GB DAT 72 data cartridge	€12.80	72	€0.18
50 4.7 GB DVD+R discs	€56.59	235	€0.24
4 GB flash drive	€7.51	4	€1.88
9.1 GB write-once, read-many optical disc	€55.84	9.1	€6.14
1 GB DDR2 SDRAM computer memory upgrade	€12.04	1	€12.04



**Principles Of Business Information Systems 3<sup>rd</sup> Edition, Ralph Stair, George Reynolds and Thomas Chesney Chapter 3 Page Number 75**

## Access Methods

Data and information access can be either sequential or direct. **Sequential access** means that data must be accessed in the order in which it is stored. For example, inventory data might be stored sequentially by part number, such as 100, 101, and 102 and so on. If you want to retrieve information on part number 125, you must read and discard all the data relating to parts 001 to

124. **Direct access** means that data can be retrieved directly without the need to pass by other data in sequence. With direct access, it is possible to go directly to and access the needed data – for example, part number 125 – without having to read through parts 001 to 124. For this reason, direct access is usually faster than sequential access. The devices used only to access secondary storage data sequentially are **called sequential access storage devices (SASDs)**; those used for direct access are called **direct access storage devices (DASDs)**.

## Secondary Storage Devices

Secondary data storage is not directly accessible by the CPU. Instead, computers usually use input/output channels to access secondary storage and transfer the desired data using intermediate areas in primary storage. The most common forms of secondary storage devices are magnetic, optical and solid state.

### Magnetic Secondary Storage Devices

Magnetic storage uses tape or disc devices covered with a thin magnetic coating that enables data to be stored as magnetic particles. **Magnetic tape** is a type of sequential secondary storage medium, which is now used primarily for storing back-ups of critical organizational data in the event of a disaster. Examples of tape storage devices include cassettes and cartridges measuring a few millimetres 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. Australia Wide IT offers clients a robotic tape backup system, where a robotic arm automatically loads tapes into the tape drive to be read to use for storage. A **magnetic disc** is a direct access storage device that represents bits using 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 ideal for companies that need to respond quickly to customer requests, such as airlines and credit card firms. For example, if a manager needs information on the credit history of a customer or the seat availability on a particular flight, the information can be obtained in seconds if the data is stored on a direct access storage device. Magnetic disc storage varies widely in capacity and portability. Hard discs, though more costly and less portable, are more popular because of their greater storage capacity and quicker access time. IBM is building a data repository nearly 10 times larger than anything in existence. This huge storehouse consists of 200 000 conventional hard discs working together to provide a storage capacity of 120 petabytes large enough to hold 60 copies of the 150 billion pages needed to back up the web.

An unnamed client will use the storage device with a supercomputer to perform detailed simulations of real-world events such as weather forecasts, seismic processing for the petroleum industry, or molecular studies of genomes or proteins. 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 magnetic disc storage device – the disc drives, the fans and other input/ output devices – can fail. Thus organizations now require that their data storage devices be fault tolerant; that is, they can continue with little or no loss of performance if one or more key components fail.

A **redundant array of independent/inexpensive discs (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 is split and stored on different physical disc drives using a technique called striping to evenly distribute the data. RAID technology has been applied to storage systems to improve system performance and reliability. RAID can be implemented in several ways. In the simplest form, RAID sub- systems duplicate data on drives. This process, called **disc 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 only duplicate part of the data, allowing storage managers to minimize the amount of extra disc space they must purchase to protect data. Optional second drives for personal computer users who need to mirror critical data are available for less than €75.

Advanced Audio Rentals produced the soundtrack for the movie Avatar. They used 3 GB and 6 GB RAID storage devices to store the film's soundtracks and to ensure smooth, efficient data transfers to guarantee high, consistent performance. Virtual tape is a storage technology for less frequently needed data so that it appears to be stored entirely on tape cartridges, although some parts might actually be located on faster hard discs.

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. Baldor Electric Company designs, manufactures and markets industrial electric motors, transmission products, drives and generators. The firm implemented a virtual tape system to replace its tape-based storage system consisting of thousands of magnetic tapes. Baldor uses the new virtual tape system to back up its five production databases twice a day and stores the data for 14 days. The time to create backups has been cut by 40 per cent, and the new system takes up about 100 square feet less of data-centre floor space.

### Optical Secondary Storage Devices

An **optical storage device** uses special lasers to read and write data. The lasers record data by physically burning pits in the disc. Data is directly accessed from the disc by an optical disc device, which operates much like a compact disc player. This optical disc device uses a low power laser that measures the difference in reflected light caused by a pit (or lack thereof) on the disc. A common optical storage device is the **compact disc read-only memory (CDROM)** with a storage capacity of 740 MB of data. After data is recorded on a CD-ROM, it cannot be modified – the disc is ‘read-only’. A CD burner, the informal name for a CD recorder, is a device that can record data to a compact disc. CD-recordable (CD-R) and CD-rewritable (CD-RW) are the two most common types of drives that can write CDs, either once (in the case of CD-R) or repeatedly (in the case of CD-RW). CD-RW technology allows PC users to backup data on CDs.

A **digital video disc (DVD)** looks like a CD but can store about 135 minutes of digital video or several gigabytes of data. Software, video games and movies are often stored and distributed on DVDs. At a data transfer rate of 1.352 MB per second, the access speed of a DVD drive is faster than that of the typical CD-ROM drive.

DVDs have replaced recordable and rewritable CD discs (CD-R and CD-RW) as the preferred format for sharing movies and photos. Whereas a CD can hold about 740 MB of data, a single-sided DVD can hold 4.7 GB, with double-sided DVDs having a capacity of 9.4 GB. Several types of recorders and discs are currently in use. Recordings can be made on record-once discs (DVD-R and DVD+R) or on rewritable discs (DVD-RW, DVD+RW and DVD-RAM). Not all types of rewritable DVDs are compatible with other types. The US Naval Air Warfare Centre Weapons Division at China Lake, California, is testing various brands of archival-quality DVDs for longevity and reliability. It has a need to store large volumes of data for generations. The Blu-ray high-definition video disc format, based on blue laser technology, stores at least

three times as much data as a DVD. The primary use for this new format is in home entertainment equipment to store high-definition video, although this format can also store computer data. A dualayer Blu-ray disc can store 50 GB of data. The Holographic Versatile Disc (HVD) is an advanced optical disc technology still in the development stage that will store more data than even the Blu-ray optical disc system. HVD is the same size and shape as a regular DVD but can hold 1 terabyte (or more) of information. One HVD approach records data through the depth of the storage media in three dimensions by splitting a laser beam in two – the signal beam carries the data, and the reference beam positions where the data is written and read. HVD will make it possible to view 3D visuals on home TV's

### **Solid State Secondary Storage Devices**

Solid state storage devices (SSDs) store data in memory chips rather than magnetic or optical media. These memory chips require less power and provide faster data access than magnetic data storage devices. While hard drives can provide 250 to 350 IOPS (input/output operations per second or read/write operations per second), advanced SSDs can perform at the rate of half a million IOPS.<sup>23</sup> In addition, SSDs have few moving parts, so they are less fragile than hard disc drives. All these factors make the SSD a preferred choice for portable computers. Two current disadvantages of SSD are their high cost per GB of data storage (roughly a 5:1 disadvantage compared to hard discs) and lower capacity compared to current hard drives. However, SSD is a rapidly developing technology, and future improvements will lower its cost and increase its capacity. 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 30 grams and can provide storage of 1 to 64 GB. For example, SanDisk manufactures its Ultra Backup USB Flash Drive with a storage capacity of 128 GB for less than €50, which includes password protection and hardware encryption.<sup>24</sup> Qualcomm is a US global communications company that designs, manufactures and markets wireless communications products and services. Its information systems organization used SSD to reduce the time required to boot up its employees' notebook computers, speed up over-all system performance and reduce downtime caused by hard disc failures.<sup>25</sup> The Valliant Group and its over 12 000 employees provide heating, ventilation and air conditioning (HVAC) Products and systems world wide

Vaillant converted from the use of traditional hard drive storage systems to SSD to improve the performance of its key business systems. Critical business interactive transactions as well as batch processing jobs were dramatically improved, taking 10 per cent or less of the time required using the old technology.

### **Enterprise Storage Options**

Businesses need to store large amounts of data created throughout an organization. Such large secondary storage is called enterprise storage and comes in three forms: attached storage, network-attached storage (NAS) and storage area networks (SANs).

#### **Attached Storage**

Attached storage methods include the tape, hard discs and optical devices discussed previously, which are connected directly to a single computer. Attached storage methods, though simple and cost effective for single users and small groups, do not allow systems to share storage, and they make it difficult to backup data. Because of the limitations of attached storage, firms are turning to network-attached storage (NAS) and storage area networks (SANs). These alternatives enable an organization to share data storage resources among a much larger number of computers and users, resulting in improved storage efficiency and greater cost effectiveness.

In addition, they simplify data backup and reduce the risk of downtime. Nearly one-third of system downtime is a direct result of data storage failures, so eliminating storage problems as a cause of downtime is a major advantage.

### Network-Attached Storage

**Network-attached storage (NAS)** is hard disc storage that is set up with its own network address rather than being attached to a computer. Figure 3.4 shows a NAS storage device. NAS includes software to manage storage access and file management, relieving the users' computers of those tasks. The result is that both application software and files can be served faster because they are not competing for the same processor resources. Computer users can share and access the same information, even if they are using different types of computers. Common applications for NAS include consolidated storage, Internet and e-commerce applications, and digital media

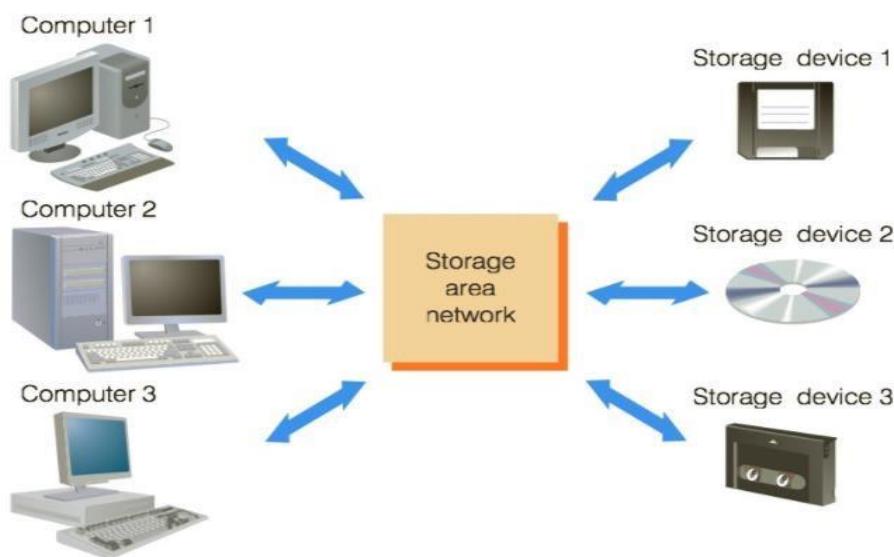
Figure 3.4



One of the most popular Swiss skiing destinations is the Davos Klosters resort with more than 300 kilometres of ski slopes, 5 mountain railways, and 22 hotels with 1700 beds. Resort guests expect hassle-free hotel check-ins, an always available online ticket shop, reliable information display boards, and efficient and on-time mountain railways. It takes powerful information systems to meet these expectations. The resort decided to implement NAS storage devices to make sure its information systems are reliable and provide fast access to data, dependable backups of operational data and easy expansion of storage capacity.

## Storage Area Network

A **storage area network (SAN)** is a special-purpose, high-speed network that provides direct connections between data storage devices and computers across the enterprise (see Figure 3.5). A SAN also integrates different types of storage subsystems, such as multiple RAID storage devices and magnetic tape backup systems, into a single storage system. Use of a SAN offloads the network traffic associated with storage onto a separate network. The data can then be copied to a remote location, making it easier for companies to create backups and implement disaster recovery policies. Using a SAN, an organization can centralize the people, policies, procedures and practices for managing storage, and a data storage manager can apply the data consistently across an enterprise. This centralization eliminates inconsistent treatment of data by different system administrators and users, providing efficient and cost-effective data storage practices. Northgate Arinso is a global human resources services provider that equips its clients with HR solutions using advanced technology, outsourcing and consulting. The firm's systems support multicounty payroll, training, recruiting and talent management.<sup>28</sup> NorthgateArinso implemented two integrated data centres, one in London and one in Brussels, with an information systems architecture based on standard servers from a single supplier and data storage provided by SAN hardware and software. The SAN makes the total data stored available to all users. The company's prior collection of separate servers, applications and databases is now integrated into an infrastructure that is easier to manage and can more flexibly meet the challenges of a highly fluctuating workload. Figure 3.5



**Principles of Business Information Systems 3<sup>rd</sup> Edition, Ralph Stair, George Reynolds and Thomas Chesney Chapter 3 Page 80**

A fundamental difference between NAS and SAN is that NAS uses file input/output, which defines data as complete containers of information, while SAN deals with block input/output, which is based on subsets of data smaller than a file. SAN manufacturers include EMC, Hitachi Data Systems Corporation, Xiotech and IBM. As organizations set up large-scale SANs, they

use more computers and network connections than in a NAS environment and, consequently, the network becomes difficult to manage.

In response, software tools designed to automate storage using previously defined policies are finding a place in the enterprise. Known as **policy-based storage management**, the software products from industry leaders such as Veritas Software Corporation, Legato Systems, EMC and IBM automatically allocate storage space to users, balance the loads on servers and discs, and reroute network traffic when systems go down – all based on policies set up by system administrators. The trend in secondary storage is towards higher capacity, increased portability and automated storage management. Organizations should select a type of storage based on their needs and resources. In general, storing large amounts of data and information and providing users with quick access make an organization more efficient.

### Storage as a Service

**Storage as a service** is a data storage model in which a data storage service provider rents space to people and organizations. Users access their rented data storage via the Internet. Such a service enables the users to store and backup their data without requiring a major investment to create and maintain their own data storage infrastructure. Businesses can also choose pay-per-use services where they rent space on massive storage devices housed either at a service provider (such as Hewlett-Packard or IBM) or on the customers' premises, paying only for the amount of storage they use. This approach is sensible for organizations with wildly fluctuating storage needs, such as those involved in the testing of new drugs or in developing software.

Amazon, Google, Microsoft, Stortech based in South Africa, HP and IBM are a few of the storage-as-a-service providers used by organizations. Amazon.com's Simple Storage Service (S3) provides storage

As a service with a monthly cost of roughly €0.10 per GB stored and €0.075 per GB of data transferred into the Amazon.com storage. Box.net, Carbonite, Sugar Sync, Symantec and Mozy are a few of the storage-as-a-service providers used by individuals. This set of providers all charge less than €6 per month for up to 5 GB of storage. A Mozy customer who had his laptop stolen was able to provide police with photos of the thief because Mozy continued to backup data after the laptop was stolen, including the thief's photos and documents. The customer accessed the photos from his online storage site, and police captured the thief and returned the laptop.

### 3.4 Input and Output Devices: The Gateway to Computer Systems

Your first experience with computers is usually through input and output devices. These 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. As with other computer system components, an organization should keep its business goals in mind when selecting input and output devices. For example, many restaurant chains use handheld input devices or computerized terminals that let food servers enter orders efficiently and accurately. These systems have also cut costs by helping to track inventory and market to customers.

## Characteristics and Functionality

In general, businesses want input devices that let them rapidly enter data into a computer system, and they want output devices that let them produce timely results. When selecting input and output devices, businesses also need to consider the form of the output they want, the nature of the data required to generate this output, and the speed and accuracy they need for both. Some organizations have very specific needs for output and input, requiring devices that perform specific functions. The more specialized the application, the more specialized the associated system input and output devices. The speed and functions of input and output devices should be balanced with their cost, control and complexity. More specialized devices might make it easier to enter data or output information, but they are generally more costly, less flexible and more susceptible to malfunction.

### The Nature of Data

Getting data into the computer – input – often requires transferring human-readable data, such as a sales order, into the computer system. ‘Human-readable’ means data that people can read and understand. A sheet of paper containing inventory adjustments is an example of human readable data. In contrast, machine-readable data can be read by computer devices (such as the universal barcode on many grocery and retail items) and is typically stored as bits or bytes. Inventory changes stored on a disc is an example of machine-readable data. Some data can be read by people and machines, such as magnetic ink on bank cheques. 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

Getting data into the computer system is a two-stage process. First, the human-readable data is converted into a machine-readable form through **data entry**. The second stage involves transferring the machine-readable data into the system. This is data input. Today, many companies are using online data entry and input: they communicate and transfer data to computer devices directly connected to the computer system. Online data entry and input place data into the computer system in a matter of seconds. Organizations in many industries require the instantaneous updating offered by this approach. For example, when ticket agents enter a request for concert tickets, they can use online data entry and input to record the request as soon as it is made. Ticket agents at other terminals can then access this data to make a seating check before they process another request

### Source Data Automation

Regardless of how data gets into the computer, it should be captured and edited at its source. **Source data automation** involves capturing and editing data where it is originally created and in a form that can be directly entered into a computer, thus ensuring accuracy and timeliness. For example, using source data automation, salespeople enter sales orders into the computer at the time and place they take the orders. Any errors can be detected and corrected immediately. If an item is temporarily out of stock, the salesperson can discuss options with the customer. Prior to source data automation, orders were written on paper and entered into the computer later (usually by a clerk, not by the person who took the order). Often the handwritten information wasn’t legible or, worse still, got lost. If problems occurred during data entry, the clerk had to contact the salesperson or the customer to ‘recapture’ the data needed for order entry, leading to further delays and customer dissatisfaction.

## Input Devices

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.

### Personal Computer Input Devices

A keyboard and a computer mouse are the most common devices used for entry and input of data such as characters, text and basic commands. Some companies are developing keyboards that are more comfortable, more easily adjusted and faster to use than standard keyboards. These ergonomic keyboards, such as the split keyboard offered by Microsoft and others, are designed to avoid wrist and hand injuries caused by hours of typing. Other keyboards include touchpads that let you enter sketches on the touchpad while still using keys to enter text. Other innovations are wireless mice and keyboards, which keep a physical desktop free from clutter. You use a computer mouse to point to and click symbols, icons, menus and commands on the screen. The computer makes a number of actions in response, such as placing data into the computer system.

### Speech-Recognition Technology

Using **speech-recognition technology**, a computer equipped with a source of speech input, such as a microphone, can interpret human speech as an alternative means of providing data or instructions to the computer. The most basic systems require you to train the system to recognize your speech patterns or are limited to a small vocabulary of words. More advanced systems can recognize continuous speech without requiring you to break your speech into discrete words. Interactive voice response (IVR) systems allow a computer to recognize both voice and keypad inputs. Companies that must constantly interact with customers are eager to reduce their customer support costs while improving the quality of their service. Time Warner Cable implemented a speech-recognition application as part of its customer call centre. Subscribers who call customer service can speak commands to begin simple processes such as ‘pay my bill’ or ‘add Show- Time’. The voice recognition system saves time and money even though most people would prefer to speak to a live person. ‘We have roughly 13 million customers, and a few seconds or minutes here or there for each customer can really add up to longer hold times and higher staffing costs – which makes cable rates climb’, says Time Warner spokesman Matthew Tremblay

### Digital Cameras

**Digital cameras** record and store images or video in digital form, so when you take pictures, the images are electronically stored in the camera. You can download the images to a computer either directly or by using a flash memory card. After you store the images on the computer’s hard disc, you can then edit and print them, send them to another location or paste them into another application. This digital format saves time and money by eliminating the need to process film in order to share photos. For example, you can download a photo of your project team captured by a digital camera and then post it on a website or paste it into a project status report. Digital cameras have eclipsed film cameras used by professional photographers for photo quality and features such as zoom, flash, exposure controls, special effects and even video-capture capabilities. With the right software, you can add sound and handwriting to the photo. Many computers and smart- phones come equipped with a digital camera to enable their

users to place video calls and take pictures and videos. Canon, Casio, Nikon, Olympus, Panasonic, Pentax, Sony and other camera manufacturers offer full-featured, high-resolution digital camera models at prices ranging from €190 to €2600. Some manufacturers offer pocket-sized camcorders for less than €110. The police department in Wallis, Mississippi, consists of only five officers but is one of the first departments in the USA to use tiny digital cameras that clip onto the front pocket of the officers' uniforms. The cameras are the size of a pack of chewing gum and come with a memory card capable of holding hours of evidence. The cameras record each police stop in its entirety and provide evidence that supports prosecution of suspects.

### Scanning Devices

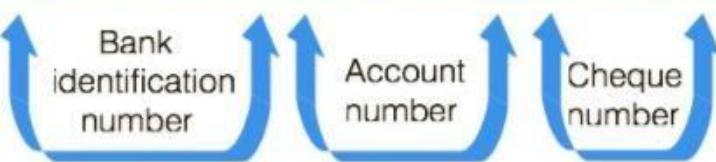
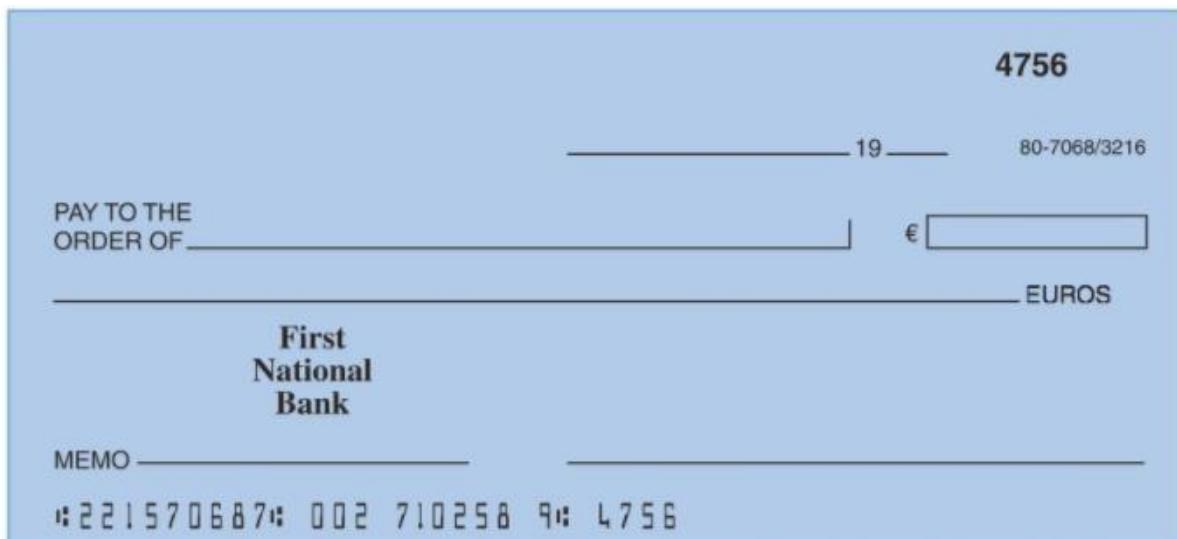
Scanning devices capture image and character data. A page scanner is like a photocopier. You either insert a page into the scanner or place it face down on the glass plate of the scanner and then scan it. With a handheld scanner, you manually move or roll the scanning device over the image you want to scan. Both page and handheld scanners can convert monochrome or colour pictures, forms, text and other images into machine-readable digits. Considering that US enterprises generate an estimated 1 billion pieces of paper daily, many companies are looking to scanning devices to help them manage their documents and reduce the high cost of using and processing paper. Silicon Valley Bank (SVB) Financial Group is headquartered in Santa Clara, California, and is surrounded by hundreds of high-tech companies and start-up ventures in the life science, clean technology, venture capital, private equity and premium wine markets.<sup>33</sup> SVB used to store loan and deposit documents for some 4000 clients in paper files at its headquarters. The firm received more than 75 requests per day from branches for copies of documents, with each request taking about 15 minutes to process. SVB implemented document-scanning hardware and software that can create a digital, online copy of all documents. Now users can immediately access the documents online, leading to improvements in customer service and reductions in administrative costs.

### Optical Data Readers

You can also use a special scanning device called an optical data reader to scan document. The two categories of optical data readers are for optical mark recognition (OMR) and optical character recognition (OCR). You use OMR readers for grading tests and other purposes such as forms. With this technology, you use pencils to fill in bubbles or check boxes on OMR paper, which is also called a 'mark sense form'. OMR systems are used in standardized tests, including the USA's SAT and GMAT tests, and on Lotto tickets in the UK. 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 being entered, this data can be shared, modified and distributed over computer networks to hundreds or thousands of people.

### Magnetic Ink Character Recognition (MICR) Devices

In the 1950s, the banking industry became swamped with paper cheques, loan applications, bank statements and so on. The result was the development of magnetic ink character recognition (MICR), a system for reading banking data quickly. With MICR, data is placed on the bottom of a cheque or other form using a special magnetic ink. Using a special character set, data printed with this ink is readable by people and computers (see Figure 3.6).



Activate W  
ith your card

## Magnetic Strip Cards

A **magnetic strip card** stores a limited amount of data by modifying the magnetism of tiny iron-based particles contained in a band on the card. The magnetic strip is read by physically swiping the card at a terminal. For this reason, such cards are called a contact card. Magnetic strip cards are commonly used in credit and debit cards, transportation tickets and ID cards.

## Chip-and-PIN Cards

Most European countries as well as many countries in Asia and South America are converting to the chip-and-PIN (personal identification number) card, which uses ‘smart card’ technology.<sup>35</sup> These cards are also known as EMV-enabled cards because they are named after their developers Europay, MasterCard and Visa.<sup>36</sup> This technology employs a computer chip that communicates with a card reader using radio frequencies, which means the cards do not need to be swiped at a terminal. **Chip-and-PIN cards** require different terminals from those used for magnetic stripe cards. For security, the card holder is also required to enter a PIN at the point of sale, making such cards more effective at preventing fraud. Although credit card fraud is a problem, credit card issuers cannot force merchants to invest in the new terminals required for chip-and-PIN cards. As a result, deployment of this technology is lagging.

## Contactless Cards

A **contactless card** has an embedded chip that only needs to be held close to a terminal to transfer its data; no PIN needs to be entered. MasterCard is testing the use of contactless-based payments aboard flights of West- Jet, a Canadian airline. One problem with the current method of payment using regular credit cards is that these transactions are conducted in an offline mode with no credit check authorization possible. With contactless cards, it will eventually be possible to support online credit card authorization, thus reducing the potential for fraud. This fraud protection will open the door to expanding in-flight sales beyond drinks and refreshments to the sale of wine and apparel that is delivered to the passengers’ homes when they land.

## Point-of-Sale Devices

**Point-of-sale (POS) devices** are terminals used to capture data for data entry. They are frequently used in retail operations to enter sales information

Into the computer system. The POS device then computes the total charges, including any tax. In medical settings, POS devices are often used for remote monitoring in hospitals, clinics, laboratories, doctors' offices and patients' homes. With network- enabled POS equipment, medical professionals can instantly get an update on the patient's condition from anywhere at any time via a network or the Internet. POS devices use various types of input and output devices, such as keyboards, barcode readers, scanning devices, printers and screens. Much of the money that businesses spend on computer technology involves POS devices. La Paz is an upscale Mexican restaurant in Atlanta, Georgia. Its POS was outdated, and workers needed hours each night to close off and balance the books. The restaurant replaced its POS with a new system that provides useful payroll and management reporting features such as tracking tips and sales. Workers also like the feature that lets them close the books rapidly and accurately.<sup>38</sup> Special input devices can be attached to smartphones and computers to accept payments from credit and debit cards for goods and services. Intuit Go Payment and Square can provide a small credit card scanner that plugs into your smartphone.

## Automated Teller Machine (ATM) Devices

Another type of special-purpose input/output device, the automated teller machine (ATM), is a terminal that bank customers use to perform transactions with their bank accounts. Companies use various ATM devices, sometimes called kiosks, to support their business processes. Some can dispense tickets, such as for airlines, concerts and football games. Some colleges use them to produce transcripts.

## 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 handwriting on the screen into text. The Tablet PC from Microsoft and its hardware partners can transform handwriting into typed text and store the 'digital ink' in the same way in which person writes it. People can use a pen to write and send email, add comments to Word documents, mark up PowerPoint presentations and even hand-draw charts in a document. The data can then be moved, highlighted, searched and converted into text. Pen input is especially attractive if you 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. Audi AG installed interactive white boards at its five technical training locations in Germany. PowerPoint presentations can be projected onto the screen, and trainers can draw over the image and highlight features by circling or underlining. Consequently, static presentations have become more interactive.

## Touch-Sensitive 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-sensitive screens can remove the need for a keyboard, which conserves space and increases portability. Touchscreens are frequently used at petrol stations to allow customers to select grades of petrol and request a receipt; on photocopy machines for

selecting options; at fast-food restaurants for entering customer choices; at information centres for finding facts about local eating and drinking establishments; and at amusement parks to provide directions to patrons. They are also used in kiosks at airports and department stores. Touch-sensitive screens are also being considered for gathering votes in elections in some countries. As touchscreens get smaller, the user's fingers begin to block the information on the display. Nanotech technology is being explored as a means of overcoming this problem. Using this technology, users control the touchscreen 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 touchscreen. Such displays are useful for mobile audio players the size of a coin.

## Barcode Scanners

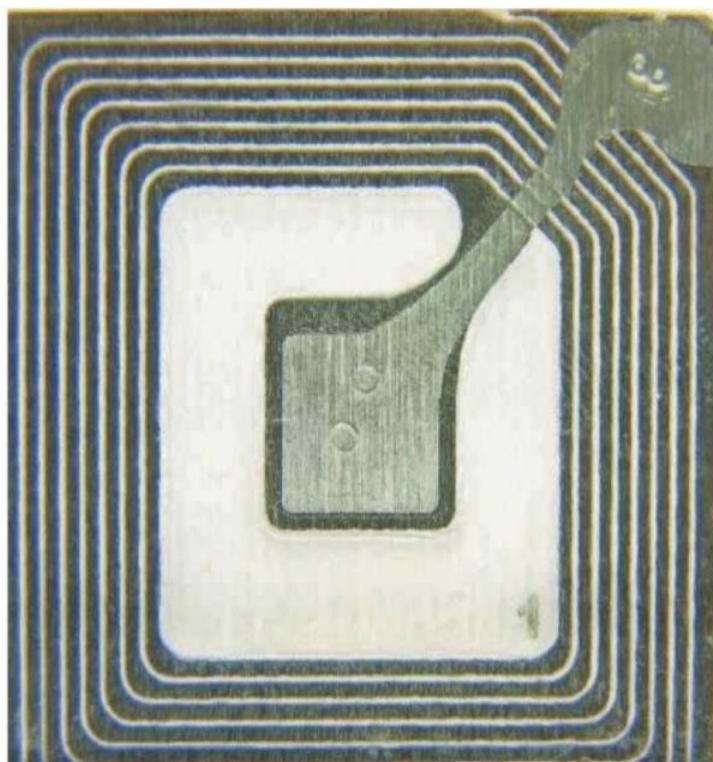
A barcode scanner employs a laser scanner to read a barcoded label and pass the data to a computer. The barcode reader may be stationary or hand-held to support a wide variety of uses. This form of input is used widely in store checkouts and warehouse inventory control. Barcodes are also used in hospitals, where a nurse first scans a patient's wristband and then a barcode on the medication about to be administered to prevent medication errors. Mobil, an international mobile payments and marketing company, has developed an iPhone application that it is testing with fans of the Jacksonville Jaguars football team. The fans use the application to scan a barcode at their seat and a menu of food and beverage items is displayed on their phone. Fans then select and pay for the items they want using the iPhone application, and the order is then delivered to their seat

## Radio Frequency Identification

**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 via a mobile device called a tag (see Figure 3.7), 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 manufactured, retail price, colour or date of purchase. The Canadian government is supporting a move to require the sheep industry to use RFID chips to enable a 'farm to fork' traceability system. Figure 3.7

 Read

**Principles Of Business Information Systems 3<sup>rd</sup> Edition, Ralph Stair,George Reynolds and Thomas Chesney Chapter 3 Page Number 87**



## 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 Monitors

The display monitor is a device used to display the output from the computer. Because early monitors used a cathode-ray tube to display images, they were sometimes called CRTs. The cathode-ray tubes generate one or more electron beams. As the beams strike a phosphorescent compound (phosphor) coated on the inside of the screen, a dot on the screen called a pixel lights up. A pixel is a dot of colour on a photo image or a point of light on a display screen. It appears in one of two modes: on or off. The electron beam sweeps across the screen so that as the phosphor starts to fade, it is struck and lights up again. A plasma display uses thousands of smart cells (pixels) consisting of electrodes and neon and xenon gases that are electrically

turned into plasma (electrically charged atoms and negatively charged particles) to emit light. The **plasma display** lights up the pixels to form an image based on the information in the video signal. Each pixel is made up of three types of light red, green and blue with the plasma display varying the intensities of the lights to produce a full range of colours. Plasma displays can produce high resolution and accurate representation of colours to create a high-quality image. **LCD displays** are flat displays that use liquid crystals – organic, oil-like material placed between two polarizers – to form characters and graphic images on a backlit screen. These displays are easier on your eyes than CRTs because they are flicker-free, brighter and do not emit the type of radiation that concerns some CRT users. In addition, LCD monitors take up less space and use less than half of the electricity required to operate a comparably sized CRT monitor. Thin-film transistor (TFT) LCDs are a type of liquid crystal display that assigns a transistor to control each pixel, resulting in higher resolution and quicker response to changes on the screen. TFT LCD monitors have displaced the older CRT technology and are available in sizes from 12 to 30 inches. Many companies now provide multimonitor solutions that enable users to see a wealth of related information at a single glance.

**Organic light-emitting diode (OLED)** uses a layer of organic material sandwiched between two conductors, which in turn are sandwiched between a glass top plate and a glass bottom plate. When electric current is applied to the two conductors, a bright, electroluminescent light is produced directly from the organic material. OLEDs can provide sharper and brighter colours than LCDs and CRTs, and, because they do not require a backlight, the displays can be half as thick as LCDs and are flexible. Another big advantage is that OLEDs do not break when dropped. OLED technology can also create 3D video displays by taking a traditional LCD monitor and then adding layers of transparent OLED films to create the perception of depth without the need for 3D glasses or laser optics. The iZ3D monitor is capable of displaying in both 2D and 3D modes. The manufacturer offered a 22-inch version of the monitor at a price of €226.53 to coincide with the debut of Avatar, a film directed by James Cameron. Because most users leave their computers on for hours at a time, power usage is an important factor when deciding which type of monitor to purchase. Although the power usage varies from model to model, LCD monitors generally consume between 35 and 50 per cent less power than plasma screens.<sup>43</sup> OLED monitors use even less power than LCD monitors. 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. An aspect ratio of 4 to 3 is common. For widescreen LCD monitors used for viewing DVD movies in widescreen format, playing games or displaying multiple screens side by-side, an aspect ratio of 16 to 10 or 15 to 9 is preferred. The screen size is measured diagonally from the outside of the screen casing for CRT monitors and from the inside of the screen casing for LCD displays. With today's wide selection of monitors, price and overall quality can vary tremendously. The quality of a screen image is measured by the number of horizontal and vertical pixels used to create it. Resolution is the total number of pixels contained in the display; the more pixels, the clearer and sharper the image. 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. Over the years, display monitor sizes have increased and display standards and resolutions have changed, as shown in Table 3.3.

Table 3.3 Common Display Monitor Standards and Associated Resolutions


 Read

**Principles Of Business Information Systems 3<sup>rd</sup> Edition, Ralph Stair,George Reynolds and Thomas Chesney Chapter 3 Page Number 89**

Standard	Resolution (number of horizontal pixels × vertical pixels)
WSXGA (Wide SGXA plus)	1680 × 1050
UXGA (Ultra XGA)	1600 × 1200
WUXGA (Wide Ultra XGA)	1920 × 1200
QXGA (Quad XGA)	2048 × 1536

Another way to measure image quality is the distance between one pixel on the screen and the next nearest pixel, which is known as dot pitch. The common range of dot pitch is from 0.25 mm to 0.31 mm. The smaller the dot pitch, the better the picture. A dot pitch of 0.28 mm or smaller is considered good. Greater pixel densities and smaller dot pitches yield sharper images of higher resolution. The characteristics of screen colour depend on the quality of the monitor, the amount of RAM in the computer system and the monitor's graphics adapter card.

Digital Video Interface (DVI) is a video interface standard designed to maximize the visual quality of digital display devices such as flat-panel LCD computer displays. Companies are competing on the innovation frontier to create thinner display devices for computers, mobile phones and other mobile devices. In its effort to gain an edge, LG Phillips has developed an extremely thin display that is only 0.15 mm thick, or roughly as thick as a human hair. The display is also so flexible that it can be bent or rolled without damage. Nokia has demonstrated a flexible portable computer that you can actually twist and bend to change a music track or adjust the volume.<sup>44</sup> Such screens open possibilities for manufacturers to make mobile phones and laptops with significantly larger displays but without increasing the size of the device itself, as the screen could be rolled up or folded and tucked away into a pocket. The Microsoft Surface platform is designed to help people learn, collaborate and make decisions. The Surface can be used as a tablet, mounted on the wall, or embedded in furniture or fixtures. Its large 40-inch screen is an effective way to share photos, maps, modelling and simulations. The Surface allows a single user or multiple users to manipulate digital content by motion of their hands. The Bank of Canada is Canada's largest bank and uses the Surface as a component of its Discovery Zone, a unique and digitally interactive approach to engage customers to learn more about the bank, its services and its employees. Arbie, an animated character, guides people through various applications with the results displayed on the Surface screen.

These applications help people learn which bank services can help them meet their financial needs, demonstrates the value of a Tax Free Savings Account compared with a standard savings

account, and provides photos and brief profiles of the local branch staff. The software includes an Instant Win application and puzzles for children to do while their parents do their banking.

## 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 cheque forms and invoice forms. Newer printers allow businesses to create customized printed output using full colour for each customer from 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 the printer is typically measured by the number of pages printed per minute (ppm). Like 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 to 900 pages for inkjet printers. Costing less than €400, laser printers are generally faster than inkjet printers and can handle more volume: 25 to 60 ppm for black and white and 6 to 25 ppm for colour. Inkjet printers that can print 12 to 40 ppm for black and white and 5 to 20 ppm for colour are available for less than €150. For colour printing, inkjet printers print vivid hues with an initial cost much less than colour laser printers and can produce high-quality banners, graphics, greeting cards, letters, text and photo prints. A number of manufacturers offer multi-function printers that can copy, print (in colour 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.

The typical price of multifunction printers ranges from €75 to €400, 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 standalone fax plus a standalone 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. 3D printers can be used to turn 3D computer models into 3D objects. One form of 3D printer uses an inkjet printing system to print an adhesive in the shape of a cross-section of the model. Next, a fine powder is sprayed onto the adhesive to form one layer of the object.

This process is repeated thousands of times until the object is completed. 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 new printers from Hewlett-Packard and others allow printing without requiring the printer to be connected to a computer. A USB storage device such as a thumb drive can be inserted into a slot in the printer, and the user can specify what is to be printed without entering commands to the computer.<sup>46</sup> Other mobile print solutions enable users to wirelessly send documents, email messages and attachments, presentations and even boarding passes from any smartphone, tablet computer or laptop to any mobile printer in the world. For example, mobile users who use the Printer On service only need to access a directory of Printer On printers and locations and then send an email with attachment to be printed to the email address of the printer.

American Airlines Admiral Club, Delta Sky Club, Embassy Suites and Double Tree by Hilton have installed Printer On printers at many of their locations.<sup>47</sup> 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

### Digital Audio Players

A **digital audio player** is a device that can store, organize and play digital music files. **MP3** (MPEG-1 Audio Layer-3) is a popular format for compressing a sound sequence into a very small file, while preserving the original level of sound quality when it is played. By compressing the sound file, it requires less time to download the file and less storage space on a hard drive.

You can use many different music devices smaller than a pack of cards to download music from the Internet and other sources. These devices have no moving parts and can store hours of music. Apple expanded into the digital music market with an MP3 player (the iPod) and the iTunes Music Store, which allows you to find music online, preview it and download it in a way that is safe, legal and affordable. Other MP3 manufacturers include Dell, Sony, Samsung, Iomega, Creative and Motorola, whose Roker product was the first iTunes- compatible phone.

The Apple iPod Touch, with a 3.5-inch widescreen, is a music player that also plays movies and TV shows displays photos and connects to the internet and connects to the internet. You can, therefore, use it to view YouTube videos, buy music online, check emails and more. The display automatically adjusts the view when it is rotated from portrait to landscape. An ambient light sensor adjusts brightness to match the current lighting conditions.

### E-book Readers

The digital media equivalent of a conventional printed book is called an e-book (short for electronic book). The Project Gutenberg Online Book Catalog lists over 36 000 free e-books and a total of over 100 000 e-books available. E-books can be downloaded from Project Gutenberg ([www.gutenberg.org](http://www.gutenberg.org)) or many other sites onto personal computers or dedicated hardware devices known as e-book readers. The devices themselves cost from around €70 to €170, and downloads of the bestselling books and new releases cost less than €9.99. The ebook reader has the capacity to store thousands of books. The most current Amazon Kindle, Sony PRS, Kobo e-reader, Barnes & Noble's Nook and iRiver's Story are popular e-readers that use e-paper displays that either look like printed pages or LCD screens that are bright and shiny but can be difficult to read in bright sunlight.<sup>48</sup> E-books weigh less than 12 ounces, are less than half an inch thick, and come with a display screen ranging from 5 to 8 inches. Thus, these readers are more compact than most paperbacks and can be easily held in one hand. Recent e-book readers display content in 16 million colours and high resolution. On many ereaders, the size of the text can be magnified for readers with poor vision.

## 3.5 Computer System Types

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, mechanics 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, conative computers will be able to learn through experiences and outcomes and mimic human learning patterns. General-purpose computers are used for a variety of applications and to execute the business applications discussed in this text. General-purpose computer systems can be divided into two major groups: systems used by one user at a time and systems used by multiple concurrent users. Table 3.4 shows the general ranges of capabilities for various types of computer systems. General-purpose computer systems can range from small handheld computers to massive supercomputers that fill an entire room. We will first cover single-user computer systems.

Table 3.4 Types of Computer Systems

Factor	Single-User Computers				
	Portable Computers				
	Handheld	Laptop	Notebook	Netbook	Tablet
<b>Cost</b>	€100–€300	€350–€2000	€500–€2000	€150–€600	€150–€400
<b>Weight (pounds)</b>	<.30	4.0–7.0	<4	<2.5	0.75–2.0
<b>Screen size (inches)</b>	2.4–3.6	11.5–15.5	11.6–14.0	7.0–11.0	5.0–14.0
<b>Typical use</b>	Organize personal data	Improve worker productivity	Improve productivity of mobile worker	Access the Internet and email	Capture data via pen or finger input, improve worker productivity

Nonportable Computers				
	Thin Client	Desktop	Nettop	Workstation
<b>Cost</b>	€150–€400	€400–€2000	€100–€300	€600–€4000
<b>Weight (pounds)</b>	1–3	<30	<5	<35
<b>Screen size (inches)</b>	10.0–15.0	13.0–27.0	Comes with or without attached screen	13.0–27.0
<b>Typical use</b>	Enter data and access applications via the Internet	Improve worker productivity	Replace desktop with small, low-cost, low-energy computer	Perform engineering, CAD and software development

Multiple-user computer systems include servers, mainframes and supercomputers.

Factor	Multiple-User Computers		
	Server	Mainframe	Supercomputer
<b>Cost</b>	€400–€40 000	>€75 000	>€200 000
<b>Weight (pounds)</b>	>25	>100	>100
<b>Screen size (inches)</b>	n/a	n/a	n/a
<b>Typical use</b>	Perform network and Internet applications	Perform computing tasks for large organizations and provide massive data storage	Run scientific applications; perform intensive number crunching

## Portable Computers

Many computer manufacturers offer a variety of **portable computers**, those that are small enough to carry easily. Portable computers include handheld computers, laptop computers, notebook computers, netbook computers and tablet computers.

**Handheld computers** are single-user computers that provide ease of portability because of their small size some are as small as a credit card. These systems often include a variety of software and communications capabilities. Most can communicate with desktop computers over wireless networks. Some even add a built-in GPS receiver with software that can integrate location data into the application. For example, if you click an entry in an electronic address book, the device displays a map and directions from your current location. Such a computer can also be mounted in your car and serve as a navigation system. One of the shortcomings of handheld computers is that they require a lot of power relative to their size.

A **smartphone** is a handheld computer that combines the functionality of a mobile phone, camera, web browser, email tool, MP3 player and other devices into a single device. BlackBerry was one of the earliest smart- phone devices, developed by the Canadian company Research in Motion in 1999.

In early 2011, both LG and Motorola announced new smartphones based on dual-core 1 GHz processors that can run in parallel to deliver faster performance, provided the soft- ware has been designed to take advantage of the dual-core processing capability. Such chips enable 3D enabled handsets that do not require users to wear special glasses to view the content.<sup>50</sup> While Apple with its iPhone dominated the smartphone market for several years, it is now facing stiff competition from Amazon, Samsung, HTC, Motorola, Nokia, Samsung and others.

Apple has sued many of its competitors for allegedly violating its patents and trademarks used in mobile devices. In return, many of these competitors have countersued Apple, with Samsung and Apple alone being engaged in 30 legal battles in 9 countries.<sup>51</sup> Industry observers point out that such patent wars stifle innovation and competition, but unfortunately they have become a common tactic in dealing with the competition.<sup>52</sup> The technology market is shifting to low power mobile devices such as smartphones and tablet computers. In 2013, PC sales slipped by

8 per cent while sales of tablets increased 53 per cent.<sup>53</sup> Increasingly, consumers and workers alike will perform data processing, email, and web surfing and database lookup tasks on smartphone-like devices.

The number of business applications for smartphones is increasing rapidly to meet this need, especially in the medical field where it is estimated that about 30 per cent of doctors have an iPad and more than 80 per cent carry a smartphone.<sup>54</sup> epSOS is an attempt to offer seamless healthcare to European citizens. Part of the project is a system for electronic prescriptions. Doctors can log into the epSOS portal and transmit a patient's prescription directly to a pharmacy.<sup>55</sup> Access Reflex is software that enables users to view Microsoft Access databases from a smartphone.<sup>56</sup> EBSCOhost Mobile offers mobile access to a broad range of full text and bibliographic databases for research.<sup>57</sup> Mobile police officers can use their smartphones to connect to national crime databases, and emergency first responders can use theirs to connect to hazardous materials databases to find out advice on how to deal with dangerous spills or fires involving such materials.

### Laptop Computers

A **laptop computer** is a personal computer designed for use by mobile users, being small and light enough to sit comfortably on a user's lap. Laptop computers use a variety of flat panel technologies to produce a lightweight and thin display screen with good resolution. In terms of computing power, laptop computers can match most desktop computers as they come with powerful CPUs as well as large-capacity primary memory and disc 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 computer to a desktop because of its portability, lower energy usage and smaller space requirements.

### Notebook Computers

Many highly mobile users prefer **notebook computers** that weigh less than 2 kilogrammes compared to larger laptops that weigh up to around 3 kilogrammes. However, there are limitations to these small, lighter laptops. They typically come without optical drives for burning DVDs or playing Blu-ray movies. Because they are thinner, they have less room for larger, longer-life batteries. Their thin profile also does not allow for heat sinks and fans to dissipate the heat generated by fast processors, so they typically have less processing power. Finally, few come with a high-power graphics card, so these machines are less popular with gamers.

### Netbook Computers

**Netbook computers** are small, light and inexpensive members of the laptop computer family that are great for tasks that do not require a lot of computing power, such as sending and receiving email, viewing DVDs, playing games or accessing the Internet. However, netbook computers are not good for users who want to run demanding applications, have many applications open at one time or need lots of data storage capacity.

Many netbooks use the Intel Atom CPU (the N450), which is specially designed to run on minimal power so that the computer can use small, lightweight batteries and avoid potential overheating problems without the need for fans and large heat sinks. Battery life is a key distinguishing feature when comparing various netbooks, with expected operating times varying from 4 hours to nearly 12 hours depending on the manufacturer and model. All 320 high school students in Bloomingdale, Michigan, have been provided with their own netbook computers and free wireless Internet access.

The goal of this program is to provide students with additional learning resources and improve the level of instruction. This is important for a community where nearly half of the households are without Internet access. Teachers update the system each day to notify students and parents about missing assignments; they can also attach a worksheet if applicable. Students appreciate the ability to track their homework and to watch online videos covering many topics and providing step-by-step directions on how to complete homework assignments.

## Tablet Computers

**Tablet computers** are portable, lightweight computers with no keyboard that allow you to roam the office, home or factory floor, carrying the device like a clipboard. You can enter text with a writing stylus or finger directly on the screen thanks to built-in handwriting recognition software. Other input methods include an optional keyboard or speech recognition. Tablet PCs 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 do not yet have the processing power of desktop computers. They also are limited in displaying some videos because the Flash software does not run at all on an iPad neither does it run reliably on Android tablets. Further, tablet screens of most manufacturers need better antiglare protection before they can be used outside in full sunlight. Tablet computers are especially popular with students and gamers. They are also frequently used in the healthcare, retail, insurance and manufacturing industries because of their versatility. M&D Oral Care and Maxillofacial Surgery is an oral surgery practice in Connecticut that installed iPads and a Motorola Xoom tablet at five patient chairs in its office so that patients can view their CT scans and X-rays as well as educational videos. De Santos is a high-end Italian-American restaurant in New York's West Village.

Its waiters use tablet computers to take orders and swipe credit cards. In addition to displaying the full menu, the tablet displays the restaurant's table and seating chart. Accordingly, the tablets make the whole process of seating customers, taking orders, sending orders to the kitchen and paying the bill simpler and more time efficient. By using tablets, waiters can serve more tables and provide improved customer service. 'Nowadays in New York City, the menus don't list the entire specifications of each dish', says Sebastian Gonella, one of the owners and cofounders of the restaurant. 'With this software, you can show them exactly the dish itself and all the specifications for each dish, so people are really buying what they're seeing and there's no more confusion. It's pretty important'.

The Apple iPad is a tablet computer capable of running the same software that runs on the older Apple iPhone and iPod Touch devices, giving it a library of over 300 000 applications.<sup>63</sup> It also runs software developed specifically for it. The device has a 9.7-inch screen and an on-screen keypad, weighs 1.5 pounds, and supports Internet access over wireless networks. A number of computer companies offer tablet computers to compete with Apple's iPad and iPad II, including the Playbook from BlackBerry, the TouchPad from Hewlett-Packard, the Kindle Fire from Amazon, the Streak by Dell, the Tablet S and Tablet P from Sony, the Thrive by Toshiba, the Galaxy Tab from Samsung, the Xoom from Motorola and the low-cost (less than €50) Aakash and Ubislate from the India-based company Quad.

## No portable Single-User Computers

No portable single-user computers include thin client computers, desktop computers, net top computers and workstations.

A **thin client** is a low-cost, centrally managed computer with no extra drives (such as CD or DVD drives) or expansion slots. 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, neither do they need it for the role they play. With no hard disc, they never pick up viruses or suffer a hard disc 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.<sup>64</sup> Thin clients work well in a cloudcomputing environment to enable users to access the computing and data resources available within the cloud.<sup>65</sup> Jewellery Television is viewed by over 65 million people in the USA and millions more visit its website ([www.jtv.com](http://www.jtv.com)). As a result of this exposure, the company has become one of the world’s largest jewellery retailers. Its 300 call centre representatives handle more than 6 million calls per year using thin client computers to access information to respond to customer queries and to place orders.

### Desktop Computers

**Desktop computers** are single-user computer systems that are highly versatile. Named for their size, desktop computers 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, disc drives and so on) fit behind the display screen. The Intel iMac is available with Intel’s new core i5 or i7 processors making such machines the first quad-core iMacs.

### Nettop Computers

A nettop computer is an inexpensive (less than €250) desktop computer designed to be smaller and lighter and to consume 10 per cent of the power of a traditional desktop computer. A nettop is designed to perform basic processing tasks such as exchanging email, Internet surfing and accessing web-based applications. This computer can also be used for home theatre activities such as watching video, viewing pictures, listening to music and playing games. Unlike netbook computers, nettop computers are not designed to be portable, and they come with or without an attached screen. (Nettops with attached screens are called all-in-ones.) A nettop without an attached screen can be connected to an existing monitor or even a TV screen. They also may include an optical drive (CD/DVD). The CPU is typically an Intel Atom or AMD Geode, with a single-core or dual-core processor.

Choosing a single-core processor CPU reduces the cost and power consumption but limits the processing power of the computer. A dual-core processor nettop has sufficient processing power to enable you to watch video and do limited processing tasks. Businesses are considering using nettops because they are inexpensive to buy and run, and therefore these computers can improve an organization’s profitability.

### Workstations

**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. Sekotec Security and Communication is a small company that provides video surveillance systems to supermarkets, petrol stations, retail stores and hotels throughout Germany. Their customer solutions typically involve clusters of 4, 8, 16 or 32 video cameras linked to a powerful workstation that controls the operation of the cameras and can store multiple terabytes of video data for rapid viewing.

### Multiple-User Computer Systems

Multiple-user computers 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. Multiple-user systems include servers, mainframe computers and supercomputers.

#### Servers

A **server** is a computer employed by many users to perform a specific task, such as running network or Internet applications. Servers typically have large memory and storage capacities, along with fast and efficient communications abilities. A web server handles 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. 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 from this single location. Such a facility is called a server farm. Google runs a server farm in Finland, using wind to power it and sea water to cool it. Google buys electricity from a wind farm in Northern Sweden, and brings in water from the Bay of Finland. The farm is based in an old paper mill which already had massive quarter-milelong sea water tunnels, which had been used to cool the paper mill's manufacturing systems. 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 increased by adding more, or more powerful, processors. Scaling up adds more powerful processors, and scaling out adds many more equal (or even less powerful) processors to increase the total data-processing capacity.

The Intel 10-core Westmere EX processor is targeted at high-end servers such as those frequently used in data centres to support large databases and other processing intense applications. The processor supports a technology called hyper threading, which enables each core to conduct two sets of instructions, called threads. Hyper threading gives each processor the ability to run up to 20 threads simultaneously.<sup>70</sup> Advanced Micro Devices (AMD) has announced the release of a 16-core server chip code-named Interlagos Opteron 6200.<sup>71</sup> Less powerful servers are often used on a smaller scale to support the needs of many users. For example, the Gashora Girls Academy located in the republic of Rwanda deployed server computers to ensure that its 270 students and 12 teachers could have access to the latest technology.<sup>72</sup> Each server computer supports multiple students, each working independently using their own basic workstation that allows them to run word processing and spreadsheet software, use computer science applications, stream videos and listen to audio programs. This solution minimized the school's investment in hardware and reduced ongoing power and maintenance costs, making it feasible for students to access computing technology to gain the work skills necessary to be successful in the twenty-first century. Server manufacturers are also competing heavily to reduce the power required to operate their servers and making 'performance per watt' a key part of their product differentiation strategy. Low power usage is a critical factor for organizations that run servers farms of hundreds or even thousands of servers. Typical servers draw up to 220 watts, while 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 euro for operators of a large server farm.

A virtual server is a method of logically dividing the resources of a single physical server to create multiple logical servers, each acting as its own dedicated machine. The server administrator uses software to divide one physical server into multiple isolated virtual environments. For example, a single physical web server might be divided into two virtual private servers. One of the virtual servers hosts the organization's live website, while the other hosts a copy of the website.

The second private virtual server is used to test and verify updates to software before changes are made to the live website. The use of virtual servers is growing rapidly. In a typical data centre deployment of several hundred servers, companies using virtualization can build 12 virtual machines for every actual server with resulting savings in capital and operating expenses (including energy costs) of millions of euros per year.

EZZI.net is a web hosting service provider for many companies including some of the largest Fortune 500 companies. It has data centres located in New York City and Los Angeles that employ virtual servers because they are easy to use, can be supported around the clock, and operate with a 99.7 per cent uptime to meet the needs of its many customers. 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 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.

Norddeutsche Landsman (NORD/LB) is a major financial institution with headquarters in Hanover, Germany. The bank was suffering from slow response time for its key systems while trying to meet new business needs. New blade server computers were installed to improve system response time by 40 per cent and provide the bank's departments with the data they needed on a timely basis so they could operate efficiently.

### Mainframe Computers

**A mainframe computer** is a large, powerful computer shared by dozens or even hundreds of concurrent users connected to the machine over a network. The mainframe computer must reside in a data centre with special HVAC equipment to control temperature, humidity and dust level. In addition, most mainframes are kept in a secure data centre with limited access. The construction and maintenance of a controlled-access room with HVAC can add hundreds of thousands of euros to the cost of owning and operating a mainframe computer. The role of the mainframe is undergoing some remarkable changes as lower-cost, single-user computers become increasingly powerful. Many computer jobs that used to run on mainframe computers have migrated onto these smaller, less expensive computers. This information-processing migration is called computer downsizing. The new role of the mainframe is as a large information-processing and data storage utility for a corporation running jobs too large for other computers, storing files and databases too large to be stored elsewhere, and storing backups of files and databases created elsewhere. For example, the mainframe can handle the millions of

daily transactions associated with airline, car and hotel reservation systems. It can process the tens of thousands of daily queries necessary to provide data to decision support systems. Its massive storage and input/output capabilities enable it to play the role of a video computer, providing full-motion video to multiple, concurrent users. Payment Solution Providers (PSP) is a Canadian corporation specializing in e-payment networks and the integration of financial transaction processing systems. PSP recently

Selected an IBM system z mainframe computer on which to run its credit card processing business. Other alternatives examined lacked the security PSP requires and would make it difficult to meet the banking industry's compliance standards for increasing controls around card-holder data to reduce credit card fraud. In addition, consolidation of operations onto a single mainframe provides a compact, efficient infrastructure that minimizes space requirements and reduces costs for IT management, power and cooling, and software licences by 35 per cent

## **Supercomputers**

**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 around the world 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 soap suds and improve the quality of its nappies. Supercomputers are based on a new architecture that employs both **graphics processing unit (GPU)** chips to perform high-speed processing.

The GPU chip is a specialized circuit that is very efficient at manipulating computer graphics and is much faster than the typical CPU chip at performing floating point operations and executing algorithms for which processing of large blocks of data is done in parallel. This maths is precisely the type performed by supercomputers. At the time of writing, according to the TOP500 list ([www.top500.org](http://www.top500.org)), the world's top three supercomputers are 3) the Titan from Cray Inc. which is in use at the Oak Ridge National Laboratory in the US; 2) the Tianhe-2 at the National Super Computer Centre in Guangzhou China; and 1) the Sunway TaihuLight in use at the National Supercomputing Centre in Wuxi China. All are used for basic research such as studying climate and weather modelling.

The Sunway TaihuLight can perform 93 000 trillion floating point operations per second, three times faster than the Tianhe-2 computer in the number two spot. Amazingly, it also draws less power. All of its processors were designed and manufactured locally, meaning that China does not have to rely on Western technology for its computing power. Table 3.5 lists the three most powerful supercomputers in use as of May 2017. Table 3.5

Rank	System	Manufacturer	Research Centre	Location	Speed (teraflops)
1	Sunway TaihuLight	NRCPC	National Super Computing Center in Wuxi	China	93 000
2	Tianhe-2	NUDT	National Super Computing Center in Guangzhou	China	33 000
3	Titan	Cray	Oak Ridge National Laboratory	USA	18 000

Watson, an IBM supercomputer, is best known for defeating former Jeopardy! Quiz champions. The contest was a means to demonstrate the various systems, data management and analytics technology that can be applied in business and across different industries. Watson is being ‘trained’ by the medical insurance company WellPoint to diagnose treatment options for patients. There are plans to develop a new supercomputer (called Titan) with a computing power of 20 petaflops at the Oak Ridge Laboratory. This machine will employ the new architecture using a combination of GPU chips from NVidia and CPU chips from Intel and Advanced Micro Devices.<sup>81</sup> Table 3.6 lists the processing speeds of supercomputers.

Table 3.6

Speed	Meaning
GigaFLOPS	$1 \times 10^9$ FLOPS
TeraFLOPS	$1 \times 10^{12}$ FLOPS
PetaFLOPS	$1 \times 10^{15}$ FLOPS
ExaFLOPS	$1 \times 10^{18}$ FLOPS



**Principles Of Business Information Systems 3<sup>rd</sup> Edition, Ralph Stair, George Reynolds and Thomas Chesney Chapter 3 Page Number 101**

**Green computing** is concerned with the efficient and environmentally responsible design, manufacture, operation and disposal of IS-related products, including all types of computers, printers and printer materials such as cartridges and toner. Business organizations recognize that going green is in their best interests in terms of public relations, safety of employees and the community at large.

They also recognize that green computing presents an opportunity to substantially reduce total costs over the lifecycle of their IS equipment. Green computing has three goals: reduce the use of hazardous material, allow companies to lower their power-related costs, and enable the safe disposal or recycling of computers and computer-related equipment. According to Greenpeace, 50 million tons of computers, monitors, lap-tops, printers, disc drives, mobile phones, DVDs and CDs are discarded worldwide each year. Computers contain many toxic substances including beryllium, brominated flame retardants, cadmium, lead, mercury, polyvinyl chloride and selenium. As a result, electronic manufacturing employees and suppliers at all steps along the supply chain and in the manufacturing process are at risk of unhealthy exposure.

Computer users can also be exposed to these substances when using poorly designed or damaged devices. Because it is impossible to ensure safe recycling or disposal, the best practice is 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. Safe disposal and reclamation operations must be extremely careful 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 developing 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 defence, these countries point out that the USA and other developed countries

were allowed to grow robust economies and rise up out of poverty without the restrictions of strict environmental policies. One of the earliest initiatives towards green computing in the USA was the voluntary labelling programme known as Energy Star. It was conceived by the Environmental Protection Agency in 1992 to promote energy efficiency in hardware of all kinds. This programme resulted in the widespread adoption of sleep mode for electronic products. For example, Energy Star monitors have the capability to power down into two levels of 'sleep'. In the first level, the monitor energy consumption is less than or equal to 15 Watts, and in the second power consumption reduces to 8 Watts, which is less than 10 per cent of its operating power consumption. The European Union Directive 2002/95/EC required that as of July 2006 new electrical and electronic equipment cannot contain any of six banned substances in quantities exceeding certain maximum concentration values. The six banned substances are lead, mercury, cadmium, hexavalent chromium, polybrominated biphenyls and polybrominated diphenylethers. The Directive was modified in September 2011 to exclude lead and cadmium because of the impracticality of finding suitable substitutes for these materials. This Directive applies to US organizations selling equipment to members of the European Union (EU) and has encouraged US manufacturers to meet the standards as well. The Green Electronics Council manages the Electronic Product Environment Assessment Tool (EPEAT) to assist in the evaluation and purchase of green computing systems. The EPEAT assesses products against 51 lifecycle environmental criteria developed by representatives of the environmental community, manufacturers, private and public purchasers, resellers, recyclers and other

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%

interested parties. These criteria are documented in IEEE Standard 1680 and are concerned with the reduction of hazardous materials, the use of recycled materials, the design for recovery through recycling systems, product longevity, energy conservation, end of life management, the manufacturer's corporate environmental policy and packaging. The products evaluated against the EPEAT criteria are placed into one of three tiers based on their rating, as shown in Table 3.7

Table 3.7

Computer manufacturers such as Apple, Dell and Hewlett-Packard have long competed on the basis of price and performance. As the difference between the manufacturers in these two arenas narrows, support for green computing is emerging as a new business strategy for these companies to distinguish themselves from the competition. Apple claims to have the 'greenest line up of notebooks' and is making progress at removing toxic chemicals. Dell's new mantra is to become 'the greenest technology company on Earth'. Hewlett-Packard highlights its long tradition of environmentalism and is improving its packaging to reduce the use of materials. It is also urging computer users around the world to shut down their computers at the end of the day to save energy and reduce carbon emissions.



## Chapter Summary/Review

Computer hardware must be carefully selected to meet the evolving needs of the organization and its supporting information systems. Computer hardware should be selected to meet specific user and business requirements. These requirements can evolve and change over time.

The computer hardware industry is rapidly changing and is highly competitive, creating an environment ripe for technological breakthroughs. CPU processing speed is limited by physical constraints such as the distance between circuitry points and circuitry material.

The computer hardware industry and users are implementing green computing designs and products efficient and environmentally responsible design, manufacture, operation and disposal of IT-related products. 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: reduce the use of hazardous material, lower power-related costs and enable the safe disposal and/or recycling of IT products.



### Review Questions (Short)

1. What is a pixel?
2. Describe a SAN.
3. What is parallel computing?
4. Explain storage capacity.
5. List some secondary storage devices.



### Review Questions (Long)

1. Describe the function of the main components of a CPU.
2. Explain the role of a mainframe computer in a business.
3. Who would use a supercomputer?
4. Describe the main functionality of a smartphone.
5. What is the goal of green computing?



### Review Questions (MCQ)

1. The \_\_\_\_\_ computer hardware component performs mathematical calculations.
  - A. Local Area Network
  - B. Arithmetic/logic unit
  - C. ERP
  - D. Patch
  
2. A \_\_\_\_\_ holds small units of program instructions and data immediately before, during and after execution by the computer.
  - A. Entity
  - B. Chief Programming Team
  - C. Switch
  - D. Register
  
3. \_\_\_\_\_ is a measure of machine cycle time.
  - A. MIPS
  - B. Domain
  - C. Legal feasibility
  - D. Encryption
  
4. A terabyte is 2 to the power of \_\_\_\_\_ bytes.
  - A. 25
  - B. 30
  - C. 40
  - D. 100
  
5. Magnetic tape is an example of \_\_\_\_\_.
  - A. Cold site
  - B. Virus
  - C. Secondary Storage
  - D. Foreign key



## Case Studies

### Moore's Law About to Be Overturned

In the 1930s, British mathematician Alan Turing was writing a paper about the limits of what can be calculated. In one section he wrote a single paragraph that can...’ What followed described in English what became the basic design for all modern computers.

The actual text he wrote was: “ We may compare a man in the process of computing a real number to a machine which is only capable of a finite number of conditions q1: q2... qI; which will be called “m-configurations”. The machine is supplied with a “tape” (the analogue of paper) running through it, and divided into sections (called “squares”) each capable of bearing a “symbol”. At any moment there is just one square ... which is “in the machine”. We may call this square the “scanned square”. The symbol on the scanned square may be called the “scanned symbol”. The “scanned symbol” is the only one of which the machine is, so to speak, “directly aware”.

### Questions

1. Do you think the industry’s research road map is anti-competitive?
2. Is computing power in your device really that important anymore, given the rise of cloud com- need?
3. Hardware performance may have doubled every two years, but software performance certainly has not. Do you think engineers should now concentrate on software efficiency rather than hardware?
4. The (theoretical) creature on the black and white search to try to explain how it could be used to ‘compute anything’



**Principles Of Business Information Systems 3<sup>rd</sup> Edition, Ralph Stair,George Reynolds and Thomas Chesney Chapter 3 Page Number 106**



## Case Studies

### **Sen.Se is Helping to Create the Internet of Things**

American computer company Sen.Se is trying to develop smart systems that invade all areas of everyday life. They want to impact on everything from walking your dog to brushing your teeth. Their flag- ship product is called Mother. Technology publication CNET describes Mother as ‘a data-tracker with a ton of built-in flexibility’. The basic Mother kit comes with a base unit called a hub, which is de- signed to look like a friendly Japanese style cartoon character, and a set of four sensors which Sen.Se call ‘cookies’. An app is downloaded separately. Call ‘cookies’. An app is downloaded separately.

The cookies are remote sensors that are used to monitor location, motion and temperature. The cookies spend all day storing and sharing data with the hub. They can be attached to just about any- thing, and once they are attached to an object they ET point out, this system is extremely flexible. For instance, a parent might put a cookie on a child’s toothbrush to make sure they are brushing twice a day. Unless the cookie detects the proper movement at the right times of day, it will send an alert. Another cookie might go on the dog’s collar. If poochie hasn’t been for his walk, the app will send a reminder. A cookie might go on the car keys make sure they never get lost again

### **Questions**

1. Does anyone ever need to be reminded to buy ever delegate tooth brushing monitoring to the Mother hub?
2. What are some more serious applications for?
3. What are some of the concerns users of this overcome them?
4. What use could a third party make of data from a smart meter?



**Principles Of Business Information Systems 3<sup>rd</sup> Edition, Ralph Stair,George Reynolds and Thomas Chesney Chapter 3 Page Number 108**



### LEARNING OUTCOMES

After reading this Section of the guide, the learner should be able to:

#### Learning Objectives

- Identify and briefly describe the functions of the two basic kinds of software.
- Outline the role of the operating system and identify the features of several popular operating systems.
- Discuss how application software can support personal, workgroup and enterprise business objectives.
- Identify three basic approaches to developing application software and discuss the pros and cons of each.
- Outline the overall evolution and importance of programming languages and clearly differentiate between the generations of programming languages.
- Identify several key software issues and trends that have an impact on organizations and individuals.

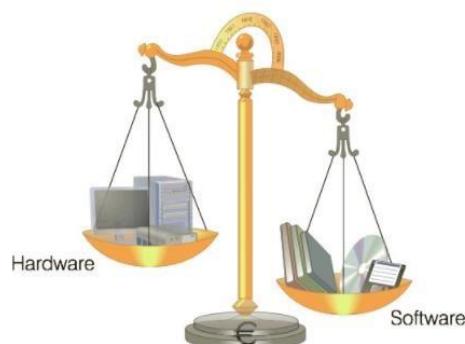
### Introduction

Software is indispensable for any computer system and the people using it. In this chapter you will learn about systems and application software. Without systems software, computers would not be able to accept data input from a keyboard, process data or display results. Application software is one of the keys to helping you achieve your career goals. Sales representatives use software on their smartphones and tablet computers to enter sales orders and help their customers get what they want. Stock and bond traders use software to make splitsecond decisions involving millions of dollars. Scientists use software to analyze the threat of climate change. Regardless of your job, you will most likely use software to help you advance in your career and earn higher wages. You can also use software to help you prepare your tax return, keep a budget and keep in contact with friends and family online. Software can truly advance your career and enrich your life. We begin with an overview of software.

Software has a profound impact on individuals and organizations. It can make the difference between profits and losses and between financial health and bankruptcy. As Figure 4.1 shows, companies recognize this impact, spending more on software than on computer hardware.

**Figure 4.1 Importance of Software in Business**

*Since the 1950s, businesses have greatly increased their expenditures on software compared with hardware.*



**Principles Of Business Information Systems 3<sup>rd</sup> Edition, Ralph Stair, George Reynolds and Thomas Chesney Chapter 4 Page Number 116**

## 4.1 An Overview of Software

As you learned in Chapter 1, software consists of computer programs that control the workings of computer hardware. **Computer programs** are sequences of instructions for the computer. **Documentation** describes the program functions to help the user operate the computer system. Some documentation is given on-screen or online, while other forms appear in external resources, such as printed manuals. Software is a growing and dynamic industry. Some believe that software development and sales have more growth potential than hardware.

### Systems Software

Systems software is the set of programs that coordinates the activities and functions of the hardware and other programs throughout the computer system. Each type of systems software is designed for a specific CPU and class of hardware. The combination of a hardware configuration and systems software is known as a computer system platform

### Application Software

Application software consists of programs that help users solve particular computing problems.<sup>2</sup> An architectural firm in Boise, Idaho, for example, used ProjectDox software to streamline the paperwork required to get approval and permits for building projects.<sup>3</sup> According to one architect from the firm, ‘The nice thing is that most files, whether it be a PDF or Word document, can be dropped into different folders online and sent. It’s not a big deal like it was before’. Software from Amcom allows companies in the USA such as Eddie Bauer to provide the exact location of someone who calls from an Eddie Bauer retail location to

emergency call centres.<sup>4</sup> According to a company technical analyst, ‘We take communications and security very seriously. The Amcom system is a perfect communications safety net in case someone dials 911 and can’t explain where they are’.

In most cases, application software resides on the computer’s hard drive before it is brought into the computer’s memory and run. Application software can also be stored on CDs, DVDs and even USB flash drives. An increasing amount of application software is available on the web. Sometimes referred to as a rich Internet application (RIA), a web-delivered application combines hardware resources of the web server and the PC to deliver valuable software services through a web browser interface. Before a person, group or enterprise decides on the best approach for acquiring application software, they should analyze their goals and needs carefully.

### **Supporting Individual, Group and Organizational Goals**

Every organization relies on the contributions of people, groups and the entire enterprise to achieve its business objectives. One useful way of classifying the many potential uses of information systems is to identify the scope of the problems and opportunities that an organization addresses. This scope is called the sphere of influence. For most companies, the spheres of influence are personal, workgroup and enterprise. Table 4.1 shows how various kinds of software support these three spheres.

**Table 4.1** Software Supporting Individuals, Workgroups and Enterprises

<b>Software</b>	<b>Personal</b>	<b>Workgroup</b>	<b>Enterprise</b>
Systems software	Smartphone, tablet computer, personal computer and workstation operating systems	Network operating systems	Server and mainframe operating systems
Application software	Word processing, spreadsheet, database and graphics	Electronic mail, group scheduling, shared work and collaboration	General ledger, order entry, payroll and human resources

Information systems that operate within the personal sphere of influence serve the needs of individual users. These information systems help users improve their personal effectiveness, increasing the amount and quality of work they can do. Such software is often **called personal productivity software**. For example, MindManager software from Mindjet provides tools to help people represent complex ideas and projects using an intuitive graphic interface.

When two or more people work together to achieve a common goal, they form a **workgroup**. A workgroup might be a large formal, permanent organizational entity, such as a section or department or a temporary group formed to complete a specific project.

An information system in the **workgroup sphere of influence** helps workgroup members attain their common goals. Often, software designed for the personal sphere of influence can extend into the workgroup sphere. For example, people can use online calendar software such as Google Calendar to store personal appointments but also to schedule meetings with others.

Information systems that operate within the **enterprise sphere of influence** support the firm in its interaction with its environment, which includes customers, suppliers, shareholders,

competitors, special-interest groups, the financial community and government agencies. This means the enterprise sphere of influence includes business partners, such as suppliers that provide raw materials; retail companies that store and sell a company's products; and shipping companies that transport raw materials to the plant and finished goods to retail outlets. For example, many enterprises use IBM Cognos software as a centralized web-based system where employees, partners and stakeholders can report and analyze corporate financial data.

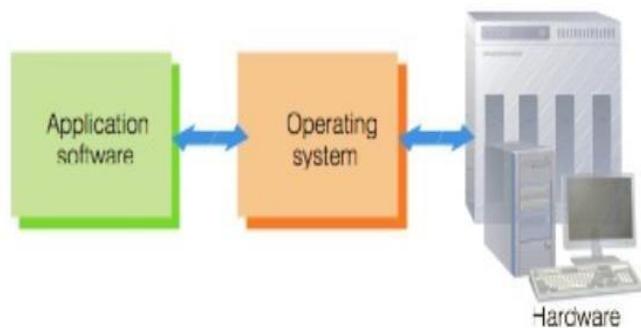
## 4.2 Systems Software

Controlling the operations of computer hardware is one of the most critical functions of systems software. Systems software also supports the application programs' problem-solving capabilities. Types of systems software include operating systems, utility programs and middleware.

### Operating Systems

An **operating system (OS)** is a set of programs that controls the computer hardware and acts as an interface with applications (see Figure 4.2). Operating systems can control one or more computers, or they can allow multiple users to interact with one computer. The various combinations of OSs, computers and users include the following:

**Figure 4.2** Role of  
Operating Systems *The  
role of the operating system  
is to act as an interface  
between application  
software and hardware.*



- **Single computer with a single user.** This system is commonly used in a personal computer, tablet computer or a smartphone that supports one user at a time. Examples of OSs for this setup include Microsoft Windows, Mac OS X and Google Android.
- **Single computer with multiple simultaneous users.** This system is typical of larger server or mainframe computers that can 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 typical of a network of computers, such as a home network with several computers attached or a large computer network with hundreds of computers attached supporting many users, sometimes located around the world. Most PC operating systems double as network operating systems. Network server OSs include Red Hat Linux, 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, space shuttles, digital cameras or home appliances. Examples of OSs for these purposes include Windows Embedded, Symbian and some distributions of Linux.

The OS, which plays a central role in the functioning of the complete computer system, is usually stored on disc on general-purpose computers and in solid state memory on special-purpose computers such as mobile phones and smartphones. After you start, or ‘boot up’, a computer system, portions of the OS are transferred to memory as the system needs them. This process can take anywhere from a split second on a smartphone, to a few minutes on a desktop PC, to hours on a large mainframe or distributed computer systems. OS developers are continuously working to shorten the time required to boot devices from being shut down and wake devices from sleep mode.

You can also boot a computer from a CD, DVD or even a USB flash drive. A storage device that contains some or all of the OS is often called a rescue disc because you can use it to start the computer if you have problems with the primary hard disc.

The set of programs that make up the OS performs a variety of activities, including the following:

- Performing common computer hardware functions.
- Providing a user interface and input/output management.
- Providing a degree of hardware independence.
- Managing system memory.
- Managing processing tasks.
- Sometimes providing networking capability.
- Controlling access to system resources.
- managing files

The **kernel**, as its name suggests, is the heart of the OS and controls its most critical processes. The kernel ties all of the OS components together and regulates other programs. For a really gentle introduction on how to write an operating system, head to the University of Cambridge Computer Laboratory at [www.cl.cam.ac.uk/projects/raspberrypi/tutorials/os](http://www.cl.cam.ac.uk/projects/raspberrypi/tutorials/os). The tutorial will show you how to write a simple kernel for the Raspberry Pi computer.

## Common Hardware Functions

All applications must perform certain hardware-related tasks, such as the following:

- Get input from the keyboard or another input device.
- Retrieve data from discs.
- Store data on discs.
- Display information on a monitor or printer.

Each of these tasks requires a detailed set of instructions. The OS converts a basic request into the instructions that the hardware requires. In effect, the OS acts as an intermediary between the application and the hardware. The OS uses special software provided by device

manufacturers, called device drivers, to communicate with and control a device. Device drivers are installed when a device is initially connected to the computer system.

## User Interface and Input/Output Management

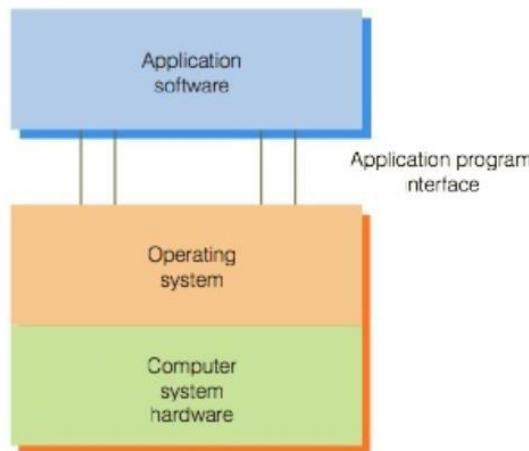
One of the most important functions of any OS is providing a **user interface**, which allows people to access and interact with the computer system. The first user interfaces for mainframe and personal computer systems were command based. A **command-based user interface** requires you to give text commands to the computer to perform basic activities. For example, the command ERASE 00TAXRTN would cause the computer to erase a file named 00TAXRTN. RENAME and COPY are other examples of commands used to rename files and copy files from one location to another. Today's systems engineers and administrators often use a command-based user interface to control the low-level functioning of computer systems. Most modern OSs (including popular graphical user interfaces such as Windows) provide a way to interact with the system through a command line.

A **graphical user interface (GUI)** displays pictures (called icons) and menus that people use to send commands to the computer system. GUIs are more intuitive to use because they anticipate the user's needs and provide easy to recognize options. Microsoft Windows is a popular GUI. As the name suggests, Windows is based on the use of a window, or a portion of the display screen dedicated to a specific application. The screen can display several windows at once.

While GUIs have traditionally been accessed using a keyboard and mouse, more recent technologies allow people to use touch screens and spoken commands. Today's mobile devices and some PCs, for example, use a touch user interface also called a natural user interface (NUI) or multitouch interface by some. Speech recognition is also available with some operating systems. By speaking into a microphone, the operating system commands and controls the computer system. Sight interfaces use a camera on the computer to determine where a person is looking on the screen and performs the appropriate command or operation. Some companies are also experimenting with sensors attached to the human brain (brain interfaces) that can detect brain waves and control a computer as a result. Sight and brain interfaces can be very helpful to disabled individuals.

## Hardware Independence

Software applications are designed to run on a particular operating system by using the operating system's **application program interface (API)**, which provides software developers with tools they use to build application software without needing to understand the inner workings of the OS and hardware (see Figure 4.3). Being able to develop software without concern for the specific underlying hardware is referred to as hardware independence. When new hardware technologies are introduced, the operating system is required to adjust to address those changes, not the application software that runs on the operating system.



**Figure 4.3 Application Program Interface (API)**  
The API links application software to the operating system, providing hardware independence for software developers.



**Principles Of Business Information Systems 3<sup>rd</sup> Edition, Ralph Stair, George Reynolds and Thomas Chesney Chapter 4 Page Number 121**

## Memory Management

The OS also controls how memory is accessed, maximizing the use of available memory and storage to provide optimum efficiency. The memory-management feature of many OSs allows the computer to execute program instructions effectively and to speed processing. One way to increase the performance of an old computer is to upgrade to a newer OS and increase the amount of memory.

Most OSs support virtual memory, which allocates space on the hard disc to supplement the immediate, functional memory capacity of RAM. Virtual memory works by swapping programs or parts of programs between memory and one or more disc devices – a concept called paging. This procedure reduces CPU idle time and increases the number of jobs that can run in a given time span.

## Processing Tasks

The task-management features of today's OSs manage all processing activities. Task management allocates computer resources to make the best use of each system's assets. Task-management software lets one user run several programs or tasks at the same time (multitasking) and allows several users to use the same computer at the same time (time sharing).

An OS with multitasking capabilities allows a user to run more than one application at the same time. While you're working in the foreground in one program, one or more other application can be churning away, unseen, in the background. Background activities include tasks such as sorting a database, printing a document, or performing other lengthy operations that otherwise would monopolize your computer and leave you staring at the screen unable to perform other work. Multitasking can save users a considerable amount of time and effort. Time sharing

allows more than one person to use a computer system at the same time. For example, customer service representatives might enter sales data into a computer system for a mail-order company at the same time. The ability of the computer to handle an increasing number of concurrent users smoothly is called scalability. This feature is critical for systems expected to handle a large and possibly fluctuating number of users, such as a mainframe computer or a web server.

## **Networking Capability**

Most operating systems include networking capabilities so that computers can join together in a network to send and receive data and share computing resources. Operating systems for larger server computers are designed specifically for computer networking environments.

## **Access to System Resources and Security**

Because computers often handle sensitive data that can be accessed over networks, the OS needs to provide a high level of security against unauthorized access to the users' data and programs. Typically, the OS establishes a logon procedure that requires users to enter an identification code, such as a user name and a matching password. Operating systems may also control what system resources a user may access. When a user successfully logs on to the system, the OS restricts access to only portions of the system for which the user has been cleared. The OS records who is using the system and for how long, and reports any attempted breaches of security.

## **File Management**

The OS manages files to ensure that files in secondary storage are available when needed and that they are protected from access by unauthorized users. Many computers support multiple users who store files on centrally located discs or tape drives. The OS keeps track of where each file is stored and who can access them.

## **Current Operating Systems**

Today's operating systems incorporate sophisticated features and impressive graphic effects. Table 4.2 classifies a few current OSs by sphere of influence.

## **Microsoft PC Operating Systems**

Since a once small company called Microsoft developed PC-DOS and MS-DOS to support the IBM personal computer introduced in the 1980s, personal computer OSs have steadily evolved. PC-DOS and MS-DOS had command-driven interfaces that were difficult to learn and use. MS-DOS gave way to Windows, which opened the PC market to everyday users.

Windows has evolved into the current system, Windows 10, which has support for touch displays, laptops and tablets, improved security and new features for the consumer market. However, some users have complained about the number of advertisements that appear all throughout the software.

## **Apple Computer Operating Systems**

**Table 4.2** Operating Systems Serving Three Spheres of Influence

Personal	Workgroup	Enterprise
Microsoft Windows	Microsoft Windows Server	Microsoft Windows Server
Mac OS X, Mac OS X iPhone	Mac OS X Server	Linux
Linux	Linux	UNIX
Google Android, Chrome OS	UNIX	IBM i and z/OS
HP webOS	IBM i and z/OS	HP-UX
		HP-UX

In July 2001, Mac OS X was released as an entirely new OS for the Mac based on the UNIX operating system. It included a new user interface, which provided a new visual appearance for users – including luminous and semitransparent elements, such as buttons, scroll bars, windows and fluid animation to enhance the user’s experience.

Since its first release, Apple has upgraded OS X several times. OS X Sierra is Apple’s latest operating system. It offers multitouch, full-screen applications, mission control features and other innovations. It also incorporates many features of Apple’s mobile devices into Apple’s desktop and laptop computers.<sup>9</sup> Sierra can also automatically save a document every time a change is made to an application, such as a word-processing or spreadsheet application. In one survey, ease of use, the number of available applications and overall user appeal for Apple’s mobile operating system (iOS) received high ratings.

Because Mac OS X runs on Intel processors, Mac users can set up their computer to run both Windows and Mac OS X and select which platform they want to work with when they boot their computer. Such an arrangement is called dual booting.

## Linux

Linux is an OS developed by Linus Torvalds in 1991 as a student in Finland. The OS is distributed under the GNU General Public Licence, and its source code is freely available to everyone. It is, therefore, called an open-source operating system. This designation doesn’t mean, however, that Linux and its assorted distributions are necessarily free – companies and developers can charge money for a distribution as long as the source code remains available. Linux is actually only the kernel of an OS, the part that controls hardware, manages files, separates processes and so forth.

Several combinations of Linux are available, with various sets of capabilities and applications to form a complete OS. Each of these combinations is called a distribution of Linux. Many distributions are available as free downloads.

Linux is available on the Internet and from other sources. Popular versions include Red Hat Linux, OpenSUSE and Caldera OpenLinux. Several large computer vendors, including IBM, Hewlett-Packard and Intel, support the Linux operating system. Although Linux is free software, Red Hat had revenues of about \$0.75 billion in 2011 distributing and servicing the software.

## Google

Over the years, Google has extended its reach from providing the most popular search engine to application software (Google Docs), mobile operating system (Android), web browser (Chrome) and, more recently, PC operating system – Chrome OS. Today, over 100 million people are using Google's Android operating system in smartphones and mobile devices. This number is up from less than 10 million users in 2009. Some believe that the number of Android users could explode to more than 200 million in a few years or less.

Google's Gingerbread operating system was designed for smartphones and other mobile devices, such as Samsung's Galaxy Note. Chrome OS is a Linux-based operating system for netbooks and nettops, which are notebooks and desktop PCs primarily used to access webbased information and services such as email, web browsing, social networks and Google online applications. The OS is designed to run on inexpensive low-power computers. Chrome OS for personal computers doesn't need application software. All applications can be accessed through the Internet. An open-source version of Chrome OS, named Chromium OS, was made available at the end of 2009. Because it is open-source soft- ware, developers can customize the source code to run on different platforms, incorporating unique features.

## Workgroup Operating Systems

To keep pace with user demands, the technology of the future must support a world in which network usage, data-storage requirements and data-processing speeds increase at a dramatic rate. Powerful and sophisticated OSs are needed to run the servers that meet these business needs for workgroups.

## Windows Server

Microsoft designed Windows Server to perform a host of tasks that are vital for websites and corporate web applications. For example, Microsoft Windows Server can be used to coordinate large data centres. It 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. It provides a convenient way to store and manage photos, video, music and other digital content. It also pro- vides backup and data recovery functions.

## UNIX

UNIX is a powerful OS originally developed by AT&T for minicomputers – the predecessors of servers that are larger than PCs and smaller than mainframes. Ken Thompson, one of the creators of the UNIX operating system, was awarded the Japan Prize, a prize for outstanding contribution to science and technology. UNIX can be used on many computer system types and platforms including workstations, servers and mainframe computers. UNIX also makes it much easier 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, AIX from IBM and Solaris from Oracle. Oracle's Solaris operating system manages eBay's systems, including database servers, web servers, tape libraries and identity management systems. The online auction company found that when it switched to Solaris, system performance increased.

## Red Hat Linux

Red Hat Software offers a Linux network OS that taps into the talents of tens of thousands of volunteer programmers who generate a steady stream of improvements for the Linux OS. The Red Hat Linux network OS is very efficient at serving web pages and can manage a cluster of up to eight servers. Distributions such as SuSE and Red Hat have proven Linux to be a very stable and efficient OS. Red Hat's newest version of Red Hat Enterprise Virtualization (RHEV) software no longer requires Windows Server software to operate. According to a director of Red Hat's virtualization business, 'We're in a really good position to capitalize on the growing demand for alternatives to VMware'. RHEV provides virtualization capabilities for servers and desktop computers. Other vendors are also investigating virtualization for open-source software such as Linux.

## Mac OS X Server

The Mac OS X Server is the first modern server OS from Apple Computer and is based on the UNIX OS. The most recent version is macOS Server 5. It includes support for 64-bit processing, along with several server functions and features that allow the easy management of network and Internet services such as email, website hosting, calendar management and sharing, wikis and podcasting.

## Enterprise Operating Systems

Mainframe computers, often referred to as 'Big Iron', provide the computing and storage capacity to meet massive data-processing requirements and offer many users high performance and excellent system availability, strong security and scalability. In addition, 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. It supports IBM's mainframes that can come with up to sixteen 64bit processors. (The z stands for zero downtime.) The HP-UX is a robust UNIX-based OS from Hewlett-Packard designed to handle a variety of business tasks, including online transaction processing and web applications. HP-UX supports Hewlett-Packard's computers and those designed to run Intel's Itanium processors.

## Operating Systems for Small Computers, Embedded Computers and Special-Purpose Devices

New OSs are changing the way we interact with smartphones, mobile phones, digital cameras, TVs and other digital electronics devices. Companies around the world are developing operating systems for these devices. Alibaba Cloud Computing, a part of the Chinese Alibaba Group, has developed an operating system for smartphones and mobile devices. This operating system will compete with operating systems from Google, Apple and Microsoft in China. Hewlett-Packard is hoping that car and appliance makers will increasingly use its webOS operating system. The webOS uses a touch interface and allows people to connect to the Internet. According to a company spokesperson, 'We're looking at expanding the base and bringing to the webOS an ecosystem that inspires developers'.

These OSs are also called embedded operating systems or just embedded systems because they are typically embedded within a device. Embedded systems are typically designed to perform specialized tasks. For example, an automotive embedded system might be responsible for controlling fuel injection. A digital camera's embedded system supports taking and viewing photos and may include a limited set of editing tools. A GPS device uses an embedded system to help people find their way around town or more remote areas. Some of the more popular OSs for devices are described in the following section.

## **Mobile Phone Embedded Systems and Operating Systems**

Mobile phones have traditionally used embedded systems to provide communication and limited personal information management services to users. These systems have transformed into full-fledged personal computer operating systems such as the iPhone OS, Google Android and Microsoft Windows Mobile.

### **Windows Embedded**

Windows Embedded is a family of Microsoft OSs included with or embedded into small computer devices. Windows Embedded includes several versions that provide computing power for TV set top boxes, automated industrial machines, media players, medical devices, digital cameras, PDAs, GPS receivers, ATMs, gaming devices and business devices such as cash registers. Windows Embedded Automotive provides a computing platform for automotive software such as Ford Sync. The Ford Sync system uses an in-dash display and wireless networking technologies to link automotive systems with mobile phones and portable media players.

### **Proprietary Linux-Based Systems**

Because embedded systems are usually designed for a specific purpose in a specific device, they are usually proprietary or custom-created and owned by the manufacturer. Sony's Wii, for example, uses a custom-designed OS 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, ATM machines, mobile phones, networking devices and media players.

### **Utility Programs**

**Utility programs** help to perform a variety of tasks. For example, some utility programs merge and sort sets of data, keep track of computer jobs being run, compress files of data before they are stored or transmitted over a network (thus saving space and time) and perform other important tasks. Parallels Desktop is a popular utility that allows Apple Mac computers to run Windows programs. The utility, which costs under €75, creates a virtual Windows machine inside a Mac computer.

Another type of utility program allows people and organizations to take advantage of unused computer power over a network. Often called grid computing, this approach can be very efficient and less expensive than purchasing additional hardware or computer equipment. CERN, home of the Large Hadron Collider (LHC), the world's largest scientific instrument, is also home to one of the world's largest scientific grid computing and storage systems. The LHC Computing Grid (LCG) project provides scientists around the world with access to shared

computer power and storage systems over the Internet. In 2012, this project helped identify a particle that may be the Higgs boson.

Although many PC utility programs come installed on computers, you can also purchase utility programs separately. The following sections examine some common types of utilities.

### **Hardware Utilities**

Some hardware utilities are available from companies such as Symantec, which produces Norton Utilities. Hardware utilities can check the status of all parts of the PC, including hard discs, memory, modems, speakers and printers. Disc utilities check the hard disc's boot sector, file allocation tables and directories, and analyze them to ensure that the hard disc is not damaged. Disc utilities can also optimize the placement of files on a crowded disc.

### **Security Utilities**

Computer viruses and spyware from the Internet and other sources can be a nuisance – and sometimes can completely disable a computer. Antivirus and antispyware software can be installed to constantly monitor and protect the computer. If a virus or spyware is found, most of the time it can be removed. It is also a good idea to protect computer systems with firewall software. Firewall software filters incoming and outgoing packets, making sure that neither hackers nor their tools are attacking the system. Symantec, McAfee and Microsoft are the most popular providers of security software.

### **File-Compression Utilities**

File-compression programs can reduce the amount of disc 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 zip file has a .zip extension, and its contents can be easily unzipped to the original size. MP3 (Motion Pictures Experts GroupLayer 3) is a popular file-compression format used to store, transfer and play music and audio files, such as podcasts – audio programs that can be downloaded from the Internet.

### **Spam-Filtering Utilities**

Receiving unwanted email (spam) can be a frustrating waste of time. Email software and services include spam-filtering utilities to assist users with these annoyances. Email filters identify spam by learning what the user considers spam and routing it to a junk mail folder. However, this method is insufficient for protecting enterprise-level email systems where spam containing viruses is a serious threat. Businesses often use additional spam-filtering software from companies including Cisco, Barracuda Networks and Google at the enterprise level to intercept dangerous spam as it enters the corporate email system.

### **Network and Internet Utilities**

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 and Hewlett-Packard's Automated Network Management Suite can be used to solve computer-network problems and help save money. In one survey, about 60 per cent of responding organizations used monitoring software to determine if their Internet sites and Internet applications were running as expected.

### **Server and Mainframe Utilities**

Some utilities enhance the performance of servers and mainframe computers. James River Insurance uses a utility program from Confio to help it monitor the performance of its computer systems and databases. According to a manager for James River, ‘We take a proactive

approach to database management to ensure we maintain high availability and performance in our virtual and physical environments'. IBM and other companies have created systems-management software that allows a support person to monitor the growing number of desktop computers attached to a server or mainframe computer. Similar to the virtual machine software discussed earlier, server virtualization software allows a server to run more than one operating system at the same time. For example, you could run four different virtual servers simultaneously on one physical server.

### Other Utilities

Utility programs are available for almost every conceivable task or function. Managing the vast array of operating systems for smartphones and mobile devices, for example, has been difficult for many companies. In one survey, two-thirds of responding organizations allowed managers and workers to connect to corporate databases using smartphones and mobile devices with very little or no guidance or supervision. Utility programs can help. Research in Motion (RIM) has developed a utility program that helps companies manage mobile phones and mobile devices from its company and others. Often called mobile device management (MDM), this type of software should help companies as smartphones and other mobile devices become more popular for managers and workers in a business setting. MDM software helps a company manage security, enforce corporate strategies, and control downloads and content streaming from corporate databases into smartphones and mobile devices. In addition, a number of companies, such as CNET, offer utilities that can be downloaded for most popular operating systems.

### Middleware

**Middleware** is software that allows various systems to communicate and exchange data. It is often developed to address situations where a company acquires different types of information systems through mergers, acquisitions or expansion and wants the systems to share data and interact. Middleware can also serve as an interface between the Internet and private corporate systems. For example, it can be used to transfer a request for information from a corporate customer on the corporate website to a traditional database on a mainframe computer and return the results 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. **A service-oriented architecture (SOA)** uses modular application services to allow users to interact with systems and systems to interact with each other. Systems developed with SOA are flexible and ideal for businesses that need a system to expand and evolve over time. SOA modules can be reused for a variety of purposes, thus reducing development time. Because SOA modules are designed using programming standards so that they can interact with other modules, rigid custom-designed middleware software is not needed to connect systems.

### 4.3 Application Software

As discussed earlier in this chapter, the primary function of application software is to apply the power of the computer to give people, workgroups and the entire enterprise the ability to solve problems and perform specific tasks. One debt collection agency, for example, was able to save more than €180 000 annually by using application software from Latitude to monitor people not paying their bills on time. Applications help you perform common tasks, such as create and format documents, perform calculations or manage information. Some applications are more specialized. Accenture, for example, offers application software specifically for the property and causality insurance industry. NB Publishers in South Africa uses application software to

format books so they can be read on e-readers. Yusen Logistics in Australia uses application software to calculate its costs and to route packages from sender to receiver. New passengerscreening software at the Tulsa International Airport has streamlined the check-in process and reduced privacy concerns. The software, called automated target recognition, uses a new fullbody scanning technology. The US Army is testing new application software on smartphones and tablet computers in combat zones. The military software will help commanders and combat troops analyze surveillance video and data from battlefields to help them locate and eliminate enemy troops, giving new meaning to the term ‘killer app’.

## Overview of Application Software

Proprietary software and off-the-shelf software are important types of application software. **Proprietary software** is one-of-a-kind software designed for a specific application and owned by the 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. **Off-the-shelf software** is mass-produced by software vendors to address needs that are common across businesses, organizations or individuals. For example, Amazon uses the same off-the-shelf payroll software as many businesses, but the company uses custom-designed proprietary software on its website that allows visitors to more easily find items to purchase. The relative advantages and disadvantages of proprietary software and off-the-shelf software are summarized in Table 4.3.

**Table 4.3** 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 significant resources to develop required features	The initial cost is lower because the software firm can spread the development costs over many customers	An organization might have to pay for features that are not required and never used
Being involved in the development offers 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 – you can analyze existing features and the performance of the package before purchasing	The software might lack important features, thus requiring future modification or customization. This lack can be very expensive because users must adapt future releases of the software as well
You can modify features that you might need 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 present 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



**Principles Of Business Information Systems 3<sup>rd</sup> Edition, Ralph Stair,George Reynolds and Thomas Chesney Chapter 4 Page Number 130**

Many companies use off-the-shelf software to support business processes. Key questions for selecting off-the-shelf software include the following. First, will the software run on the OS and hardware you have selected? Second, does the software meet the essential business requirements that have been defined? Third, is the software manufacturer financially solvent and reliable? Finally, does the total cost of purchasing, installing and maintaining the software compare favourably to the expected business benefits?

Some off-the-shelf programs can be modified, in effect blending the off-the-shelf and customized approaches. For example, El Camino Hospital in Mountain View, California, customized Microsoft's e-health management system, Amalga, to track patients with the H1N1 flu and those that may have been exposed to it.

Another approach to obtaining a customized software package is to use an application service provider. An **application service provider (ASP)** is a company that can provide the software, support and computer hardware on which to run the software from the user's facilities over a network. Some vendors refer to the service as on-demand software.

Today, many companies are running software on the web. This approach is called **Software as a Service (SaaS)**, which allows businesses to subscribe to web-delivered application software. In most cases, the company pays a monthly service charge or a per-use fee. Guardian Life Insurance, for example, implemented an actuarial application by using Amazon's Ec2 SaaS approach.

According to the CIO of the company, 'We don't do anything because it's Cloud. But if the financials look right, if the risk profile looks right, if the richness and robustness look right, we go with that solution'. Like ASP, SaaS providers maintain software on their own servers and provide access to it over the Internet. SaaS usually uses a web browser-based user interface. Many business activities are supported by SaaS. Vendors include Oracle, SAP, Net Suite, Salesforce and Google. Tidewell, a hospice that serves about 8000 Florida families, acquired software from Salesforce.com to save money and streamline its operations. SaaS can reduce expenses by sharing its running applications across many businesses. Some people, however, are concerned about the security of data and programs on the Internet using the SaaS approach. SaaS and new web development technologies have led to a new paradigm in computing called cloud computing. Cloud computing refers to the use of computing resources, including software and data storage, on the Internet (the cloud) rather than on local computers. Google, for example, is launching new personal computers built by Samsung and Acer called Chromebooks that include only an Internet browser. All of the software applications are accessed through an Internet connection. Businesses can get a Chromebook and Chrome OS for under €22 per user. In addition, Google's email and productivity suite can be purchased for about €37 per month per individual. Rather than installing, storing and running software on your own computer, with cloud computing you use the web browser to access software stored and delivered from a web server. Typically the data generated by the software is also stored on the web server. For example, Tableau software allows users to import databases or spreadsheet data to create powerful visualizations that provide useful information. Cloud computing also provides the benefit of being able to easily collaborate with others by sharing documents on the Internet.

ASP, SaaS and cloud computing, however, involve some risks. For example, sensitive information could be compromised in a number of ways, including unauthorized access by employees or computer hackers; the host might not be able to keep its computers and network up and running as consistently as necessary; or a disaster could disable the host's data Centre, temporarily putting an organization out of business. In addition, these approaches are not accepted and used by everyone. According to one survey, about 15 per cent of enterprises are either using the SaaS approach or plan to use the approach in the next year. It can also be difficult to integrate the SaaS approach with existing software. According to the CIO of Hostess Brands, 'Figuring out integration requirements and how providers handle those and getting everything in sync have been among our tougher challenges'.

### Personal Application Software

Hundreds of computer applications can help people at school, home and work. New computer software under development and existing GPS technology, for example, will allow people to see 3D views of where they are, along with directions and 3D maps to where they would like to go. Absolute software, which uses GPS technology, helps people and organizations retrieve stolen computers. The company has recovered almost 10 000 devices worth over €7 million. According to a special investigator for the Detroit Public Schools (DPS), 'At DPS, we've already seen the effect of these recoveries. We would have never recovered any of the 300 plus laptops stolen from our district without the aid of Absolute Software'.

The features of some popular types of personal application software are summarized in Table 4.4 (overleaf). In addition to these general-purpose programs, thousands of other personal computer applications perform specialized tasks that help you do your taxes, get in shape, lose weight, get medical advice, write wills and other legal documents, repair your computer, fix your car, write music, and edit your 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.

## Word-Processing

Word-processing applications are installed on most PCs today. These applications come with a vast array of features, including those for checking spelling, creating tables, inserting formulas, creating graphics and much more. Much of the work required to create this book used the popular word-processing software, Microsoft Word.

A team of people can use a word-processing program to collaborate on a project. This book was written in part using Google Docs, a cloud-based word processing package which makes it easy for two or more people to contribute to one file.

**Table 4.4** Examples of Personal Application Software

Type of Software	Explanation	Example
Word-processing	Create, edit and print text documents	Microsoft Word Google Docs Apple Pages Open Office Writer
Spreadsheet	Provide a wide range of built-in functions for statistical, financial, logical, database, graphics, and date and time calculations	Microsoft Excel IBM Lotus 1-2-3 Google Spreadsheet Apple Numbers Open Office Calc
Database	Store, manipulate and retrieve data	Microsoft Access IBM Lotus Approach Borland dBASE Google Base Open Office Base
Graphics	Develop graphs, illustrations and drawings	Adobe Illustrator Adobe FreeHand Microsoft PowerPoint Open Office Impress
Project management	Plan, schedule, allocate and control people and resources (money, time and technology) needed to complete a project according to schedule	Microsoft Project Symantec On Target Scitor Project Scheduler Symantec Time Line
Financial management	Provide income and expense tracking and reporting to monitor and plan budgets (some programs have investment portfolio management features)	Intuit Quicken
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	QuarkXPress Microsoft Publisher Adobe PageMaker Corel Ventura Publisher Apple Pages

## Spreadsheet Analysis

Spreadsheets are powerful tools for manipulating and analyzing numbers and alphanumeric data. Individuals and organizations use spreadsheets. Features of spreadsheets include formulas, statistical analysis, built-in business functions, graphics, limited database capabilities and much more. The business functions include calculation of depreciation, present value, internal rate of return and the monthly payment on a loan, to name a few. Optimization is another powerful feature of many spreadsheet programs. Optimization allows the spreadsheet to maximize or minimize a quantity subject to certain constraints. For example, a small furniture manufacturer that produces chairs and tables might want to maximize its profits. The constraints could be a limited supply of lumber, a limited number of workers who can assemble the chairs and tables, or a limited amount of various hardware fasteners that might be required. Using an optimization feature, such as Solver in Microsoft Excel, the spreadsheet can determine what number of chairs and tables to produce with labour and material constraints to maximize profits.

## Database Applications

Database applications are ideal for storing, organizing and retrieving data. These applications are particularly useful when you need to manipulate a large amount of data and produce reports and documents. Database manipulations include merging, editing and sorting data. The uses of a database application are varied. You can keep track of a CD collection, the items in your apartment, tax records and expenses. A student club can use a database to store names, addresses, phone numbers and dues paid. In business, a database application can help process sales orders, control inventory, order new supplies, send letters to customers and pay employees. Database management systems can be used to track orders, products and customers; analyze weather data to make forecasts for the next several days; and summarize medical research results. A database can also be a front end to another application. For example, you can use a database application to enter and store income tax information and then export the stored results to other applications, such as a spreadsheet or tax-preparation application.

## Presentation Graphics Program

It is often said that a picture is worth a thousand words. With today's graphics programs, it is easy to develop attractive graphs, illustrations and drawings that assist in communicating important information. Presentation graphics programs can be used to develop advertising brochures, announcements and full-colour presentations, and to organize and edit photographic images. If you need to make a presentation at school or work, you can use a special type of graphics program called a presentation application to develop slides and then display them while you are speaking. Because of their popularity, many colleges and departments require students to become proficient at using presentation graphics programs.

Many graphics programs, including Microsoft PowerPoint, consist of a series of slides. Each slide can be displayed on a computer screen, printed as a handout or (more commonly) projected onto a large viewing screen for audiences. Powerful built-in features allow you to develop attractive slides and complete presentations. You can select a template for a type of presentation, such as recommending a strategy for managers, communicating news to a sales force, giving a training presentation or facilitating a brainstorming session. The presentation graphics program lets you create a presentation step-by-step, including applying colour and attractive formatting. You can also design a custom presentation using the many types of charts, drawings and formatting available. Most presentation graphics programs come with many pieces of clip art, such as drawings and photos of people meeting, medical equipment, telecommunications equipment, entertainment and much more.

## Personal Information Managers

*Personal information management (PIM)* software helps people, groups and organizations store useful information, such as a list of tasks to complete or a set of names and addresses. PIM software usually provides an appointment calendar, an address book or contacts list, and a place to take notes. In addition, information in a PIM can be linked. For example, you can link an appointment with a sales manager in the calendar to information on the sales manager in the address book. When you click the appointment in the calendar, a window opens displaying information on the sales manager from the address book. Microsoft Outlook is an example of very popular PIM software. Increasingly, PIM software is moving online where it can be accessed from any Internet-connected device.

Some PIMs allow you to schedule and coordinate group meetings. If a computer or handheld device is connected to a network, you can upload the PIM data and coordinate it with the calendar and schedule of others using the same PIM software on the network. You can also use

some PIMs to coordinate emails inviting others to meetings. As users receive their invitations, they click a link or button to be automatically added to the guest list.

## Software Suites and Integrated Software Packages

A **software suite** is a collection of single programs packaged together in a bundle. Software suites can include a word-processor, spreadsheet program, database management system, graphics program, communications tools, organizers and more. Some suites support the development of web pages, note taking and speech recognition so that applications in the suite can accept voice commands and record dictation. Software suites offer many advantages. The software programs have been designed to work similarly so that 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.

Microsoft Office, Corel WordPerfect Office, Lotus SmartSuite and Sun Microsystems Open-Office are examples of popular general-purpose software suites for personal computer users. Microsoft Office has the largest market share. Most of these software suites include a spreadsheet program, word processor, database program and graphics presentation software. All can exchange documents, data and diagrams (see Table 4.5). 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 4.5** Major Components of Leading Software Suites

Personal Productivity Function	Microsoft Office	Lotus Symphony	Corel WordPerfect Office	Open Office	Apple iWork	Google
Word-Processing	Word	Documents	WordPerfect	Writer	Pages	Docs
Spreadsheet	Excel	Spreadsheets	Quattro Pro	Calc	Numbers	Spreadsheet
Presentation Graphics	PowerPoint	Presentations	Presentations	Impress and Draw	Keynote	Presentation
Database	Access			Base		

In addition to suites, some companies produce integrated application packages that contain several programs. For example, Microsoft Works is one program that contains a basic word processor, spreadsheet, database, address book, calendar and other applications. Although not as powerful as stand-alone software included in software suites, integrated software packages offer a range of capabilities for less money. QuickOffice can be used on tablet computers and smartphones to read and edit Microsoft Office documents. Onlive can also be used to open and edit Microsoft Office documents on an Apple iPad. Some integrated packages cost about €75. Some companies offer web-based productivity software suites that require no installation – only a web browser. Zoho, Google and Thinkfree offer free online word processor, spreadsheet, presentation and other software that requires no installation on the PC. Adobe has developed Acrobat.com, a suite of programs that can be used to create and combine Adobe PDF (Portable

Document Format) files, convert PDF files to Microsoft Word or Excel files, create web forms and more. After observing this trend, Microsoft responded with an online version of some of its popular Office applications. Office 365 offers basic software suite features over the Internet using cloud computing. The cloud-based applications can cost €7 per user per month depending on the features used. Microsoft offers plans for professionals and small businesses, enterprises and education. Some believe that Office 365 has advantages over many other online suites. According to the director of online services at Microsoft, 'With Office 365, businesses of all sizes can get the same robust capabilities that have given larger businesses an edge for years'. The city of Winston-Salem, North Carolina, for example, used Office 365 to save money and place software applications on the Internet. According to the CIO of the city, 'I have to improve technology with a constrained budget. Because we were able to package Microsoft cloud and local products in one enterprise agreement, we ended up with more bang for no additional cost'. The online versions of Word, Excel, PowerPoint and OneNote are tightly integrated with Microsoft's desktop Office suite for easy sharing of documents among computers and collaborators.

### **Other Personal Application Software**

In addition to the software already discussed, people can use many other interesting and powerful application software tools. In some cases, the features and capabilities of these applications can more than justify the cost of an entire computer system. TurboTax, for example, is a popular tax-preparation program in the US. You can find software for creating web pages and sites, composing music, and editing photos and videos. Many people use educational and reference software and entertainment, games and leisure software. Gameplaying software is popular and can be very profitable for companies that develop games and various game accessories, including virtual avatars such as colourful animals, fish and people. Game-playing software has even been used as therapy for young children and adults recovering from cancer and other diseases. According to a hospital executive, 'It's a very motivating tool for the patients. It's visual, the feedback is instant, and it's fun'. Some believe that online game players may have solved an important AIDS research question. Engineers, architects and designers often use computer-aided 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 often have a number of courses in statistics that use this type of application software. Two popular applications in the social sciences are SPSS and SAS.

### **Mobile Application Software**

The number of applications (apps) for smartphones and other mobile devices has exploded in recent years. Besides the valuable mobile applications that come with these devices, tens of thousands of applications have been developed by third parties. For example, iPhone users can download and install thousands of applications using Apple's App Store. Many iPhone apps are free, while others range in price from 99 cents to hundreds of euros. Thousands of mobile apps are available in the Android Market for users of Android handsets. Microsoft and other software companies are also investing in mobile applications for devices that run on its software. 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. This approach 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. New facial-recognition software developed at Carnegie Mellon University was able to correctly identify about one-third of the people tested from a simple photograph from a mobile phone or camera. Facial-recognition

software, however, could be a potential invasion of privacy. The market for mobile application software for smartphones and mobile devices could reach €60 billion by 2017. Table 4.6 lists a few mobile application categories.

**Table 4.6** Categories of Mobile Applications for Smartphones

Category	Description
Books and reference	Access e-books, subscribe to journals or look up information in dictionaries on Wikipedia
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 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, Rock Band and The Sims
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, 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 camera phone

Productivity and utilities	Create grocery lists, practise PowerPoint presentations, work on spreadsheets, synchronize with PC files and more
Social networking	Connect with others via major social networks including Facebook, Twitter and MySpace
Sports	Keep up with your favourite 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



**Principles Of Business Information Systems 3<sup>rd</sup> Edition, Ralph Stair,George Reynolds and Thomas Chesney Chapter 4 Page Number 136**

Workgroup application software is designed to support teamwork, whether team members are in the same location or dispersed around the world. This support can be accomplished with software known as groupware that helps groups of people work together effectively. Microsoft Exchange Server, for example, has groupware and email features. Also called collaborative software, this approach allows a team of managers to work on the same production problem, letting them share their ideas and work via connected computer systems.

Examples of workgroup software include group-scheduling software, electronic mail and other software that enables people to share ideas. Lotus Notes and Domino are examples of workgroup software from IBM. 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. Google provides options in its online applications that allow users to share documents, spreadsheets, presentations, calendars and notes with other specified users or everyone on the web. This sharing makes it convenient for several people to contribute to a document without concern for software compatibility or storage. Google also provides a tool for creating webbased forms and surveys. When invited parties fill out the form, the data is stored in a Google spreadsheet.

### **Enterprise Application Software**

Software that benefits an entire organization – enterprise application software – can also be developed specifically for the business or purchased off the shelf. The Copper Mountain Ski Resort in the US used Visual One software from Agilysys to manage apartment blocks and other real estate holdings. According to the information technology director, ‘We need a dynamic software system that allows us to manage our rather complex condominium lodging model’. More accountancy firms are acquiring sophisticated tax software for their corporate clients. According to a manager at the Citrin Cooper CPA firm in the US, ‘The number of available software programs has expanded in recent years. At the same time, more specialized software is available that focuses on individual industries’. Verafin has developed specialized software that helps banks find people and organizations that attempt to launder money. The software works by looking for suspicious transactions or patterns in large databases of financial transactions.

Enterprise software also helps managers and workers stay connected. Traditional email might not be the best approach. According to the vice president of a large publishing company, ‘If you have a really important message you need to get to people; email is where it goes to die. People need a sense of ambient awareness’. This type of awareness can come from enterprise software and group support systems, first introduced in Chapter 1. The following are some applications that can be addressed with enterprise software:

Accounts payable	Invoicing
Accounts receivable	Manufacturing control
Airline industry operations	Order entry
Automatic teller systems	Payroll
Cash-flow analysis	Receiving
Cheque processing	Restaurant management
Credit and charge card administration	Retail operations
Distribution control	Sales ordering

Fixed asset accounting	Savings and time deposits
General ledger	Shipping
Human resource management	Stock and bond management
Inventory control	Tax planning and preparation

According to a survey, cost is the greatest concern for selecting enterprise software. Other factors include the difficulty to install and manage enterprise software and the ability to integrate enterprise software with other software applications. Increasingly, enterprise application software is being found on smartphones and mobile devices. In one survey, over 80 per cent of respondents believe that having enterprise application software that can be used on smartphones and mobile devices was an important factor in selecting enterprise software.

**Application Software for Information, Decision Support and Competitive Advantage**  
Specialized application software for information, decision support and competitive advantage is available in every industry. For example, many schools and colleges use Blackboard or other learning management software to organize class materials and grades. Genetic researchers, as another example, are using software to visualize and analyze the human genome. Music executives use decision support software to help pick the next hit song. Companies seeking a competitive advantage, first discussed in Chapter 2, are increasingly building or developing their own enterprise software. According to the CIO of the New York Stock Exchange Euronext, ‘Building is not easy. If it were, everyone would do it and we’d get no edge’. But how are all these systems actually developed and built? The answer is through the use of programming languages, which is discussed next.

#### 4.4 Programming Languages

Both system and application software are written in coding schemes called programming languages. The primary function of a **programming language** is to provide instructions to the computer system so that it can perform a processing activity. Information systems professionals work with programming languages, which are sets of keywords, 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’. As discussed in Chapter 3, 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

**Table 4.7** Evolution of Programming Languages

Generation	Language	Approximate Development Date	Sample Statement or Action
First	Machine language	1940s	00010101
Second	Assembly language	1950s	MVC
Third	High-level language	1960s	READ SALES
Fourth	Query and database languages	1970s	PRINT EMPLOYEE NUMBER IF GROSS PAY > 1000
Beyond Fourth	Natural and intelligent languages	1980s	IF gross pay is greater than 40, THEN pay the employee overtime pay

names such as SALES, PAYRATE and TOTAL follow the syntax because they start with a letter, whereas variables such as %INTEREST, \$TOTAL and #POUNDS do not.

### The Evolution of Programming Languages

The desire for faster, more efficient, more powerful information processing has pushed the development of new programming languages. The evolution of programming languages is typically discussed in terms of generations of languages (see Table 4.7).

### Visual, Object-Oriented and Artificial Intelligence Languages

Today, programmers often use visual and object-oriented languages. In the future, they may be using artificial intelligence languages to a greater extent. In general, these languages are easier for nonprogrammers to use, compared with older generation languages.

Visual programming uses a graphical or ‘visual’ interface combined with text-based commands. Prior to visual programming, programmers were required to describe the windows, buttons, text boxes and menus that they were creating for an application by using only textbased programming language commands. With visual programming, the software engineer drags and drops graphical objects such as buttons and menus onto the application form. Then, using a programming language, the programmer defines the capabilities of those objects in a separate code window. Visual Basic was one of the first visual programming interfaces. Today, software engineers use Visual Basic.NET, Visual C++, Visual C# (# is pronounced ‘sharp’ as in music) and other visual programming tools.

Many people refer to visual programming interfaces such as Visual C# as ‘visual programming languages’. This custom is fine for casual references, but a lesser-known category of programming language is more truly visual. With a true visual programming language, programmers create software by manipulating programming elements only graphically, without the use of any text-based programming language commands. Examples include Alice, Mindscript and Micro- soft Visual Programming Language (VPL). Visual programming languages are ideal for teaching novices the basics about programming without requiring them to memorize programming language syntax.

Some programming languages separate data elements from the procedures or actions that will be performed on them, but another type of programming language ties them together into units

called objects. An object consists of data and the actions that can be performed on the data. For example, an object could be data about an employee and all the operations (such as payroll calculations) that might be performed on the data. Programming languages that are based on objects are called object-oriented programming languages. C ++ and Java are popular generalpurpose object-oriented programming languages. Languages used for web development, such as JavaScript and PHP, are also object oriented. In fact, most popular languages in use today take the object-oriented approach – and for good reason.

Using object-oriented programming languages is like constructing a building using prefabricated modules or parts. The object containing the data, instructions and procedures is a programming building block. The same objects (modules or parts) can be used repeatedly. One of the primary advantages of an object is that it contains reusable code. In other words, the instruction code within that object can be reused in different programs for a variety of applications, just as the same basic prefabricated door can be used in two different houses. An object can relate to data on a product, an input routine or an order-processing routine. An object can even direct a computer to execute other programs or to retrieve and manipulate data. So, a sorting routine developed for a payroll application could be used in both a billing program and an inventory control program. By reusing program code, programmers can write programs for specific application problems more quickly. By combining existing program objects with new ones, programmers can easily and efficiently develop new object-oriented programs to accomplish organizational goals.

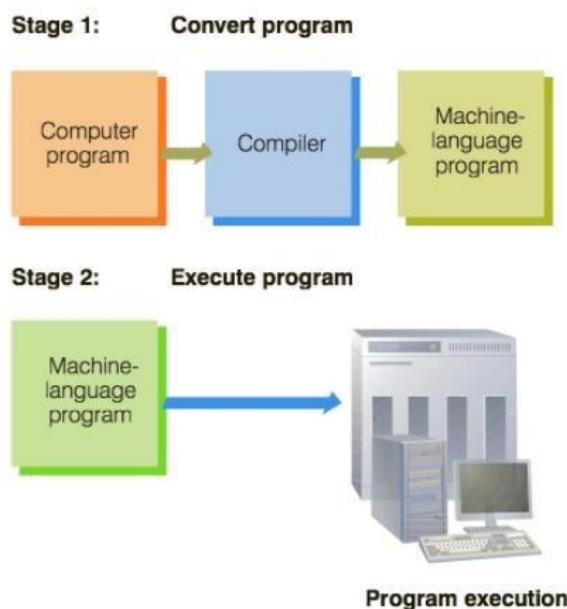
Programming languages used to create artificial intelligence or expert systems applications are often called fifth-generation languages (5GLs). Fifth-generation languages are sometimes called natural languages because they use even more English-like syntax than 4GLs. They allow programmers to communicate with the computer by using normal sentences. For example, computers programmed in fifth-generation languages can understand queries such as ‘How many athletic shoes did our company sell last month?’

With third-generation and higher-level programming languages, each statement in the language translates into several instructions in machine language. A special software program called a **compiler** converts the programmer’s source code into the machine- language instructions, which consist of binary digits, as shown in Figure 4.4 (overleaf). A compiler creates a twostage process for program execution. First, the compiler translates the program into a machine language; second, the CPU executes that program. Another 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.

The majority of software used today is created using an integrated development environment. An integrated development environment, or 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, a compiler and interpreter, programming automation tools, a debugger (a tool for finding errors in the code) and other tools that provide convenience to the developer.

Software Development Kits (SDKs) often serve the purpose of an IDE for a particular platform. For example, software developers for Google’s Android smartphone platform use Java (an object-oriented programming language) along with the Eclipse SDK. They use special code

**Figure 4.4** How a Compiler Works A compiler translates a complete program into a complete set of binary instructions (Stage 1). After this is done, the CPU can execute the converted program in its entirety (Stage 2).



libraries provided by Google for Android functionality, and they test out their applications in an Android Emulator.

IDEs and SDKs have made software development easier than ever. Many novice coders and some who might have never considered developing software are publishing applications for popular platforms such as Facebook and the iPhone.

## 4.5 Software Issues and Trends

Because software is such an important part of today's computer systems, issues such as software bugs, licensing, upgrades, global software support and taxation have received increased attention. The governor of Colorado and the Colorado General Assembly, for example, repealed a tax on certain types of software. The tax repeal should help Colorado's software industry. Software can also be harmful to companies and countries. For example, a TV programme might have shown software to its viewers designed to attack websites in another country.

### Software Bugs

A software bug is a defect in a computer program that keeps it from performing as it is designed to perform. Some software bugs are obvious and cause the program to terminate unexpectedly. Other bugs are subtler and allow errors to creep into your work. Computer and software vendors say that as long as people design and program hardware and software, bugs are inevitable. The following list summarizes tips for reducing the impact of software bugs:

- Register all software so that you receive bug alerts, fixes and patches. ▪ Check the manual or read-me files for solutions to known problems.
- Access the support area of the manufacturer's website for patches.
- Install the latest software updates.
- Before reporting a bug, make sure that you can recreate the circumstances under which it occurs.
- After you can recreate the bug, call the manufacturer's tech support line.

- Consider waiting before buying the latest release of software, to give the vendor a chance to discover and remove bugs. Many schools and businesses don't purchase software until the first major revision with patches is released.

### Copyrights and Licences

Most companies aggressively guard and protect the source code of their software from competitors, lawsuits and other predators. As a result, most software products are protected by law using copyright or licensing provisions. Those provisions can vary, however. In some cases, you are given unlimited use of software on one or two computers. This stipulation is typical with many applications developed for personal computers. In other cases, you pay for your usage. If you use the software more, you pay more. This approach is becoming popular with software placed on networks or larger computers. Most of these protections prevent you from copying software and giving it to others. Some software now requires that you register or activate it before it can be fully used. This requirement is another way software companies prevent illegal distribution of their products.

When people purchase software, they don't actually own the software, but rather they are licensed to use the software on a computer. This is called a single-user licence.

A **single-user licence** permits you to install the software on one or more computers, used by one person. A single-user licence does not allow you to copy and share the software with others. Table 4.8 describes different types of software licences. Licences that accommodate multiple users are usually provided at a discounted price.

**Table 4.8** Software Licences

Licence	Description
Single-user licence	Permits you to install the software on one computer, or sometimes two computers, used by one person
Multiuser licence	Specifies the number of users allowed to use the software and can be installed on each user's computer. For example, a 20-user licence can be installed on 20 computers for 20 users
Concurrent-user licence	Designed for network-distributed software, this licence allows any number of users to use the software but only a specific number of users to use it at the same time
Site licence	Permits the software to be used anywhere on a particular site, such as a college campus, by everyone on the site

### Freeware and Open-Source Software

Some software developers are not as interested in profiting from their intellectual property as others and have developed alternative copyrights and licensing agreements. Freeware is software that is made available to the public for free.<sup>88</sup> Software developers might give away their product for several reasons. Some want to build customer interest and name recognition. Others simply don't need the money and want to make a valuable donation to society. Still others, such as those associated with the Free Software Foundation ([www.fsf.org](http://www.fsf.org)), believe that all software should be free. Some freeware is placed in the public domain where anyone can use the software free of charge. (Creative works that reach the end of their term of copyright revert to the public domain.) Table 4.9 shows some examples of freeware.

**Table 4.9** Examples of Freeware

Software	Description
Thunderbird	Email and newsgroup software
Pidgin	Instant messaging software
Adobe Reader	Software for viewing Adobe PDF documents
AVG Anti-Virus	Antivirus security software
WinPatrol	Antispyware software
IrfanView	Photo-editing software

Freeware differs slightly from free software. Freeware simply implies that the software is distributed for free. The term free software was coined by Richard Stallman and the Free Software Foundation and implies that the software is not only freeware, but it is also open source. **Open-source software** is distributed, typically for free, with the source code also available so that it can be studied, changed and improved by its users.<sup>89</sup> Open-source software evolves from the combined contribution of its users. The Code for America (CFA) organization, for example, used open- source software in Boston and other American cities to help cities and municipalities solve some of their traffic problems, such as locating fire hydrants that might be completely covered with snow in the winter.<sup>90</sup> CFA made its efforts free to other cities and municipalities. Table 4.10 provides examples of popular open-source software applications.

**Table 4.10** Examples of Open-Source Software

Software	Category
Linux	Operating system
Open Office	Application software
MySQL	Database software
Mozilla Firefox	Internet browser
Gimp	Photo editing
OpenProj	Project management
Grisbi	Personal accounting

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 Licence (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.

Software under the GPL is typically protected by a ‘copy left’ (a play on the word copyright), which requires that any copies of the work retain the same licence. A copy left work cannot be owned by any one person, and no one is allowed to profit from its distribution. The Free Software Directory (<http://directory.fsf.org>) lists over 5000 software titles in 22 categories licensed under the GPL.

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 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 the 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 for user support or solving problems with the software. Licensed software comes with guarantees and support services, while open-source software does not. Still, many businesses appreciate the additional freedom that open-source software provides. The question of software support is 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 freephone support number or access its website. 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 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. 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 Send mail, Inc., for Send mail. These companies offer high-quality, for-pay technical assistance.

## Software Upgrades

Software companies revise their programs periodically. Software upgrades 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. Should the newest version be purchased when it is released? Some users do not always get the most current software upgrades or versions unless it includes significant improvements or capabilities. Developing an upgrading 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.

## Global Software Support

Large global companies have little trouble persuading vendors to sell them software licences for even the most far-flung outposts of their company. But can those same vendors provide adequate support for their software customers in all locations? Supporting local operations is one of the biggest challenges IS teams face when putting together standardized companywide systems. Slower technology growth markets, such as Eastern Europe and Latin America, might not have any official vendor presence. Instead, large vendors such as Sybase, IBM and Hewlett-Packard typically contract with local providers to support their software.

One approach that has been gaining acceptance in North America is to outsource global support to one or more third-party distributors. The user company can still negotiate its licence with the software vendor directly, but it then hands the global support contract to a third-party supplier. The supplier acts as a middleman between software vendor and user, often providing distribution, support and invoicing.

In today's computer systems, software is an increasingly critical component. Whatever approach people and organizations take to acquire software, everyone must be aware of the current trends in the industry. Informed users are wise consumers.



## Chapter Summary

Systems and application software are critical in helping individuals and organizations achieve their goals. Software consists of programs that control the workings of the computer hardware. The two main categories of software are systems software and application software. System software is a collection of programs that interacts between hardware and application software and includes operating systems, utility programs and middleware. Application software can be proprietary or off the shelf and enables people to solve problems and perform specific tasks.

Organizations use off-the-shelf application software for common business needs and proprietary application software to meet unique business needs and provide a competitive advantage. Organizations should choose programming languages with functional characteristics that are appropriate for the task at hand and well suited to the skills and experience of the programming staff.

The software industry continues to undergo constant change; users need to be aware of recent trends and issues to be effective in their business and personal life. Software bugs, software licensing and copyrighting, open-source software, shareware and freeware, multiorganizational software development, software upgrades and global software support are all important software issues and trends.



### Review Questions (Short)

1. Why would anyone write open source software?
2. Define Syntax Examples
3. Name two visual programming languages
4. What are the advantages of off-the-shelf software?
5. Should an IT student learn program and why?



### Review Questions (Long)

1. Give four examples of application software.
2. Name an embedded operating system , PC operating system and a workgroup operating system
3. Describe the GPL software bug?
4. What is a difference between freeware and open source software? 5. List four tasks performed by operating system



### Review Questions (MCQ)

1. Software can broadly be separated into and software.
  - A. Operating and Application
  - B. Application and Operating
  - C. System and Application
  - D. Open and Embedded
  
2. Linux was developed in 1991 by.
  - A. Linus Masilo
  - B. Linus Torvalds
  - C. Bill Linus
  - D. Lee Barns
  
3. The PC operation system by Google is called.
  - A. Google
  - B. Google
  - C. Chrome
  - D. Yahoo!
  
4. An operating system designed for a device such as a smartphone is often known as .
  - A. Imbedded
  - B. Fixed embedded
  - C. Pre-installed
  - D. Embedded
  
5. One-of-a-kind software developed for a specific business application is called .
  - A. Proprietary bespoke software
  - B. Proprietary software
  - C. Open source software
  - D. Closed source software



## Case Studies / Projects

### Ready. Steady. Go!

On 16 March 2016, world Go champion Lee Sedol was beaten four to one by Google's artificial intelligence program AlphaGo, a feat many AI experts felt was more than ten years away. More complex than chess, Go is a two player Chinese board game played with white and black stones where the goal is to surround more board territory than the opponent. There are  $10^{170}$  board configurations. That's more than the number of atoms in the universe. Developed by London-based, Google-owned, company DeepMind, AlphaGo was not taught how to play Go – in fact it taught itself how to play. Alpha-Go's algorithm is a general purpose problem solver that uses a technique known as deep-learning to interpret the game's patterns. DeepMind's cofounder, Demise Hassabis, says the same approach could be used on many real world problems. These include making medical diagnoses and improving climate change models. Richard Sutton, a computer scientist who studies learning says, 'Understanding the mind is an incredibly difficult problem, but games allow you to break it down into parts that you can study', which is, which is why the team behind AlphaGo started with a game. AlphaGo is inspired by the design of a human brain and thinks by sending signals through a vast network of simulated neurons. Learning involves adjusting the strength of the signals so that they affect different parts of the brain differently.

### QUESTIONS

1. Why are games a good test bed for AI?
2. Why is it so difficult to imitate human intelligence? (Hint: try to define human intelligence first.)
3. What business applications could deep-learning be used for?
4. Should Lee Sedol keep playing Go?

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Principles Of Business Information Systems 3<sup>rd</sup> Edition, Ralph Stair, George Reynolds and Thomas Chesney Chapter 4 Page Number 151



## Case Studies / Projects

### Software Cuts Legal Costs

Startup companies face many challenges. These include finding and paying for employees, finding and renting property and machinery, reaching customers, providing quality after sales services and services to write employment contracts, check rental agreements and patent products.

Digital marketer, Josh Steimle less than positive feelings about attorneys – until I needed to hire one. Now I have a huge amount of respect for the attorneys I work with. They provide services that are valuable to my business. I'm less enamoured, however, with government regulations that force me into a position of requiring so many of their services'. These regulations cover becoming incorporated, drafting employment contracts and registering trademarks, legal services that become very costly very quickly.

business with the expertise it needs to solve routine would take the mystery out of legal services, and give business owners the know-how and confidence to make business decisions that would protect and save significant time and money'.

#### Questions

- 1 What concerns might clients have when using this service? How could Dragon Law handle these?
- 2 Are there any other services that could be
- 3 Is Dragon Law a positive advance for the legal profession?
4. What are the essential features of a signature? How could these be captured in your opinion? Does someone really have to drag their finger across a tablet computer?



**Principles Of Business Information Systems 3<sup>rd</sup> Edition, Ralph Stair, George Reynolds and Thomas Chesney Chapter 4 Page Number 149**



### LEARNING OUTCOMES

After reading this Section of the guide, the learner should be able to:

#### Learning Objectives

- Define general data management concepts and terms, highlighting the advantages of the database approach to data management.
- Describe the relational database model and outline its basic features.
- Identify the common functions performed by all database management systems and identify popular user database management systems.
- Identify and briefly discuss current database applications

### Introduction

Having different types of hardware and software, we now turn to look at using that hardware and software to store and process data entered into computer systems every day. In this chapter, you will learn about database management systems and how they can help you. If you become a marketing manager, you can access a vast store of data on existing and potential customers from surveys, their web habits and their past purchases. This information can help you sell products and services. If you work in business law, you will have access to past cases and legal opinions from sophisticated legal databases. This information can help you win cases and protect your organization legally. If you become a human resource (HR) manager, you will be able to use databases to analyse the impact of pay rises, employee benefits and retirement contributions on long-term costs to your company. Using database management systems will likely be a critical part of your job. In this chapter, you will see how you can use data mining to extract valuable information to help you succeed. This chapter starts by introducing basic concepts of database management systems.

### **5.1 Data Management and Data Modelling**

At the centre of almost every information system is a database, used to store data so that it can be processed to provide useful information. A database is used by almost every firm to record a history of that firm's transactions. This historical data can be hugely useful in uncovering patterns and relationships the firm had never even considered before, a practice known as 'data mining', something that is explained later in this chapter. The most common type of database

is a relational database, so-named because the basic structure for storing data is a table, and the word relation is another name for a table. A **relational database** is defined as a series of related tables, stored together with a minimum of duplication to achieve a consistent and controlled pool of data.

So a relational database is made up of a number of tables. In loose terms, each table stores the data about someone or something of interest to the firm. This someone or something is known as an **entity**. (We will see later that sometimes the data about one entity is stored in two or more tables, and sometimes the data about two or more entities are stored in one table.) For example, a small business selling office furniture might have a customer table to store all the data about their customers, a supplier table to store information about suppliers and an order table that records all the orders that are placed by its customers. In this example, there are three entities – customer, order and supplier.

The rows in a table collect together all the data about one specific entity. For example, in the customer table, each row stores all the data about one particular customer – Jane Smith, for instance, or Desmond Paton. These rows are known as **records**. The columns in a table are the specific items of data that get stored; for example, first name, and surname or telephone number. These columns are known as **fields** or attributes.

So a database is made up of tables, which are made up of records, which are made up of fields. This is illustrated in Figure 5.1 using the customer table example. Notice that in the figure each customer has been given a unique customer number. This is because, as can be seen, there are two customers called Jane Wilson. Both work for the same company and therefore have the same address and phone number. The database needs some way of differentiating between them, and that is the job of the customer number, which is the primary key. Every table should have a primary key field used to identify individual records, and also to create relationships between tables, something we will examine next.

Customer_Number	First_Name	Surname	Address1	Address2
10	Jane	Wilson	London Road	Oxford
11	John	Smith	Quai d'Orsay	Paris
12	Jane	Wilson	London Road	Oxford
13	Desmond	Paton	Marshall Street	Johannesburg
14	Susan	Haynes	Baker Street	London

**Figure 5.1** The Customer Table for an Office Furniture Seller

 Read

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The advantages and disadvantages of using a relational database to store data are listed in Table 5.1.

**Table 5.1** Advantages and Disadvantages of the Database Approach

Advantages	Explanation
Improved strategic use of corporate data	Accurate, complete, up-to-date data can be made available to decision makers where, when and in the form they need it. The database approach can also give greater visibility to the organization's data resource
Reduced data redundancy	Data is organized by the database management system (DBMS) and stored in only one location. This results in more efficient use of system storage space
Improved data integrity	With the traditional approach, some changes to data were not reflected in all copies of the data kept in separate files. This is prevented with the database approach because no separate files contain copies of the same piece of data
Easier modification and updating	The DBMS coordinates updates and data modifications. Programmers and users do not have to know where the data is physically stored. Data is stored and modified once. Modification and updating is also easier because the data is stored in only one location in most cases
Data and program independence	The DBMS organizes the data independently of the application program, so the application program is not affected by the location or type of data. Introduction of new data types not relevant to a particular application does not require rewriting that application to maintain compatibility with the data file
Better access to data and information	Most DBMSs have software that makes it easy to access and retrieve data from a database. In most cases, users give simple commands to get important information. Relationships between records can be more easily investigated and exploited, and applications can be more easily combined
Standardization of data access	A standardized, uniform approach to database access means that all application programs use the same overall procedures to retrieve data and information

*(continued)*

## Relationships Between Tables

**Table 5.1** *Continued*

<b>Advantages</b>	<b>Explanation</b>
A framework for program development	Standardized database access procedures can mean more standardization of program development. Because programs go through the DBMS to gain access to data in the database, standardized database access can provide a consistent framework for program development. In addition, each application program needs to address only the DBMS, not the actual data files, reducing application development time
Better overall protection of the data	Accessing and using centrally located data is easier to monitor and control. Security codes and passwords can ensure that only authorized people have access to particular data and information in the database, thus ensuring privacy
Shared data and information resources	The cost of hardware, software and personnel can be spread over many applications and users. This is a primary feature of a DBMS
<b>Disadvantages</b>	<b>Explanation</b>
More complexity	DBMS can be difficult to set up and operate. Many decisions must be made correctly for the DBMS to work effectively. In addition, users have to learn new procedures to take full advantage of a DBMS
More difficult to recover from a failure	With the traditional approach to file management, a failure of a file affects only a single program. With a DBMS, a failure can shut down the entire database
More expensive	DBMS can be more expensive to purchase and operate. The expense includes the cost of the database and specialized personnel, such as a database administrator, who is needed to design and operate the database. Additional hardware might also be required

Activate Windows  
Go to [DC settings to activate](#) 

Consider the customer table (Figure 5.1) and the order table (Figure 5.2) in the office furniture seller's database. It should be obvious that there is a relationship between these two – the firm needs to know which orders have been placed by which customer, otherwise they wouldn't know where to ship the goods or who to charge for them. How this relationship is created in a database is shown in Figure 5.2, which shows the order table. The fourth record in the table is an order for a computer desk. The first field in the table, Order\_Number, is the order table's primary key. Then there are details of what the order is, description, price and colour. The last field on the right-hand side is the Customer\_Number. This creates the relationship between an order and a customer – customer 13 has ordered the computer desk. To find out who customer 13 is, look back at Figure 5.1, find 13 in the Customer\_Number field, and we see it is Desmond Paton.

We also find the delivery address – the desk is being shipped to South Africa. The customer number in the order table is known as a foreign key. An important concept when setting up relationships is 'referential integrity'. What this means is that you cannot have an instance of a foreign key before it exists as an instance of a primary key. Using the office furniture database as an example, if the database has enforced referential integrity (which it should) it means you can't have an order for Customer\_Number 15 unless there actually is a customer with Customer\_Number 15 in the customer table. This is an extremely convenient and useful way of organizing data (refer back to Table 5.1). It means, in this case, that the delivery address doesn't have to be stored twice – once with the order and again with the customer details.

Storing the same information twice is very bad practice and leads to all sorts of problems. If a customer moves and one address is updated but the other is not, then the firm has useless data – it is not known which address is the correct one. A large part of organizing data involves deciding which fields are going to be primary keys and identifying where the foreign keys should be. A process for making that decision is described next.

**Figure 5.2** The Order Table for an Office Furniture Seller

Order_Number	Description	Price	Colour	Customer_Number
100	Swivel chair	€89	Black	10
101	Coat rack	€15	Silver	10
102	White board	€23	White	11
103	Computer desk	€150	Brown	13
104	Filing cabinet	€50	Gray	10

## Designing Relational Databases

This section describes an approach to designing a relational database. A database design is also known as a data model or a database schema. It is a list of all the tables in the database, along with all the fields, with any primary and foreign keys identified. The approach has four stages:

1. Identify all entities.
2. Identify all relationships entities.
3. Identify all attributes.
4. Resolve all relationships.

If you are trying this approach out for yourself, you are unlikely to get the perfect data model first time. The approach is iterative; that is, you do all four stages once, and examine the resulting schema. If it doesn't work perfectly, go back to stage one and adjust your list of entities, then go through the rest of the stages again. Do this over and over again until, eventually, a good data model emerges.

### Identify Entities

The first step is to identify all the entities you want to store data about. This is usually done by interviewing the firm's managers and staff. If there are too many of them to interview, sometimes database designers will use a questionnaire to get opinions from as many people as possible. If you are designing a database for a student project, you will probably think that this first step is the easy bit, but in fact getting the right list of entities is vital if your data model is to be useful, and it is often not a trivial task, specifically because you have to interview different people and each might give you a different list! (This problem is examined more closely in a later chapter on system development.)

### Identify Relationships

You next need to identify any relationships that exist between entities. The sort of relationships that you have to identify are relationships that the firm wants to store information about. For example, there might be a relationship between customers and suppliers – some of them might play golf together. However, this is unlikely to be the sort of thing the firm will want to store. The relationship between customers and orders is definitely something that the firm will want

to store, so that they can see which customers have placed which orders. Like identifying entities, identifying relationships between them is not trivial and may take several attempts to get right.

Once you identify a relationship, there are three things you need to document about it: its degree, cardinality and optionality.

The **degree** of a relationship is simply how many entities are involved, and this figure is often two. When the degree is two, it is known as a ‘binary relationship’.

The **cardinality** of a relationship is whether each entity in the relationship is related to one or more than one of the other entities. For example, going back to the customer–order relationship, each order is placed by just one customer, but each customer can place many orders. Hence the cardinality in this case is one to many (1 : M). Cardinality for a binary relationship can be one to one (1 : 1), one to many (1 : M) or many to many (M : M).

Last, the **optionality** documents whether the relationship must exist for each entity or whether it is optional. For instance, an order must be placed by a customer – there is no option. An order can’t exist unless a customer has placed it! However, a customer can be in the database even though they have no current orders, so the relationship is optional for the customer. All of the above are documented in an entity–relationship diagram, shown in Figure 5.3.

**Figure 5.3** Entity–Relationship Diagram (E–RD) with Notation Explained



The crow’s foot notation means ‘many’, so a supplier supplies many products, but each product is supplied by only one supplier.

The 0 and | represent optionality – a 0 means the relationship is optional so a customer doesn’t have to have an order. A | means not-optional (or ‘obligatory’) so an order has to have one (and only one) customer.



**Principles Of Business Information Systems 3<sup>rd</sup> Edition, Ralph Stair, George Reynolds and Thomas Chesney Chapter 5 Page Number 162**

It is important to note that the database designer doesn’t get to make up the degree, cardinality and optionality herself. These are dictated to her by what are known as the **enterprise rules**, which the designer must uncover by, usually, interviewing staff. An example of the enterprise rules describing the customer– order relationship is as follows:

- **Each order must be placed by one and only one customer.**

- **Each customer can place many orders, but some won't have placed any orders.**

Enterprise rules are specific to the firm. For example, consider the relationship between employee and car, which a firm wants to store so it can manage its parking spaces. One employee can own as many cars as he can afford, so does that mean this relationship is one to many? Not necessarily. If the firm has decided that it is only going to store information on one car for each of its employees, then the relationship is one to one regardless of how many cars each actually owns. The relationship will probably be optional on one side because not every employee will own a car, but every car in the database will be owned by an employee.

### **Identify Attributes**

The third stage is to identify all the attributes that are going to be stored for each entity. An attribute should be the smallest sensible piece of data that is to be stored. For example, customer name is probably a bad attribute – customer first name and surname would be better (some databases also include title and initial as separate attributes). Why is this? It is so that first name and surname can be accessed separately. For example, if you wanted to start a letter to a customer, ‘Dear John’, you would be unable to do this if you had stored the name as ‘John Smith’. In this case, the letter would have to read ‘Dear John Smith’. As before, attributes can be identified by interviewing staff.

### **Resolve Relationships**

The customer–order relationship was implemented by taking the primary key of customer and posting it as a foreign key in the order table. This is essentially what resolving a relationship means – deciding how to implement it. Sometimes a relationship between two entities will result in three tables being implemented, sometimes one, most often two. There is a series of rules to decide what tables to implement and which primary keys to use as a foreign key. First, let us examine the customer–order relationship more closely to see why we implemented it the way we did. If we had taken the order table primary key (order number) and posted it as a foreign key in the customer table, we would have had two problems, both illustrated in Figure 5.4. First, we have a repeating group – that means we would be trying to squeeze more than one piece of information into one cell in the database, in this case the fact that customer 10 has three orders. We also have a null (blank space) because customers 12 and 14 haven’t placed any orders. Posting the customer number into the order table (look back at Figure 5.2) solves both those problems. Basically, the null isn’t too big a problem, but a relational database cannot cope with a repeating group. Trying to implement the relationship by posting order number into the customer table simply won’t work.

Customer_Number	First_Name	Surname	Address1	Address2	Order_Number
10	Jane	Wilson	London Road	Oxford	100,101,104
11	John	Smith	Quai d'Orsay	Paris	102
12	Jane	Wilson	London Road	Oxford	
13	Desmond	Paton	Marshall Street	Johannesburg	103
14	Susan	Haynes	Baker Street	London	

**Figure 5.4** Posting Order Number into Customer for an Office Furniture Seller

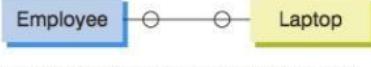
A full discussion of resolving relationships is beyond the scope of this book. However, there only are six types of binary relationship. Figure 5.5 gives one example of each and explains how to implement it. Note that the figure illustrates the most ‘elegant’ way to resolve each relationship, not necessarily the most efficient in terms of access time. A company with a lot of data would implement its database for speed rather than elegance. (What this means in practice is that its database might have some nulls in the foreign keys or store some information twice.)

What you should end up with after you resolve each relationship is a list of tables along with all primary and foreign keys identified, such as that shown in Figure 5.6. This could then be implemented using a DBMS.

**Figure 5.5** The Six Types of Binary Relationship

1. One-to-one relationship, obligatory on both sides.  

  
Employee – Passport  
Each employee must have one and only one passport; each passport must have one and only one employee.  
To resolve this relationship, combine both entities into one table.
2. One-to-one relationship, optional on one side.  

  
Employee – Company car  
Each employee might have one and only one company car; each company car is owned by one and only one employee.  
To resolve this relationship, take the primary key from employee and post it as a foreign key in company car.
3. One-to-one relationship, optional on both sides.  

  
Employee – Laptop  
Each employee might have one laptop; each laptop might belong to one employee (but some are for general use and therefore won't belong to anyone).  
To resolve this relationship, implement three tables – an employee table, a laptop table and a new table that we will call ‘owns’. The owns table only has two fields – employee number and laptop number. The primary key of owns is a ‘composite key’, i.e. it is the employee number and laptop number combined, and each combination of the two is unique.

**Figure 5.6** A Database Design (Also Known as a Data Model or a Database Schema)

Primary keys are identified with a # symbol, foreign keys are underlined.

```

Customer{Customer_Number#, FirstName, Surname, Telephone}
Order{Order_Number#, Description, Price, Colour, Customer_Number}
Supplier{Supplier_Number#, Company_Name, Contact_FirstName, Contact_Surname, Telephone}

```

4. One-to-many relationship, many side obligatory to one side.

Customer – Order

A customer can place many orders; but might have placed no orders, each order must be placed by one and only one employee.

Resolve this relationship by taking the primary key from customer and posting it as a foreign key in order.



5. One-to-many relationship, many side optional to one side.

Student – Elective module

A student might take one elective module; each module is taken by many students (i.e. the students don't have to take an elective module).

Most companies would implement this in the same way as for Relationship 4 above. However, the way to avoid nulls in the foreign key is to implement three tables – one for student, one for elective module and one that we'll call 'studies' (as a student studies a module). The studies table has just two fields – student number and module number. The primary key of the studies table is student number (or you could implement a composite key).

6. Many-to-many relationship.

Student – Tutor

Each tutor teaches many students; each student is taught by many tutors.

To resolve this relationship, implement three tables – one for student, one for tutor, and a third we'll call 'teaches'. The teaches table has two fields – student number and tutor number, and its primary key is a composite key, i.e. a combination of student number and tutor number.



## 5.2 Database Management Systems

How do we actually create, implement, use and update a database? The answer is found in the DBMS. A DBMS is a group of programs used as an interface between a database and application programs or between a database and the user. The capabilities and types of database systems, however, vary, but generally they provide the following.

### Creating and Modifying the Database

Schemas or designs are entered into the DBMS (usually by database personnel) via 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. A DDL allows the database's creator to describe the data and relationships. Structured Query Language (SQL) is a DDL. Figure 5.7 shows four SQL statements to create a database called Let- tings, a table called Landlords and insert a record about John Smith.

Another important step in creating a database is to establish a data dictionary, a detailed description of all data used in the database. The data dictionary describes all the fields in the database, their range of accepted values, the type of data (such as alphanumeric or numeric), the amount of storage space needed for each and a note of who can access each and who updates each. Figure 5.8 shows a typical data dictionary entry.

Attribute	Data Type	Primary Key?	Required?
Customer_Number	Text	Y	Y
First_Name	Text	N	Y
Surname	Text	N	Y
Date_of_Birth	Date	N	N

**Figure 5.8** A Typical Data Dictionary Entry for the Customer Table for an Office Furniture Seller

A data dictionary helps achieve the advantages of the database approach in these ways:

```

CREATE DATABASE Lettings;
USE Lettings;
CREATE TABLE landlords(
Firstname CHAR(10),
Surname CHAR(10),
Telephone CHAR(10));
INSERT INTO landlords(
'John', 'Smith', '123456');

```

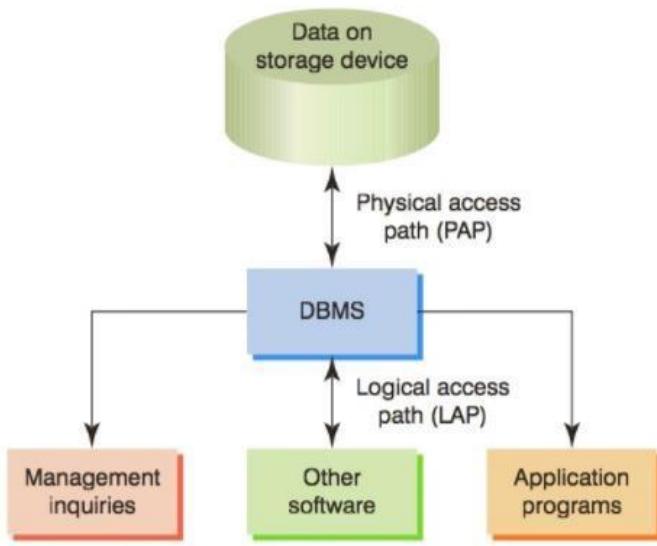
**Figure 5.7 SQL as a DDL** SQL code is being used to create a database called 'Lettings' with a table called 'Landlords' which has three fields: 'Firstname', 'Surname' and 'Telephone'. The code then enters one landlord called John Smith into the table.

- **Reduced data redundancy:** By providing standard definitions of all data, it is less likely that the same data item will be stored in different places under different names. For example, a data dictionary reduces the likelihood that the same part number would be stored as two different items, such as PT\_NO and PARTNO.
- **Increased data reliability:** A data dictionary and the database approach reduce the chance that data will be destroyed or lost. In addition, it is more difficult for unauthorized people to gain access to sensitive data and information.
- **Assists program development:** With a data dictionary, programmers know what data is stored and what data type each field is. This information is valuable when writing programs that make use of the data.
- **Easier modification of data and information:** The data dictionary and the database approach make modifications to data easier because users do not need to know where the data is stored. The person making the change indicates the new value of the variable or item, such as part number, that is to be changed. The database system locates the data and makes the necessary change.

## Storing and Retrieving Data

One function of a DBMS is to be an interface between an application program and the database. When an application program needs data, it requests that data through the DBMS. Suppose that to calculate the total price of a new car, a car dealer pricing program needs price data on the engine option – six cylinders instead of the standard four cylinders. The application program thus requests this data from the DBMS. In doing so, the application program follows a logical access path. Next, the DBMS, working with various system programs, accesses a storage device, such as disc drives, 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) where the price of this option is stored. In the pricing example, the DBMS might go to a disc drive to retrieve the price data for six-cylinder engines. This relationship is shown in Figure 5.9.

**Figure 5.9** Logical and Physical Access Paths



**Principles Of Business Information Systems 3<sup>rd</sup> Edition, Ralph Stair, George Reynolds and Thomas Chesney Chapter 5 Page Number 166**

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 EUROS. This is the logical access path (LAP). Then, the DBMS might go to the options price section of a disc to get the information for the user. This is the physical access path (PAP).

Two or more people or programs attempting to access the same record in the same database 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 ten units because ten 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 more inventory was just received. Without proper database control, one of the inventory updates might not be correctly made, 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.

## Manipulating Data and Generating Reports

After a DBMS has been installed, employees, managers and consumers can use it to review reports and obtain important information. Some databases use Query-by-Example (QBE), which is a visual approach to developing database queries or requests.

Alternatively, SQL can be used to query the database. For example, `SELECT * FROM EMPLOYEE WHERE JOB_CLASSIFICATION = 'C2'`.

This will output all employees who have a job classification of 'C2'. The '\*' tells the DBMS to include all columns from the EMPLOYEE table in the results. In general, the concurrency control A method of dealing with a situation in which two or more people need to access the same record in a commands that are used to manipulate the database are part of the **data manipulation language (DML)**, of which SQL is an example. (So SQL is both a DDL and DML.) SQL commands can be used in a computer program to query a database, which is convenient for programmers.

SQL, which is pronounced like the word 'sequel', was developed in the 1970s at the IBM Research Laboratory in San Jose, California. 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), find the largest value (MAX), find the smallest value (MIN) and others. Table 5.2 contains examples of SQL commands.

SQL lets programmers learn one powerful query language and use it on systems ranging from PCs to the largest mainframe computers. Programmers and database users also find SQL valuable because SQL statements can be embedded into many programming languages (discussed in Chapter 4), such as C11, Visual Basic and COBOL. Because SQL uses standardized and simplified procedures for retrieving, storing and manipulating data in a database system, the popular database query language can be easy to understand and use.

After a database has been set up and loaded with data, it can produce any desired reports, documents and other outputs. These outputs usually appear in screen displays or hard-copy printouts. The output-control features of a database program allow you to select the records and fields to appear in reports. You can also make calculations specifically for the report by manipulating database fields. Formatting controls and organization options (such as report headings) help you to customize reports and create flexible, convenient and powerful information-handling tools.

**Table 5.2** Examples of SQL Commands

SQL Command	Description
SELECT ClientName, Debt FROM Client WHERE Debt > 1000	This query displays all clients (ClientName) and the amount they owe the company (Debt) from a database table called Client for clients who owe the company more than €1000 (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 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

A DBMS can produce a wide variety of documents, reports and other outputs that can help organizations achieve their goals. 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 towards completion and delivery. Polygon, for example, has developed the ColorNet database to help traders of rare gemstones perform routine processing activities, including the buying and selling of precious gemstones.

Databases can also provide support to help executives and other people make better decisions. A database by Intellifit, for example, can be used to help shoppers make better decisions and get clothes that fit when shopping online.<sup>2</sup> The database contains true sizes of apparel from various clothing companies that do business on the web. The process starts when a customer's body is scanned into a database at one of the company's locations, typically in a shopping mall. About 200 000 measurements are taken to construct a 3D image of the person's body shape. The database then compares the actual body dimensions with sizes given by web-based clothing stores to get an excellent fit. According to one company executive, 'We're 90 per cent (accurate) about the sizes and the styles and the brands that will fit you best'.

A database is central to every business selling over the Internet. Amazon, for example, has a huge amount of data on customers' past purchases, which other books sellers must envy, that it uses to make personal recommendations and generate more sales. Each time a returning customer comes back to the website, a report is produced (which becomes part of the web page itself, something described later in this chapter) of their recommendations.

## Database Administration

Database systems require a skilled **database administrator (DBA)**. A DBA is expected to have a clear understanding of the fundamental business of the organization, be proficient in the use of selected DBMSs and stay abreast of emerging technologies and new design approaches. The role of the DBA is to plan, design, create, operate, secure, monitor and maintain databases. Typically, a DBA has a degree in computer science or management information systems, and some on-the-job training with a particular database product or more extensive experience with a range of database products.

The DBA works with users to decide the content of the database – to determine exactly what entities are of interest and what attributes are to be recorded about those entities. Thus, personnel outside of IS must have some idea of what the DBA does and why this function is

important. The DBA can play a crucial role in the development of effective information systems to benefit the organization, employees and managers.

The DBA also works with programmers as they build applications to ensure that their programs comply with DBMS standards and conventions. After the database is built and operating, the DBA monitors operations logs for security violations. Database performance is also monitored to ensure that the system's response time meets users' needs and that it operates efficiently. If there is a problem, the DBA attempts to correct it before it becomes serious.

Some organizations have also created a position called the **data administrator**, a non-technical but important role that ensures data is managed as an important organizational resource. The data administrator is responsible for defining and implementing consistent principles for a variety of data issues, including setting data standards and data definitions that apply across all the databases in an organization. For example, the data administrator would ensure that a term such as 'customer' is defined and treated consistently in all corporate databases. This person also works with business managers to identify who should have read or update access to certain databases and to selected attributes within those databases. This information is then communicated to the database administrator for implementation. The data administrator can be a high-level position reporting to top-level managers.

## Selecting a Database Management System

The DBA often selects the DBMS for an organization. The process begins by analyzing database needs and characteristics. The information needs of the organization affect the type of data that is collected and the type of DBMS that is used. Important characteristics of databases include the following:

- Database size: The number of records or files in the database.
- Database cost: The purchase or lease costs of the database.
- Concurrent users: The number of people who need to use the database at the same time (the number of concurrent users).
- Performance: How fast the database is able to update records.
- Integration: The ability to be integrated with other applications and databases.
- Vendor: The reputation and financial stability of the database vendor.

For many organizations, database size doubles about every year or two. Wal-Mart, for example, adds billions of rows of data to its databases every day. Its database of sales and marketing information is approximately 500 terabytes large. According to Dan Phillips, Wal-Mart's vice president of information systems, 'Our database grows because we capture data on every item, for every customer, for every store, every day'. Wal-Mart deletes data after two years and doesn't track individual customer purchases. Scientific databases are probably the largest in the world. The UK's forensic DNA database is vast and NASA's Stanford Linear Accelerator Center stores about 1000 terabytes of data.

## Using Databases with Other Software

DBMSs are often used with other software packages or the Internet. A DBMS can act as a front-end application or a back-end application. A front-end application is one that directly interacts with people or users. Marketing researchers often use a database as a front end to a statistical analysis program. The researchers enter the results of market questionnaires or surveys into a database. The data is then transferred to a statistical analysis program to determine the potential for a new product or the effectiveness of an advertising campaign. A back-end application interacts with other programs or applications; it only indirectly interacts

with people or users. When people request information from a website, the website can interact with a database (the back end) that supplies the desired information. For example, you can connect to a university website to find out whether the university's library has a book you want to read. The website then interacts with a database that contains a catalogue of library books and articles to determine whether the book you want is available.

### 5.3 Database Applications

Database applications manipulate the content of a database to produce useful information. Common manipulations are searching, filtering, synthesizing and assimilating the data contained in a database using a number of database applications. These applications allow users to link the company databases to the Internet, set up data warehouses, use databases for strategic business intelligence, place data at different locations, use online processing and open connectivity standards for increased productivity, and search for and use unstructured data, such as graphics, audio and video.

#### Linking Databases to the Internet

Linking databases to the Internet is an incredibly useful application for organizations and individuals. Every e-commerce website uses database technology to dynamically create its web pages, saving vast amounts of efforts. Every time you visit Amazon, for instance, or the South African fashion retailer Edgars, or one of thousands of other Internet businesses, the pages you see are created at that time from a database of product and customer information. This simplifies the maintenance of the website – to add new stock, all that needs to be done is enter a new record in the product table.

Yahoo! and several educational partners are scanning books and articles into large web-based databases.<sup>6</sup> Called the Open-Content Alliance, they plan to offer free access to material that is no longer under copyright agreements. General Electric and Intermountain Health Care are developing a comprehensive web database on medical treatments and clinical protocols for doctors. The database is expected to cost about €74 million to develop and should help physicians more accurately diagnose patient illnesses. Some banner ads on websites are linked directly with sophisticated databases that contain information on products and services. This allows people to get product and service information without leaving their current website. LetsGoDigital, a company that sells cameras and other digital products over the Internet, based in the Netherlands, uses this approach.

Developing a seamless integration of traditional databases with the Internet is often called a 'semantic web'. A semantic web allows people to access and manipulate a number of traditional databases at the same time through the Internet. Many software vendors – including IBM, Oracle, Microsoft, Macromedia, Inline Internet Systems and Netscape Communications – are incorporating the capability of the Internet into their products. Such databases allow companies to create an Internet-accessible catalogue, which is nothing more than a database of items, descriptions and prices.

In addition to the Internet, organizations are gaining access to databases through networks to get good prices and reliable service. Connecting databases to corporate websites and networks can lead to potential problems, however. One database expert believes that up to 40 per cent of websites that connect to corporate databases are susceptible to hackers taking complete control of the database. By typing certain characters in a form on some websites, a hacker can issue SQL commands to control the corporate database.

## Big Data Applications

Much of the data that organizations store comes from their Transaction Processing Systems, which are described fully in Chapter 7. However, firms are frequently storing less wellstructured data too, such as photos, videos, data from customers' blogs, data from social networks and from their own website, including the order in which people view their web pages. All of this is often called Big Data – large amounts of unstructured data that are difficult or impossible to capture and analyze using traditional DBMSs.

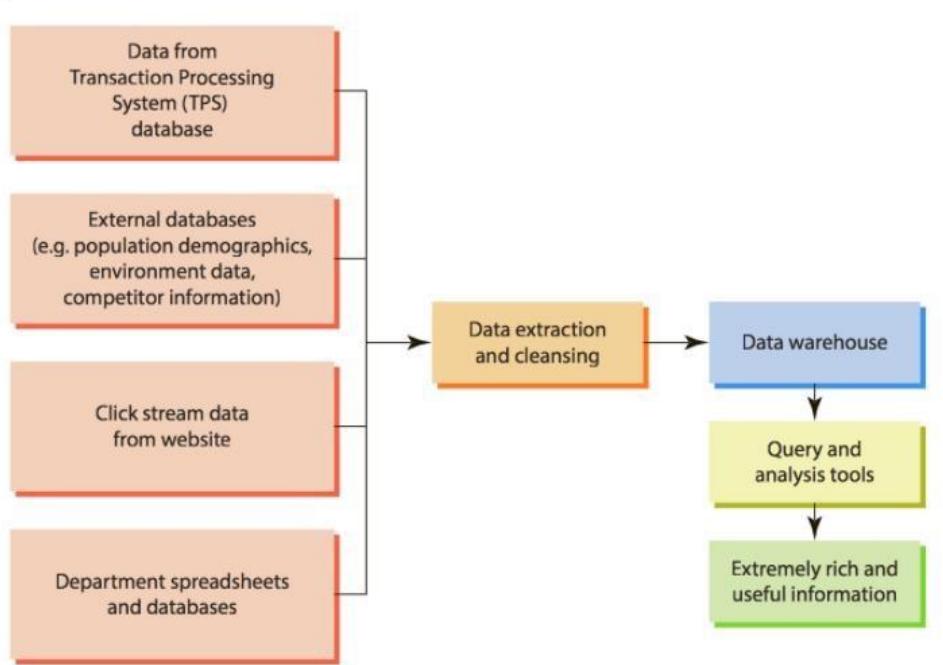
Big Data can provide valuable insights to help organizations achieve their goals. It can reveal which potential customers are most likely to purchase which products. It can identify where and when a customer tends to shop. It can even determine how much a customer would be willing to pay for a product.

Special Big Data hardware and software tools have been developed to collect, store and analyze these data. Apache Hadoop is an open-source database that can be used to manage large unstructured datasets in conjunction with relational databases. Yahoo! for example, uses Hadoop to collect and analyze exabytes (millions of terabytes) of data. Oracle has developed Big Data Appliance, which is a combination of hardware and software specifically designed to capture, store and analyze large amounts of unstructured data. IBM has developed InfoSphere BigInsights, which is based on Hadoop, to help organizations analyze continuously created data.

## Data Warehouses

The data necessary to make sound business decisions is stored in a variety of locations and formats. This data is initially captured, stored and managed by transaction processing systems that are designed to support the day-to-day operations of the organization. For decades, organizations have collected operational, sales and financial data with their transaction processing systems (explained fully in Chapter 7). A **data warehouse** is a database or a collection of databases that holds business information from many sources in the enterprise, covering all aspects of the company's processes, products and customers. The data warehouse provides business users with a multidimensional view of the data they need to analyze business conditions. A data warehouse stores historical data that has been extracted from transaction processing systems, as well as data from external sources (see Figure 5.10). This operational and external data is 'cleaned' to remove inconsistencies and integrated to create a new information database that is more suitable for business analysis.

**Figure 5.10** Elements of a Data Warehouse



**Principles Of Business Information Systems 3<sup>rd</sup> Edition, Ralph Stair, George Reynolds and Thomas Chesney Chapter 5 Page Number 171**

Data warehouses typically start out as very large databases, containing millions and even hundreds of millions of data records. As this data is collected from various sources, one data warehouse is built that business analysts can use. To keep it accurate, the data warehouse receives regular updates. Old data that is no longer needed is purged. It is common for a data warehouse to contain from three to ten years of current and historical data. Data-cleaning tools can merge data from many sources to make the warehouse, automate data collection and verification, delete unwanted data and maintain the data. Data warehouses can also receive data from unique sources. Oracle's Warehouse Management software, for example, can accept information from radio frequency identification (RFID) technology, which is being used to tag products as they are shipped or moved from one location to another. A data warehouse can be extremely difficult to establish, with the typical cost exceeding €2 million.

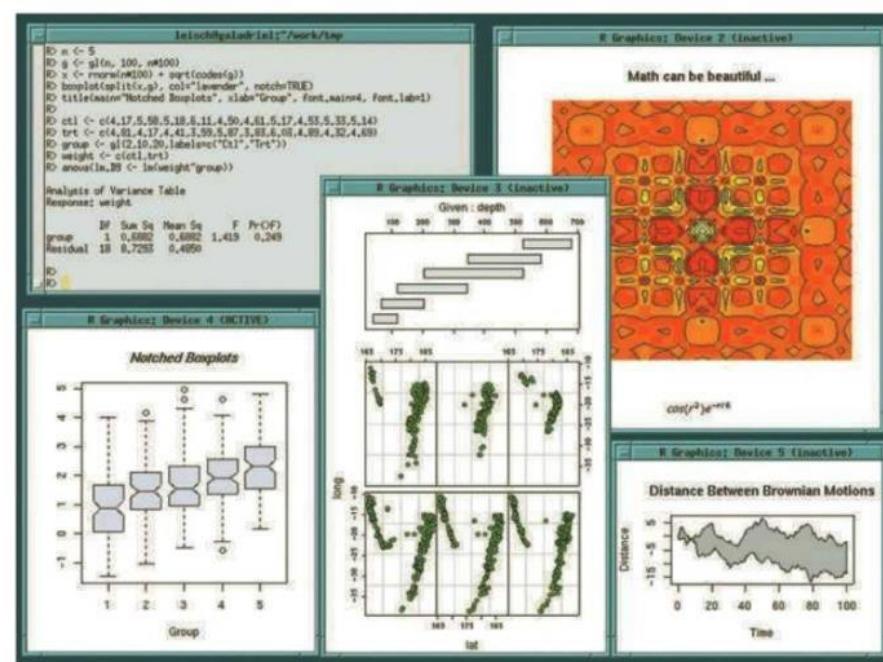
## Data Mining

**Data mining** is the process of analyzing data to try to discover patterns and relationships within the data. Typically, a data warehouse is mined. Like gold mining, data mining sifts through mountains of data to find a few nuggets of valuable information. There are a number of data mining tools and techniques. Association rules algorithms are used to find associations between items in the data. A question that an association rule algorithm might be used to answer is, if someone buys eggs, how likely is it that they will also buy cheese? This information could be used in a supermarket to lay out the goods in the best configuration. Rattle (Figure 5.11) is an extremely powerful data mining application which can be used within the programming language R. Both are entirely free and can be downloaded from [www.r-project.org/](http://www.r-project.org/).

Data mining is used extensively in marketing to improve customer retention; identify cross-selling opportunities; manage marketing campaigns; market, channel and pricing analysis; and customer segmentation analysis (especially one-to-one marketing). Data-mining tools help users find answers to questions they haven't thought to ask.

**Figure 5.11** Data

**Mining with Rattle** Rattle is a software package that runs in the R programming language. Both are available for free. To get started visit [www.r-project.org/](http://www.r-project.org/).



E-commerce presents another major opportunity for effective use of data mining. Attracting customers to websites is tough; keeping them can be tougher. For example, when retail websites launch deep-discount sales, they cannot easily determine how many first-time customers are likely to come back and buy again. Neither do they have a way of understanding which customers acquired during the sale are price sensitive and more likely to jump on future sales. As a result, companies are gathering data on user traffic through their websites and storing that data in databases. This data is then analyzed using data-mining techniques to personalize and customize the website, and develop sales promotions targeted at specific customers.

Traditional DBMS vendors are well aware of the great potential of data mining. Thus, companies such as Oracle, Sybase, Tandem and Red Brick Systems are all incorporating data-mining functionality into their products. Table 5.3 summarizes a few of the most frequent applications for data mining. See Case Two at the end of the chapter for an explanation of one data-mining algorithm.

## Business Intelligence

Closely linked to the concept of data mining is the use of databases for business-intelligence purposes. **Business intelligence (BI)** involves gathering enough of the right information in a timely manner and usable form, and analyzing it so that it can be used to have a positive effect on business strategy, tactics or operations. ‘Right now, we are using our BI tools to generate on-demand statistics and process-control reports’, said Steve Snodgrass, CIO of Granite Rock Company. The company uses Business Objects to produce graphic displays of construction supplies, including concrete and asphalt. BI turns data into useful information that is then distributed throughout an enterprise.

**Table 5.3** Common Data-Mining Applications

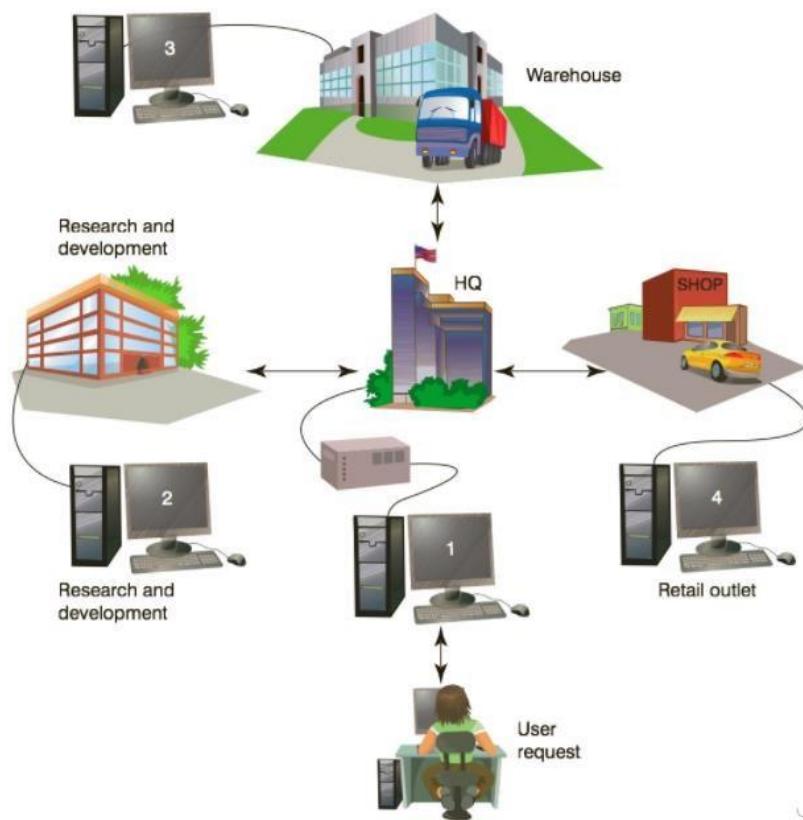
Application	Description
Branding and positioning of products and services	Enable the strategist to visualize the different positions of competitors in a given market using performance (or other) data on dozens of key features of the product and then to condense all that data into a perceptual map of only two or three dimensions
Customer churn	Predict current customers who are likely to switch to a competitor
Direct marketing	Identify prospects most likely to respond to a direct marketing campaign (such as a direct mailing)
Fraud detection	Highlight transactions most likely to be deceptive or illegal
Market basket analysis	Identify products and services that are most commonly purchased at the same time (e.g. nail polish and lipstick)
Market segmentation	Group customers based on who they are or what they prefer
Trend analysis	Analyze how key variables (e.g. sales, spending, promotions) vary over time

**Competitive intelligence** is one aspect of BI and is limited to information about competitors and the ways that knowledge affects strategy, tactics and operations. Competitive intelligence is a critical part of a company’s ability to see and respond quickly and appropriately to the changing marketplace. Competitive intelligence is not espionage: the use of illegal means to gather information. In fact, almost all the information a competitive-intelligence professional needs can be collected by examining published information sources, conducting interviews and using other legal, ethical methods. Using a variety of analytical tools, a skilled competitiveintelligence professional can by deduction fill the gaps in information already gathered. The term **counterintelligence** describes the steps an organization takes to protect information sought by ‘hostile’ intelligence gatherers. One of the most effective counterintelligence measures is to define ‘trade secret’ information relevant to the company and control its dissemination.

## Distributed Databases

Distributed processing involves placing processing units at different locations and linking them via telecommunications equipment. A **distributed database** – a database in which the data is spread across several smaller databases connected through telecommunications devices – works on much the same principle. A user in the London branch of a clothing manufacturer,

for example, might make a request for data that is physically located at corporate headquarters in Milan, Italy. The user does not have to know where the data is physically stored (see Figure 5.12).



**Figure 5.12** The Use of a Distributed Database

This figure shows how data from a clothing manufacturer is stored across multiple sites.

For the clothing manufacturer, computers might be located at the headquarters, in the research and development centre, in the warehouse and in a company-owned retail store. Telecommunications systems link the computers so that users at all locations can access the same distributed database no matter where the data is actually stored.

Distributed databases give organizations more flexibility in how databases are organized and used. Local offices can create, manage and use their own databases, and people at other offices can access and share the data in the local databases. Giving local sites more direct access to frequently used data can improve organizational effectiveness and efficiency significantly. The New York City Police Department, for example, has about 35 000 officers searching for information located in over 70 offices around the city. According to one database programmer, ‘They had a lot of information available in a lot of different database systems and wanted finger-tip access to the information in a very user-friendly front-end’. Dimension Data helped the police department by developing a US\$11(€8) million system to tie their databases together. ‘Now, we can send them critical details before they even arrive at the scene’, said police commissioner Raymond Kelly. The new distributed database is also easier for police officers to use.

Despite its advantages, distributed processing creates additional challenges in integrating different databases (information integration), maintaining data security, accuracy, timeliness and conformance to standards. Distributed databases allow more users direct access at different sites; thus controlling who accesses and changes data is sometimes difficult. Also, because

distributed databases rely on telecommunications lines to transport data, access to data can be slower.

To reduce telecommunications costs, some organizations build a **replicated database**. A replicated database holds a duplicate set of frequently used data. The company sends a copy of important data to each distributed processing location when needed or at predetermined times. Each site sends the changed data back to update the main database on an update cycle. This process, often called data synchronization, is used to make sure that replicated databases are accurate, up to date and consistent with each other. A railway, for example, can use a replicated database to increase punctuality, safety and reliability. The primary database can hold data on fares, routes and other essential information. The data can be continually replicated and downloaded from the master database to hundreds of remote servers across the country. The remote locations can send back the latest figures on ticket sales and reservations to the main database.

### Online Analytical Processing (OLAP)

For nearly two decades, databases and their display systems have provided flashy sales presentations and trade show demonstrations. All you have to do is ask where a certain product is selling well, for example, and a colourful table showing sales performance by region, product type and time frame appears on the screen. Called **online analytical processing (OLAP)**, these programs are now being used to store and deliver data warehouse information efficiently. The leading OLAP software vendors include Cognos, Comshare, Hyperion Solutions, Oracle, MineShare, WhiteLight and Microsoft. (Note that in this context, the word ‘online’ does not refer to the Internet – it simply means that a query is made and answered immediately, as opposed to a user submitting a query and the processing taking place at some other time, for instance at night when the servers are used less.) The value of data ultimately lies in the decisions it enables. Powerful information-analysis tools in areas such as OLAP and data mining, when incorporated into a data warehousing architecture, bring market conditions into sharper focus and help organizations deliver greater competitive value. OLAP provides topdown, query-driven data analysis; data mining provides bottom-up, discovery-driven analysis.

OLAP requires repetitive testing of user-originated theories; data mining requires no assumptions and instead identifies facts and conclusions based on patterns discovered. OLAP, or multidimensional analysis, requires a great deal of human ingenuity and interaction with the database to find information in the database. A user of a data-mining tool does not need to figure out what questions to ask; instead, the approach is, ‘here’s the data, tell me what interesting patterns emerge’. For example, a data-mining tool in a credit card company’s customer database can construct a profile of fraudulent activity from historical information. Then, this profile can be applied to all incoming transaction data to identify and stop fraudulent behavior, which might otherwise go undetected. Table 5.4 compares the OLAP and datamining approaches to data analysis.

**Table 5.4** Comparison of OLAP and Data Mining

Characteristic	OLAP	Data Mining
Purpose	Supports data analysis and decision making	Supports data analysis and decision making
Type of analysis supported	Top-down, query-driven data analysis	Bottom-up, discovery-driven data analysis
Skills required of user	Must be very knowledgeable of the data and its business context	Must trust in data-mining tools to uncover valid and worthwhile hypotheses

### Visual, Audio and Other Database Systems

Organizations are increasingly finding a need to store large amounts of visual and audio signals in an organized fashion. Credit card companies, for example, enter pictures of charge slips into an image database using a scanner. The images can be stored in the database and later sorted by customer name, printed and sent to customers along with their monthly statements. Image databases are also used by medical staff to store x-rays and transmit them to clinics away from the main hospital. Financial services, insurance companies and government branches are using image databases to store vital records and replace paper documents. Drug companies often need to analyze many visual images from laboratories. The PetroView database and analysis tool allows petroleum engineers to analyze geographic information to help them determine where to drill for oil and gas. Recently, a visual-fingerprint database was used to solve a 40-year-old murder case in California. Visual databases can be stored in some object-relational databases or special-purpose database systems. Many relational databases can also store graphic content.

Combining and analyzing data from different databases is an increasingly important challenge. Global businesses, for example, sometimes need to analyze sales and accounting data stored around the world in different database systems. Companies such as IBM are developing virtual database systems to allow different databases to work together as a unified data-base system. DiscoveryLink, one of IBM's projects, can integrate biomedical data from different sources.

The Centre for Disease Control (CDC) also has the problem of integrating more than 100 databases on various diseases.

In addition to visual, audio and virtual databases, there are a number of other special-purpose database systems. Spatial data technology involves using a database to store and access data according to the locations it describes and to permit spatial queries and analysis. Map Extreme is spatial technology software from MapInfo that extends a user's database so that it can store, manage and manipulate location-based data. Police departments, for example, can use this type of software to bring together crime data and map it visually so that patterns are easier to analyze. Police officers can select and work with spatial data at a specified location, within a rectangle, a given radius or a polygon such as their area of jurisdiction. For example, a police officer can request a list of all alcohol shops within a two-mile radius of the police station. Builders and insurance companies use spatial data to make decisions related to natural hazards. Spatial data can even be used to improve financial risk management, with information stored by investment type, currency type, interest rates and time.



### Chapter Summary/Review

Data management and modelling are key aspects of organizing data and information. Data is one of the most valuable resources that a firm possesses. The most common way to organize data is in relational database. A relational database is made up of tables, each table is made up of records and each record is made up of fields.\

A well-designed and well-managed database is central to almost all information systems and is an extremely valuable tool in supporting decision making. A DBMS is a group of programs used as an interface between a database and its users and other application programs. When an application program requests data from the database, it follows a logical access path.

The number and types of database applications will continue to evolve and yield real business benefits. Organizations are building data warehouses, which are relational DBMSs specifically designed to support management decision making.



#### Review Questions (Short)

1. What can you do with SQL?
2. Explain the CREATE SQL statement.
3. What is data mining?
4. How does Rattle work?
5. What is business intelligence?



### Review Questions (Long)

1. Should a company store every scrap of data it can get its hands on?
2. How can data mining be used to improve an e-commerce website?
3. What does DBMS stand for? What does it do?
4. What should a business manager know about SQL?
5. List some SQL functions.



### Review Questions (MCQ)

1. A \_\_\_\_\_ uniquely identifies a record.
  - A. Primary key
  - B. Secondary key
  - C. Unique key
  - D. Gold key
2. A relational database is made up of \_\_\_\_\_.
  - A. Rows
  - B. Tables
  - C. Columns
  - D. Fields
3. An \_\_\_\_\_ is a person, place or thing about whom or about which a company stores data.
  - A. Administrator
  - B. Object
  - C. Entity
  - D. Programmer
4. If a company stores a fact only one, it is said to have reduced \_\_\_\_\_.
  - A. Data recurrence
  - B. Data storage
  - C. Data space
  - D. Data redundancy
5. SQL is a data \_\_\_\_\_ language and a data \_\_\_\_\_.
  - A. Definition and Manipulation
  - B. Reader and Editor
  - C. None of the above
  - D. Manipulation and Definition



## Case Studies / Projects

### Just Tell Me My Password Already!

Nature magazine recently published a list of the most common passwords. The top five were:

1.123456

2.password

3.qwerty

4.12345

5.123456789

It's understandable that people are stressed with trying to manage their passwords – almost every time you make a purchase online – or even read an article in an online newspaper – a company tries to get you to 'register for all these great benefits' that you probably don't want or care about. When money isn't on the line (that is, when they're not handing over their credit card details), many people seem to care less and use 12345 as their password.

What's more interesting is where Nature is getting its data, because password information is not as easy to find as you might think, unless the company storing them doesn't know what they are doing. Nature can't have just phoned up Google to ask them for their most common passwords, and we know that not just because Google probably wouldn't tell them – we know it because Google doesn't know your password!

### Questions

1. The hacker at the end is using something called social engineering. How would you protect yourself from this sort of attack? How would you protect your employees?
2. Why do you think Facebook and Google offer a login service?
3. Why do you think people use such easy to guess passwords? How could you prevent this?



Principles Of Business Information Systems 3<sup>rd</sup> Edition, Ralph Stair, George Reynolds and Thomas Chesney Chapter 5 Page Number 182



## Case Studies

### Reading every book that ever been written

#### Reading every book that ever been written (page 183)

Developed at the University of Waikato, New Zealand, Weka is a collection of machine learning algorithms for data mining tasks. Named after a flightless bird found only in New Zealand, Weka is open source software. Weka is a popular way to learn data mining.

One application for Weka is text mining, which involves processing chunks of text to extract useful summary information from it. For example, Weka has been used to automatically process movie reviews to determine whether most reviewers like it or love it, something known as “sentiment analysis”. When Google announced Google Books, researcher Erez Lieberman Aiden saw an opportunity to text mine on a grand scale.

In 1996 google co-founders Sergey Brin and Larry Page had the idea for Google Books, a world in which vast collections of books are digitized, indexed by a computer program to analyze their content and explore the connections between them. In fact, the program they envisioned for this task was their BackRub algorithm, which developed into the Google search program, the core search technology that makes Google Google! Before being in a position to make it happen, Brin and Page envisioned people everywhere being able to search through all of the world’s books to find the ones they’re looking for.

#### Questions

1. What uses of culturomics, if any, can you think of for a business?
2. What uses of sentiment analysis can you think of?
3. Why should a business be interested in text 4 mining? Should every company that collects data have a knowledge of software such as Weka?



Principles Of Business Information Systems 3<sup>rd</sup> Edition, Ralph Stair,George Reynolds and Thomas Chesney Chapter 5 Page Number 183



### LEARNING OUTCOMES

After reading this Section of the guide, the learner should be able to:

#### Learning Objectives

- Define the terms ‘communications’ and ‘telecommunications’ and describe the components of a telecommunications system.
- Identify several communications hardware devices and discuss their function.
- Describe many of the benefits associated with a telecommunications network.
- Define the term ‘communications protocols’ and identify several common ones.
- Briefly describe how the Internet works, including alternatives for connecting to it and the role of Internet service providers.
- Describe the World Wide Web and the way it works.
- Explain the use of web browsers, search engines and other web tools.
- Outline a process for creating web content.
- Define the terms ‘intranet’ and ‘extranet’ and discuss how organizations are using them.

## Introduction

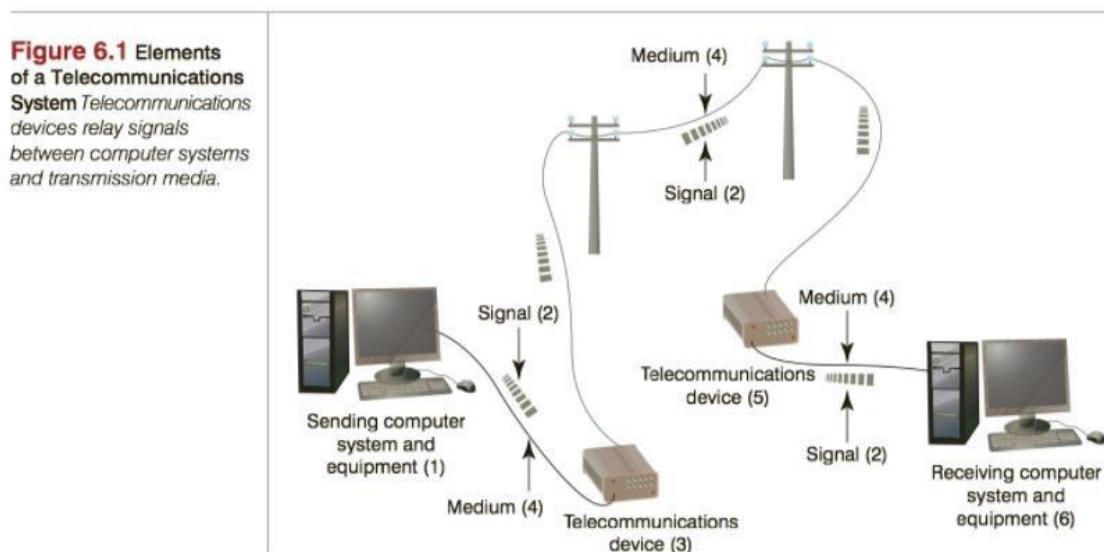
We have examined hardware and software, and paid special attention to how data is organized for storage. The power of information technology greatly increases when devices are linked or networked, which is the subject of this chapter.

### 6.1 Telecommunications

**Telecommunications** refers to the electronic transmission of signals for communications, by such means as telephone, radio and television. Telecommunications impacts businesses greatly because it lessens the barriers of time and distance. Telecommunications is not only changing the way businesses operate but also the nature of commerce itself. As networks are connected with one another and transmit information more freely, a competitive marketplace demands excellent quality and service from all organizations. Figure 6.1 shows a general model of telecommunications. The model starts with a sending unit (1), such as a person, a computer system, a terminal or another device, that originates the message. The sending unit transmits a signal to a telecommunications device. The telecommunications device – a hardware component that facilitates electronic communication performs many tasks, which can include converting the signal into a different form or from one type to another. The telecommunications

device then sends the signal through a medium. A telecommunications medium is any material substance that carries an electronic signal to support communications between a sending and receiving device. Another telecommunications device (5) connected to the receiving computer receives the signal.

Table 6.1



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Activate Windows



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The process can be reversed, and the receiving unit (6) can send another message to the original sending unit (1). An important characteristic of telecommunications is the speed at which information is transmitted, which is measured in bits per second (bps). Common speeds are in the range of thousands of bits per second (Kbps) to millions of bits per second (Mbps) and even billions of bits per second (Gbps). Advances in telecommunications technology allow us to communicate rapidly with clients and co-workers almost anywhere in the world. Communication between two people can occur synchronously or asynchronously. With synchronous communication, the receiver gets the message almost instantaneously when it is sent. Phone communication is an example of synchronous communication. With asynchronous communication, there is a measurable delay between the sending and receiving of the message, sometimes hours or even days. Sending a letter through the post office or by email are examples of asynchronous communications. Both types of communications are important in business. However, to use telecommunications effectively, you must carefully analyze telecommunications media and devices.

## Channel Bandwidth

Telecommunications **channel bandwidth** refers to the rate at which data is exchanged, usually measured in bits per second (bps) – the broader the bandwidth, the more information can be exchanged at one time. **Broadband communications** can exchange data very quickly, as opposed to **narrowband communications** which supports a much lower rate of data exchange. Telecommunications professionals consider the capacity of the channel when they recommend transmission media for a business. In general, today's organizations need more bandwidth for increased transmission speed to carry out their daily functions. To increase bandwidth, first consider the different types of telecommunications media you can use.

### Guided Transmission Media Types

Transmission media can be divided into two broad categories: guided 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. There are many different guided transmission media types. Table 6.1 summarizes the guided media types by physical media type. Several guided transmission media types are discussed in the sections following the table

Table 6.1

Guided Media Types			
Media Type	Description	Advantages	Disadvantages
Twisted-pair wire	Twisted pairs of copper wire, shielded or unshielded	Used for telephone service; widely available	Transmission speed and distance limitations
Coaxial cable	Inner conductor wire surrounded by insulation	Cleaner and faster data transmission than twisted-pair wire	More expensive than twisted-pair wire
Fibre-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; less distortion of signal; capable of high transmission rates	Expensive to purchase and install
Broadband over power lines	Data is transmitted over standard high-voltage power lines	Can provide Internet service to rural areas where cable and phone service may be non-existent	Can be expensive and may interfere with ham/amateur radios, and police and fire communications

### Twisted-Pair Wire

Twisted-pair wire contains two or more twisted pairs of wire, usually copper (see Figure 6.2a). Proper twisting of the wire keeps the signal from 'bleeding' into the next pair and creating electrical interference. Because the twisted-pair wires are insulated, they can be placed close together and packaged in one group. Hundreds of wire pairs can be grouped into one large wire cable. Twisted-pair wires are classified by category, depending on the frequency of data transmission. The lower categories are used primarily in homes. Higher categories are sometimes used in smaller networks. Ten gigabit ethernet (labelled IEEE 802.3an) is an emerging standard for transmitting data at the speed of 10 billion bits per second for limited distances over shielded twisted-pair wires. It will be used for the high-speed links that connect

groups of computers or to move data stored in large databases on large computers to standalone storage devices.

### **Coaxial Cable**

Figure 6.2b shows a typical coaxial cable. Coaxial cable falls in the middle of the guided transmission media in terms of cost and performance. The cable itself is more expensive than twisted-pair wire but less so than fibre-optic cable. However, the cost of installation and other necessary communications equipment makes it difficult to compare the total costs of each media. Coaxial cable offers cleaner and crisper data transmission (less noise) than twisted-pair wire. It also offers a higher data transmission rate. Companies such as Virgin Media are aggressively courting customers for telephone service, enticing them away from the phone companies such as BT by bundling Internet and phone services along with TV.

### **Fibre-Optic Cable**

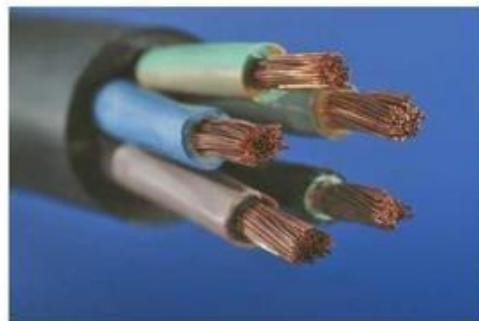
Fibre-optic cable, consisting of many extremely thin strands of glass or plastic bound together in a sheathing (a jacket), transmits signals with light beams (see Figure 6.2c). These highintensity light beams are generated by lasers and are conducted along the transparent fibres.

These fibres have a thin coating, called cladding, which effectively works like a mirror, preventing the light from leaking out of the fibre. The much smaller diameter of fibre-optic cable makes it ideal when there is not room for bulky copper wires for example, in crowded conduits, which can be pipes or spaces carrying both electrical and communications wires. In such tight spaces, the smaller fibre-optic telecommunications cable is very effective. Because fibre-optic cables are immune to electrical interference, they can transmit signals over longer distances with fewer expensive repeaters to amplify or rebroadcast the data.

Fibre-optic cable and associated telecommunications devices are more expensive to purchase and install than their twisted-pair wire counterparts, although the cost is decreasing. Laying thousands of miles of fibre-optic cable across its vast expanses is credited for helping propel India into the high-tech world. With the capability that this infrastructure provided, Indian workers were able to collaborate closely with their Western counterparts even though they were thousands of miles away. As a result, India has emerged as a key business partner to many firms that have outsourced part of their business operations or that use Indian firms for information systems projects.

### **Broadband Over Power Lines**

Many utilities, cities and organizations are experimenting with providing network connections over standard high-voltage power lines. Manassas, Virginia, became the first city in the US to offer this service to all its citizens. To access the Internet, broadband over power lines (BPL) users connect their computer to a special hardware device that plugs into any electrical wall socket. A potential issue with BPL is that transmitting data over unshielded power lines can interfere with both ham radio broadcasts, and police and fire radios. However, BPL can provide Internet service in rural areas where broadband access is unavailable, because electricity is prevalent in homes even more than telephone lines.



(a)



(b)



(c)

**Figure 6.2** Types of Guided Transmission Media  
 (a) Twisted-pair wire  
 (b) Coaxial cable  
 (c) Fibre-optic cable

## Wireless Transmission Media Types

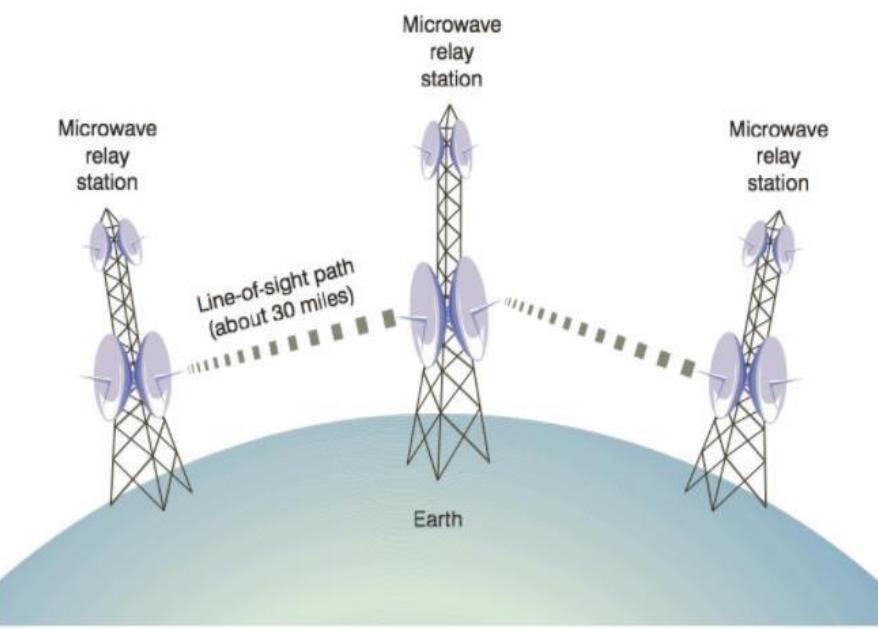
Many technologies are used to transmit communications wirelessly. The major technologies include microwave, satellite, radio and infrared. Their key distinguishing feature is the frequency at which signals are transmitted.

### Microwave Transmission

Microwave is a high-frequency (300 MHz–300 GHz) signal sent through the air (see Figure 6.3). Terrestrial (Earth-bound) microwaves are transmitted by line-of-sight devices, so that 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’. Microwave signals can carry thousands of channels at the same time.

**Figure 6.3** **Microwave Communications** Because they are line-of-sight transmission devices, microwave dishes are frequently placed in relatively high locations, such as atop mountains, towers or tall buildings.



**Principles Of Business Information Systems 3<sup>rd</sup> Edition, Ralph Stair, George Reynolds and Thomas Chesney Chapter 6 Page Number 192**

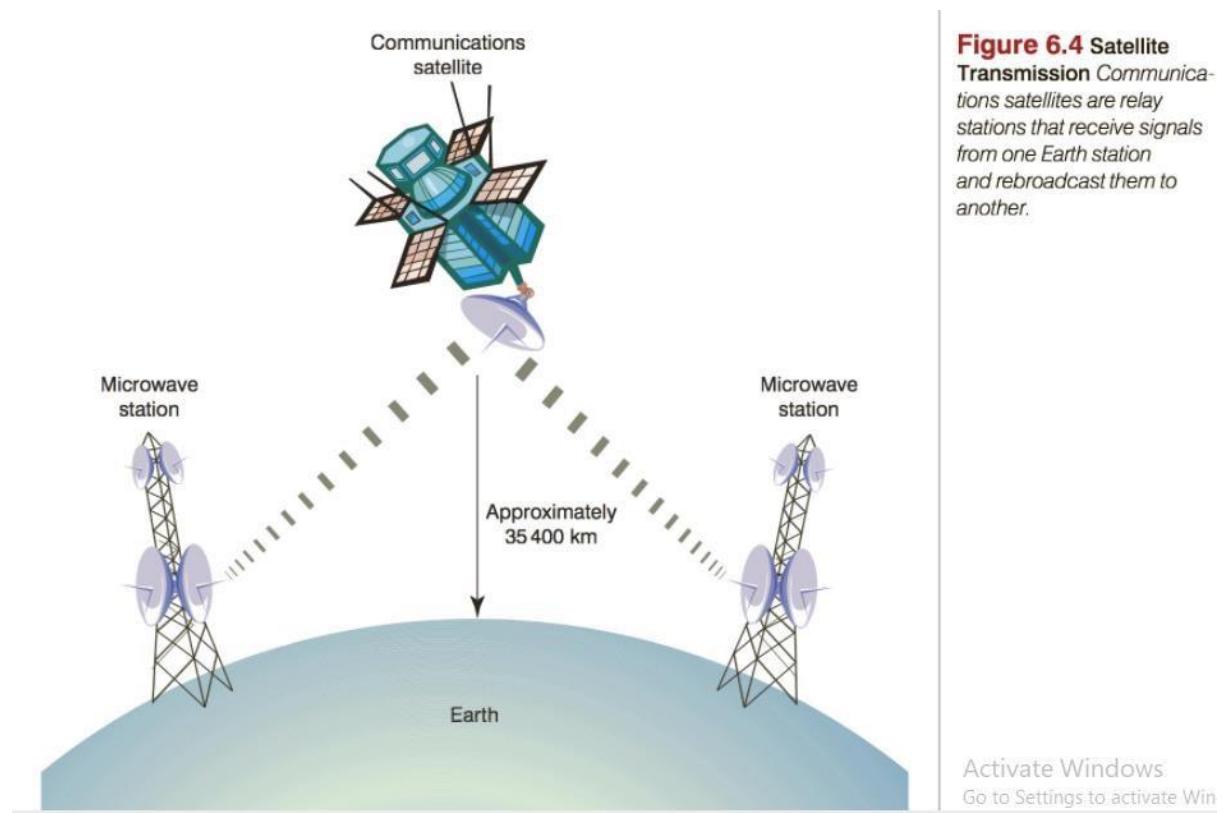
A communications satellite also operates in the microwave frequency range (see Figure 6.4). The satellite receives the signal from the Earth station, amplifies the relatively weak signal and then rebroadcasts it at a different frequency.

The advantage of satellite communications is that it can receive and broadcast over large geographic regions. Such problems as the curvature of the Earth, and 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. A geostationary satellite orbits the Earth directly over the equator approximately 35 400 km (22 000 miles) above the Earth so that it appears stationary. Three such satellites, spaced at equal intervals (120 angular degrees apart), can cover the entire world.

A geostationary satellite can be accessed using a dish antenna aimed at the spot in the sky where the satellite hovers. A low earth orbit (LEO) satellite system employs many satellites, each in

a circular orbit at an altitude of a few hundred kilometres. The satellites are spaced so that from any point on the Earth at any time, at least one satellite is on a line of sight.



A very small aperture terminal (VSAT) is a two-way satellite ground station with a dish antenna smaller than three metres in diameter. Many retail chains employ this technology to support point-of-sale transactions, including credit cards. News organizations employ VSAT dishes that run on battery power to transmit news stories from remote locations. VSAT technology is being used to rebuild the telecommunications infrastructure in Afghanistan and Iraq.

### 3G Wireless Communication

Wireless communication for mobile devices has evolved through four generations of technology and services. The 1G (first generation) of wireless communications standards originated in the 1980s and were based on analogue communications. The 2G (second generation) were fully digital networks that superseded 1G networks in the early 1990s. In 2G, phone conversations were encrypted, mobile phone usage was expanded and short message services (SMS), or texting, was introduced. 3G or third generation wireless communication supports voice and broadband data communications in a mobile environment at speeds of 2–4 Mbps. Additional capabilities include mobile video, e-commerce, location-based services, gaming and music. The wide variety of 3G communications protocols can support many business applications. The challenge is to enable these protocols to intercommunicate and support fast, reliable, global wireless communications.

### 4G Wireless Communication

The International Telecommunications Union (ITU) has defined 4G as a network that has meaningful improvement over 3G. 4G broadband mobile wireless is delivering enhanced versions

of multimedia, smooth video streaming, universal access, portability across all types of device and, eventually, worldwide roaming. 4G delivers access speeds in the range 5–20 Mbps, ten times the speed of 3G. For example, Worldwide Interoperability for Microwave Access (WiMAX) is a version of 4G which is based on a set of IEEE 802.16 wireless metropolitan area network standards that support various types of communications access. IEEE stands for the Institute of Electrical and Electronic Engineers, a non-profit organization and one of the leading standards-setting organizations. In many respects, WiMAX operates like Wi-Fi only over greater distances and faster transmission speeds. Fewer WiMAX base stations are therefore required to cover the same geographical area than when using Wi-Fi technology. Most telecommunications experts agree that WiMAX is an attractive option for countries that lack an existing wired telephone infrastructure.

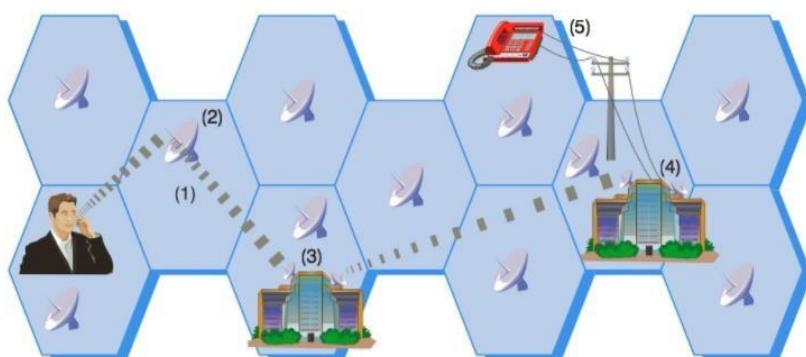
### Wi-Fi

**Wi-Fi** is a wireless telecommunications technology 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 telecommunications standards.

Wi-Fi is a medium-range wireless option typically operating up to about 30 metres around a single building. With a Wi-Fi network, the user's computer, smartphone or tablet 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. 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 (see Figure 6.5). Mobile devices typically come with built-in wireless transmitters and software that enable them to detect the existence of a Wi-Fi network and alert the user. 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 have been established in many airports, coffee shops, libraries, university campuses and hotels.

Figure 6.5

**Figure 6.5 A Typical Mobile Transmission Scenario** Using a mobile phone, the caller dials the number (1). The signal is sent from the phone's antenna to the low-powered mobile antenna located in that area (2). The signal is sent to the regional mobile phone switching office, also called the mobile telephone subscriber office (MTSO) (3). The signal is switched to the local telephone company switching station located nearest the call destination (4). Now integrated into the regular phone system, the call is switched to the number originally dialled (5), all without the need for operator assistance.



## Near Field Communication

**Near field communication (NFC)** is a very short-range wireless connectivity technology designed for consumer electronics, smartphones and credit cards. Once two NFC-enabled devices are in close proximity (touching or a few centimetres apart), they exchange the necessary communications parameters and passwords to enable bluetooth, wi-fi or other wireless communications between the devices. Because only two devices participate, NFC establishes a peer-to-peer network. Barclays Bank was one of the first banks in the UK to offer a contactless payment system built into its credit cards. Customers can pay for goods easily and safely by waving their card across a reader in the store. The system uses NFC technology.

### Bluetooth

**Bluetooth** is a wireless communications specification that describes how smartphones, computers, printers and other electronic devices can be interconnected over distances of a few metres at a rate of about 2 Mbps. One important application of Bluetooth is in hands-free use of mobile phones when driving, using a Bluetooth headset to connect to a phone

### Ultra Wideband

**Ultra wideband (UWB)** communications involves the transmission of extremely short electromagnetic pulses lasting just 50 to 1000 picoseconds. (One picosecond is one trillionth or one-millionth of one-millionth of a second.) The pulses are capable of supporting data transmission rates of 480 to 1320 Mbps over relatively short ranges of 10 to 50 metres.

UWB offers several advantages over other communications means: a high throughput rate, the ability to transmit virtually undetected and impervious to interception or jamming, and a lack of interference with current communications services. A wireless communications specification that describes how smartphones, computers, printers and other electronic devices can be interconnected over distances of a few metres at a rate of about 2Mbps. ultra wideband (UWB) A form that employs extremely short electromagnetic pulses lasting 50 to 1000 picoseconds that are transmitted across a broad range of radio frequencies or several gigahertz.

Potential UWB applications include wirelessly connecting printers and other devices to desktop computers or enabling home multimedia networks. Manufacturers of medical instruments are using UWB for video endoscopes, laryngoscopes and ultrasound transducers.

### Infrared Transmission

Another mode of transmission, called infrared transmission, sends signals through the air via light waves at a frequency of 300 GHz and above. Infrared transmission requires line-of-sight transmission and short distances – under a few hundred metres. Infrared transmission can be used to connect a display screen, a printer and a mouse to a computer, meaning there are no wires to clutter up the desk. Some special-purpose phones can also use infrared transmission. You can use infrared to establish a wireless network, with the advantage that devices can be moved, removed and installed without expensive wiring and network connections. The Apple remote is a remote control made for use with Apple products with infrared capabilities. It has just six buttons: Menu, Play/Pause, Volume Up, Volume Down, Previous/Rewind and Next/Fast-forward. The Mac Mini features an infrared port designed to work with the Apple remote and supports Front Row, a multimedia application that allows users to access shared iTunes and iPhoto libraries and video throughout their home.

### Telecommunications Hardware

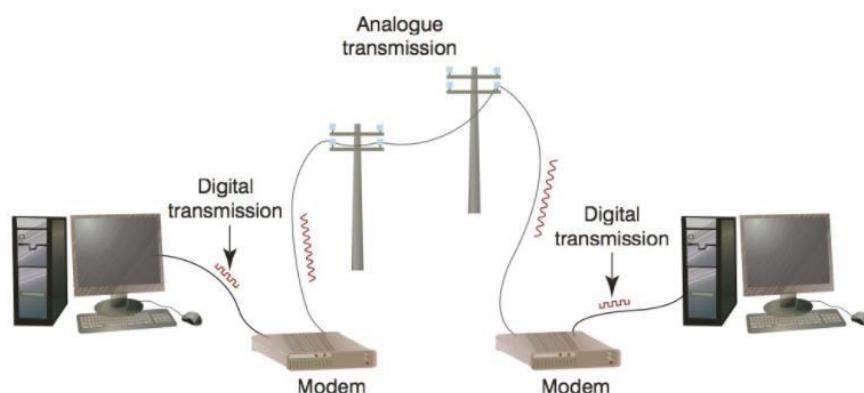
Telecommunications hardware devices include modems, multiplexers and front-end processors.

## Modems

At different stages in the communication process, telecommunications often uses transmission media of different types and capacities. If you use an analogue telephone line to transfer data, it can only accommodate an **analogue signal** (a variable signal continuous in both time and amplitude so that any small fluctuations in the signal are meaningful). Because a computer generates a **digital signal** representing bits, you need a special device to convert the digital signal to an analogue signal and vice versa (see Figure 6.6). Translating data from digital to analogue is called ‘modulation’, and translating data from analogue to digital is called ‘demodulation’. Thus, these devices are modulation/demodulation devices or **modems**. Modems can dial telephone numbers, originate message sending and answer incoming calls and messages. Cellular modems in laptop computers allow people on the go to communicate with other computer systems and devices.

Figure 6.6

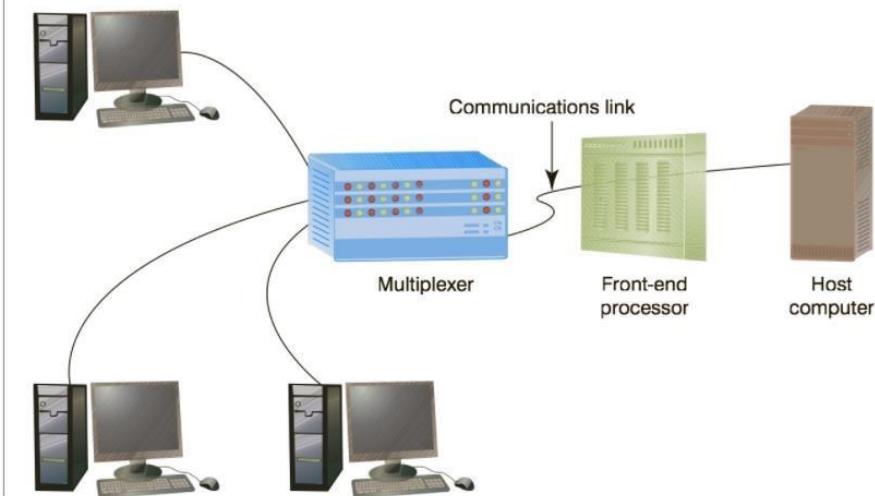
**Figure 6.6 How a Modem Works** Digital signals are modulated into analogue signals, which can be carried over existing phone lines. The analogue signals are then demodulated back into digital signals by the receiving modem.



## Multiplexers

A **multiplexer** is a device that encodes data from two or more data sources onto a single communications channel, thus reducing the number of communications channels needed and therefore lowering telecommunications costs

**Figure 6.7** Use of a Multiplexer to Consolidate Data Communications Onto a Single Communications Link



**Principles Of Business Information Systems 3<sup>rd</sup> Edition, Ralph Stair, George Reynolds and Thomas Chesney Chapter 6 Page Number 196**

## Front-End Processors

**Front-end processors** are special-purpose computers that manage communications to and from a computer system serving hundreds or even thousands of users. They poll user devices to see if they have messages to send and facilitate efficient, error-free communications. By performing this work, the front-end processor relieves the primary computer system of much of the overhead processing associated with telecommunications.

## Private Branch Exchange

A **private branch exchange (PBX)** is a telephone switching exchange that serves a single organization. It enables users to share a certain number of outside lines (trunk lines) to make telephone calls to people outside the organization. This sharing reduces the number of trunk lines required, which in turn reduces the organization's telephone costs. A PBX also enables the routing of calls between individuals within the organization. The PBX can also provide many other functions including voicemail, voice paging, three-way calling, call transfer and call waiting. A VoIP-PBX can accept Voice over IP (VoIP) calls as well as traditional phone calls. With VoIP calls, the callers' voices are converted into packets of data for routing over the Internet.

## Switches, Bridges, Routers and Gateways

In addition to communications protocols, certain hardware devices switch messages from one network to another at high speeds. A **switch** uses the physical device address in each incoming message on the network to determine to which output port it should forward the message to reach another device on the same network. A **bridge** connects one local area network (LAN) to another LAN that uses the same telecommunications protocol. A **router** forwards data packet across two or more distinct networks towards their destinations through a process known as ‘routing’. A **gateway** is a network device that serves as an entrance other network.

## 6.2 Networks and Distributed Processing

A **computer network** consists of communications media, devices and software needed to connect two or more computer systems or devices. The computers and devices on the networks are called ‘network nodes’. After they are connected, the nodes can share data, information and processing jobs. Increasingly, businesses are linking computers in networks to streamline work processes and allow employees to collaborate on projects. If a company uses networks effectively, it can grow into an agile, powerful and creative organization. Organizations can use networks to share hardware, programs and databases. Networks can transmit and receive information to improve organizational effectiveness and efficiency. They enable geographically separated workgroups to share information, which fosters teamwork, innovative ideas and new business strategies.

### Network Types

Depending on the physical distance between nodes on a network and the communications and services it provides, networks can be classified as personal area, local area, metropolitan area or wide area.

### Personal Area Networks

A **personal area network (PAN)** is a wireless network that connects information technology devices within a range of ten metres or so. One device serves as the controller during wireless PAN initialization, and this controller device mediates communication within the PAN. The controller broadcasts a beacon that synchronizes all devices and allocates time slots for the devices. With a PAN, you can connect a laptop, digital camera and portable printer without physical cables. You could download digital image data from the camera to the laptop and then print it on a high-quality printer – all wirelessly. The Bluetooth communication protocol is the industry standard for PAN communications. Metro AG is a major German retailer that owns and operates about 2400 wholesale stores, supermarkets, hypermarkets, department stores and specialty retailers (such as home improvement and consumer electronics). The firm is testing a new voice-operated, smart tag system equipped with Bluetooth communications to help warehouse personnel quickly and accurately fill merchandise orders. Item pickers wear a headset to receive instructions on which items to pick. They also wear a high-tech glove that gathers product information from the RFID chip on each item that they pick from the shelves. The glove and RFID chip communicate using Bluetooth technology. If workers accidentally

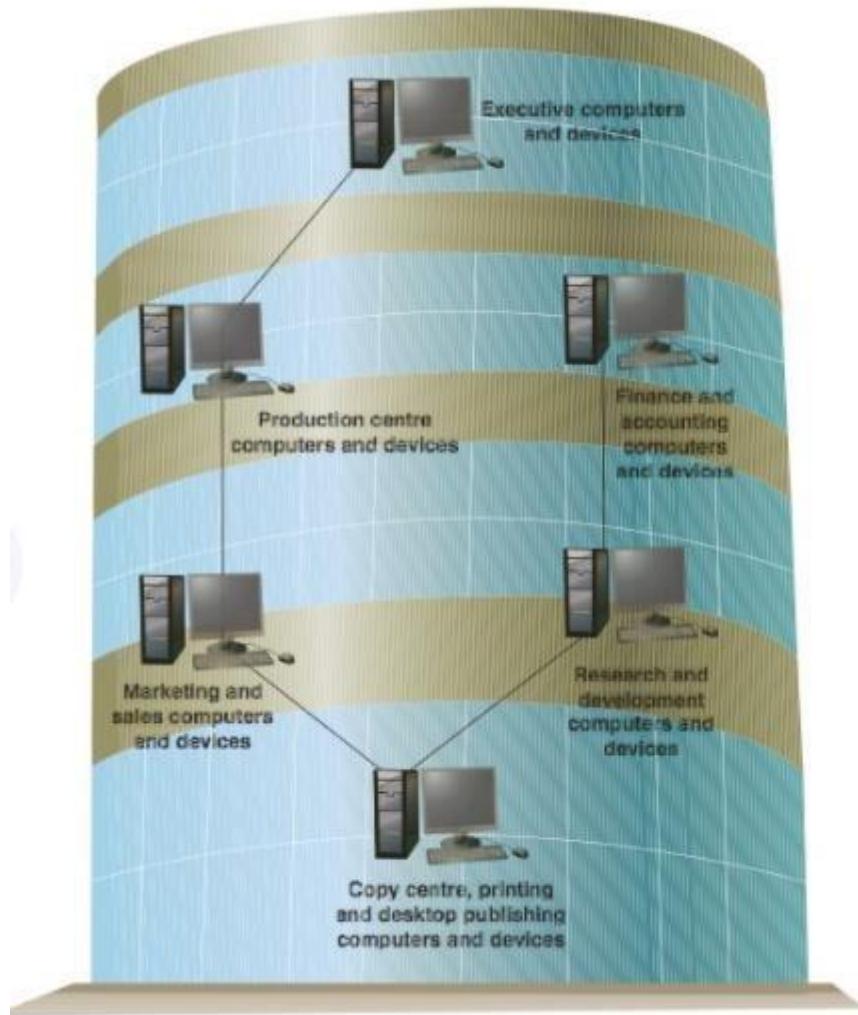
pick the wrong product, they receive a message requesting them to repeat the process. The main benefit of the voice-operated RFID picking system is that work sequences aren't interrupted by employees having to manually compare product identification data on the item to the description on a written list.

## Local Area Networks

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 LAN. Typically, LANs are wired into office buildings and factories (see Figure 6.8). Although LANs often use unshielded twisted-pair wire, other media – including fibre-optic cable – is also popular. Increasingly, LANs are using some form of wireless communications. An example of a sophisticated LAN is the one that Digital Globe uses. Digital Globe is the company responsible for the detailed satellite images accessed by millions of Google Earth users. The firm uses a high-speed LAN (110GB/sec) to connect workers to its huge file storage system (200 TB) so that new images can be quickly captured and added to its rapidly growing repository of Earth photos.<sup>7</sup> 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 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 Windows for Work- groups, Windows NT and AppleShare.

Performance of the computers on a peer-to-peer network is usually slower because one computer is actually sharing the resources of another computer. However, these networks provide a good foundation from which small businesses can grow. The software cost is minimal, and businesses can use the network cards if they decide to enlarge the system. In addition, peer-to-peer networks are becoming cheaper, faster and easier to use for home-based businesses. With more people working at home, connecting home computing devices and equipment into a unified network is on the rise. Small businesses are also connecting their systems and equipment. A home or small business can connect network, computers, printers, scanners and other devices. A person working on one computer, for example, can use data and programs stored on another computer's hard disc. In addition, several computers on the network can share a single printer. To make home and small business networking a reality, many companies are offering standards, devices and procedures. Copyright 2018 Cengage Learning. All Rights Reserved. May not be copied

Figure 6.8



**Figure 6.8 A 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 centre.

## Metropolitan Area Networks

A **metropolitan area network (MAN)** is a telecommunications network that connects users and their computers in a geographical area that spans a campus or city. Most MANs have a range of roughly 100 kilometres. For example, a MAN might redefine the many networks within a city into a single larger network or connect several LANs into a single campus LAN. EasyStreet (an Internet service provider) and OnFibre (a metro network solutions provider) designed a MAN for the city of Portland, Oregon, to provide local businesses with fast (more than 1 Gps), low-cost Internet connections.

## Wide Area Networks

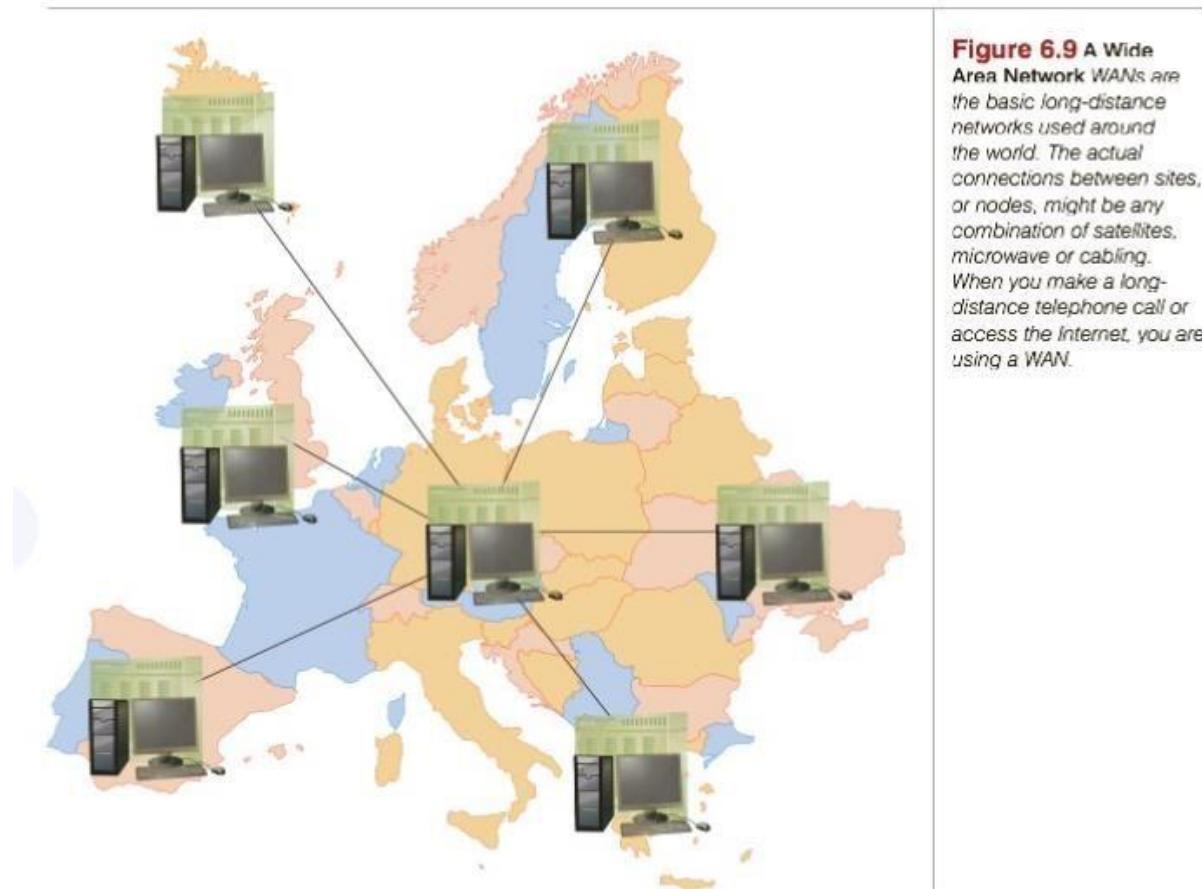
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designed a MAN for the city of Portland, Oregon, to provide local businesses with fast (more than 1 Gps), low-cost Internet connections.

## Wide Area Networks

**A wide area network (WAN)** is a telecommunications 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 telecommunications links provided by various carriers and service providers (see Figure 6.9).

Figure 6.9



International Networks

Networks that link systems between countries are called **international networks**. However, international telecommunications involves special problems. In addition to requiring sophisticated equipment and software, international networks must meet specific national and international laws regulating the electronic flow of data across international boundaries, often called transborder data flow. Some countries have strict laws limiting the use of telecommunications and databases,

Making normal business transactions such as payroll costly, slow or even impossible. Other countries have few laws concerning telecommunications and database use.

These countries, sometimes called data havens, allow other governments and companies to process data within their boundaries. International networks in developing countries can have inadequate equipment and infrastructure that can cause problems and limit the usefulness of the network. Marks & Spencer plc has a substantial international presence with 550 stores worldwide operating in 30 countries. It depends on an international network to link all its stores to capture daily sales and track results. It also deals with roughly 2000 direct suppliers of finished products located in places such as Bangalore, Bangladesh, Delhi, Hong Kong, Istanbul and Sri Lanka. Reliable international communications are also required for it to work quickly and effectively with its supply base so that it can acquire goods more efficiently while still meeting the firm's strict trading standards.

The firm is working with Cable & Wireless plc to implement an Internet protocol virtual private network to provide Voice over Internet Protocol (VoIP) at its 400 UK stores and a converged voice/data IP international network for all its operations.<sup>9</sup> The stores involved in the first phase of the development have experienced a great improvement in the response times of customer-facing systems, such as payment processing and customer ordering, as well as stock ticketing, email and personnel management systems

## Mesh Networking

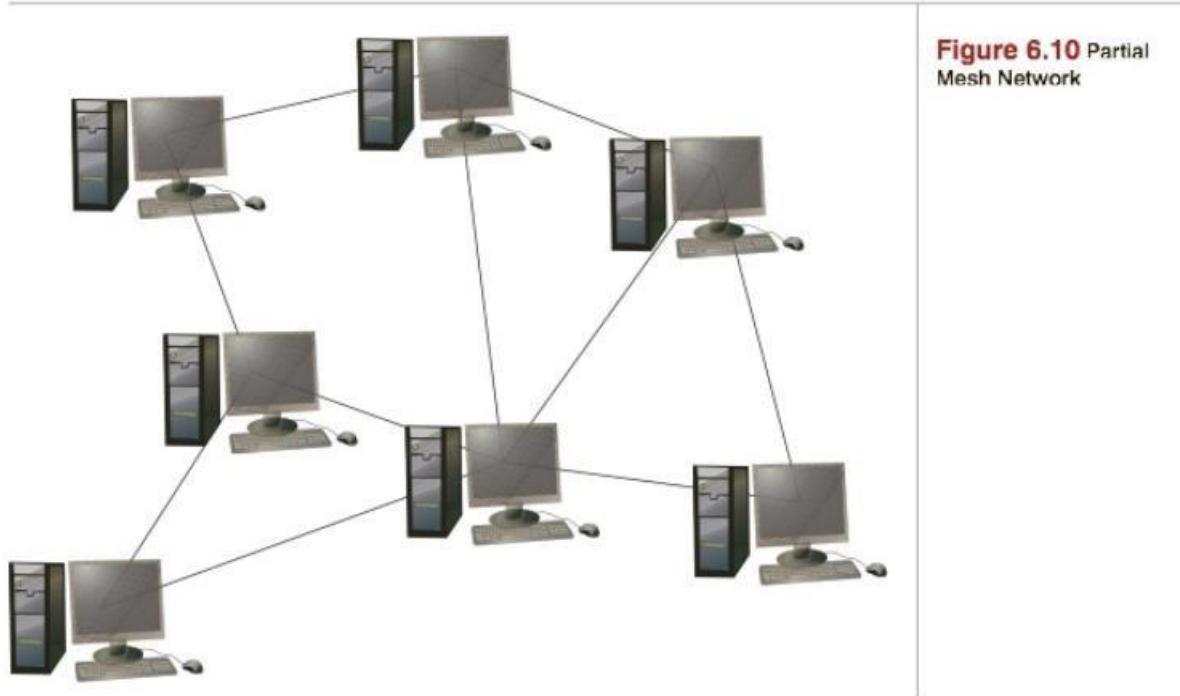
**Mesh networking** is a way to route communications among network nodes (computers or other devices) by allowing for continuous connections and reconfiguration around blocked paths by ‘hopping’ from node to node until a connection can be established. In the full mesh topology, each node (workstation or other device) is connected directly to each of the other nodes. In the partial mesh topology, some nodes might be connected to all the others, and other nodes are connected only to nodes with which they frequently exchange communications (see Figure 6.10). 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. Mesh networks are being set up to blanket large areas to provide Internet access, secure connections to corporate networks and VoIP calls. Many cities throughout Europe are setting up mesh networks to give residents, sometimes free, Internet access.

## Distributed Processing

When an organization needs to use two or more computer systems, it can use one of three basic processing alternatives: centralized, decentralized or distributed. With **centralized processing**, all processing occurs in a single location or facility. This approach offers the highest degree of control because a single centrally managed computer performs all data processing. With decentralized processing, processing devices are placed at various remote locations. Each

computer system is isolated and does not communicate with another system. **Decentralized systems** are suitable for companies that have independent operating divisions. With distributed processing, computers are placed at remote locations but connected to each other via telecommunications devices. One benefit of distributed processing is that managers can allocate data to the locations that can process it most efficiently. The 11 September 2001 terrorist attacks on the World Trade Center in New York and the current relatively high level of natural disasters such as hurricane Katrina in the Gulf of Mexico in the southern US in 2005 sparked many companies to distribute their workers, operations and systems much more widely, a reversal of the recent trend towards centralization. The goal is to minimize the consequences of a catastrophic event at one location while ensuring uninterrupted systems availability.

Figure 6.10

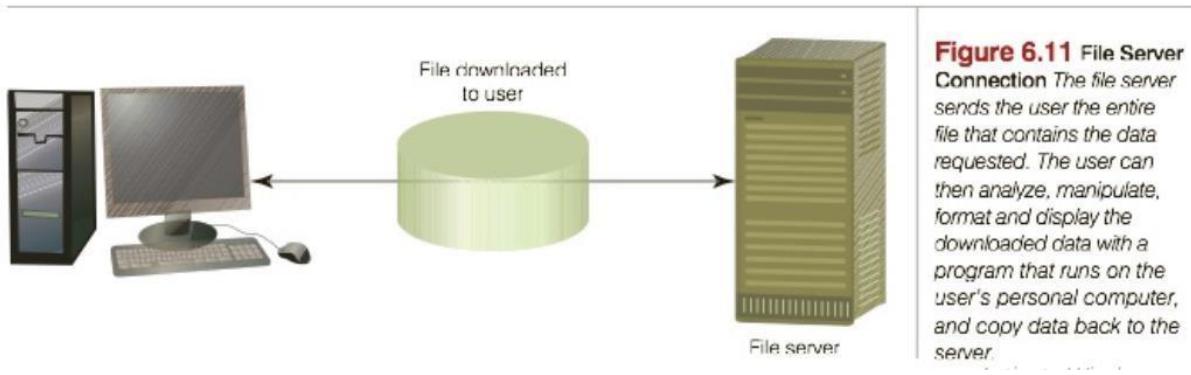


**Figure 6.10** Partial Mesh Network

### Client/Server Systems

Users can share data through file server computing, which allows authorized users to download entire files from certain computers designated as file servers. After downloading data to a local computer, a user can analyse, manipulate, format and display data from the file (see Figure 6.11).

Figure 6.11

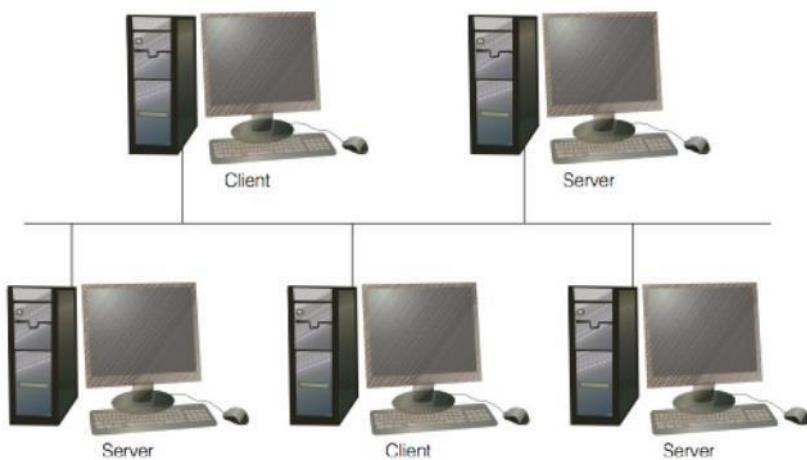
**Figure 6.11** File Server

**Connection** The file server sends the user the entire file that contains the data requested. The user can then analyze, manipulate, format and display the downloaded data with a program that runs on the user's personal computer, and copy data back to the server.

In **client/server** architecture, multiple computer platforms are dedicated to special functions such as database management, printing, communications and program execution. These platforms are called servers. Each server is accessible by all computers on the network. Servers can be computers of all sizes; they store both application programs and data files and are equipped with operating system software to manage the activities of the network. The server distributes programs and data to the other computers client/server (clients) on the network as they request them. An application server holds the programs and data files for a particular application, such as an inventory database. The client or the server can do the processing. An email server sends and receives emails. A web server sends out web pages. A client is any computer (often a user's personal computer) that sends messages requesting services from the servers on the network. A client can converse with many servers concurrently (see Figure 6.12)

Figure 6.12

**Figure 6.12 Client/Server Connection**  
 Multiple computer platforms, called servers, are dedicated to special functions. Each server is accessible by all computers on the network. The client requests services from the servers, provides a user interface and presents results to the user.



**Principles Of Business Information Systems 3<sup>rd</sup> Edition, Ralph Stair,George Reynolds and Thomas Chesney Chapter 6 Page Number 204**

## Communications Software

Chapter 4 you learned that all computers have operating systems that control many functions. When an application program requires data from a disc drive, it goes through the operating system. Now consider a computer attached to a network that connects large disc drives, printers, and other equipment and devices. How does an application program request data from a disc drive on the network? The answer is through the network operating system. **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 the same types of 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 disc drives) is required, the NOS makes sure that these resources are used correctly. In most cases, companies that produce and sell networks provide the NOS. For example, NetWare is the NOS from Novell, a popular network environment for personal computer systems and equipment.

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 licences. 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 on individual computers. In addition, network-management software protects software from being copied, modified or downloaded illegally, and performs error control to locate telecommunications 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. Network management is one of the most important tasks of IS managers. In fact, poor management of the network can cause a whole company to suffer. Because companies use networks to communicate with customers and business partners, network downtime or slow performance can even mean a loss of business. Network management includes a wide range of technologies and processes that monitor the infrastructure and help IS staff identify and address problems before they affect customers, business partners or employees. Fault detection and performance management are the two types of network-management products. Both employ the Simple Network Management Protocol (SNMP) to obtain key information from individual network components. SNMP allows anything on the network, including switches, routers, firewalls and even operating systems and server products and utilities, to communicate with management software about its current operations and state of health. SNMP can also control these devices and products, telling them to redirect traffic, change traffic priorities or even to shut down.

Fault management software alerts IS staff in real time when a device is failing. Equipment vendors place traps (code in a software program for handling unexpected or unallowable conditions) on their hardware to identify problems. In addition, the IS staff can place agents – automated pieces of software – on networks to monitor functions. When a device exceeds a given performance threshold, the agent sends an alarm to the company's IS fault management program. For example, if a CPU registers that it is more than 80 per cent busy, the agent might trigger an alarm. Performance management software sends messages to the various devices (i.e. polls them) to sample their performance and to determine whether they are operating within acceptable levels.

The devices reply to the management system with performance data that the system stores in a database. This real-time data is correlated to historical trends and displayed graphically so that the IS staff can identify any unusual variations.

Today, most IS organizations use a combination of fault management and performance management to ensure that their network remains up and running and that every network component and application is performing acceptably. With the two technologies, the IS staff can identify and resolve fault and performance issues before they affect customers and service.

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. Sierra Pacific is a wood products provider in the US that prior to installing network-management software, learned about network problems in the worst way – from users calling the network operations centre to complain.

The company has operations in about 50 distributed server locations, including deep in the woods where users are connected through routers to a high-speed network. Sierra Pacific installed Systems Intrusion Analysis and Reporting Environment open-source software on all servers to collect network and performance data around the clock and forward it to a central network server. Now, Sierra Pacific has the data it needs to identify bottlenecks and failed

components before users are affected. 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 licences. Copyright 2018 Cengage Learning. All Rights Reserved. May not be copied, scanned

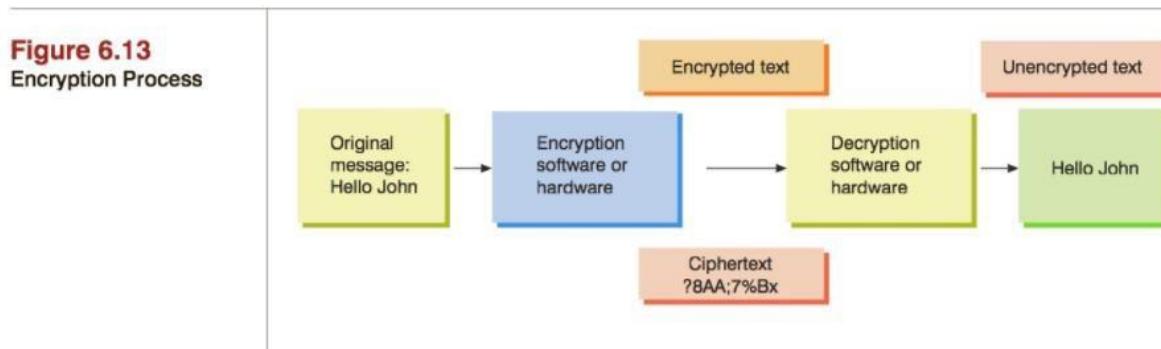
## Securing Data Transmission

The interception of confidential information by unauthorized individuals can compromise private information about employees or customers, reveal marketing or new product development plans, or cause organizational embarrassment. Organizations with widespread operations need a way to maintain the security of communications with employees and business partners, wherever their facilities are located. Guided media networks have an inherently secure feature: only devices physically attached to the network can access the data. Wireless networks, on the other hand, are surprisingly often configured by default to allow access to any device that attempts to ‘listen to’ broadcast communications. Action must be taken to override the defaults.

**Encryption** of data is one approach taken to protect the security of communications over both wired and wireless networks. Encryption is the process of converting an original message into a form that can be understood only by the intended receiver. An **encryption key** is a variable value that is applied (using an algorithm) to a set of unencrypted text to produce encrypted text or to decrypt encrypted text (see Figure 6.13). The key is chosen from one of a large number of possible encryption keys. The longer the key, the greater the number of possible encryption keys. An encryption protocol based on a 56-bit key, for example, has 256 different possible keys, while one based on

a 56-bit key, for example, has 256 different possible keys, while one based on a 128-bit key has 2128 different possible keys. Of course, it is essential that the key be kept secret from possible interceptors. A hacker who obtains the key by whatever means can recover the original message from the encrypted data.

Figure 6.13



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. With headquarters in Dallas, Texas, 7-Eleven operates franchises or licenses over

8800 stores in North America and another 33 900 in 16 countries. The company uses encryption to secure its email. Todd Cohen, leader of 7-Eleven's Information Security, Risk and Compliance practice, states that 'The protection of sensitive partner information is essential to our leadership as a trusted retailer. Email is a critical communication tool in everyday business with our partners, and [encryption services] enable us to use email securely and confidently'.

## Securing Wireless Networks

WEP and WPA are the two main approaches to securing wireless networks such as wi-fi and WiMAX. Wired equivalent privacy (WEP) used to use encryption based on 64-bit key, which has been upgraded to a 128-bit key. WEP represents an early attempt at securing wireless communications and is not difficult for hackers to crack. Most wireless networks now use the Wi-Fi Protected Access (WPA) security protocol that offers significantly improved protection over WEP. The following steps, while not foolproof, help safeguard a wireless network:

- Connect to the router and change the default logon (admin) and password (password) for the router. These defaults are widely known by hackers.
- Create a service set identifier (SSID). This is a 32-character unique identifier attached to the header portion of packets sent over a wireless network that differentiates one net-work from another. All access points and devices attempting to connect to the network must use the same SSID.
- Configure the security to WPA. Surprisingly, many routers are shipped with encryption turned off.
- Disable SSID broadcasting. By default, wireless routers broadcast a message communicating the SSID so wireless devices within range (such as a laptop) can identify and connect to the wireless network. If a device doesn't know the wireless network's SSID, it cannot connect. Disabling the broadcasting of the SSID will discourage all but the most determined and knowledgeable hackers.
- Configure each wireless computer on the network to access the network by setting the security to WPA and entering the same password entered to the router.

War driving involves hackers driving around with a laptop and antenna trying to detect insecure wireless access points. Once connected to such a network, the hacker can gather enough traffic to analyze and crack the encryption

## Virtual Private Network (VPN)

The use of a virtual private network is another means used to secure the transmission of communications. A **virtual private network (VPN)** is a private network that uses a public network (usually the Internet) to connect multiple remote locations. A VPN provides network connectivity over a potentially long physical distance and thus can be considered a form of wide area network. VPNs support secure, encrypted connections between a company's employees and remote users through a third-party service provider. Telecommuters, sales-people and frequent travellers find the use of a VPN to be a safe, reliable, low-cost way to connect to their corporate intranets. Often, users are provided with a security token that displays a constantly changing password to log onto the VPN (Figure 6.14). This solution avoids the

problem of users forgetting their password while providing added security through use of a password constantly changing every 30 to 60 seconds. Werner Enterprises is a transportation and logistics company with a fleet of 7250 trucks, nearly 25 000 tractors, and more than 13 000 employees and independent contractors.

Figure 6.14



**Figure 6.14 RSA SecurID Security Token**  
*The six digits displayed on the token are used as an access code to gain access to a VPN network. The digits change every 60 seconds.*

Most of its business is in North America, but it is expanding globally with customers in Africa, China, Europe and Latin America. Werner employs a VPN solution to link its Shanghai operations centre to its headquarters and data centre in Omaha, Nebraska, so that employees can access load management systems to support global operations.

### 6.3 The Internet

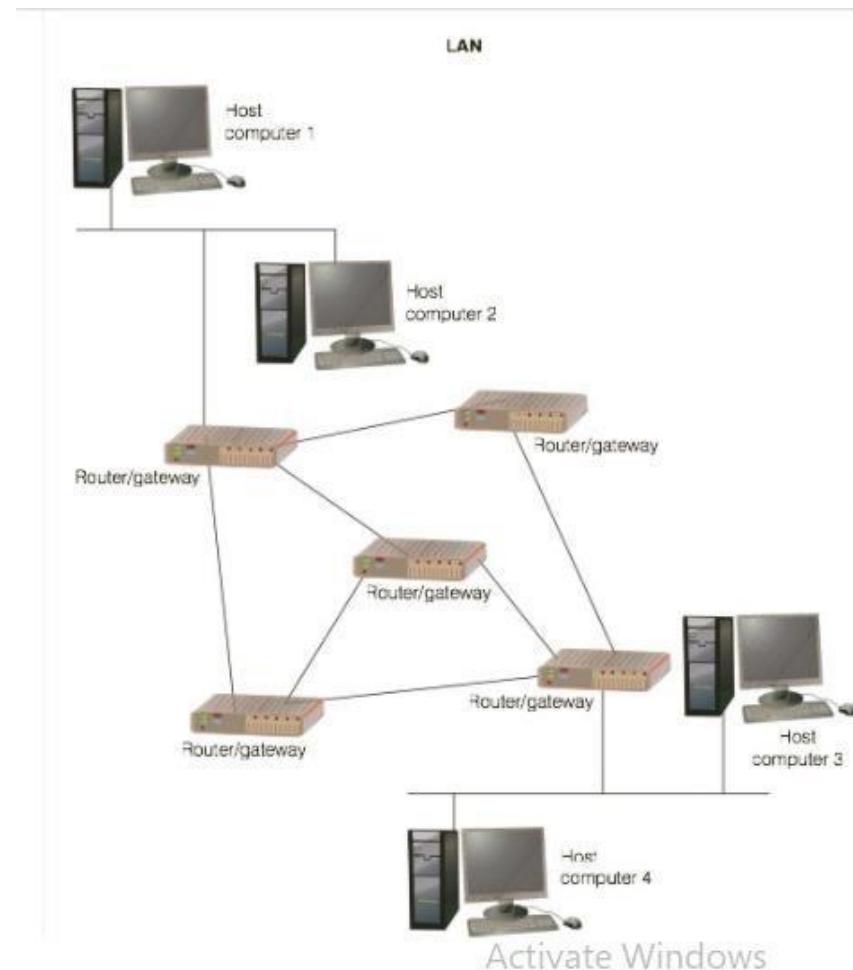
The Internet is the world's largest computer network. Actually, the Internet is a collection of interconnected networks, all freely exchanging information. Nobody knows exactly how big the Internet is because it is a collection of separately run, smaller computer networks. There is no single place where all the connections are registered. Figure 6.15 shows the staggering growth of the Internet, as measured by the number of Internet host sites or domain names. Domain names are discussed later in the chapter. The Internet is truly international in scope, with users on every continent including Antarctica. China has spent many billions on its telecommunications infrastructure in the last few years. China, however, restricts the use of the Internet.<sup>15</sup> In 2005, for example, China implemented new Internet rules. According to the Xinhua News Agency of China, '[Only] healthy and civilized news and information that is beneficial to the improvement of the quality of the nation, beneficial to its economic development and conducive to social progress will be allowed. The sites are prohibited from spreading news and information that goes against state security and public interest'. The penalties for sharing unauthorized information are severe, with more than one Internet user being imprisoned for things they have published online.

The ancestor of the Internet was the **ARPANET**, a project started by the US 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 its large and 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 non-military 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. Katie Hafner's book, *Where Wizards Stay Up Late: The Origins of the Internet*, detailed description of the history of the Internet.<sup>16</sup> Today, people, universities and companies are attempting to make the Internet faster and easier to use. Robert Kahn, who managed the early development of the ARPANET, wants to take the Internet to the next level. He is president of the non-profit organization, National Research Initiatives, which provides guidance and funding for the development of a national information infrastructure. The organization is looking into using 'digital objects', which allow all types of computer systems to use and share programs and data. To speed Internet access, a group of corporations and universities called the University Corporation for Advanced Internet Development (UCAID) is working on a faster, new Internet. Called Internet2 (I2), Next Generation Internet (NGI) or Abilene (depending on the universities or corporations involved), the new Internet offers the potential of faster Internet speeds, up to 2 Gbps or more.<sup>17</sup> Some I2 connections can transmit data at 100 Mbps, which is about 200 times faster than dial-up connections. This speed would allow you to transfer the contents of a DVD in less than a minute.

Figure 6.16 Routing Messages Over The Internet



## How the Internet Works

The Internet transmits data from one computer (called a host) to another (see Figure 6.16). If the receiving computer is on a network to which the first computer is directly connected, it can send the message directly. If the receiving and sending computers are not directly connected to the same network, the sending computer relays the message to another computer which forwards it on. The message might be sent through a router to reach the forwarding computer. The forwarding host, which needs to be attached to at least one other network, delivers the message directly if it can or passes it to another forwarding host. A message can pass through a dozen or more forwarders on its way from one part of the Internet to another. The various networks that are linked to form the Internet work in much the same way they pass data around in chunks called packets, each of which carries the addresses of its sender and its receiver. 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 in connection with IP. The best known is the **Transmission Control Protocol (TCP)**, which operates at the transport layer. Many people use TCP/IP as an abbreviation for the combination of TCP and IP used by most Internet applications. After a network following these standards links to a backbone – one of the Internet's high-speed, long-distance communications links – it becomes part of the worldwide Internet community. Each computer on the Internet has an assigned address called its **uniform resource locator** (URL), to identify it to other hosts. The URL gives those who provide information over the Internet a standard way to designate where Internet elements such as servers, documents and newsgroups can be found. Consider the URL for Cengage Learning, <http://www.cengage.co.uk>. 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. Thus, [http:// www.cengage.co.uk](http://www.cengage.co.uk) can be abbreviated to [www.cengage.co.uk](http://www.cengage.co.uk).

The ‘www’ part of the address signifies that the files associated with this website reside on the World Wide Web server of ‘cengage.co.uk’. The ‘cengage.co.uk’ itself is the domain name that identifies the Internet host site. Domain names must adhere to strict rules. They always have at least two parts, with each part separated by a dot (full stop). For some Internet addresses, the far right part of the domain name is the country code (such as uk for the United Kingdom, au for Australia, ca for Canada, ds for Denmark, fr for France and jp for Japan). Many Internet addresses have a code denoting affiliation categories. (Table 6.2 contains a few popular 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.

Table 6.2

Affiliation ID	Affiliation
com	Commercial organizations
edu	Educational sites (mostly based in the US)
gov	Government sites (mostly based in the US)
net	Networking organizations
org	Organizations
scot	Related to Scotland and Scottish culture

Originally, Herndon, Virginia-based Network Solutions, Inc. (NSI), was the sole company in the world with the direct power to register addresses using .com, .net or .org domain names. However, its government contract ended in October 1998, as part of the US government's move to turn management of the web's address system over to the private sector. Today, other companies, called registrars, can register domain names, and additional companies are seeking accreditation to register domain names from the Internet Corporation for Assigned Names and Numbers (ICANN). Some registrars are concentrating on large corporations, where the profit margins might be higher, compared with small businesses or individuals.

An **Internet service provider (ISP)** is any company that provides people and organizations with access to the Internet. Thousands of organizations serve as Internet service providers, ranging from universities to major communications giants such as BT and AT&T. To use this type of connection, you must have an account with the service provider and software that allows a direct link via TCP/IP. In most cases, ISPs charge a monthly fee of around €20 for unlimited Internet connection through a standard modem. Some ISPs are experimenting with low-fee or no-fee Internet access, though strings are attached to the no-fee offers in most cases, typically that the user must subscribe to telephone services as well.

#### 6.4 Internet Applications

Many people believe the terms 'Internet' and 'World Wide Web' are synonymous. However the web, which is examined next, is just one application of the Internet. Others also discussed in this section are email, telnet and FTP.

#### The World Wide Web

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 World Wide Web (web, WWW or W3) has grown to a collection of tens of thousands of independently owned computers that work together as one in an Internet service. These computers, called web servers, are scattered all over the world and contain every imaginable type of data. Thanks to

the high-speed Internet circuits connecting them and some clever cross-indexing software, users can jump from one web computer to another effortlessly, creating the illusion of using one big computer. Because of its ability to handle multimedia objects, including linking multimedia objects distributed on web servers around the world, the web has become the most popular means of information access on the Internet today. The web is a menu-based system that uses the client/server model. It organizes Internet resources throughout the world into a series of menu pages or screens that appear on your computer. Each web server maintains pointers or links to data on the Internet and can retrieve that data. However, you need the right hardware and telecommunications connections, or the web can be painfully slow.

Data can exist on the web as ASCII characters, word-processing files, audio files, graphic and video images, or any other sort of data that can be stored in a computer file. A website is like a magazine, with a cover page called a **home page** which includes links to the rest of its material. The words on a website are typically written in hypertext. Hypertext allows the linking of certain words to other web pages, so users can click on them to access related material. This feature gives the web its name, as all information is linked together like a spider's web. **Hypertext Markup Language (HTML)** is the standard page description language for web pages. One way to think about HTML is as a set of highlighter pens that you use to mark up plain text to make it a web page – one colour for the headings, another for bold and so on. The **HTML tags** let the browser know how to format the text: as a heading, as a list or as main text, for example. HTML also tells whether pictures, videos and other elements should be inserted, and where they should go. Users mark up a page by placing HTML tags before and after a word or words. For example, to turn a sentence into a heading, you place the tag at the start of the sentence. At the end of the sentence, you place the closing tag . When you view this page in your browser, the sentence will be displayed as a heading. So, an HTML file is made up of two things: text and tags. The text is your message, and the tags are codes that mark the way words will be displayed. All HTML tags are enclosed in a set of angle brackets (< and >), such <hi align = “centre”> principles of business information </h1>

This HTML code centres Principles of Information Systems as a major, or level 1, heading. The ‘h1’ in the HTML code indicates a first-level heading. On some web browsers, the heading might be 14-point type size with a Times Roman font. On other browsers, it might be a larger 18-point size in a different font. There is a standard, but not all browsers stick to it. Figure 6.17 shows a simple document and its corresponding HTML tags. Notice the tag at the top indicating the beginning of the HTML code. The tag indicates the end of the title.

Figure 6.17



**Figure 6.17** Sample Hypertext Markup Language Shown at the left on the screen is a document, and at the right are the corresponding HTML tags.



### Principles Of Business Information Systems 3<sup>rd</sup> Edition, Ralph Stair, George Reynolds and Thomas Chesney Chapter 6 Page Number 213

Some newer web standards are gaining in popularity, including Extensible Markup Language (XML), Extensible Hypertext Markup Language (XHTML), Cascading Style Sheets (CSS), Dynamic HTML (DHTML) and Wireless Markup Language (WML). WML can display web pages on small screens, such as smartphones and PDAs. XHTML is a combination of XML and HTML that has been approved by the World Wide Web Consortium (W3C). 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

Not have a predefined tag set. With HTML, for example, the `<h1>` tag always means a firstlevel heading. The content and formatting are contained in the same HTML document. With XML, web documents contain the content of a web page. The formatting of the content is contained in a separate style sheet. A few typical instructions in XML follow:

`<Chapter> Hardware`

`<Topic> input devices`

<Topic>processing and storage devices

<Topic>output devices

How the preceding content is formatted and displayed on a web page is contained in the corresponding style sheet, such as the following cascading style sheet (CSS). Note that the chapter title ‘Hardware’ is displayed on the web page in a large font (18 points). ‘Hardware’ will appear in bold blue text. ‘Input Devices’ and the other titles will appear in a smaller font (12 points) in italic red text. 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:

XML includes the capabilities to define and share document information over the web. A company can use XML to exchange ordering and invoicing information with its customers. CSS improves web page presentation, and DHTML provides dynamic presentation of web content. These standards move more of the processing for animation and dynamic content to the web browser and provide quicker access and displays.

## Web Browsers

A **web browser** translates HTML so you can read it. It provides a graphical interface to the web. The menu consists of graphics, titles and text with hyper- text links. **Hypermedia** links you to Internet resources, including text documents, graphics, sound files and newsgroup servers. As you choose an item or resource, or move from one document to another, you might be accessing various computers on the Internet without knowing it, while the web handles all the connections.

The beauty of web browsers and the web is that they make surfing the Internet fun. Clicking with a mouse on a highlighted word or graphic whisks you effortlessly to computers halfway around the world. Most browsers offer basic features such as support for backgrounds and tables, displaying a web page’s HTML source code and a way to create hot lists of your favourite sites. Web browsers enable net surfers to view more complex graphics and 3D models, as well as audio and video material, and to run small programs embedded in web pages called **applets**.

A web browser plug-in is an external program that is executed by a web browser when it is needed. For example, if you are working with a web page and encounter an Adobe pdf file, the web browser will typically run the external Adobe pdf reader program or plug-in to allow you to open the file. Microsoft Internet Explorer and Google Chrome are examples of web browsers for PCs. Safari is a popular web browser from Apple for their Macintosh computer, and Mozilla Firefox is a web browser available in numerous languages that can be used on PCs, computers with the Linux operating system and Apple Mac computers.

## Search Engines and Web Research

Looking for information on the web is like browsing in a library without the alphabetic listing of books in the card catalogue, it is difficult to find information. Web search tools – called search engines – take the place of the card catalogue. Most **search engines**, such as Google, are free. They make money by, among other things, charging advertisers to put ad banners in their search engine results. Companies often pay a search engine for a sponsored link, which is usually displayed at the top of the list of links for an Internet search. Google has over 60 per cent of search volume.<sup>18</sup> a web Search engines that that use keyword indexes produce an index of all the text on the sites they examine. Typically, the engine reads at least the first few hundred

words on a page, including the title and any keywords or descriptions that the author has built into the page structure. The engine throws out common words such as ‘and’, ‘the’, ‘by’ and ‘for’. The engine assumes remaining words are valid page content; it then alphabetizes these words (with their associated sites) and places them in an index where they can be searched and retrieved. Some companies include a Meta tag in the HTML header for search engine robots from sites such as Google to find and use. Meta tags are not shown on the web page when it is displayed; they only help search engines discover and display a website. To place the search results in the most relevant order, Google counts the number of links that are made to each from other websites and puts the one with the most at the top. Today’s search engines do more than look for words, phrases or sentences on the web. For example, you can use Google to search for images and video.<sup>19</sup> You can even search for geographic locations to get a view from the skies using satellites.<sup>20</sup> Google, for example, offers Google Maps and Google Earth to provide aerial views. After downloading and installing Google Earth, you can type an address and Google will show you the neighbourhood or even a house in some cases. Microsoft Virtual Earth and Local Search also give aerial views and close-ups of some locations, including retail stores in some cases.<sup>21</sup> You can also use news organizations’ websites, such as the BBC’s (<http://news.bbc.co.uk/>), to access current information on a variety of topics. Some websites maintain versions in different languages, especially for research purposes. In addition, many ordinary web users are publishing lists of their favourite web pages along with explanations of what they are, to classify web content and to make it easier for them (and others) to retrieve information. Such lists are known as ‘folksonomies’, although this word has been voted one of the most annoying Internet terms.

## Web Programming Languages

There are a number of important web programming languages. **Java**, for example, is an object-oriented programming language from Sun Microsystems based on the C++ programming language, which allows small programs – the applets mentioned earlier – to be embedded within an HTML document. When the user clicks the appropriate part of an HTML page to retrieve an applet from a web server, the applet is downloaded onto the client workstation, where it begins executing. Unlike other programs, Java software can run on any type of computer. Programmers use Java to make web pages come alive, adding splashy graphics, animation and real-time updates. The user accesses the web page from a web server. If the user clicks the app rectangle to execute the Java applications, the client’s computer checks for a copy on its local hard drive. If it does not find the applet, the client requests the web server to download the applet. The web server that delivers the Java applet to the web client cannot determine what kind of hardware or software environment the client is running, and the developer who creates the Java applet does not have to worry about whether it will work correctly on Windows, UNIX or Mac OS. Java is thus often described as a ‘cross-platform’ programming language. In addition to Java, companies use a variety of other programming languages and tools to develop websites. Ruby on Rails is a popular software framework for developing web applications that is optimized for programming productivity. It has been used by companies like Airbnb, Fab.com and Hulu to develop their web-based products. VBScript and ActiveX (used with Internet Explorer) are Internet languages used to develop web pages and perform important functions, such as accepting user input. Hypertext Preprocessor, or PHP, is an open-source programming language. PHP code or instructions can be embedded directly into HTML code. Unlike some other Internet languages, PHP can run on a web server, with the results being transferred to a client computer. PHP can be used on a variety of operating systems. It can also be used with a variety of database management systems, such as DB2, Oracle, Informix, MySQL and many others. These characteristics – running on different

operating systems and database management systems, and being an open source language – make PHP popular with many web developers.

200

## Developing Web Content

The art of web design involves working within the technical limitations of the web and using a set of tools to make appealing designs. A study at Glamorgan University Business School in Wales, for example, concluded that women prefer web pages with more colour in the background and informal pictures and images.<sup>22</sup> Men prefer darker colours and like 3D, moving images. You can create a web page using one of the following approaches: (a) write your copy with a word processor and then use an HTML converter to convert the page into HTML format; (b) use an HTML editor to write text (it will add HTML tags at the same time); (c) edit an existing HTML template (with all the tags ready to use) to meet your needs; or (d) use an ordinary text editor such as Notepad and type the start and end tags for each item. After you develop web content, your next step is to place or publish the content on a web server so others can access it. Popular publishing options include using ISPs, free sites and web hosting. BT's starter package comes with 5 GB of web space and users can pay to increase this.<sup>23</sup> Free sites offer limited space for a website. In return, free sites often require the user to view advertising or agree to other terms and conditions. Web hosting services provide space on their websites for people and businesses that don't have the financial resources, time or skills to host their own website. A web host charges a monthly fee, depending on services offered. Some web hosting sites include domain name registration, web authoring software, and activity reporting and monitoring of the website. Often, FTP (described later in this chapter) is used to copy files from the developer's computer to the web server. Some web developers are creating programs and procedures to combine two or more web-sites into one website, called a 'mashup'.<sup>24</sup> A mash-up is named for the process of mixing two or more (often hip-hop) songs into one song. A website containing crime information, for example, can be mashed up with a mapping website to produce a website with crime information placed on top of a map of a metropolitan area. People are becoming very creative in how they mash up several websites into new ones. Mashing up websites is becoming popular, but not everyone is happy with the practice. Some companies are trying to block the mash-up of the content on their website without permission. After a website has been constructed, a content management system (CMS) can keep the website running smoothly. CMS consists of both software and support.

Companies that provide CMS can charge from €11 000 to more than €400 000 annually, depending on the complexity of the website being maintained and the services being performed. Adobe Experience Manager is an example of a CMS. Many products make it easy to develop web content and interconnect web services. Microsoft, for example, has introduced a development and web services platform called .NET. The .NET platform allows developers to use different 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.

## Web Services

**Web services** consist of standards and tools that streamline and simplify communication among websites, promising to revolutionize the way we develop and use the web for business and personal purposes. Internet companies, including Amazon, eBay and Google, are now using web services. Amazon, for example, has developed Amazon Web Services (AWS) to

make the contents of its huge online catalogue available by other websites or software applications.

The key to web services is XML. Just as HTML was developed as a standard for formatting web content into web pages, XML is used within a web page to describe and transfer data between web service applications. XML is easy to read and has wide industry support. Besides XML, three other components are used in web service applications:

1. SOAP (Simple Object Access Protocol) is a specification that defines the XML format for messages. SOAP allows businesses, their suppliers and their customers to communicate with each other. It provides a set of rules that makes it easier to move information and data over the Internet.
2. WSDL (Web Services Description Language) provides a way for a web service application to describe its interfaces in enough detail to allow a user to build a client application to talk to it. In other words, it allows one software component to connect to and work with another software component on the Internet.
3. UDDI (Universal Discovery Description and Integration) is used to register web service applications with an Internet directory so that potential users can easily find them and carry out transactions over the web.

## **Developing Web Content and Applications**

Popular tools for creating web pages and managing websites include Adobe Dreamweaver, Microsoft Expression Web and the open source alternative Nvu. Such software allows users to create web pages using an interface similar to a word-processor. The software converts what the user types into HTML code and creates hyperlinks to connect the pages. Web application frameworks have arisen to simplify web development by providing the foundational code – or framework – for a professional interactive website which users can customize as they need. Websites are usually developed on a user's computer and then uploaded to a web server. Although a business may manage its own web server, the job is often outsourced to a webhosting company.

## **Email**

Email or electronic mail is a method of sending communications over computer networks. It is no longer limited to simple text messages. Depending on your hardware and software, and the hardware and software of your recipient, you can embed sound and images in your message and attach files that contain text documents, spreadsheets, graphics or executable programs. Email travels through the systems and networks that make up the Internet. Gateways can receive email messages from the Internet and deliver them to users on other networks. Thus, you can send email messages to anyone in the world if you know that person's email address and you have access to the Internet or another system that can send email. For large organizations whose operations span a country or the world, email allows people to work around the time zone changes. Some users of email claim that they eliminate two hours of verbal communications for every hour of email use.

Some companies use bulk email to send legitimate and important information to sales representatives, customers and suppliers around the world. With its popularity and ease of use,

however, some people feel they are drowning in too much email. Many emails are copies sent to a large list of corporate users. Users are taking a number of steps to cope with and reduce their mountain of email. For instance, some users only look at their in-boxes once each day. Many companies have software that scans incoming messages for possible junk or bulk email, called spam, and deletes it or places it in a separate file. Some have banned the use of copying others in on emails unless it is critical.

## Telnet and FTP

**Telnet** is a terminal emulation protocol that enables you to log on to other computers on the Internet to gain access to their publicly available files. Telnet is particularly useful for perusing library holdings and large databases. It is also called ‘remote logon’.

**File Transfer Protocol (FTP)** is a protocol that describes a file transfer process between a host and a remote computer. Using FTP, users can copy files from one computer to another. Companies, for example, use it to transfer vast amounts of business transactional data to the computers of its customers and suppliers. You can also use FTP to gain access to a wealth of free soft- ware on the Internet. FTP can be used to upload or download content to a website.

## Cloud Computing

**Cloud computing** refers to a computing environment where software and storage are provided as an Internet service and accessed with a web browser. Apple Computer has developed a service called iCloud to allow users to store their music, photos and other information. Google Docs, Zoho, 37signals, Flypaper, Adobe Buzzword and others provide web-delivered productivity and information management software including word-processors, spread- sheets and presentation software.

Cloud computing offers many advantages to companies. By outsourcing business information systems to the cloud, a business saves on system design, installation and maintenance. No universally accepted standard exists yet for cloud computing, and managing applications can be difficult when many providers are involved. A company wanting to make full use of the cloud will need a clear cloud computing strategy.

## 6.5 Intranets and Extranets

An intranet is an internal company network built using Internet and World Wide Web standards and products. Employees of an organization use it to gain access to company information. After getting their feet wet with public websites that promote company products and services, corporations are seizing the web as a swift way to streamline – even transform – their organizations. A big advantage of using an intranet is that 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 an intranet’s most obvious virtues is its ability to reduce the need for paper. Because web browsers run on any type of computer, 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 on the web and be constantly 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 sales force that needs access to rapidly changing information

**Table 6.3** Summary of Internet, Intranet and Extranet Users

Type	Users	Need User ID and Password?
Internet	Anyone	No
Intranet	Employees and managers	Yes
Extranet	Employees, managers and business partners	Yes



## Chapter Summary

.Effective communications are essential to organizational success. Telecommunications refers to the electronic transmission of signals for communications, including telephone, radio and television. Telecommunications is creating profound changes in business because it removes the barriers of time and distance.

.Communications technology lets more people send and receive all forms of information over greater distances. The telecommunications media that physically connect data communications devices can be divided into two broad categories: guided transmission media, in which communications signals are guided along a solid medium, and wireless media, in which the communications signal is sent over airwaves.

.The Internet is like many other technologies – it provides a wide range of services, some of which are effective and practical for use today, others are still evolving and still others will fade away from lack of use.

.Because the Internet and the World Wide Web are becoming more universally used and accepted for business use, management, service and speed, privacy and security issues must continually be addressed and resolved. A rapidly growing number of companies are doing business on the web and enabling shoppers to search for and buy products online.



### Review Questions (Short)

1. What can you do with a PAN?
2. What is an intranet?
3. What is mesh networking?
4. What is a web service?
5. \What is HTML?



### Review Questions (Long)

1. What is the difference between synchronous and asynchronous communication?
2. What are some of the uses of NFC?
3. Describe a metropolitan area network. How does it compare to a LAN?
4. What are some of the uses of NFC?
5. Describe microwave transmission.



### Review Questions (MCQ)

1. \_\_\_\_\_ Is the rate at which data is exchanged.
  - A. Channel Bandwidth
  - B. Open source software
  - C. Phicon
  - D. Run-Time
2. Fibre Optic cable transmits data as a \_\_\_\_\_.
  - A. Unit
  - B. Transaction
  - C. Beam of Light
  - D. File
3. Using electricity cables for data transmission is \_\_\_\_\_.
  - A. Units
  - B. TPS
  - C. Virtual Pet
  - D. Broadband over Powerlines
4. A very short range wireless data transmission is \_\_\_\_\_.
  - A. Near Field Communication
  - B. System Unit
  - C. Blog
  - D. Proto-typing
5. A \_\_\_\_\_ uses a physical device address in each incoming message on a network to determine to which output port it should forward the message to reach another device on the same network.
  - A. Dialogue
  - B. Disc
  - C. Prompt
  - D. Switch



## Case Studies

### Anatomy Of A Hack

A Remote Administration Tool (RAT) is software that allows users to access their computer from a distance. The classic example is accessing your work computer, which is usually underneath the desk in your office, from home. A RAT lets users do anything that they would be able to do if they were at their computer including creating, reading, copying and deleting files. Cybercriminals use RATs to steal both data and processing time on a company's computers. Many businesses have been victims of this sort of attack, and many more are but do not yet realize it. PlugX is a good example of a RAT attack. Discovered in 2012, this software is used in targeted attacks, so called spear-phishing. A spearphishing attack is where cybercriminals identify particular targets, actual individuals, often on social media, who work for a particular firm, and then contact them with an email that appears to come from a friend.

For example, an employee who works for a company that the cybercriminals want to target announces this fact on his Facebook page. The criminals can see this and also who his friends are. They may also be able to see his company email address, or they may be able to guess this – it's often just 'first\_name@company.com'. They send him an email, with content tailored to arouse his interest. The message will appear to be from one of his friends – the friend's name is taken from Facebook – and will contain an attachment, typically a Word file, with a name that should appeal to them. For instance, if the basis of their Facebook friendship appears to be rock climbing, then the attachment will appear to be about climbing.

### Questions

1. Outline a company policy that would minimize the threat of PlugX.
2. Why would cybercriminals want to steal data?
3. Who would want to steal government and political secrets?
4. Should an employee be blamed if they allow a malicious RAT to be installed?

Read



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## Case Studies

### Instant Messaging Is Easier To Secure Than Email

If you look at the top left corner of your web browser when you see it, all traffic that leaves your computer to go to the web server that is storing the web page you are currently looking at, and all the traffic that comes back, is encrypted using something called between your computer and the web server appear to everyone else as mixed up, random gibberish. The messages only make sense when your computer and the server decrypt them.

This is easy to achieve when the two computers (yours and the server) are interacting with each instant messaging someone, using WhatsApp for example, your chat can be secured. However, this doesn't work with email. Email is asynchronous. An email to your friend gets sent to your email provider and then their email provider and then later your friend accesses their provider's server to read it. Your computer is at no time in direct contact with your friend's computer. But why does this make a difference?

The result is a super-secret code that is used once and then forgotten. The size of the numbers used means that each code is extremely unlikely to ever be used twice. Ever! It would be like two people choosing the same grain of sand on a million planet Earths. This has grave implications for those governments who would like to be able to read everyone's private messages. Especially given how easy the above is to 1) explain and 2) implement on a computer.

(Note that some software developers are working on end-to-end encryption for email, to make it as secure encrypted instant messaging. The Dark Mail Technical alliance for instance states as their mission 'To bring the world our unique to-end encrypted protocol and architecture that is the "next-generation" of private and secure email'.)

#### Questions

1. Does this mean that email is less secure than instant messaging?
2. Should a government be able to read all instant messages? Why or why not?
3. Investigate clock arithmetic in enough detail so that you can explain it to a friend.
4. Could governments ever be able to control encryption technology?

Read



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