CHAPTER

7

# Telecommunications, the Internet, and Wireless Technology

## LEARNING OBJECTIVES

After reading this chapter, you will be able to answer the following questions:

**7-1** What are the principal components of telecommunications networks and key networking technologies?

**7-2** What are the different types of networks?

**7-3** How do the Internet and Internet technology work, and how do they support communication and e-business?

**7-4** What are the principal technologies and standards for wireless networking, communication, and Internet access?

**7-5** How will MIS help my career?

## CHAPTER CASES

- Tour de France Wins with Wireless Technology
- Singapore Shuts Down 2G Network
- Talking Cars Make for Better Road Safety
- Google, Apple, and Facebook Battle for Your Internet Experience

## VIDEO CASES

- Telepresence Moves out of the Boardroom and into the Field
- Virtual Collaboration with IBM Sametime

**MyLab MIS**

- Discussion Questions: 7-5, 7-6, 7-7
- Hands-On MIS Projects: 7-8, 7-9, 7-10, 7-11

# TOUR DE FRANCE WINS WITH WIRELESS TECHNOLOGY

Every July about two hundred cyclists race across 2,200 miles of the most difficult terrain in France, including steep roads in the Pyrenees and Alps. The Tour de France is considered the world's greatest bicycle race.

The first Tour de France took place in 1903 as a way of promoting sales of *L'Auto* newspapers, initially attracting mostly local competitors and spectators. Thanks to newspapers, radio, and television, coverage and prestige of the event expanded. As with other competitive sports, such as football, baseball, tennis, and soccer, today's Tour de France fans don't just want to just watch a sport; they want to engage with it, and they expect more information and interaction—data-enhanced viewing, live streaming, video on demand, mobile apps, and social media interaction. Digital technology has become essential for attracting fans, athletes, sponsors, and broadcasters.

Up until 2014, Tour de France was a technology laggard. The sport doesn't easily generate real-time statistics. The only source of real-time information was a chalkboard held up by a race executive sitting as a passenger on a motorbike ahead of the cyclists. TV viewers could see timings and the race from numerous camera angles, but little more.

Today, data from Tour de France racing bikes are relayed to TV viewers within two seconds. A small, lightweight tracking sensor is attached to a clip below the saddle of every competing rider's bike. The sensor contains a global positioning system (GPS) chip, a radio frequency (RF) chip, and a rechargeable battery. Each sensor transmits data about the bike's GPS position and speed every second, generating over 3 billion data points during the course of the race. These real-time data are combined with feeds from other sources, such as weather services, road gradients, and historical race data from the past few years. Race organizers, broadcasters, teams, TV viewers, and fans using the Tour de France mobile app can now access detailed statistics on the progress of the race and individual riders. Riders wear earpiece radios that relay real-time data to them as they are cycling. The system does not include biometric data to monitor riders' physical performance—the teams keep these data private.

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Dimension Data, a global IT services firm headquartered in South Africa, built and operates Tour de France's digital infrastructure. The sensor data from each racing bike are relayed to planes and helicopters flying overhead to cover the race for television. Race data are transmitted to Dimension Data's cloud service, hosted in remote data centers in London and Amsterdam, where powerful algorithms developed by cycling experts analyze the data, including external feeds, to generate real-time information for broadcasters, social media, and the Tour de France race app. Getting the data from bike to viewer takes only two seconds. The system is able to make predictions before and during the race based on current and historic data about riders and the state of the race; for example, the likelihood that the main body of riders might catch up to breakaway riders. The system can also generate rider profiles showing each rider's strengths and weaknesses across different race conditions based on historical race results and performance.

Digital technology has dramatically increased Tour de France fan involvement. Fans are able to see live performance information on their TVs and discuss the results on social media. In 2014, there were only 6 million views of video clips put out by the Tour de France organization. By 2016, that number had soared to 55 million. Seventeen million people access the live-tracking website. The goal is to pull you, the fan, into the race, and it appears Tour de France has succeeded.

Sources: www.letour.fr/en, accessed May 20, 2019;www.dimensiondata.com, accessed May 30, 3019; Bryan Glick, "Tour de France Pumps Tech," *Computer Weekly*, August 15–21, 2017; "Tour de France Behind the Scenes: How Dimension Data Rider Live Tracking Works," *DCRainmaker*, July 13, 2017; Dave Michels, "Adding an IoT Dimension to the Tour de France," *Network World*, May 23, 2017; and Scott Gibson, "5 Ways Tour de France Is Winning the Digital Race in 2017," *Dimension Data*, June 29, 2017.

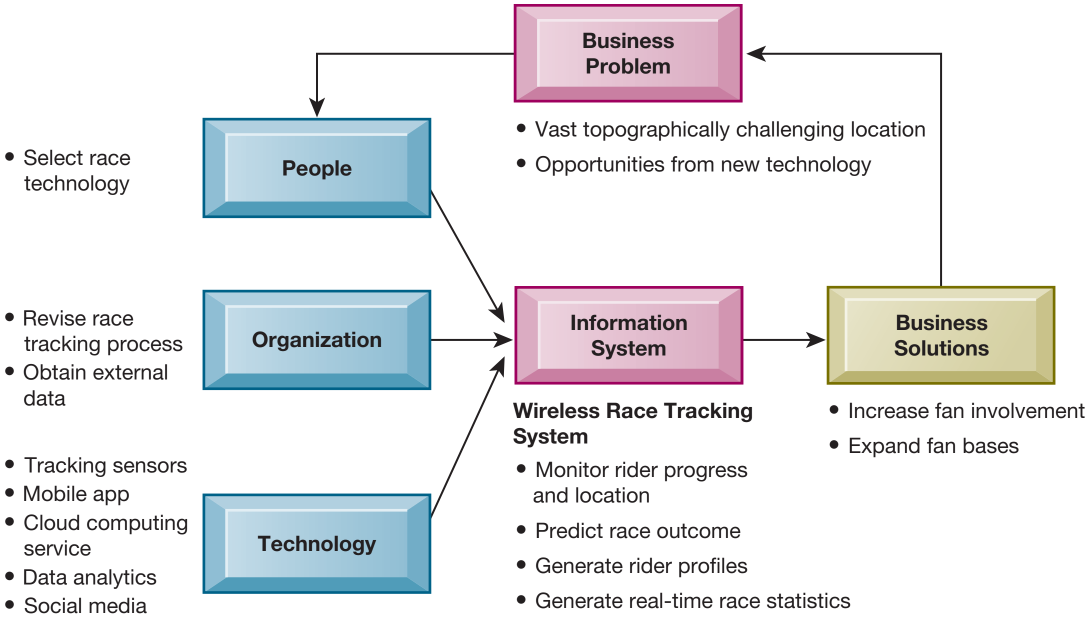
The experience of the Tour de France illustrates some of the powerful capabilities and opportunities provided by contemporary networking technology. The annual Tour de France bicycle race now uses wireless networking and wireless sensor technology to closely track cyclists' speed and position in relation to other variables affecting race outcome, and to deliver race information instantaneously to fans and broadcasters.

The chapter-opening diagram calls attention to important points raised by this case and this chapter. The Tour de France race takes place over a vast and topographically challenging terrain, where it is difficult to track riders and generate real-time race statistics. This legendary race has many fans, but management realized it could expand its fan base and deepen fan engagement by taking advantage of opportunities presented by wireless networking technology and the Internet of Things (IoT). The Tour de France is thus able to provide real-time race statistics, rider profiles, predictions about race outcomes, and content for TV broadcasts and social media, increasing the popularity of the sport and fans' interest. Tour de France cyclists and teams can use this information to improve their performance.

Here are some questions to think about: Why has wireless technology played such a key role at the Tour de France? Describe how the technology changed the way the Tour de France provided and used data from its races.

## 7-1 What are the principal components of telecommunications networks and key networking technologies?

If you run or work in a business, you can't do without networks. You need to communicate rapidly with your customers, suppliers, and employees. Until about 1990, businesses used the postal system or telephone system with voice or fax for communication. Today, however, you and your employees use computers, email, text messaging, the Internet, mobile phones, and mobile computers connected to wireless networks for this purpose. Networking and the Internet are now nearly synonymous with doing business.




## NETWORKING AND COMMUNICATION TRENDS

Firms in the past used two fundamentally different types of networks: telephone networks and computer networks. Telephone networks historically handled voice communication, and computer networks handled data traffic. Telephone companies built telephone networks throughout the twentieth century by using voice transmission technologies (hardware and software), and these companies almost always operated as regulated monopolies throughout the world. Computer companies originally built computer networks to transmit data between computers in different locations.

Thanks to continuing telecommunications deregulation and information technology innovation, telephone and computer networks are converging into a single digital network using shared Internet-based standards and technology. Telecommunications providers today, such as Vodafone, offer data transmission, Internet access, mobile phone service, and television programming as well as voice service. Cable companies, such as Kabel and British Telecom, offer voice service and Internet access. Computer networks have expanded to include Internet telephone and video services.

Both voice and data communication networks have also become more powerful (faster), more portable (smaller and mobile), and less expensive. For instance, the typical Internet connection speed in 2000 was 56 kilobits per second, but today the majority of US households have high-speed **broadband** connections provided by telephone and cable TV companies running at 3 to 20 megabits (millions of bits per second). The cost for this service has fallen exponentially, from 50 cents per kilobit in 2000 to a tiny fraction of a cent today.

Increasingly, voice and data communication, as well as Internet access, are taking place over broadband wireless platforms such as mobile phones, mobile handheld devices, and PCs in wireless networks. More than 70 percent of Internet users in the United States use smartphones and tablets to access the Internet.

## WHAT IS A COMPUTER NETWORK?

If you had to connect the computers for two or more employees in the same office, you would need a computer network. In its simplest form, a network consists of two or more connected computers. Figure 7.1 illustrates the major hardware, software, and transmission components in a simple network: a client computer and a dedicated server computer, network interfaces, a connection medium, network operating system software, and either a hub or a switch.

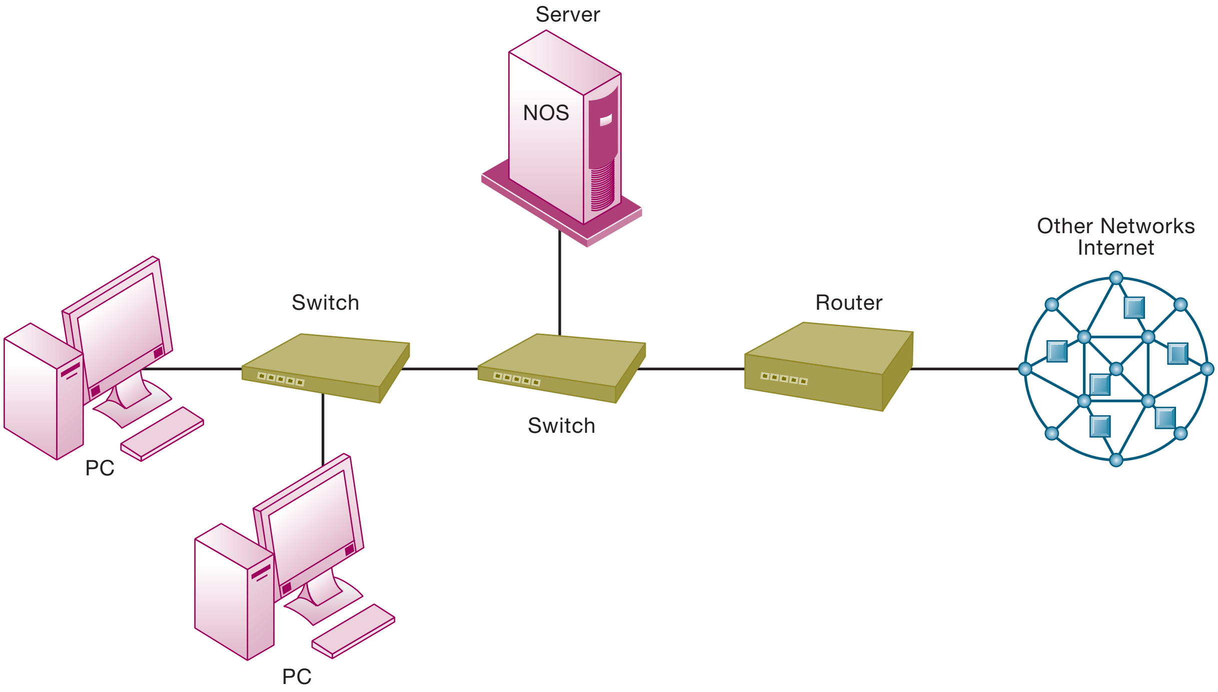



**Figure 7.1**
Components of a Simple Computer Network.
*Illustrated here is a simple computer network consisting of computers, a network operating system (NOS) residing on a dedicated server computer, cable (wiring) connecting the devices, switches, and a router.*

Each computer on the network contains a network interface device to link the computer to the network. The connection medium for linking network components can be a telephone wire, coaxial cable, or radio signal in the case of cell phone and wireless local area networks (Wi-Fi networks).

The **network operating system (NOS)** routes and manages communications on the network and coordinates network resources. It can reside on every computer in the network or primarily on a dedicated server computer for all the applications on the network. A server is a computer on a network that performs important network functions for client computers, such as displaying web pages, storing data, and storing the network operating system (hence controlling the network). Microsoft Windows Server and Linux are the most widely used network operating systems.

Most networks also contain a switch or a hub acting as a connection point between the computers. **Hubs** are simple devices that connect network components, sending a packet of data to all other connected devices. A **switch** has more intelligence than a hub and can filter and forward data to a specified destination on the network.

What if you want to communicate with another network, such as the Internet? You would need a router. A **router** is a communications processor that routes packets of data through different networks, ensuring that the data sent get to the correct address.

Network switches and routers have proprietary software built into their hardware for directing the movement of data on the network. This can create network bottlenecks and makes the process of configuring a network more complicated and time-consuming. **Software-defined networking (SDN)** is a networking approach in which many of these control functions are managed by one central program, which can run on inexpensive commodity servers that are separate from the network devices

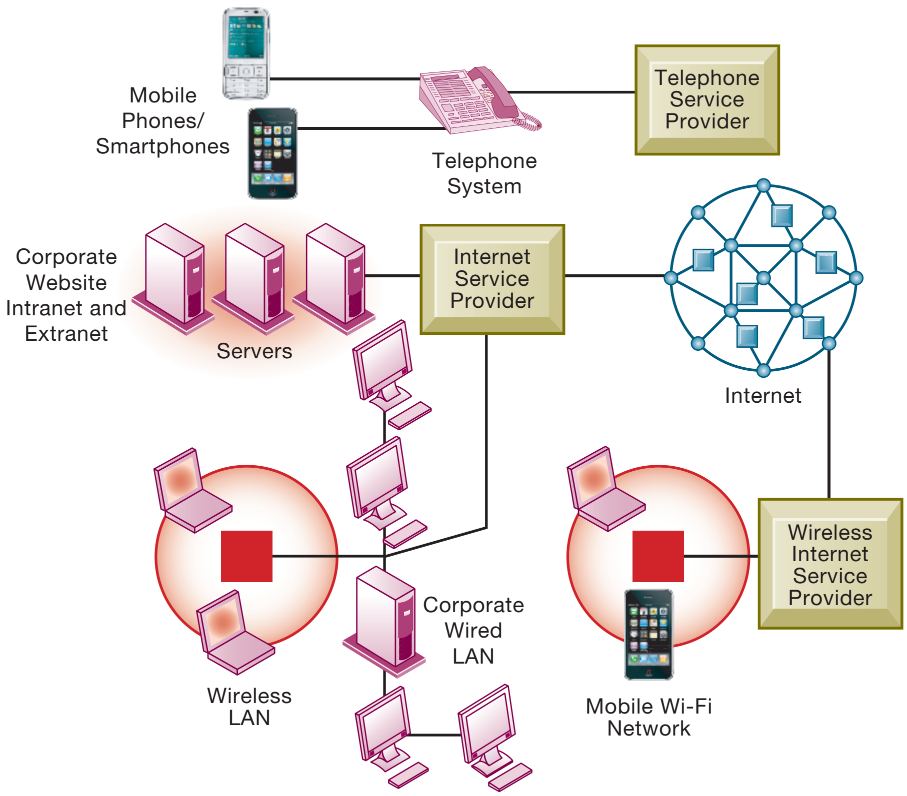



**Figure 7.2**
Corporate Network Infrastructure.
*Today's corporate network infrastructure is a collection of many networks from the public switched telephone network to the Internet to corporate local area networks linking workgroups, departments, or office floors.*

themselves. This is especially helpful in a cloud computing environment with many pieces of hardware because it allows a network administrator to manage traffic loads in a flexible and more efficient manner.

## Networks in Large Companies

The network we've just described might be suitable for a small business, but what about large companies with many locations and thousands of employees? As a firm grows, its small networks can be tied together into a corporate-wide networking infrastructure. The network infrastructure for a large corporation consists of a large number of these small local area networks linked to other local area networks and to firmwide corporate networks. A number of powerful servers support a corporate website, a corporate intranet, and perhaps an extranet. Some of these servers link to other large computers supporting back-end systems.

Figure 7.2 provides an illustration of these more-complex, larger-scale corporate-wide networks. Here the corporate network infrastructure supports a mobile sales force using mobile phones and smartphones, mobile employees linking to the company website, and internal company networks using mobile wireless local area networks (Wi-Fi networks). In addition to these computer networks, the firm's infrastructure may include a separate telephone network that handles most voice data. Many firms are dispensing with their traditional telephone networks and using Internet telephones that run on their existing data networks (described later).

As you can see from this figure, a large corporate network infrastructure uses a wide variety of technologies—everything from ordinary telephone service and corporate data networks to Internet service, wireless Internet, and mobile phones. One of the major problems facing corporations today is how to integrate all the different communication networks and channels into a coherent system that enables information to flow from one part of the corporation to another and from one system to another.

## KEY DIGITAL NETWORKING TECHNOLOGIES

Contemporary digital networks and the Internet are based on three key technologies: client/server computing, the use of packet switching, and the development of widely used communications standards (the most important of which is Transmission Control Protocol/Internet Protocol, or TCP/IP) for linking disparate networks and computers.

### Client/Server Computing

Client/server computing, introduced in Chapter 5, is a distributed computing model in which some of the processing power is located within small, inexpensive client computers and resides literally on desktops or laptops or in handheld devices. These powerful clients are linked to one another through a network that is controlled by a network server computer. The server sets the rules of communication for the network and provides every client with an address so others can find it on the network.

Client/server computing has largely replaced centralized mainframe computing in which nearly all the processing takes place on a central large mainframe computer. Client/server computing has extended computing to departments, workgroups, factory floors, and other parts of the business that could not be served by a centralized architecture. It also makes it possible for personal computing devices such as PCs, laptops, and mobile phones to be connected to networks such as the Internet. The Internet is the largest implementation of client/server computing.

### Packet Switching

**Packet switching** is a method of slicing digital messages into parcels called packets, sending the packets along different communication paths as they become available, and then reassembling the packets once they arrive at their destinations (see Figure 7.3). Prior to the development of packet switching, computer networks used leased, dedicated telephone circuits to communicate with other computers in remote locations. In circuit-switched networks, such as the telephone system, a complete point-to-point circuit is assembled, and then communication can proceed. These dedicated circuit-switching techniques were expensive and wasted available communications capacity—the circuit was maintained regardless of whether any data were being sent.

Packet switching is more efficient. Messages are first broken down into small fixed bundles of data called packets. The packets include information for directing the packet to the right address and for checking transmission errors along with the data. The packets are transmitted over various communications channels by using routers, each packet traveling independently. Packets of data originating at one source will be routed through many paths and networks before being reassembled into the original message when they reach their destinations.

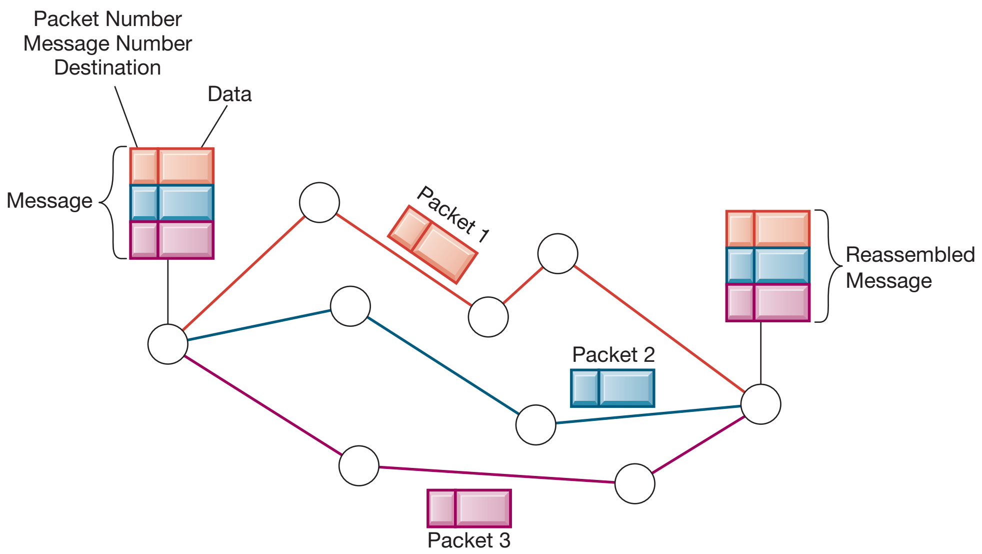



**Figure 7.3**
**Packet-Switched Networks and Packet Communications.**
*Data are grouped into small packets, which are transmitted independently over various communications channels and reassembled at their final destination.*

## TCP/IP and Connectivity

In a typical telecommunications network, diverse hardware and software components need to work together to transmit information. Different components in a network communicate with each other by adhering to a common set of rules called protocols. A **protocol** is a set of rules and procedures governing transmission of information between two points in a network.

In the past, diverse proprietary and incompatible protocols often forced business firms to purchase computing and communications equipment from a single vendor. Today, however, corporate networks are increasingly using a single, common, worldwide standard called **Transmission Control Protocol/Internet Protocol (TCP/IP)**. TCP/IP was developed during the early 1970s to support US Department of Defense Advanced Research Projects Agency (DARPA) efforts to help scientists transmit data among different types of computers over long distances.

TCP/IP uses a suite of protocols, the main ones being TCP and IP. TCP refers to the Transmission Control Protocol, which handles the movement of data between computers. TCP establishes a connection between the computers, sequences the transfer of packets, and acknowledges the packets sent. IP refers to the Internet Protocol (IP), which is responsible for the delivery of packets and includes the disassembling and reassembling of packets during transmission. Figure 7.4 illustrates the four-layered Department of Defense reference model for TCP/IP, and the layers are described as follows:

1. Application layer. The Application layer enables client application programs to access the other layers and defines the protocols that applications use to exchange data. One of these application protocols is the Hypertext Transfer Protocol (HTTP), which is used to transfer web page files.
2. Transport layer. The Transport layer is responsible for providing the Application layer with communication and packet services. This layer includes TCP and other protocols.
3. Internet layer. The Internet layer is responsible for addressing, routing, and packaging data packets called IP datagrams. The Internet Protocol is one of the protocols used in this layer.
4. Network Interface layer. At the bottom of the reference model, the Network Interface layer is responsible for placing packets on and receiving them from the network medium, which could be any networking technology.

Two computers using TCP/IP can communicate even if they are based on different hardware and software platforms. Data sent from one computer to the other passes downward through all four layers, starting with the sending computer's Application layer and passing through the Network Interface layer. After the data reach the recipient host computer, they travel up the layers and are reassembled into a format the receiving computer can use. If the receiving computer finds a damaged packet, it asks the sending computer to retransmit it. This process is reversed when the receiving computer responds.

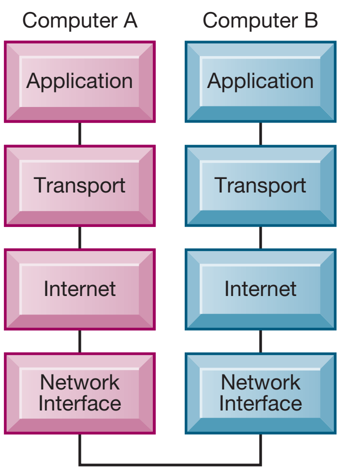



**Figure 7.4**
The Transmission Control Protocol/Internet Protocol (TCP/IP) Reference Model.
*This figure illustrates the four layers of the TCP/IP reference model for communications.*

# 7-2 What are the different types of networks?

Let's look more closely at alternative networking technologies available to businesses.

## SIGNALS: DIGITAL VERSUS ANALOG

There are two ways to communicate a message in a network: an analog signal or a digital signal. An *analog signal* is represented by a continuous waveform that passes through a communications medium and has been used for audio communication. The most common analog devices are the telephone handset, the speaker on your computer, or your iPhone earphone, all of which create analog waveforms that your ear can hear.

A *digital signal* is a discrete, binary waveform rather than a continuous waveform. Digital signals communicate information as strings of two discrete states: 1 bits and 0 bits, which are represented as on-off electrical pulses. Computers use digital signals and require a modem to convert these digital signals into analog signals that can be sent over (or received from) telephone lines, cable lines, or wireless media that use analog signals (see Figure 7.5). **Modem** stands for modulator-demodulator. Cable modems connect your computer to the Internet by using a cable network. DSL modems connect your computer to the Internet using a telephone company's landline network. Wireless modems perform the same function as traditional modems, connecting your computer to a wireless network that could be a cell phone network or a Wi-Fi network.

## TYPES OF NETWORKS

There are many kinds of networks and ways of classifying them. One way of looking at networks is in terms of their geographic scope (see Table 7.1).

### Local Area Networks

If you work in a business that uses networking, you are probably connecting to other employees and groups via a local area network. A **local area network (LAN)** is designed to connect personal computers and other digital devices within a half-mile or 500-meter radius. LANs typically connect a few computers in a small office, all the computers in one building, or all the computers in several buildings in close proximity. LANs also are used to link to long-distance wide area networks (WANs, described later in this section) and other networks around the world, using the Internet.

Review Figure 7.1, which could serve as a model for a small LAN that might be used in an office. One computer is a dedicated network server, providing users with access to shared computing resources in the network, including software programs and data files.

The server determines who gets access to what and in which sequence. The router connects the LAN to other networks, which could be the Internet, or another corporate network, so that the LAN can exchange information with networks external to it. The most common LAN operating systems are Windows and Linux.

Ethernet is the dominant LAN standard at the physical network level, specifying the physical medium to carry signals between computers, access control rules, and a standardized set of bits that carry data over the system. Originally, Ethernet supported a data transfer rate of 10 megabits per second (Mbps). Newer versions, such as Gigabit Ethernet, support a data transfer rate of 1 gigabit per second (Gbps).

**Figure 7.5**
Functions of the Modem.
*A modem is a device that translates digital signals into analog form (and vice versa) so that computers can transmit data over analog networks such as telephone and cable networks.*

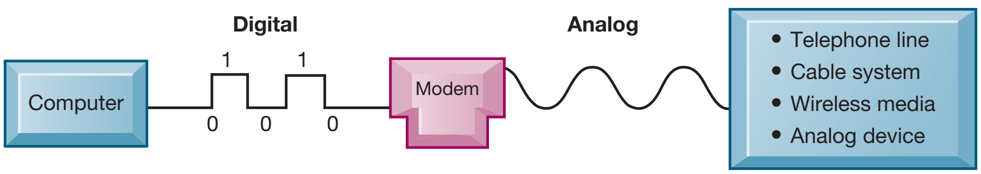


**TABLE 7.1**

Types of Networks

| Type | Area |
|---|---|
| Local area network (LAN) | Up to 500 meters (half a mile); an office or floor of a building |
| Campus area network (CAN) | Up to 1,000 meters (a mile); a college campus or corporate facility |
| Metropolitan area network (MAN) | A city or metropolitan area |
| Wide area network (WAN) | A regional, transcontinental, or global area |

The LAN illustrated in Figure 7.1 uses a client/server architecture in which the network operating system resides primarily on a single server, and the server provides much of the control and resources for the network. Alternatively, LANs may use a **peer-to-peer** architecture. A peer-to-peer network treats all processors equally and is used primarily in small networks with ten or fewer users. The various computers on the network can exchange data by direct access and can share peripheral devices without going through a separate server.

Larger LANs have many clients and multiple servers, with separate servers for specific services such as storing and managing files and databases (file servers or database servers), managing printers (print servers), storing and managing email (mail servers), or storing and managing web pages (web servers).

### Metropolitan and Wide Area Networks

**Wide area networks (WANs)** span broad geographical distances—regions, states, continents, or the entire globe. The most universal and powerful WAN is the Internet. Computers connect to a WAN through public networks, such as the telephone system or private cable systems, or through leased lines or satellites. A **metropolitan area network (MAN)** is a network that spans a metropolitan area, usually a city and its major suburbs. Its geographic scope falls between a WAN and a LAN.

## TRANSMISSION MEDIA AND TRANSMISSION SPEED

Networks use different kinds of physical transmission media, including twisted pair wire, coaxial cable, fiber-optic cable, and media for wireless transmission. Each has advantages and limitations. A wide range of speeds is possible for any given medium, depending on the software and hardware configuration. Table 7.2 compares these media.

**TABLE 7.2**

Physical Transmission Media

| Transmission Medium | Description | Speed |
|---|---|---|
| Twisted pair wire (CAT 5) | Strands of copper wire twisted in pairs for voice and data communications. CAT 5 is the most common 10 Mbps LAN cable. Maximum recommended run of 100 meters. | 10–100+ Mbps |
| Coaxial cable | Thickly insulated copper wire, which is capable of high-speed data transmission and less subject to interference than twisted wire. Currently used for cable TV and for networks with longer runs (more than 100 meters). | Up to 1 Gbps |
| Fiber-optic cable | Strands of clear glass fiber, transmitting data as pulses of light generated by lasers. Useful for high-speed transmission of large quantities of data. More expensive than other physical transmission media; used for last-mile delivery to customers and the Internet backbone. | 15 Mbps to 6+ Tbps |
| Wireless transmission media | Based on radio signals of various frequencies and includes both terrestrial and satellite microwave systems and cellular networks. Used for long-distance, wireless communication, and Internet access. | Up to 600+ Mbps |

### Bandwidth: Transmission Speed

The total amount of digital information that can be transmitted through any telecommunications medium is measured in bits per second (bps). One signal change, or cycle, is required to transmit one or several bits; therefore, the transmission capacity of each type of telecommunications medium is a function of its frequency. The number of cycles per second that can be sent through that medium is measured in **hertz**—one hertz is equal to one cycle of the medium.

The range of frequencies that can be accommodated on a particular telecommunications channel is called its **bandwidth**. The bandwidth is the difference between the highest and lowest frequencies that can be accommodated on a single channel. The greater the range of frequencies, the greater the bandwidth and the greater the channel's transmission capacity.

# 7-3 How do the Internet and Internet technology work, and how do they support communication and e-business?

The Internet has become an indispensable personal and business tool—but what exactly is the Internet? How does it work, and what does Internet technology have to offer for business? Let's look at the most important Internet features.

## WHAT IS THE INTERNET?

The Internet is the world's most extensive public communication system. It's also the world's largest implementation of client/server computing and internetworking, linking millions of individual networks all over the world. This global network of networks began in the early 1970s as a US Department of Defense project to link scientists and university professors around the world.

Most homes and small businesses connect to the Internet by subscribing to an Internet service provider. An **Internet service provider (ISP)** is a commercial organization with a permanent connection to the Internet that sells temporary connections to retail subscribers. Individuals also connect to the Internet through their business firms, universities, or research centers that have designated Internet domains.

There is a variety of services for ISP Internet connections. Connecting via a traditional telephone line and modem, at a speed of 56.6 kilobits per second (Kbps), used to be the most common form of connection worldwide, but high-speed broadband connections have largely replaced it. Digital subscriber line, cable, satellite Internet connections, and T lines provide these broadband services.

**Digital subscriber line (DSL)** technologies operate over existing telephone lines to carry voice, data, and video at transmission rates ranging from 385 Kbps all the way up to 3 Mbps, depending on usage patterns and distance. Fios (Verizon's fiber optic cable service) can deliver over 900 Mbps, although most home service delivers 100 Mbps. **Cable Internet connections** provided by cable television vendors use digital cable coaxial lines to deliver high-speed Internet access to homes and businesses. They can provide high-speed access to the Internet of up to 50 Mbps, although most providers offer service ranging from 3 Mbps to 20 Mbps. Where DSL and cable services are unavailable, it is possible to access the Internet via satellite, although some satellite Internet connections have slower upload speeds than other broadband services.

T1 and T3 are international telephone standards for digital communication. They are leased, dedicated lines suitable for businesses or government agencies requiring high-speed guaranteed service levels. **T1 lines** offer guaranteed delivery at 1.54 Mbps, and T3 lines offer delivery at 45 Mbps. The Internet does not provide similar guaranteed service levels but, simply, best effort.

## INTERNET ADDRESSING AND ARCHITECTURE

The Internet is based on the TCP/IP networking protocol suite described earlier in this chapter. Every device connected to the Internet (or another TCP/IP network) is assigned a unique **Internet Protocol (IP) address** consisting of a string of numbers.

When a user sends a message to another user on the Internet or another TCP/IP network, the message is first decomposed into packets. Each packet contains its destination address. The packets are then sent from the client to the network server and from there on to as many other servers as necessary to arrive at a specific computer with a known address. At the destination address, the packets are reassembled into the original message.

### The Domain Name System

Because it would be incredibly difficult for Internet users to remember long strings of numbers, an IP address can be represented by a natural language convention called a **domain name**. The **Domain Name System (DNS)** converts domain names to IP addresses. DNS servers maintain a database containing IP addresses mapped to their corresponding domain names. To access a computer on the Internet, users need only specify its domain name, such as Expedia.com,

DNS has a hierarchical structure (see Figure 7.6). At the top of the DNS hierarchy is the root domain. The child domain of the root is called a top-level domain, and the child domain of a top-level domain is called a second-level domain. Top-level domains are two- and three-character names you are familiar with from surfing the web; for example, .com, .edu, .gov, and the various country codes such as .ca for Canada or .it for Italy. Second-level domains have two parts, designating a top-level name and a second-level name—such as buy.com, nyu.edu, or amazon.ca. A host name at the bottom of the hierarchy designates a specific computer on either the Internet or a private network.

The following list shows the most common domain extensions currently available and officially approved. Countries also have domain names such as .uk, .au, and .fr (United Kingdom, Australia, and France, respectively), and there is a new class of internationalized top-level domains that use non-English characters. In the future, this list will expand to include many more types of organizations and industries as follows:

| | |
|---|---|
| .com | Commercial organizations/businesses |
| .edu | Educational institutions |
| .gov | US government agencies |
| .mil | US military |
| .net | Network computers |

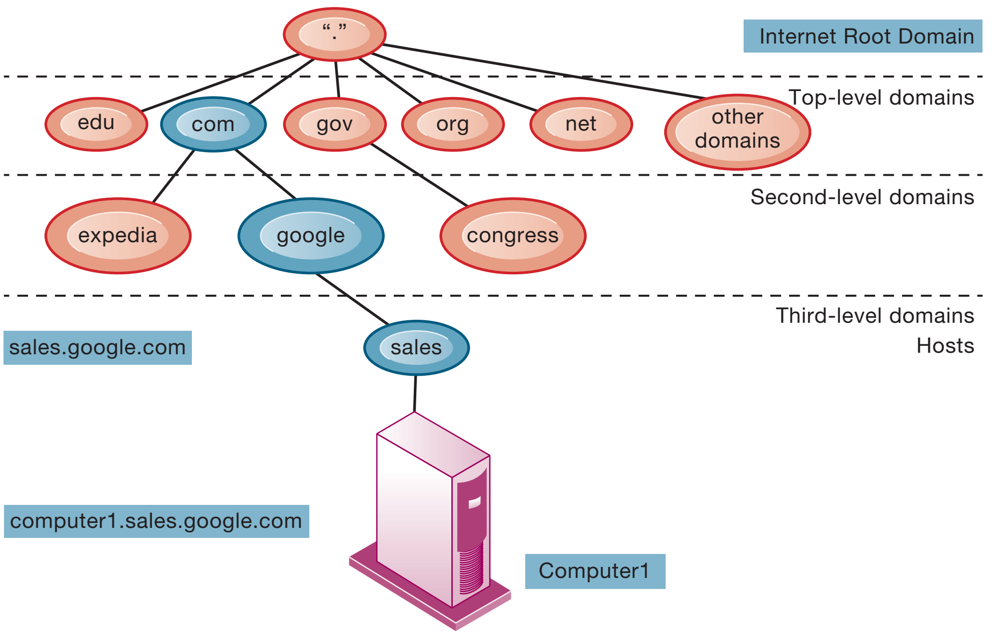



**Figure 7.6**
The Domain Name System.
*The Domain Name System is a hierarchical system with a root domain, top-level domains, second-level domains, and host computers at the third level.*

| | |
|---|---|
| .org | Any type of organization |
| .biz | Business firms |
| .info | Information providers |

## Internet Architecture and Governance

Internet data traffic is carried over transcontinental high-speed backbone networks that generally operate in the range of 155 Mbps to 2.5 Gbps (see Figure 7.7). These trunk lines are typically owned by long-distance telephone companies (called *network service providers*) or by national governments. Local connection lines are owned by regional telephone and cable television companies in the United States and in other countries that connect retail users in homes and businesses to the Internet. The regional networks lease access to ISPs, private companies, and government institutions.

Each organization pays for its own networks and its own local Internet connection services, a part of which is paid to the long-distance trunk line owners. Individual Internet users pay ISPs for using their service, and they generally pay a flat subscription fee, no matter how much or how little they use the Internet. No one owns the Internet, and it has no formal management. However, worldwide Internet policies are established by a number of professional organizations and government bodies, including the Internet Architecture Board (IAB), which helps define the overall structure of the Internet; the Internet Corporation for Assigned Names and Numbers (ICANN), which manages the domain name system; and the World Wide Web Consortium (W3C), which sets Hypertext Markup Language and other programming standards for the web.

These organizations influence government agencies, network owners, ISPs, and software developers with the goal of keeping the Internet operating as efficiently as possible. The Internet must also conform to the laws of the sovereign nation-states in which it operates as well as to the technical infrastructures that exist within the nation-states. Although in the early years of the Internet and the web there was little legislative or executive interference, this situation is changing as the Internet plays a growing role in the distribution of information and knowledge, including content that some find objectionable.

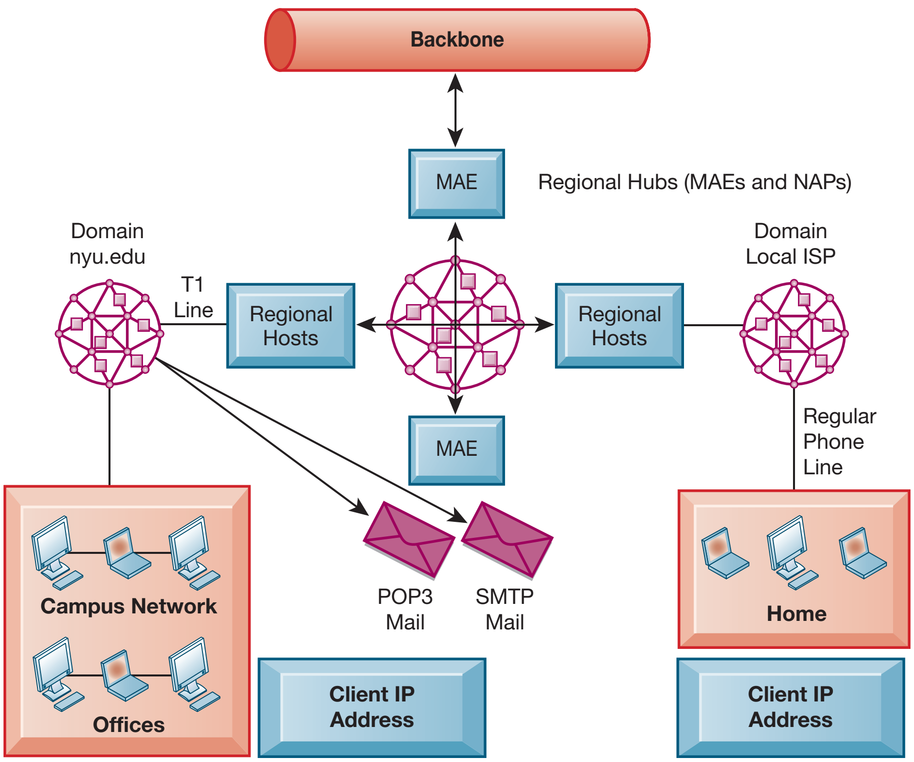



**Figure 7.7**
Internet Network Architecture.
*The Internet backbone connects to regional networks, which in turn provide access to Internet service providers, large firms, and government institutions. Network access points (NAPs) and metropolitan area exchanges (MAEs) are hubs where the backbone intersects regional and local networks and where backbone owners connect with one another.*

### The Future Internet: IPv6 and Internet2

The Internet was not originally designed to handle billions of users and the transmission of massive quantities of data. Because of sheer Internet population growth, the world is about to run out of available IP addresses using the old addressing convention. The old system based on 32-bit addresses is being replaced by a new version of IP addressing called **IPv6** (Internet Protocol version 6), which contains 128-bit addresses (2 to the power of 128), or more than a quadrillion possible unique addresses. IPv6 is compatible with most modems and routers sold today, and IPv6 will fall back to the old addressing system if IPv6 is not available on local networks. The transition to IPv6 will take several years as systems replace older equipment.

**Internet2** is an advanced networking consortium serving 317 US universities, 60 government agencies, 43 regional and state education networks, 59 leading corporations, and 70 national research and education network partners that represent more than 100 countries. To connect these communities, Internet2 developed a high-capacity, 100 Gbps network that serves as a test bed for leading-edge technologies that may eventually migrate to the public Internet, including large-scale network performance measurement and management tools, secure identity and access management tools, and capabilities such as scheduling high-bandwidth, high-performance circuits.

## INTERNET SERVICES AND COMMUNICATION TOOLS

The Internet is based on client/server technology. Individuals using the Internet control what they do through client applications on their computers, such as web browser software. The data, including email messages and web pages, are stored on servers. A client uses the Internet to request information from a particular web server on a distant computer, and the server sends the requested information back to the client over the Internet. Client platforms today include not only PCs and other computers but also smartphones and tablets.

### Internet Services

A client computer connecting to the Internet has access to a variety of services. These services include email, chatting and instant messaging, electronic discussion groups, **Telnet**, **File Transfer Protocol (FTP)**, and the web. Table 7.3 provides a brief description of these services.

Each Internet service is implemented by one or more software programs. All the services may run on a single server computer, or different services may be allocated to different machines. Figure 7.8 illustrates one way these services can be arranged in a multitiered client/server architecture.

**Email** enables messages to be exchanged from computer to computer, with capabilities for routing messages to multiple recipients, forwarding messages, and attaching text documents or multimedia files to messages. Most email today is sent through the Internet. The cost of email is far lower than equivalent voice, postal, or overnight delivery costs, and email messages can arrive anywhere in the world in a matter of seconds.

**TABLE 7.3**

Major Internet Services

| Capability | Functions Supported |
|---|---|
| Email | Person-to-person messaging; document sharing |
| Chatting and instant messaging | Interactive conversations |
| Newsgroups | Discussion groups on electronic bulletin boards |
| Telnet | Logging on to one computer system and doing work on another |
| File Transfer Protocol (FTP) | Transferring files from computer to computer |
| World Wide Web | Retrieving, formatting, and displaying information (including text, audio, graphics, and video) by using hypertext links |

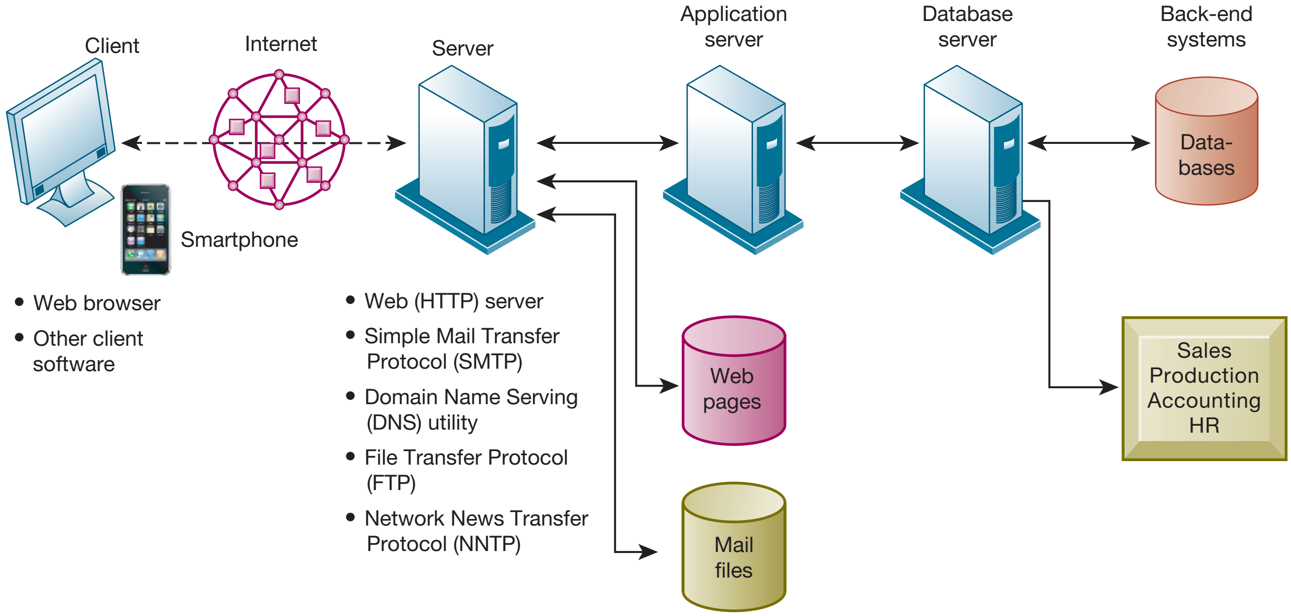



**Figure 7.8**
Client/Server Computing on the Internet.
*Client computers running web browsers and other software can access an array of services on servers over the Internet. These services may all run on a single server or on multiple specialized servers.*

Chatting enables two or more people who are simultaneously connected to the Internet to hold live, interactive conversations. **Chat** systems now support voice and video chat as well as written conversations. Many online retail businesses offer chat services on their websites to attract visitors, to encourage repeat purchases, and to improve customer service.

**Instant messaging** is a type of chat service that enables participants to create their own private chat channels. The instant messaging system alerts the user whenever someone on his or her private list is online so that the user can initiate a chat session with other individuals. Instant messaging systems for consumers include Yahoo! Messenger, Google Hangouts, AOL Instant Messenger, and Facebook Messenger. Companies concerned with security use proprietary communications and messaging systems such as IBM Sametime.

Newsgroups are worldwide discussion groups posted on Internet electronic bulletin boards on which people share information and ideas on a defined topic such as radiology or rock bands. Anyone can post messages on these bulletin boards for others to read.

Employee use of email, instant messaging, and the Internet is supposed to increase worker productivity, but this may not always be the case. Many company managers now believe they need to monitor and even regulate their employees' online activity, but is this ethical? Although there are some strong business reasons companies may need to monitor their employees' email and web activities, what does this mean for employee privacy?

## Voice over IP

The Internet has also become a popular platform for voice transmission and corporate networking. **Voice over IP (VoIP)** technology delivers voice information in digital form using packet switching, avoiding the tolls charged by local and long-distance telephone networks (see Figure 7.9). Calls that would ordinarily be transmitted over public telephone networks travel over the corporate network based on the Internet protocol, or over the public Internet. Voice calls can be made and received with a computer equipped with a microphone and speakers or with a VoIP-enabled telephone.

Cable firms such as Time Warner and Cablevision provide VoIP service bundled with their high-speed Internet and cable offerings. Skype offers free VoIP worldwide using a peer-to-peer network, and Google has its own free VoIP service.

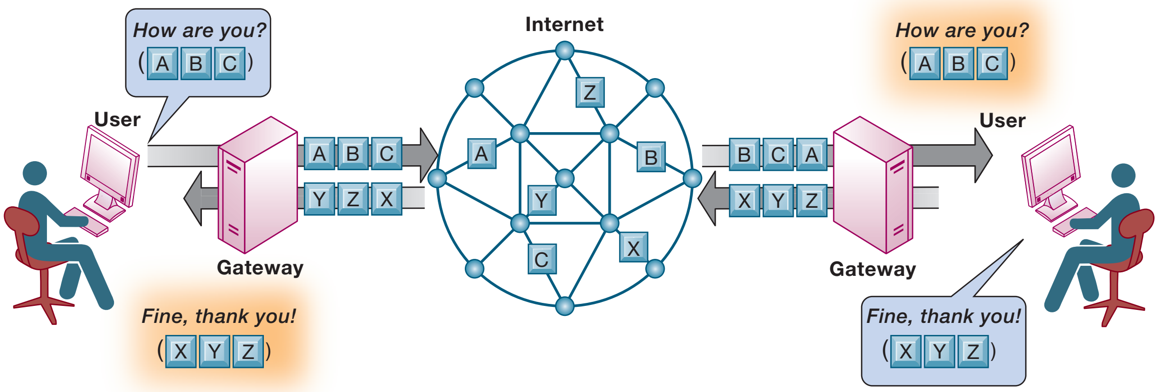



**Figure 7.9**
How Voice over IP Works.
*A VoIP phone call digitizes and breaks up a voice message into data packets that may travel along different routes before being reassembled at the final destination. A processor nearest the call's destination, called a gateway, arranges the packets in the proper order and directs them to the telephone number of the receiver or the IP address of the receiving computer.*

Although up-front investments are required for an IP phone system, VoIP can reduce communication and network management costs by 20 to 30 percent. For example, VoIP saves Virgin Entertainment Group $700,000 per year in long-distance bills. In addition to lowering long-distance costs and eliminating monthly fees for private lines, an IP network provides a single voice-data infrastructure for both telecommunications and computing services. Companies no longer have to maintain separate networks or provide support services and personnel for each type of network.

## Unified Communications

In the past, each of the firm's networks for wired and wireless data, voice communications, and videoconferencing operated independently of each other and had to be managed separately by the information systems department. Now, however, firms can merge disparate communications modes into a single universally accessible service using unified communications technology. **Unified communications** integrates disparate channels for voice communications, data communications, instant messaging, email, and electronic conferencing into a single experience by which users can seamlessly switch back and forth between different communication modes. Presence technology shows whether a person is available to receive a call.

CenterPoint Properties, a major Chicago area industrial real estate company, used unified communications technology to create collaborative websites for each of its real estate deals. Each website provides a single point for accessing structured and unstructured data. Integrated presence technology lets team members email, instant message, call, or videoconference with one click.

## Virtual Private Networks

What if you had a marketing group charged with developing new products and services for your firm with members spread across the United States? You would want them to be able to email each other and communicate with the home office without any chance that outsiders could intercept the communications. Large private networking firms offer secure, private, dedicated networks to customers, but this is expensive. A lower-cost solution is to create a virtual private network within the public Internet.

## Singapore Shuts Down 2G Network

With 4.7 million smartphone users and a mobile phone penetration rate of over 84 percent of the population, Singapore continues to lead Southeast Asia in the telecommunications industry. The main challenge facing the industry has been spectrum crunch, which relates to the availability of radio waves to carry wireless signals. Radio spectrum demand has grown exponentially, driven by the explosion of wireless devices such as smartphones, tablets, and computers, and more recently, by the emergence of the Internet of Things—everyday objects collecting data through sensors and transmitting them over the Internet. The radio spectrum is finite, but global mobile data traffic is not; it is expected to hit over 77 exabytes per month by 2022, almost seven times that of 2017.

Singapore implemented several measures to combat the spectrum crunch. In 2009, unused radio spectra called white spaces, then used for TV broadcasting, were taken over and allocated to wireless communications. Further, the Infocomm Media Development Authority (IMDA), Singapore's regulatory authority, has been actively promoting light fidelity (Li-Fi) to tap the visible light spectrum in the frequency range 400–800THz to alleviate spectrum congestion. In addition, in a landmark announcement, Singapore's large telecom companies announced that they would be shutting down 2G mobile services by April 1, 2017. The main reason was to reallocate the 2G spectrum for 3G, 4G, and even 5G services, which are about to be launched.

Although the decision to shutter 2G was widely applauded, the implementation was challenging and required many key decisions on the part of the telecoms companies and the government to ensure that 2G users—about 123,000 subscribers—would not be adversely affected, especially as they constituted some of the most vulnerable in society. These included foreign workers and domestic workers living in Singapore, who used 2G phones because they are cheaper and have a longer battery life. Many of the elderly use a phone only for basic services such as voice calls, and many children were given 2G phones by their parents for use in emergencies. Getting these stakeholders to move to 3G or 4G phones and services was a significant economic and educational challenge.

Singapore took several measures to help and encourage the 123,000 2G mobile subscribers to switch to smartphones. One was to allow the sale of basic smartphones such as the SGINO 3G phone for elderly people, which was much cheaper than a normal 3G phone. This addressed the issue of affordability. Then came education programs. The government and telecoms companies together organized various outreach programs like roadshows in neighborhoods; advertisements on the radio, in newspapers, and on television; and posters and brochures at community centers, libraries, and foreign workers' dormitories. One major initiative by the People's Association (a Singapore grassroots communities and social organization) was the Seniors for Smart Nation program, which offers 25 IT courses to help those aged 50 and above. Others included the Senior Academy program, offering courses such as Smartphone 101 and IT Learning Hubs (also known as Silver Infocomm Junctions), offering affordable and customized IT lessons to senior citizens.

Meanwhile, the major telecoms companies—Singtel, Starhub, and M1—actively promoted the smartphones to 2G users with special promotions and discounts. For example, a Samsung Galaxy J1, which normally sold at $208, was offered by Singtel at $148 with a 2G phone trade-in, and it came bundled with $30 free local talk-time. Similarly, Starhub set up various roadshows at several SingPost locations to offer upgrade packages, while M1 started to rent out 3G phones, with ownership to be transferred at end of 12 months. Such deep discounts and offers were unusual, but the telecom companies likely took the long-term view that they were gaining valuable 2G spectrum that they could use for more lucrative mobile services.

The community also played a vital role in the migration. As an example, a non-profit organization, Transient Workers Count Too (TWC2), appealed to the public to donate their used 3G phones to help migrant workers. During their donation campaign, they received approximately 350 handsets worth about $11,500, exceeding their goal of 200 phones. The donations were given to migrant workers who were unable to afford 3G handsets.

In summary, the decision to shut down 2G was easy technically but hard in terms of implementation. It required concerted action by the private sector, the public sector, as well as the people—the PPP partnership. Private telecom companies were willing to give deep discounts to gain valuable spectrum in the long run, the government rolled out many education and awareness programs to educate and encourage the elderly and the young, and the entire community stepped up to help foreign and domestic workers.

These "acts of kindness" were also strategic, for they became the springboard for Singapore to push its Smart Nation initiative, which requires 5G networks to make available such services as smart homes, autonomous cars, virtual reality, wearable technology, video conferencing, and telemedicine. This next-generation infrastructure is a win for all concerned, and the new 5G foundation, which is still being built, will not have been possible without the many managerial decisions taken by the public and private sectors that kept in view the needs of all stakeholders. In 2019, other countries such as Norway also began shutting down slower networks, such as 3G networks, in an effort to make more resources available for faster 4G and 5G services.

Sources: J. Clement, "Global Mobile Data Traffic from 2017 to 2022 (in Exabytes per Month)," Statista.com, December 17, 2019; "What Telecoms Need to Plan Before Shutting Down 3G Network," Telecomlead.com, December 3, 2019; eMarketer, "Mobile Phone Users and Penetration in Singapore," April 2019; eMarketer, "Smartphone Users and Penetration in Singapore," April 2019; "Global Mobile Data Traffic from 2017 to 2022 (in Exabytes per Month)," Statista, accessed 2018; "Spectrum Management and Coordination," Infocomm Media Development Authority, December 20, 2017; Loke Kok Fai, "100,000 Mobile Subscribers Still on 2G Despite Start of the Network's Shutdown," Channel NewsAsia, April 2, 2017; Vincent Chang, "All You Need to Know about 2G Network Shutdown," *The Straits Times*, March 28, 2017; "Donation Campaign a Huge Success, Distribution of 3G Phones Begins," TWC2, March 22, 2017; "Silver Infocomm Junctions," Infocomm Media Development Authority, September 24, 2018, https://www.imda.gov.sg/SIJ.

## CASE STUDY QUESTIONS

1. What do 2G, 3G, and 4G refer to? Explain one difference among them.
2. What is meant by "wireless spectrum" and "spectrum crunch"? What measures were taken to alleviate the spectrum scarcity?
3. The decision to shut down 2G was easy technically but hard in terms of implementation." Do you agree with this statement? Why or why not?

*Case contributed by Neerja Sethi and Vijay Sethi, Nanyang Technological University*

A **virtual private network (VPN)** is a secure, encrypted, private network that has been configured within a public network to take advantage of the economies of scale and management facilities of large networks, such as the Internet (see Figure 7.10). A VPN provides your firm with secure, encrypted communications at a much lower cost than the same capabilities offered by traditional non-Internet providers that use their private networks to secure communications. VPNs also provide a network infrastructure for combining voice and data networks.

Several competing protocols are used to protect data transmitted over the public Internet, including Point-to-Point Tunneling Protocol (PPTP). In a process called

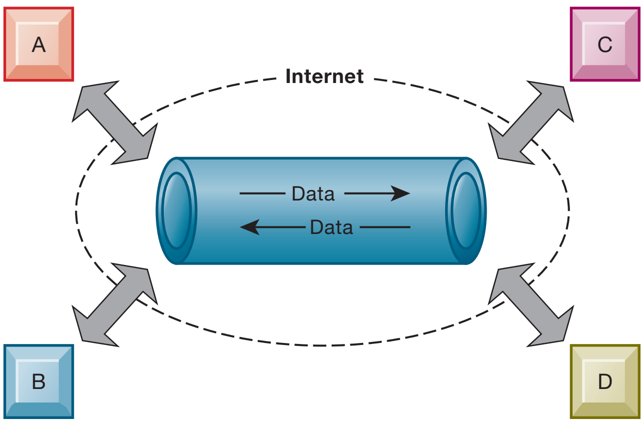



**Figure 7.10**
**A Virtual Private Network Using the Internet.**
*This VPN is a private network of computers linked using a secure tunnel connection over the Internet. It protects data transmitted over the public Internet by encoding the data and wrapping them within the Internet protocol. By adding a wrapper around a network message to hide its content, organizations can create a private connection that travels through the public Internet.*

*tunneling*, packets of data are encrypted and wrapped inside IP packets. By adding this wrapper around a network message to hide its content, business firms create a private connection that travels through the public Internet.

## THE WEB

The web is the most popular Internet service. It's a system with universally accepted standards for storing, retrieving, formatting, and displaying information by using a client/server architecture. Web pages are formatted using hypertext-embedded links that connect documents to one another and that also link pages to other objects, such as sound, video, or animation files. When you click a graphic and a video clip plays, you have clicked a hyperlink. A typical **website** is a collection of web pages linked to a home page.

### Hypertext

Web pages are based on a standard Hypertext Markup Language (HTML), which formats documents and incorporates dynamic links to other documents and other objects stored in the same or remote computers (see Chapter 5). Web pages are accessible through the Internet because web browser software operating your computer can request web pages stored on an Internet host server by using the **Hypertext Transfer Protocol (HTTP)**. HTTP is the communications standard that transfers pages on the web. For example, when you type a web address in your browser, such as http://www.sec.gov, your browser sends an HTTP request to the sec.gov server requesting the home page of sec.gov.

HTTP is the first set of letters at the start of every web address, followed by the domain name, which specifies the organization's server computer that is storing the web page. Most companies have a domain name that is the same as or closely related to their official corporate name. The directory path and web page name are two more pieces of information within the web address that help the browser track down the requested page. Together, the address is called a **uniform resource locator (URL)**. When typed into a browser, a URL tells the browser software exactly where to look for the information. For example, in the URL http://www.megacorp.com/content/features/082610.html, *http* names the protocol that displays web pages, www.megacorp.com is the domain name, content/features is the directory path that identifies where on the domain web server the page is stored, and 082610.html is the web page name and the name of the format it is in. (It is an HTML page.)

### Web Servers

A web server is software for locating and managing stored web pages. It locates the web pages a user requests on the computer where they are stored and delivers the web pages to the user's computer. Server applications usually run on dedicated computers, although they can all reside on a single computer in small organizations.

The leading web servers in use today are Microsoft Internet Information Services (IIS) and Apache HTTP Server. Apache is an open source product that is free of charge and can be downloaded from the web.

### Searching for Information on the Web

No one knows for sure how many web pages there really are. The surface web is the part of the web that search engines visit and about which information is recorded. For instance, Google indexed an estimated 130 trillion pages in 2018, and this reflects a large portion of the publicly accessible web page population. But there is a deep web that contains an estimated 1 trillion additional pages, many of them proprietary (such as the pages of *Wall Street Journal Online*, which cannot be visited without an access code), or that are stored in protected corporate databases. Facebook, with web pages of text, photos, and media for more than 2 billion members, is a closed web, and its pages are not completely searchable by Google or other search engines. A small portion of the deep web called the **dark web** has been intentionally hidden from search engines, uses masked IP addresses, and is accessible only with a special web browser in order to preserve anonymity. The dark web has become a haven for criminals because it allows the buying and selling of illicit goods, including credit card and Social Security numbers, with total anonymity.

**Search Engines** Obviously, with so many web pages, finding specific ones that can help you or your business, nearly instantly, is an important problem. The question is, how can you find the one or two pages you really want and need out of billions of indexed web pages? **Search engines** attempt to solve the problem of finding useful information on the web nearly instantly and, arguably, they are the killer app of the Internet era. Today's search engines can sift through HTML files; files of Microsoft Office applications; PDF files; and audio, video, and image files. There are hundreds of search engines in the world, but the vast majority of search results come from Google, Baidu, Yahoo, and Microsoft's Bing (see Figure 7.11). While we typically think of Amazon as an online store, it is also a powerful product search engine.

Web search engines started out in the early 1990s as relatively simple software programs that roamed the nascent web, visiting pages and gathering information about the content of each page. The first search engines were simple keyword indexes of all the pages they visited, leaving users with lists of pages that may not have been truly relevant to their search.

In 1994, Stanford University computer science students David Filo and Jerry Yang created a hand-selected list of their favorite web pages and called it "Yet Another Hierarchical Officious Oracle," or Yahoo. Yahoo was not initially a search engine but rather an edited selection of websites organized by categories the editors found useful. Currently, Yahoo relies on Microsoft's Bing for search results.

In 1998, Larry Page and Sergey Brin, two other Stanford computer science students, released their first version of Google. This search engine was different. Not only did it index each web page's words but it also ranked search results based on the relevance of each page. Page patented the idea of a page ranking system (called *PageRank System*), which essentially measures the popularity of a web page by calculating the number of sites that link to that page as well as the number of pages to which it links. The premise is that popular web pages are more relevant to users. Brin contributed a unique web crawler program that indexed not only keywords on a page but also combinations of words (such as authors and the titles of their articles). These two ideas became the foundation for the Google search engine. Figure 7.12 illustrates how Google works.

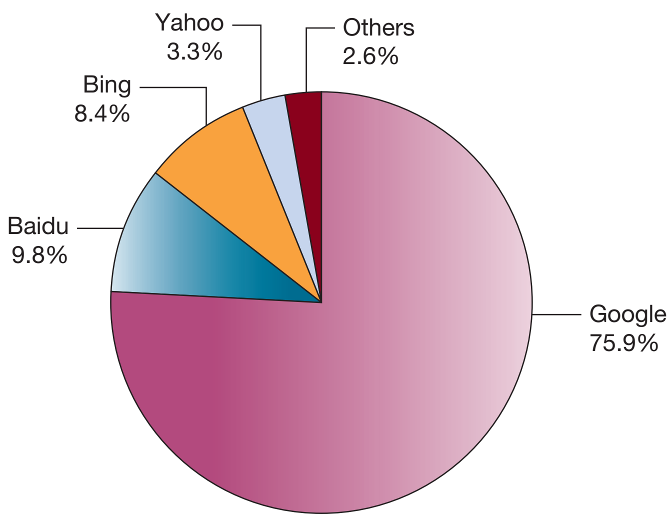



**Figure 7.11**
Top Desktop/Laptop Web Search Engines Worldwide.
*Google is the world's most popular search engine.*
*Source:* Based on data from Net Market Share, May 2019

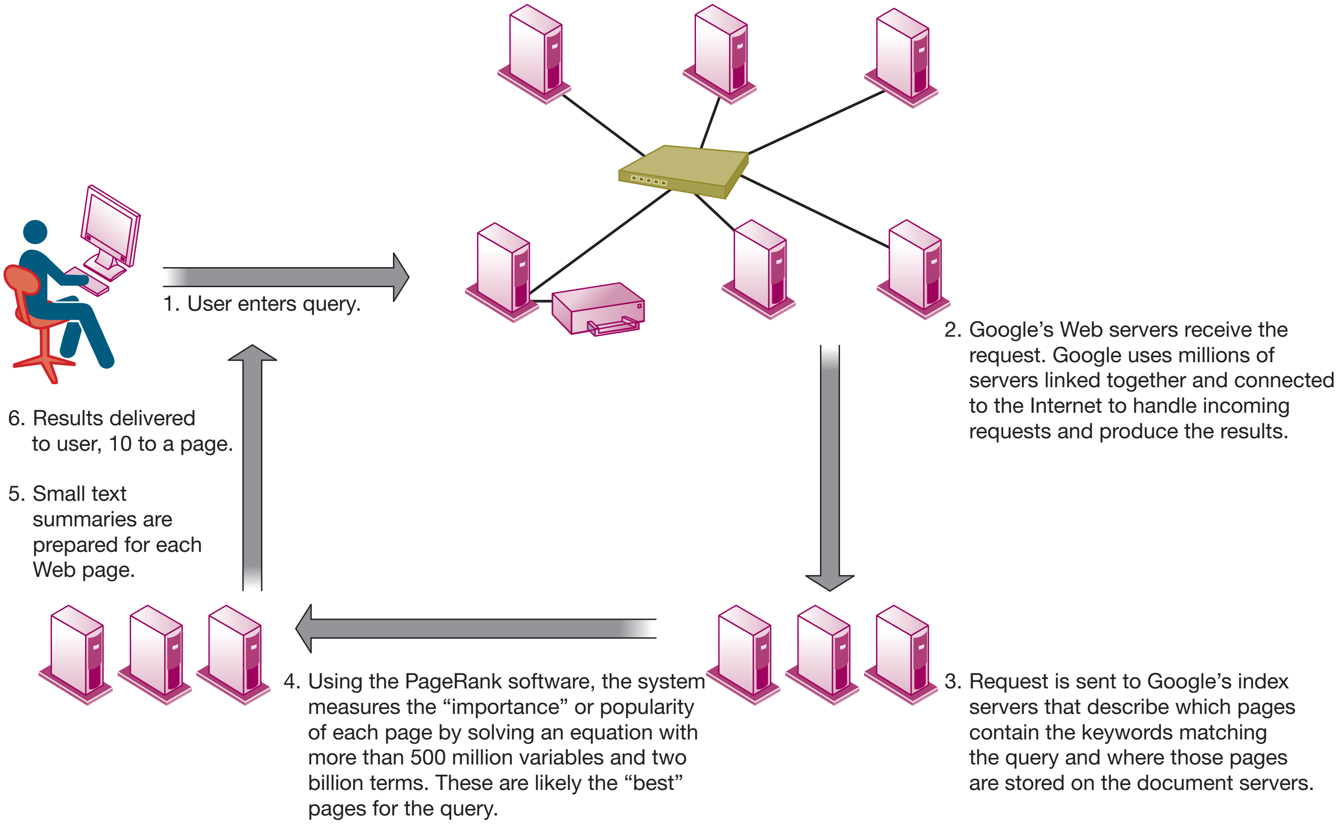



**Figure 7.12**
How Google Works.
*The Google search engine is continuously crawling the web, indexing the content of each page, calculating its popularity, and storing the pages so that it can respond quickly to user requests to see a page. The entire process takes about half a second.*

**Mobile Search** Mobile search from smartphones and tablets makes up more than 55 percent of all searches and continues to expand. Google, Amazon, and Yahoo have developed new search interfaces to make searching and shopping from smartphones more convenient. Google revised its search algorithm to favor sites that look good on smartphone screens. Although smartphones are widely used to shop, actual purchases typically take place on laptops or desktops, followed by tablets.

**Semantic Search** Another way for search engines to become more discriminating and helpful is to make search engines capable of understanding what we are really looking for. Called **semantic search**, the goal is to build a search engine that can really understand human language and behavior. Google and other search engine firms are attempting to refine search engine algorithms to capture more of what the user intended and the meaning of a search. Rather than evaluate each word separately in a search, Google's Hummingbird search algorithm tries to evaluate an entire sentence, focusing on the meaning behind the words. For instance, if your search is a long sentence like "Google annual report selected financial data 2019," Hummingbird should be able to figure out that you really want Google's parent company Alphabet's SEC Form 10K report filed with the Securities and Exchange Commission in February 2019.

Google searches also take advantage of Knowledge Graph, an effort of the search algorithm to anticipate what you might want to know more about as you search on a topic. Results of the knowledge graph appear on the right of the screen on many search result pages and contain more information about the topic or person you are searching on. For example, if you search "Lake Tahoe," the search engine will return basic facts about Tahoe (altitude, average temperature, and local fish), a map, and hotel accommodations. Google has made **predictive search** part of most search results.

This part of the search algorithm guesses what you are looking for and suggests search terms as you type your search words.

**Visual Search and the Visual Web** Although search engines were originally designed to search text documents, the explosion of photos and videos on the Internet created a demand for searching and classifying these visual objects. Facial recognition software can create a digital version of a human face. You can search for people on Facebook by using their digital image to find and identify them. Facebook is now using artificial intelligence technology to make its facial recognition capabilities more accurate.

Searching photos, images, and video has become increasingly important as the web becomes more visual. The **visual web** refers to websites such as Pinterest, where pictures replace text documents, where users search pictures, and where pictures of products replace display ads for products. Pinterest is a social networking site that provides users (as well as brands) with an online board to which they can pin interesting pictures. Pinterest had over 290 million active monthly users worldwide in 2019. Instagram is another example of the visual web. Instagram is a photo and video sharing site that allows users to take pictures, enhance them, and share them with friends on other social sites such as Facebook and Twitter. In 2019, Instagram had 1 billion monthly active users.

**Intelligent Agent Shopping Bots** Chapter 11 describes the capabilities of software agents with built-in intelligence that can gather or filter information and perform other tasks to assist users. **Shopping bots** use intelligent agent software for searching the Internet for shopping information. Shopping bots such as MySimon or PriceGrabber, and travel search tools like Trivago, can help people interested in making a purchase or renting a vacation room filter and retrieve information according to criteria the users have established, and in some cases negotiate with vendors for price and delivery terms.

**Search Engine Marketing** Search engines have become major advertising platforms and shopping tools by offering what is now called **search engine marketing**. Searching for information is one of the web's most popular activities; it is estimated that 242 million people in the United States used search engines in 2019, and 215 million used mobile search at that time. With this huge audience, search engines are the foundation for the most lucrative form of online marketing and advertising: search engine marketing. When users enter a search term on Google, Bing, Yahoo, or any of the other sites serviced by these search engines, they receive two types of listings: sponsored links, for which advertisers have paid to be listed (usually at the top of the search results page), and unsponsored, organic search results. In addition, advertisers can purchase small text boxes on the side of search results pages. The paid, sponsored advertisements are the fastest growing form of Internet advertising and are powerful new marketing tools that precisely match consumer interests with advertising messages at the right moment. Search engine marketing monetizes the value of the search process. In 2019, search engine marketing is expected to generate $48 billion, or 44.2 percent of digital ad spending, nearly half of all online advertising ($125 billion) (eMarketer, 2019a). About 90 percent of Google's revenue of $136 billion in 2018 came from online advertising, and 90 percent of that ad revenue came from search engine marketing (Alphabet, 2019).

Because search engine marketing is so effective (it has the highest click-through rate and the highest return on ad investment), companies seek to optimize their websites for search engine recognition. The better optimized the page is, the higher a ranking it will achieve in search engine result listings. **Search engine optimization (SEO)** is the process of improving the quality and volume of web traffic to a website by employing a series of techniques that help a website achieve a higher ranking with the major search engines when certain keywords and phrases are put into the search field. One technique is to make sure that the keywords used in the website description match the keywords likely to be used as search terms by prospective customers. For example, your website is more likely to be among the first ranked by search engines if it uses the keyword *lighting* rather than *lamps* if most prospective customers are searching for *lighting*. It is also advantageous to link your website to as many other websites as possible because search engines evaluate such links to determine the popularity of a web page and how it is linked to other content on the web.

Search engines can be gamed by scammers who create thousands of phony website pages and link them to a single retailer's site in an attempt to fool Google's search engine. Firms can also pay so-called link farms to link to their site. Google changed its search algorithm in 2012 to deal with this problem by examining the quality of links more carefully with the intent of down-ranking sites that have a suspicious pattern of sites linking to them.

In general, search engines have been very helpful to small businesses that cannot afford large marketing campaigns. Because shoppers are looking for a specific product or service when they use search engines, they are what marketers call hot prospects—people who are looking for information and often intending to buy. Moreover, search engines charge only for click-throughs to a site. Merchants do not have to pay for ads that don't work, only for ads that receive a click. Consumers benefit from search engine marketing because ads for merchants appear only when consumers are looking for a specific product. Thus, search engine marketing saves consumers cognitive energy and reduces search costs (including the cost of transportation needed to search for products physically). One study estimated the global value of search to both merchants and consumers to be more than $800 billion, with about 65 percent of the benefit going to consumers in the form of lower search costs and lower prices (McKinsey & Company, 2011).

## Sharing Information on the Web

Today's websites don't just contain static content—they enable people to collaborate, share information, and create new services and content online. Today's web can support interactivity, real-time user control, social participation (sharing), and user-generated content. The technologies and services behind these features include cloud computing, software mashups and apps, blogs, RSS, wikis, and social networks. We have already described cloud computing, mashups, and apps in Chapter 5 and introduced social networks in Chapter 2.

A **blog**, the popular term for a weblog, is a personal website that typically contains a series of chronological entries (newest to oldest) by its author and links to related web pages. The blog may include a *blogroll* (a collection of links to other blogs) and *trackbacks* (a list of entries in blogs that refer to a post on the first blog). Most blogs allow readers to post comments on the blog entries as well. The act of creating a blog is often referred to as blogging. Blogs can be hosted by a third-party service such as Blogger.com or TypePad.com, and blogging features have been incorporated into social networks such as Facebook and collaboration platforms such as IBM Notes. WordPress is a leading open source blogging tool and content management system. **Microblogging**, used in Twitter or other platforms with serious space or size constraints, is a type of blogging that features very small elements of content such as short sentences, individual images, or video links.

Blog pages are usually based on templates provided by the blogging service or software. Therefore, millions of people without HTML skills of any kind can post their own web pages and share content with others. The totality of blog-related websites is often referred to as the **blogosphere**. Although blogs have become popular personal publishing tools, they also have business uses (see Chapters 2 and 10).

If you're an avid blog reader, you might use RSS to keep up with your favorite blogs without constantly checking them for updates. **RSS**, which stands for Really Simple Syndication or Rich Site Summary, pulls specified content from websites and feeds it automatically to users' computers. RSS reader software gathers material from the websites or blogs that you tell it to scan and brings new information from those sites to you. RSS readers are available through websites such as Google and Yahoo, and they have been incorporated into the major web browsers and email programs.

Blogs allow visitors to add comments to the original content, but they do not allow visitors to change the original posted material. **Wikis**, in contrast, are collaborative websites on which visitors can add, delete, or modify content, including the work of previous authors. *Wiki* comes from the Hawaiian word for "quick."

Wiki software typically provides a template that defines layout and elements common to all pages, displays user-editable software program code, and then renders the content into an HTML-based page for display in a web browser. Some wiki software allows only basic text formatting, whereas other tools allow the use of tables, images, or even interactive elements, such as polls or games. Most wikis provide capabilities for monitoring the work of other users and correcting mistakes.

Because wikis make information sharing so easy, they have many business uses. The US Department of Homeland Security's National Cyber Security Center (NCSC) deployed a wiki to facilitate information sharing with other federal agencies on threats, attacks, and responses and as a repository for technical and standards information. Pixar Wiki is a collaborative community wiki for publicizing the work of Pixar Animation Studios. The wiki format allows anyone to create or edit an article about a Pixar film.

**Social networking** sites enable users to build communities of friends and professional colleagues. Members typically create a profile—a web page for posting photos, videos, audio files, and text—and then share these profiles with others on the service identified as their friends or contacts. Social networking sites are highly interactive, offer real-time user control, rely on user-generated content, and are broadly based on social participation and sharing of content and opinions. Leading social networking sites include Facebook, Twitter, and LinkedIn (for professional contacts).

Social networking has radically changed how people spend their time online; how people communicate and with whom; how business people stay in touch with customers, suppliers, and employees; how providers of goods and services learn about their customers; and how advertisers reach potential customers. The large social networking sites are also application development platforms where members can create and sell software applications to other members of the community. Facebook has millions of apps and websites integrated with it, including applications for gaming, video sharing, and communicating with friends and family. We talk more about business applications of social networking in Chapters 2 and 10, and you can find social networking discussions in many other chapters of this book.

## The Future Web

The future Internet is becoming visible. Its key features are more tools for individuals to make sense out of the trillions of pages on the Internet, or the millions of apps available for smartphones and a visual, even three-dimensional (3D) web where you can walk through pages in a 3D environment. (Review the discussion of semantic search and visual search earlier in this chapter.)

Even closer in time is a pervasive web that controls everything from a city's traffic lights and water usage, to the lights in your living room, to your car's rear view mirror, not to mention managing your calendar and appointments. This is referred to as the **Internet of Things (IoT)** and is based on billions of Internet-connected sensors throughout our physical world. Objects, animals, or people are provided with unique identifiers and the ability to transfer data over a network without requiring human-to-human or human-to-computer interaction. Firms such as General Electric, IBM, HP, and Oracle, and hundreds of smaller startups, are building smart machines, factories, and cities through extensive use of remote sensors and fast cloud computing. There were over 26 billion active IoT devices worldwide in 2019, and this number will rise to 75 billion by 2025 (Bera, 2019). Over time, more and more everyday physical objects will be connected to the Internet and will be able to identify themselves to other devices, creating networks that can sense and respond as data changes. The Tour de France race-tracking system described in the chapter-opening case is an IoT application, as is the vehicle-to-everything technology discussed in the Interactive Session on Technology. You'll find more examples of the Internet of Things in Chapters 2 and 11.

## Talking Cars Make for Better Road Safety

Toward the end of 2015, Toyota, Japan's biggest manufacturer of small-sized vehicles, began to offer the Intelligent Transportation System (ITS) Connect safety package. ITS Connect overcomes the constraints of other similar systems, such as poor function in extreme weather and blind spots, by getting cars to talk to one another. The system allows a vehicle's on-board computer to perform vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I) wireless communication—collectively known as vehicle-to-everything (V2X) wireless communication—continuously with other vehicles and with roadside infrastructure (lamp poles and traffic light poles). It collects this information, analyzes it, and then responds automatically or gives instant audio or visual safety information to the driver accordingly.

Using an international vehicular communication standard called dedicated short-range communications (DSRC), ITS Connect allows effective communication within a radius of up to 300 meters at a frequency of 760 MHz. A V2V message in the ITS Connect is quite small in size (36 bytes to 100 bytes) with free fields reserved for service expansion, but it must contain information about the position, speed, heading, acceleration, type, and size of the vehicle; it may also contain extra data about the nearest intersection ahead as well as information defined by individual applications. Additionally, each message must be appended with a timestamp.

The ITS Connect system is designed to avoid collisions with other vehicles, pedestrians, and cyclists. By providing drivers with timely information and feedback, such as a reminder to give way to an approaching emergency vehicle or a countdown to a traffic signal change, the system can improve driving efficiency. The technology also enables cooperative adaptive cruise control (CACC), which uses information obtained from V2V messages to automatically change the speed of an automobile to match that of the vehicle ahead.

Toyota and its allies began to promote Wi-Fi-based DSRC using the 5 GHz frequency band in the United States and European markets in 2017. Another standard of vehicular communication, cellular-vehicle-to-everything (C-V2X), appeared in 2018 and is trying to win different regional markets before DSRC becomes the mainstream. C-V2X consists of not only V2V and V2I but also vehicle-to-pedestrians (V2P) direct communications and vehicle-to-network (V2N) operations. V2P allows communications between vehicles and the mobile phones of non-vehicle road users, such as pedestrians and cyclists. V2N refers to exchange of traffic information, like the incidence of traffic jams, between vehicles and cloud-based data centers through the cellular network.

One of the advocates of C-V2X, German-based Continental AG, is a pioneer in applying the technology in automotive parts and has been carrying out field trials in several countries. In late 2018, Continental AG carried out a joint trial of C-V2X in Japan using 5.8 GHz as the experimental radio frequency. The test involved several avoid-collision scenarios; the results showed that the average latency was 20 milliseconds, and throughout the tests the error rate was nearly 0 percent over a distance as long as 1.2 kilometers.

It is believed that V2X will reduce the incidence of 80 percent of traffic accidents, particularly of collisions. In addition, V2X can increase efficiency in coordination of traffic flow through platooning and green wave. Platooning refers to a system in which multiple trucks drive together as a convoy, each at a consistent distance from the other, with the lead truck using a CACC application. This allows drivers on long-distance trips to take turns resting, and if the convoy is aerodynamic-optimal, fuel consumption is reduced as well. A green wave refers to a situation in which a series of traffic lights at several intersections turn green in perfect timing to allow continuous traffic flow in the same direction. The data collected in vehicular communication can be used to analyze patterns in traffic flow and in urban planning. Proper use of platooning and green waves could optimize mobility, improve congestion, save fuel, and reduce pollution.

These advances in vehicular communications are also paving the way toward the realization of the driverless automobile, which has been controversial for the same road safety issues that V2X seeks to eliminate. The development of automatic driving is expected to provide further opportunities not only for the car-makers, telecommunication service providers, and chipset manufacturers but also for other sectors, such as shipment, logistics, insurance, and mobile healthcare.

However, regardless of standard, worries abound regarding data security and privacy issues. Vehicular communications involve the transmittal of sensitive data, such as vehicle ID, and this data can be leaked. Malicious interception and alteration of transmitted messages could allow specific vehicles to be tracked—or false reports of misconduct to be generated.

Sources: K. Momota, "Connectivity Technologies Attracting Attention Due to Frequent Traffic Accidents," Furuno.com, May 31, 2019; Autotalks website, https://www.auto-talks.com; Continental AG, https://www.continental.com/en; Kristen Hall-Geisler, "In Japan, Priuses Can Talk to Other Priuses," TechCrunch, August 17, 2016; ITS Connect Promotion Consortium, https://www.itsconnect-pc.org; Toyota Motor Corporation, Official Global website, https://global.toyota/en/.

## CASE STUDY QUESTIONS

1. What are the pros and cons of the V2X technology?
2. What can be done to speed up the adoption of V2X technology among vehicle owners?
3. What other applications can you think of for the ITS Connect?

*Case contributed by Joyce Chan, City University of Hong Kong*

The App Internet is another element in the future web. The growth of apps within the mobile platform is astounding. More than 80 percent of mobile minutes in the United States are generated through apps, as opposed to browsers. Apps give users direct access to content and are much faster than loading a browser and searching for content.

Other complementary trends leading toward a future web include more widespread use of cloud computing and software as a service (SaaS) business models, ubiquitous connectivity among mobile platforms and Internet access devices, and the transformation of the web from a network of separate siloed applications and content into a more seamless and interoperable whole.

# 7-4 What are the principal technologies and standards for wireless networking, communication, and Internet access?

Welcome to the wireless revolution! Cell phones, smartphones, tablets, and wireless-enabled personal computers have morphed into portable media and computing platforms that let you perform many of the computing tasks you used to do at your desk, and a whole lot more. We introduced smartphones in our discussions of the mobile digital platform in Chapters 1 and 5. **Smartphones** such as the iPhone, Android phones, and BlackBerry combine the functionality of a cell phone with that of a mobile laptop computer with Wi-Fi capability. This makes it possible to combine music, video, Internet access, and telephone service in one device. A large part of the Internet is becoming a mobile, access-anywhere, broadband service for the delivery of video, music, and web search.

## CELLULAR SYSTEMS

Today 96 percent of US adults own mobile phones, and 81 percent own smartphones (He, 2019). Worldwide, there are almost 2.9 billion smartphone users (eMarketer, 2019b). Mobile is now the leading digital platform, with total activity on smartphones and tablets accounting for two-thirds of digital media time spent, and smartphone apps alone capturing more than half of digital media time.

Digital cellular service uses several competing standards. In Europe and much of the rest of the world outside the United States, the standard is Global System for Mobile Communications (GSM). GSM's strength is its international roaming capability. There are GSM cell phone systems in the United States, including T-Mobile and AT&T.

A competing standard in the United States is Code Division Multiple Access (CDMA), which is the system that Verizon and Sprint use. CDMA was developed by the military during World War II. It transmits over several frequencies, occupies the entire spectrum, and randomly assigns users to a range of frequencies over time, making it more efficient than GSM.

Earlier generations of cellular systems were designed primarily for voice and limited data transmission in the form of short text messages. Today wireless carriers offer 3G and 4G networks. **3G networks**, with transmission speeds ranging from 144 Kbps for mobile users in, say, a car, to more than 2 Mbps for stationary users, offer transmission speeds appropriate for email and web browsing, but are too slow for videos. **4G networks** have much higher speeds, up to 100 Mbps download and 50 Mbps upload, with more than enough capacity for watching high-definition video on your smartphone. Long Term Evolution (LTE) and mobile Worldwide Interoperability for Microwave Access (WiMax—see the following section) are the current 4G standards.

The next generation of wireless technology, called **5G**, is designed to support transmission of very large amounts of data in the gigabit range, with fewer transmission delays and the ability to connect many more devices (such as dense networks of sensors and smart devices) at once than existing cellular systems. 5G technology will be needed for self-driving vehicles, smart cities, and extensive use of the Internet of Things. AT&T, Verizon, and other carriers are starting to launch 5G networks, which will also improve the speed and intensive data-handling capabilities of smartphones. Mobile Internet users will be able to download entire movies within seconds.

## WIRELESS COMPUTER NETWORKS AND INTERNET ACCESS

An array of technologies provides high-speed wireless access to the Internet for PCs and mobile devices. These new high-speed services have extended Internet access to numerous locations that could not be covered by traditional wired Internet services and have made ubiquitous computing, anywhere, anytime, a reality.

### Bluetooth

**Bluetooth** is the popular name for the 802.15 wireless networking standard, which is useful for creating small **personal area networks (PANs)**. It links up to eight devices within a 10-meter area using low-power, radio-based communication and can transmit up to 722 Kbps in the 2.4-GHz band.

Wireless phones, pagers, computers, printers, and computing devices using Bluetooth communicate with each other and even operate each other without direct user intervention (see Figure 7.13). For example, a person could direct a notebook computer to send a document file wirelessly to a printer. Bluetooth connects wireless keyboards and mice to PCs or cell phones to earpieces without wires. Bluetooth has low power requirements, making it appropriate for battery-powered handheld computers or cell phones.

Although Bluetooth lends itself to personal networking, it has uses in large corporations. For example, FedEx drivers use Bluetooth to transmit the delivery data captured by their handheld computers to cellular transmitters, which forward the data to corporate computers. Drivers no longer need to spend time docking their handheld units physically in the transmitters, and Bluetooth has saved FedEx $20 million per year.

### Wi-Fi and Wireless Internet Access

The 802.11 set of standards for wireless LANs and wireless Internet access is also known as **Wi-Fi**. The first of these standards to be widely adopted was 802.11b, which can transmit up to 11 Mbps in the unlicensed 2.4-GHz band and has an effective distance of 30 to 50 meters. The 802.11g standard can transmit up to 54 Mbps in the 2.4-GHz range. 802.11n is capable of transmitting over 100 Mbps. Today's PCs and tablets have built-in support for Wi-Fi, as do the iPhone, iPad, and other smartphones.

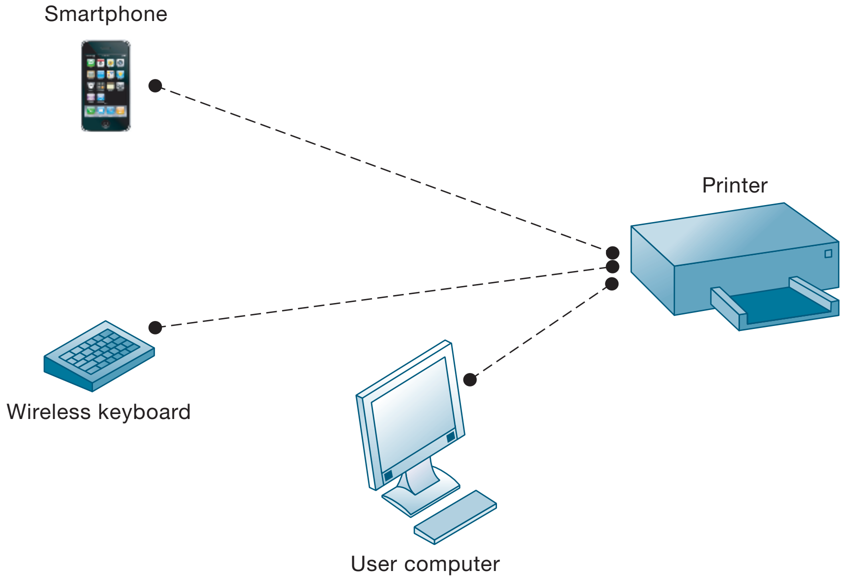



**Figure 7.13**
A Bluetooth Network (PAN).
*Bluetooth enables a variety of devices, including cell phones, smartphones, wireless keyboards and mice, PCs, and printers, to interact wirelessly with each other within a small, 30-foot (10-meter) area. In addition to the links shown, Bluetooth can be used to network similar devices to send data from one PC to another, for example.*

In most Wi-Fi communication, wireless devices communicate with a wired LAN using access points. An access point is a box consisting of a radio receiver/transmitter and antennas that links to a wired network, router, or hub.

Figure 7.14 illustrates an 802.11 wireless LAN that connects a small number of mobile devices to a larger wired LAN and to the Internet. Most wireless devices are client machines. The servers that the mobile client stations need to use are on the wired LAN. The access point controls the wireless stations and acts as a bridge between the main wired LAN and the wireless LAN. The access point also controls the wireless stations.

The most popular use for Wi-Fi today is for high-speed wireless Internet service. In this instance, the access point plugs into an Internet connection, which could come

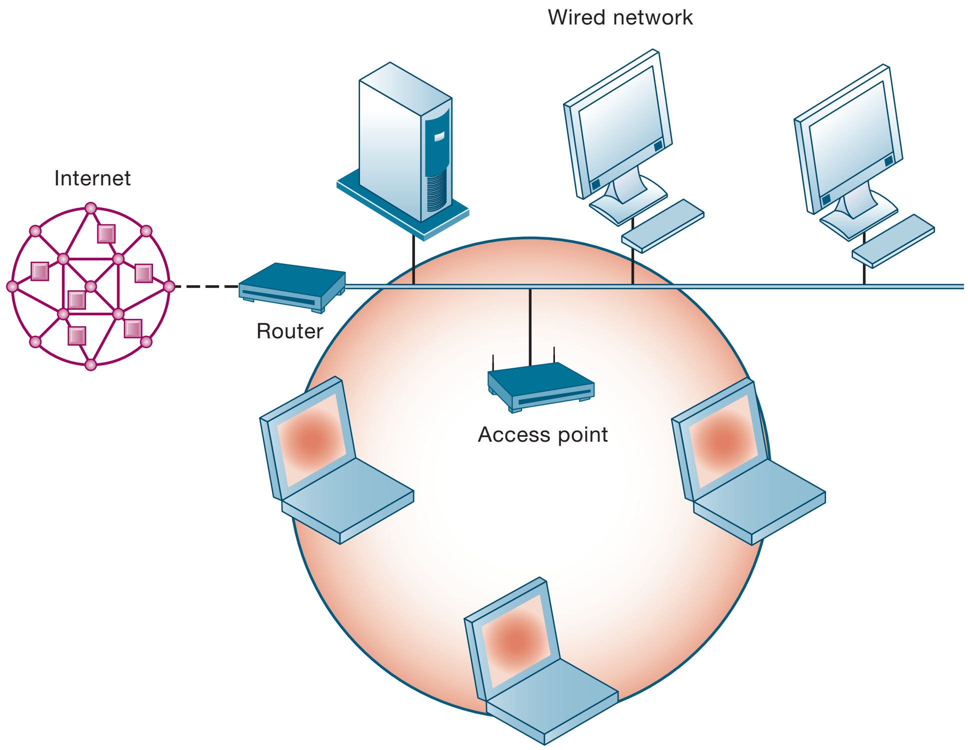



**Figure 7.14**
An 802.11 Wireless LAN.
*Mobile laptop computers equipped with network interface cards link to the wired LAN by communicating with the access point. The access point uses radio waves to transmit network signals from the wired network to the client adapters, which convert them to data that the mobile device can understand. The client adapter then transmits the data from the mobile device back to the access point, which forwards the data to the wired network.*

from a cable service or DSL telephone service. Computers within range of the access point use it to link wirelessly to the Internet.

**Hotspots** are locations with one or more access points providing wireless Internet access and are often in public places. Some hotspots are free or do not require any additional software to use; others may require activation and the establishment of a user account by providing a credit card number over the web.

Businesses of all sizes are using Wi-Fi networks to provide low-cost wireless LANs and Internet access. Wi-Fi hotspots can be found in hotels, airport lounges, libraries, cafes, and college campuses to provide mobile access to the Internet. Dartmouth College is one of many campuses where students now use Wi-Fi for research, course work, and entertainment.

Wi-Fi technology poses several challenges, however. One is Wi-Fi's security features, which make these wireless networks vulnerable to intruders. We provide more detail about Wi-Fi security issues in Chapter 8.

Another drawback of Wi-Fi networks is susceptibility to interference from nearby systems operating in the same spectrum, such as wireless phones, microwave ovens, or other wireless LANs. Wireless networks based on the 802.11n standard, however, solve this problem by using multiple wireless antennas in tandem to transmit and receive data and technology called MIMO (multiple input multiple output) to coordinate multiple simultaneous radio signals.

### WiMax

A surprisingly large number of areas in the United States and throughout the world do not have access to Wi-Fi or fixed broadband connectivity. The range of Wi-Fi systems is no more than 300 feet from the base station, making it difficult for rural groups that don't have cable or DSL service to find wireless access to the Internet.

The Institute of Electrical and Electronics Engineers (IEEE) developed a family of standards known as WiMax to deal with these problems. **WiMax**, which stands for Worldwide Interoperability for Microwave Access, is the popular term for IEEE Standard 802.16. It has a wireless access range of up to 31 miles and transmission speed of 30–40 Mbps (and up to 1 Gbps for fixed stations).

WiMax antennas are powerful enough to beam high-speed Internet connections to rooftop antennas of homes and businesses that are miles away. Cellular handsets and laptops with WiMax capabilities are appearing in the marketplace. Mobile WiMax is one of the 4G network technologies that we discussed earlier in this chapter.

## RFID AND WIRELESS SENSOR NETWORKS

Mobile technologies are creating new efficiencies and ways of working throughout the enterprise. In addition to the wireless systems we have just described, radio frequency identification systems and wireless sensor networks are having a major impact.

### Radio Frequency Identification (RFID) and Near Field Communication (NFC)

**Radio frequency identification (RFID)** systems provide a powerful technology for tracking the movement of goods throughout the supply chain. RFID systems use tiny tags with embedded microchips containing data about an item and its location to transmit radio signals over a short distance to RFID readers. The RFID readers then pass the data over a network to a computer for processing. Unlike bar codes, RFID tags do not need line-of-sight contact to be read.

The RFID tag is electronically programmed with information that can uniquely identify an item plus other information about the item such as its location, where and when it was made, or its status during production. The reader emits radio waves in ranges anywhere from 1 inch to 100 feet. When an RFID tag comes within the range of the reader, the tag is activated and starts sending data. The reader captures these

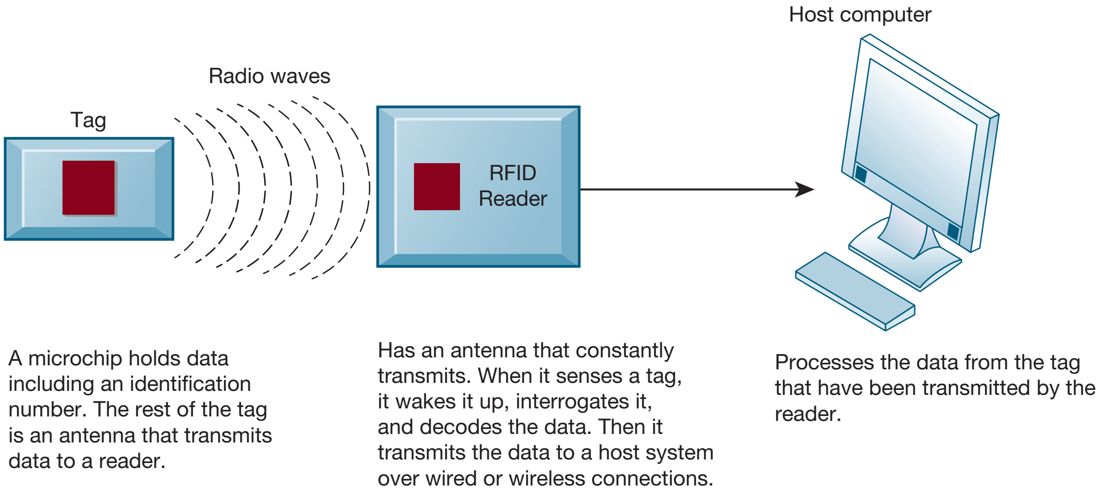



**Figure 7.15**
How RFID Works.
*RFID uses low-powered radio transmitters to read data stored in a tag at distances ranging from 1 inch to 100 feet. The reader captures the data from the tag and sends them over a network to a host computer for processing.*

data, decodes them, and sends them back over a wired or wireless network to a host computer for further processing (see Figure 7.15). Both RFID tags and antennas come in a variety of shapes and sizes.

In inventory control and supply chain management, RFID systems capture and manage more detailed information about items in warehouses or in production than bar coding systems. If a large number of items are shipped together, RFID systems track each pallet, lot, or even unit item in the shipment. This technology may help companies such as Walmart improve receiving and storage operations by improving their ability to see exactly what stock is stored in warehouses or on retail store shelves.

Walmart has installed RFID readers at store receiving docks to record the arrival of pallets and cases of goods shipped with RFID tags. The RFID reader reads the tags a second time just as the cases are brought onto the sales floor from backroom storage areas. Software combines sales data from Walmart's point-of-sale systems and the RFID data regarding the number of cases brought out to the sales floor. The program determines which items will soon be depleted and automatically generates a list of items to pick in the warehouse to replenish store shelves before they run out. This information helps Walmart reduce out-of-stock items, increase sales, and further shrink its costs.

The cost of RFID tags used to be too high for widespread use, but now it starts at around 7 cents per tag in the United States. As the price decreases, RFID is starting to become cost-effective for many applications.

In addition to installing RFID readers and tagging systems, companies may need to upgrade their hardware and software to process the massive amounts of data produced by RFID systems—transactions that could add up to tens or hundreds of terabytes.

Software is used to filter, aggregate, and prevent RFID data from overloading business networks and system applications. Applications often need to be redesigned to accept large volumes of frequently generated RFID data and to share those data with other applications. Major enterprise software vendors now offer RFID-ready versions of their supply chain management applications.

Tap-and-go services like Apple Pay or Google Wallet use an RFID-related technology called **near field communication (NFC)**. NFC is a short-range wireless connectivity standard that uses electromagnetic radio fields to enable two compatible devices to exchange data when brought within a few centimeters of each other.

A smartphone or other NFC-compatible device sends out radio frequency signals that interact with an NFC tag found in compatible card readers or smart posters. The signals create a current that flows through the NFC tag, allowing the device and the tag to communicate with one another. In most cases the tag is passive and only sends out information while the other device (such as a smartphone) is active and can both send and receive information. (There are NFC systems where both components are active.)

NFC is used in wireless payment services, to retrieve information, and even to exchange videos or information with friends on the go. You could share a website link by passing your phone over a friend's phone, while waving the phone in front of a poster or display containing an NFC tag could show information about what you're viewing at a museum or exhibit.

### Wireless Sensor Networks

If your company wanted state-of-the art technology to monitor building security or detect hazardous substances in the air, it might deploy a wireless sensor network. **Wireless sensor networks (WSNs)** are networks of interconnected wireless devices that are embedded in the physical environment to provide measurements of many points over large spaces. These devices have built-in processing, storage, and radio frequency sensors and antennas. They are linked into an interconnected network that routes the data they capture to a computer for analysis. These networks range from hundreds to thousands of nodes. Figure 7.16 illustrates one type of wireless sensor network, with data from individual nodes flowing across the network to a server with greater processing power. The server acts as a gateway to a network based on Internet technology.

Wireless sensor networks are valuable for uses such as monitoring environmental changes; monitoring traffic or military activity; protecting property; efficiently operating and managing machinery and vehicles; establishing security perimeters; monitoring supply chain management; or detecting chemical, biological, or radiological material. Output from RFID systems and wireless networks is fueling the Internet of Things (IoT), introduced earlier in this chapter, in which sensors in machines such as jet engines, power plant turbines, or agricultural equipment constantly gather data and send the data over the Internet for analysis.

## 7-5 How will MIS help my career?

Here is how Chapter 7 and this book can help you find a job as an automotive digital advisor.

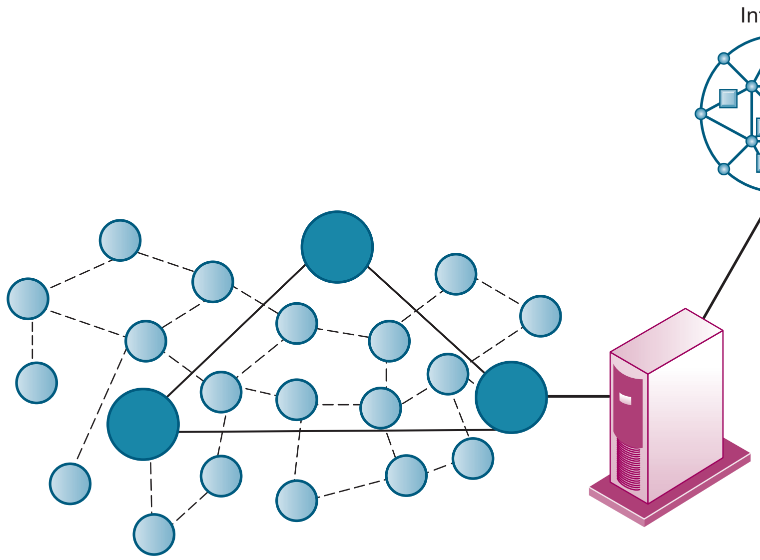



**Figure 7.16**
A Wireless Sensor Network.
*The small circles represent lower-level nodes, and the larger circles represent higher-level nodes. Lower-level nodes forward data to each other or to higher-level nodes, which transmit data more rapidly and speed up network performance.*

## THE COMPANY

Autoworld is a large and fast-growing automobile dealership in Singapore. The company is looking for an automotive digital advisor to run its digital marketing program. The company has more than 500 vehicles for sale, 170 employees, and three locations for selling and servicing new and used vehicles.

## POSITION DESCRIPTION

The automotive digital assistant will be part of a team assisting the dealership group with online marketing, including search engine optimization (SEO) and search engine marketing (SEM), social media and reputation management, and website management. Job responsibilities include coordinating efforts for the dealership owner, dealership managers, and marketing manager in the following areas:

- Online advertising, SEO, and SEM.
- Social media management, including managing the dealership's overall social media and content calendar and developing new content.
- Online reputation management.
- Website management.
- Maintaining the dealership's blog.

## JOB REQUIREMENTS

- College graduate in marketing
- Knowledge of digital marketing and social media
- Microsoft Office skills
- Knowledge of automotive sales and content management systems desirable

## INTERVIEW QUESTIONS

1. Have you ever taken any digital marketing courses?
2. Have you any experience running a digital marketing campaign? Did you use SEO and SEM? How did you measure the effectiveness of your social media campaign and audience growth?
3. Do you have any experience with social media management software?
4. Do you have any experience with online reputation management?
5. Have you ever maintained a blog?
6. What is your level of proficiency with Microsoft Office software?

## AUTHOR TIPS

1. Review the discussions of search, search engine marketing, and blogs in this chapter and also the discussions of e-commerce marketing and building an e-commerce presence in Chapter 10.
2. Use the web to learn more about SEO, SEM, social media management, and online reputation management and software tools used for this work. Look into how to generate metrics reports using standardized tools and how to put together analyses and recommendations based on the social media data.
3. Look at how major auto dealers in large metropolitan areas are using social media channels. Are they creating content on YouTube, Instagram, Facebook, and Twitter? Which channels are generating higher levels of audience engagement?
4. Inquire about exactly what you would have to do for website management and required software skills.
5. Inquire about the Microsoft Office skills that you would need for this job. Bring examples of the work you have done with this software.

## Review Summary

**7-1 What are the principal components of telecommunications networks and key networking technologies?** A simple network consists of two or more connected computers. Basic network components include computers, network interfaces, a connection medium, network operating system software, and either a hub or a switch. The networking infrastructure for a large company includes the traditional telephone system, mobile cellular communication, wireless local area networks, videoconferencing systems, a corporate website, intranets, extranets, and an array of local and wide area networks, including the Internet.

Contemporary networks have been shaped by the rise of client/server computing, the use of packet switching, and the adoption of Transmission Control Protocol/Internet Protocol (TCP/IP) as a universal communications standard for linking disparate networks and computers, including the Internet. Protocols provide a common set of rules that enable communication among diverse components in a telecommunications network.

**7-2 What are the different types of networks?** The principal physical transmission media are twisted copper telephone wire, coaxial copper cable, fiber-optic cable, and wireless transmission.

Local area networks (LANs) connect PCs and other digital devices within a 500-meter radius and are used today for many corporate computing tasks. Wide area networks (WANs) span broad geographical distances, ranging from several miles to entire continents and are often private networks that are independently managed. Metropolitan area networks (MANs) span a single urban area.

Digital subscriber line (DSL) technologies, cable Internet connections, and T1 lines are often used for high-capacity Internet connections.

**7-3 How do the Internet and Internet technology work, and how do they support communication and e-business?** The Internet is a worldwide network of networks that uses the client/server model of computing and the TCP/IP network reference model. Every computer on the Internet is assigned a unique numeric IP address.

The Domain Name System (DNS) converts IP addresses to more user-friendly domain names. Worldwide Internet policies are established by organizations and government bodies such as the Internet Architecture Board (IAB) and the World Wide Web Consortium (W3C).

Major Internet services include email, newsgroups, chatting, instant messaging, Telnet, FTP, and the web. Web pages are based on Hypertext Markup Language (HTML) and can display text, graphics, video, and audio. Website directories, search engines, and RSS technology help users locate the information they need on the web. RSS, blogs, social networking, and wikis are current information-sharing capabilities of the web. The future web will feature more semantic search, visual search, prevalence of apps, and interconnectedness of many different devices (Internet of Things).

Firms are also starting to realize economies by using VoIP technology for voice transmission and virtual private networks (VPNs) as low-cost alternatives to private WANs.

**7-4 What are the principal technologies and standards for wireless networking, communication, and Internet access?** Cellular networks are evolving toward high-speed, high-bandwidth, digital packet-switched transmission. 3G networks are capable of transmitting data at speeds ranging from 144 Kbps to more than 2 Mbps. 4G networks are capable of transmission speeds of 100 Mbps, and 5G networks capable of transmitting in the gigabit range are starting to be rolled out.

Major cellular standards include Code Division Multiple Access (CDMA), which is used primarily in the United States, and Global System for Mobile Communications (GSM), which is the standard in Europe and much of the rest of the world.

Standards for wireless computer networks include Bluetooth (802.15) for small personal area networks (PANs), Wi-Fi (802.11) for local area networks (LANs), and WiMax (802.16) for metropolitan area networks (MANs).

Radio frequency identification (RFID) systems provide a powerful technology for tracking the movement of goods by using tiny tags with embedded data about an item and its location. RFID readers read the radio signals transmitted by these tags and pass the data over a network to a computer for processing. Wireless sensor networks (WSNs) are networks of interconnected wireless sensing and transmitting devices that are embedded in the physical environment to provide measurements of many points over large spaces.

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## Review Questions

**7-1** What are the principal components of telecommunications networks and key networking technologies?
- Describe the features of a simple network and the network infrastructure for a large company.
- Name and describe the principal technologies and trends that have shaped contemporary telecommunications systems.

**7-2** What are the different types of networks?
- Define an analog and a digital signal.
- Distinguish between a LAN, MAN, and WAN.

**7-3** How do the Internet and Internet technology work, and how do they support communication and e-business?
- Explain the role of a Tier 1 Internet Service Provider (ISP).
- Explain the differences between instant messaging, emails, and chat services.
- Define and describe the purpose of unified communications.

- Explain what the term tunneling means and why it might be important to businesses.
- Explain the purpose and the value of search engine optimization.
- Describe how online search technologies are used for marketing.

**7-4** What are the principal technologies and standards for wireless networking, communication, and Internet access?

- Define Bluetooth, Wi-Fi, WiMax, and 3G, 4G, and 5G networks.
- Describe the capabilities of each and for which types of applications each is best suited.
- Define RFID, explain how it works, and describe how it provides value to businesses.
- Define WSNs, explain how they work, and describe the kinds of applications that use them.

MyLab MIS™
To complete the problems with **MyLab MIS**, go to the EOC Discussion Questions in MyLab MIS.

## Discussion Questions

**7-5** **MyLab MIS** It has been said that within the next few years, smartphones will become the single most important digital device we own. Discuss the implications of this statement.

**7-6** **MyLab MIS** Should all major retailing and manufacturing companies switch to RFID? Why or why not?

**7-7** **MyLab MIS** What are some of the issues to consider in determining whether the Internet would provide your business with a competitive advantage?

## Hands-On MIS Projects

The projects in this section give you hands-on experience evaluating and selecting communications technology, using spreadsheet software to improve selection of telecommunications services, and using web search engines for business research. Visit **MyLab MIS** to access this chapter's Hands-On MIS Projects.

### MANAGEMENT DECISION PROBLEMS

**7-8** LionClaw is a Singapore-based clothing brand with a sustainability profile. Management now wants each garment to be accompanied by a tag with a link to a website where the customer can read more about the work environment in the clothing factory, where the fabric is coming from, and so on. Use the web to search for an RFID, NFC, or QR code system for generating codes and printing tags. Work out the differences and choose from these systems to determine the best option for LionClaw.

**7-9** BestMed Medical Supplies Corporation sells medical and surgical products and equipment from more than 700 manufacturers to hospitals, health clinics, and medical offices. The company employs 500 people at seven locations in western and midwestern states, including account managers, customer service and support representatives, and warehouse staff. Employees communicate by traditional telephone voice services, email, instant messaging, and cell phones. Management is inquiring about whether the company should adopt a system for unified communications. What factors should be considered? What are the key decisions that must be made in determining whether to adopt this technology? Use the web, if necessary, to find out more about unified communications and its costs.

## IMPROVING DECISION MAKING: USING SPREADSHEET SOFTWARE TO EVALUATE WIRELESS SERVICES

Software skills: Spreadsheet formulas, formatting
Business skills: Analyzing telecommunications services and costs

**7-10** In this project, you'll use the web to research alternative wireless services and use spreadsheet software to calculate wireless service costs for a sales force.

You would like to equip your sales force of 35, based in Cincinnati, Ohio, with mobile phones that have capabilities for voice transmission, text messaging, Internet access, and taking and sending photos. Use the web to select two wireless providers that offer nationwide voice and data service as well as good service in your home area. Examine the features of the mobile handsets and wireless plans offered by each of these vendors. Assume that each of the 35 salespeople will need unlimited voice, text, and data service in the United States and the ability to take and send photos. Use your spreadsheet software to determine the wireless service and handset that will offer the best pricing per user over a two-year period. For purposes of this exercise, you do not need to consider corporate discounts.

## ACHIEVING OPERATIONAL EXCELLENCE: USING WEB SEARCH ENGINES FOR BUSINESS RESEARCH

Software skills: Web search tools
Business skills: Researching new technologies

**7-11** This project will help develop your Internet skills in using web search engines for business research.

Use Google and Bing to obtain information about ethanol as an alternative fuel for motor vehicles. If you wish, try some other search engines as well. Compare the volume and quality of information you find with each search tool. Which tool is the easiest to use? Which produced the best results for your research? Why?

## COLLABORATION AND TEAMWORK PROJECT

Evaluating Smartphones

**7-12** Form a group with three or four of your classmates. Compare the capabilities of Apple's iPhone with a smartphone from another vendor with similar features. Your analysis should consider the purchase cost of each device, the wireless networks where each device can operate, plan and handset costs, and the services available for each device. You should also consider other capabilities of each device, including available software, security features, and the ability to integrate with existing corporate or PC applications. Which device would you select? On what criteria would you base your selection? If possible, use Google Docs and Google Drive or Google Sites to brainstorm, organize, and develop a presentation of your findings for the class.

## BUSINESS PROBLEM-SOLVING CASE

### GOOGLE, APPLE, AND FACEBOOK BATTLE FOR YOUR INTERNET EXPERIENCE

Three Internet titans—Google, Apple, and Facebook—are in an epic struggle to dominate your Internet experience, and caught in the crossfire are search, music, video, and other media along with the devices you use for all of these things. Mobile devices with advanced functionality and ubiquitous Internet access are rapidly overtaking traditional desktop machines as the most popular form of computing. Today, people spend more than half their time online using mobile devices that take advantage of a growing cloud of computing capacity. It's no surprise, then, that today's tech titans are aggressively battling for control of this brave new online world.

Apple, which started as a personal computer company, quickly expanded into software and consumer electronics. Since upending the music industry with its iPod MP3 player, and the iTunes digital music service, Apple took mobile computing by storm with the iPhone, iPod Touch, and iPad. Now Apple wants to be the computing platform of choice for the Internet.

Apple's competitive strength is based not on its hardware platform alone but on its superior user interface and mobile software applications, in which it is a leader. Apple's App Store offers more than two million apps for mobile and tablet devices. Applications greatly enrich the experience of using a mobile device, and whoever creates the most appealing set of devices and applications will derive a significant competitive advantage over rival companies. Apps are the new equivalent of the traditional browser.

Apple thrives on its legacy of innovation. In 2011, it unveiled Siri (Speech Interpretation and Recognition Interface), a combination search/navigation tool and personal assistant. Siri promises personalized recommendations that improve as it gains user familiarity—all from a verbal command. Google countered by quickly releasing its own intelligent assistant tools Google Now and then Google Assistant.

Apple faces strong competition for its phones and tablets both in the United States and in developing markets like China from inexpensive Chinese smartphones and from Samsung Android phones with sophisticated capabilities. iPhone sales have started to slow, but Apple is not counting on hardware devices alone for future growth. Services have always played a large part in the Apple ecosystem, and they have emerged as a major revenue source. Apple has more than 1.4 billion active devices in circulation, creating a huge installed base of users willing to purchase services and a source of new revenue streams. Apple's services business, which includes Apple's music (both downloads and subscriptions), video sales and rentals, books, apps (including in-app purchases, subscriptions and advertising), iCloud storage, and payments, has been growing at a double-digit rate. Revenue from Apple's services business grew 33 percent in 2018 to nearly $40 billion—accounting for about 15 percent of the company's total revenue.

As Apple rolls out more gadgets, such as the Watch and HomePod, its services revenue will continue to expand and diversify, deepening ties with Apple users. According to CEO Tim Cook, Apple has become one of the largest service businesses in the world. This service-driven strategy is not without worry because both Google and Facebook offer stiff competition in the services area and Apple will need to offer some of its services on non-Apple devices to remain in this market..Google continues to be the world's leading search engine, accounting for about 75 percent of web searches from laptop and desktop devices and about 90 percent of the mobile search market. About 84 percent of the revenue from Google's parent company Alphabet comes from ads, most of them on Google's search engine. Google dominates online advertising. However, Google is slipping in its position as the gateway to the Internet. New search startups focus on actions and apps instead of the web. Facebook has become an important gateway to the web as well.

In 2005, Google had purchased the Android open source mobile operating system to compete in mobile computing. Google provides Android at no cost to smartphone manufacturers, generating revenue indirectly through app purchases and advertising. Many different manufacturers have adopted Android as a standard. In contrast, Apple allows only its own devices to use its proprietary operating system, and all the apps it sells can run only on Apple products. Android is deployed on over 80 percent of smartphones worldwide; is the most common operating system for tablets; and runs on watches, car dashboards, and TVs—more than 4,000 distinct devices. Google wants to extend Android to as many devices as possible.

Google's Android could gain even more market share in the coming years, which could be problematic for Apple as it tries to maintain customer loyalty and keep software developers focused on the iOS platform. Whoever has the dominant smartphone operating system will have control over the apps where smartphone users spend most of their time and built-in channels for serving ads to mobile devices. Google is starting to monitor the content inside Android mobile apps and provide links pointing to that content featured in Google's search results on smartphones. Google cannot monitor or track usage of iPhone apps. Since more than half of global search queries come from mobile devices, the company revised its search algorithms to add "mobile friendliness" to the 200 or so factors it uses to rank websites on its search engine. This favors sites that look good on smartphone screens. The cost-per-click paid for mobile ads has trailed desktop ads, but the gap between computer and mobile ads fees is narrowing. Google instituted a design change to present a cleaner mobile search page.

Seven Google products and services, including Search, YouTube, and Maps, have more than a billion users each. Google's ultimate goal is to knit its services and devices together so that Google users will interact with the company seamlessly all day long and everyone will want to use Google. Much of Google's efforts to make its search and related services more powerful and user-friendly in the years ahead are based on the company's investments in artificial intelligence and machine learning (see Chapter 11). These technologies already have been implemented in applications such as voice search, Google Translate, and spam filtering. The goal is to evolve search into more of a smart assistance capability, where computers can understand what people are saying and respond conversationally with the right information at the right moment. Google Assistant is meant to provide a continuing, conversational dialogue between users and the search engine.

Facebook is the world's largest social networking service, with 2.4 billion monthly active users. People use Facebook to stay connected with their friends and family and to express what matters most to them. Facebook Platform enables developers to build applications and websites that integrate with Facebook to reach its global network of users and to build personalized and social products. Facebook is so pervasive and appealing that it has become users' primary gateway to the Internet. For a lot of people, Facebook *is* the Internet. Whatever they do on the Internet is through Facebook.

Facebook has persistently worked on ways to convert its popularity and trove of user data into advertising dollars, with the expectation that these dollars will increasingly come from mobile smartphones and tablets. As of early 2019, 96 percent of active user accounts worldwide accessed the social network via smartphone and tablet. Facebook ads allow companies to target its users based on their real identities and expressed interests rather than educated guesses derived from web-browsing habits and other online behavior.

At the end of the first quarter of 2018, 98 percent of Facebook's global revenue came from advertising, and 89 percent of that ad revenue was from mobile advertising. Many of those ads are highly targeted by age, gender, and other demographics. Facebook is now a serious competitor to Google in the mobile ad market and is even trying to compete with emerging mobile platforms. Together, Facebook and Google dominate the digital ad industry and have been responsible for almost all of its growth. Facebook has overhauled its home page to give advertisers more opportunities and more information with which to target markets. The company is expanding advertising in products such as the Instagram feed, Stories, WhatsApp, Facebook Watch video on demand service, and Messenger, although the majority of ad revenue still comes from its news feed. Facebook has its own personalized search tool to challenge Google's dominance of search. Facebook CEO Mark Zuckerberg is convinced that social networking is the ideal way to use the web and to consume all of the other content people might desire, including news and video. That makes it an ideal marketing platform for companies. But he also knows that Facebook can't achieve long-term growth and prosperity based on social networking alone. During the past few years Facebook has moved into virtual reality, messaging, video, and more.

Facebook is challenging YouTube as the premier destination for personal videos, developing its own TV programming, and making its messages "smarter" by deploying chatbots. Chatbots are stripped-down software agents that understand what you type or say and respond by answering questions or executing tasks, and they run in the background of Facebook's Messenger service (see Chapter 11). Within Facebook Messenger, you can order a ride from Uber, get news updates, check your flight status, or use augmented reality to imagine what a new Nike sneaker looks like by superimposing a 3-D model of that sneaker atop images or video. Zuckerberg has said that he intends to help bring the next billion people online by attracting users in developing countries with affordable web connectivity. Facebook has launched several services in emerging markets, such as the Free Basics service designed to get people online so they can explore web applications, including its social network. Facebook wants to beam the Internet to underserved areas through the use of drones and satellites along with other technologies. Zuckerberg thinks that Facebook could eventually be an Internet service provider to underserved areas.

Monetization of personal data drives both Facebook and Google's business models. However, this practice also threatens individual privacy. The consumer surveillance underlying Facebook and Google's free services has come under siege from users, regulators, and legislators on both sides of the Atlantic. Calls for restricting Facebook and Google's collection and use of personal data have gathered steam, especially after recent revelations about Russian agents trying to use Facebook to sway American voters and Facebook's uncontrolled sharing of user data with third-party companies (see the Chapter 4 ending case study). Both companies will have to come to terms with the European Union's new privacy law, called the General Data Protection Regulation (GDPR), that requires companies to obtain consent from users before processing their data, and which may inspire more stringent privacy legislation in the United States. Business models that depend less on ads and more on subscriptions have been proposed, although any effort to curb the use of consumer data would put the business model of the ad-supported Internet—and possibly Facebook and Google—at risk. Also pressuring Facebook and Google's ad-driven business models are Apple privacy protection features that allow users of its devices to opt out of targeted advertising.

These tech giants are also being scrutinized for monopolistic behavior. In the United States, Google drives 89 percent of Internet search, 95 percent of young adults on the Internet use a Facebook product, and Google and Apple provide 99 percent of mobile phone operating systems. Critics have called for breaking up these mega-companies or regulating them as Standard Oil and AT&T once were, and the US Justice Department has launched a formal antitrust review of these big tech giants. In July 2018 European Union (EU) regulators fined Google's parent company $5 billion for forcing cellphone makers that use the company's Android operating system to install Google search and browser apps. Less than a year later, EU antitrust regulators fined Alphabet an additional $1.7 billion for restrictive advertising practices in its Adsense business unit. Have these companies become so large that they are squeezing consumers and innovation? How governments answer this question will also affect how Apple, Google, and Facebook will fare and what kind of Internet experience they will be able to provide.

Sources: Wayne Rush, "How Google, Facebook Actions Could Bring Big Tech Under Attack in US," *eWeek*, March 22, 2019; Tripp Mickle, "With the iPhone Sputtering, Apple Bets Its Future on TV and News," *Wall Street Journal,* March 25, 2019; Tripp Mickle and Joe Flint, "Apple Launches TV App, Credit Card, Subscription Services," *Wall Street Journal*, March 25, 2019; Associated Press, "EU Fines Google a Record $5 Million over Mobile Practices," July 18, 2018; "Search Engine Market Share," www.netmarketshare.com, accessed June 16, 2019; "Device Usage of Facebook Users Worldwide as of January 2019," statista.com, accessed June 17, 2019; David Streitfeld, Natasha Singer, and Steven Erlanger, "How Calls for Privacy May Upend Business for Facebook and Google," *New York Times*, March 24, 2018; "Google Wants to Be Everywhere with Everyone," *New York Times*, May 17, 2017.

## CASE STUDY QUESTIONS

**7-13** Compare the business models and core competencies of Google, Apple, and Facebook.

**7-14** Why is mobile computing so important to these three firms? Evaluate the mobile strategies of each firm.

**7-15** Which company and business model do you think is most likely to dominate the Internet, and why?

**7-16** What difference would it make to a business or to an individual consumer if Apple, Google, or Facebook dominated the Internet experience? Explain your answer.

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