Chapter 7

Telecommunications, the Internet, and Wireless Technology

LEARNING OBJECTIVES

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

1. What are the principal components of telecommunications networks and key networking technologies?
2. What are the main telecommunications transmission media and types of networks?
3. How do the Internet and Internet technology work and how do they support communication and e-business?
4. What are the principal technologies and standards for wireless networking, communication, and Internet access?
5. Why are radio frequency identification (RFID) and wireless sensor networks valuable for business?

Interactive Sessions:

The Battle Over Net Neutrality

Monitoring Employees on Networks: Unethical or Good Business?

CHAPTER OUTLINE

HYUNDAI HEAVY INDUSTRIES CREATES A WIRELESS SHIPYARD

What's it like to be the world's largest shipbuilder? Ask Hyundai Heavy Industries (HHI), headquartered in Ulsan, South Korea, which produces 10 percent of the world's ships. HHI produces tankers, bulk carriers, containerships, gas and chemical carriers, ship engines, offshore oil and gas drilling platforms, and undersea pipelines.

Coordinating and optimizing the production of so many different products, is obviously a daunting task. The company has already invested nearly $50 million in factory planning software to help manage this effort. But HHI's "factory" encompasses 11 square kilometers (4.2 square miles) stretching over land and sea, including nine drydocks, the largest of which spans more than seven football fields to support construction of four vessels simultaneously. Over 12,000 workers build up to 30 ships at one time, using millions of parts ranging in size from small rivets to five-story buildings.

This production environment proved too large and complex to easily track the movement of parts and inventory in real time as these events were taking place. Without up-to-the-minute data, the efficiencies from enterprise resource planning software are very limited. To make matters worse, the recent economic downturn hit HHI especially hard, as world trading and shipping plummeted. Orders for new ships in 2009 plunged to 7.9 million compensated gross tons (CGT, a measurement of vessel size), down from 150 million CGT the previous year. In this economic environment, Hyundai Heavy was looking for new ways to reduce expenses and streamline production.

HHI's solution was a high-speed wireless network across the entire shipyard, which was built by KT Corp., South Korea's largest telecommunications firm. It is able to transmit data at a rate of 4 megabits per second, about four times faster than the typical cable modem delivering high-speed Internet service to U.S. households. The company uses radio sensors to track the movement of parts as they move from fabrication shop to the side of a drydock and then onto a ship under construction. Workers on the ship use notebook computers or handheld mobile phones to access plans and engage in two-way video conversations with ship designers in the office, more than a mile away.

In the past, workers who were inside a vessel below ground or below sea level had to climb topside to use a phone or walkie-talkie when they had to talk to someone about a problem. The new wireless network is connected to the electric lines in the ship, which convey digital data to Wi-Fi wireless transmitters placed around the hull during construction. Workers' Internet phones, webcams, and PCs are linked to the Wi-Fi system, so workers can use Skype VoIP to call their colleagues on the surface. Designers in an office building a mile from the construction site use the webcams to investigate problems.

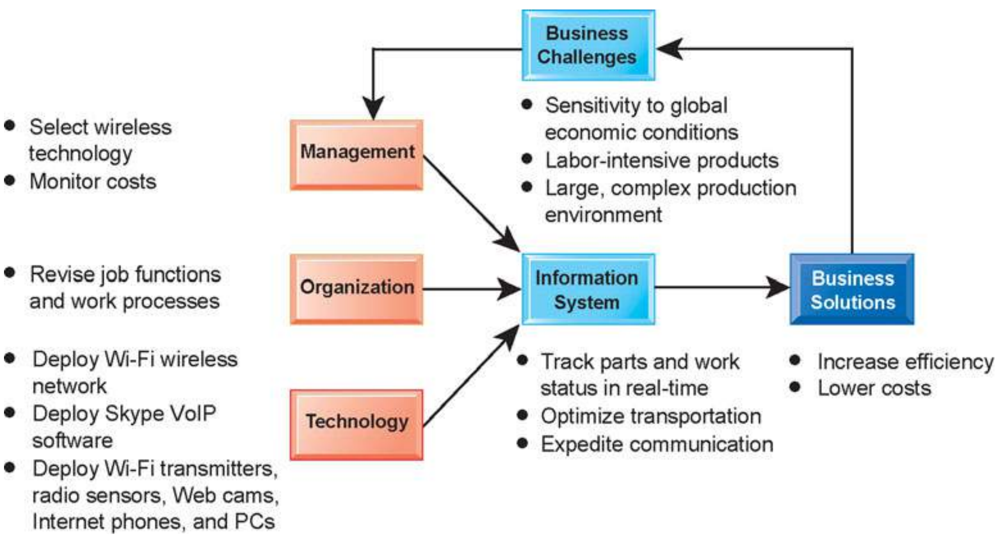
On the shipyard roads, 30 transporter trucks fitted to receivers connected to the wireless network update their location every 20 seconds to a control room. This helps dispatchers match the location of transporters with orders for parts, shortening the trips each truck makes. All of the day's movements are finished by 6 P.M. instead of 8 P.M. By making operations more efficient and reducing labor costs, the wireless technology is expected to save Hyundai Heavy $40 million annually.

Sources: Evan Ramstad, "High-Speed Wireless Transforms a Shipyard," *The Wall Street Journal*, March 15, 2010 and "Hyundai Heavy Plans Wireless Shipyard," *The Korea Herald*, March 30, 2010.

Hyundai Heavy Industries's experience illustrates some of the powerful capabilities and opportunities provided by contemporary networking technology. The company used wireless networking technology to connect designers, laborers, ships under construction, and transportation vehicles to accelerate communication and coordination, and cut down on the time, distance, or number of steps required to perform a task.

The chapter-opening diagram calls attention to important points raised by this case and this chapter. Hyundai Heavy Industries produces ships and other products that are very labor-intensive and sensitive to changes in global economic conditions. Its production environment is large, complex, and extremely difficult to coordinate and manage. The company needs to keep operating costs as low as possible. HHI's shipyard extends over a vast area, and it was extremely difficult to monitor and coordinate different projects and work teams.

Management decided that wireless technology provided a solution and arranged for the deployment of a wireless network throughout the entire shipyard. The network also links the yard to designers in HHI's office a mile away. The network made it much easier to track parts and production activities and to optimize the movements of transporter trucks. HHI had to redesign its production and other work processes to take advantage of the new technology.



7.1 Telecommunications and Networking in Today's Business World

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 and e-mail, the Internet, cell 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 networks were built by telephone companies throughout the twentieth century using voice transmission technologies (hardware and software), and these companies almost always operated as regulated monopolies throughout the world. Computer networks were originally built by computer companies seeking 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 equipment. Telecommunications providers today, such as AT&T and Verizon, offer data transmission, Internet access, cellular telephone service, and television programming as well as voice service. (See the Chapter 3 opening case.) Cable companies, such as Cablevision and Comcast, now offer voice service and Internet access. Computer networks have expanded to include Internet telephone and limited video services. Increasingly, all of these voice, video, and data communications are based on Internet technology.

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 more than 60 percent of U.S. Internet users have high-speed **broadband** connections provided by telephone and cable TV companies running at 1 to 15 million bits per second. The cost for this service has fallen exponentially, from 25 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 cell phones, mobile handheld devices, and PCs in wireless networks. In a few years, more than half the Internet users in the United States will use smartphones and mobile netbooks to access the Internet. In 2010, 84 million Americans accessed the Internet through mobile devices, and this number is expected to double by 2014 (eMarketer, 2010).

WHAT IS A COMPUTER NETWORK?

If you had to connect the computers for two or more employees together in the same office, you would need a computer network. Exactly what is a 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 used 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.

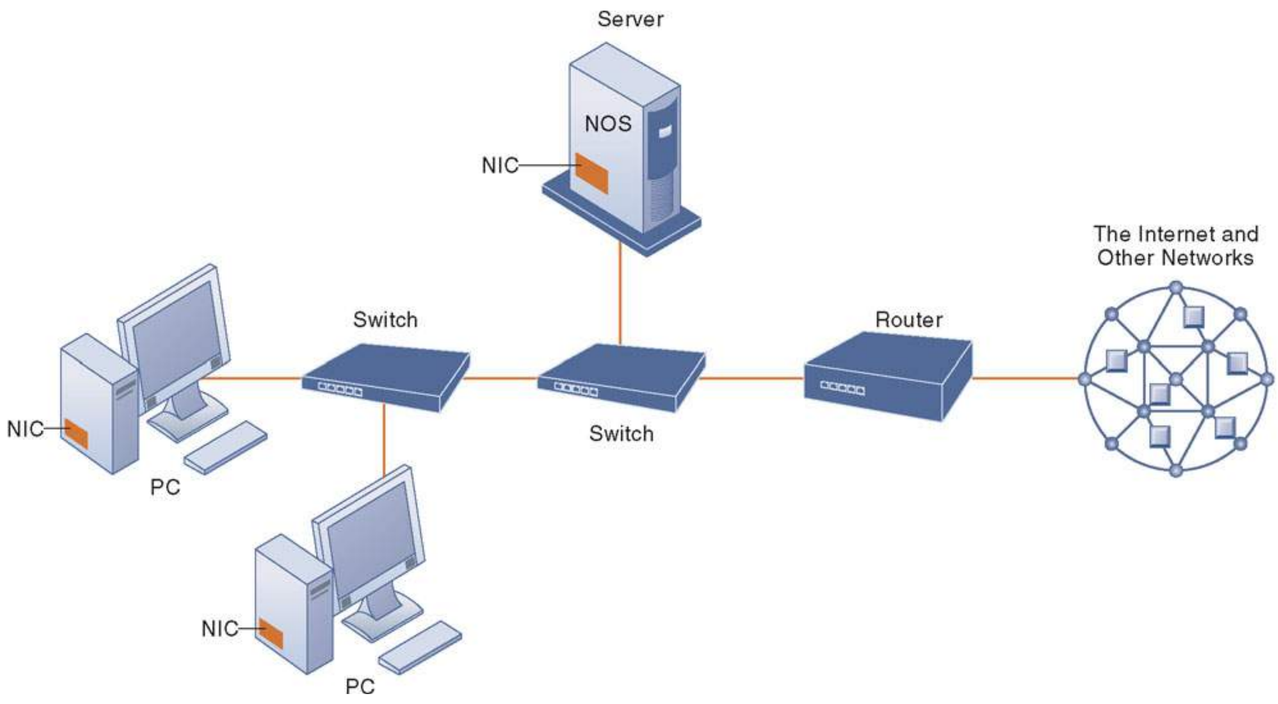
Each computer on the network contains a network interface device called a **network interface card (NIC)**. Most personal computers today have this card built into the motherboard. The connection medium for linking network components can be a telephone wire, coaxial cable, or radio signal in the case 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 it can reside primarily on a dedicated server computer for all the applications on the network. A server computer is a computer on a network that performs important network functions for client computers, such as serving up Web pages, storing data, and storing the network operating system (and hence controlling the network). Server software such as Microsoft Windows Server, Linux, and Novell Open Enterprise Server 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 very 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 used to route packets of data through different networks, ensuring that the data sent gets to the correct address.

FIGURE 7-1 COMPONENTS OF A SIMPLE COMPUTER NETWORK



Illustrated here is a very simple computer network, consisting of computers, a network operating system residing on a dedicated server computer, cable (wiring) connecting the devices, network interface cards (NICs), switches, and a router.

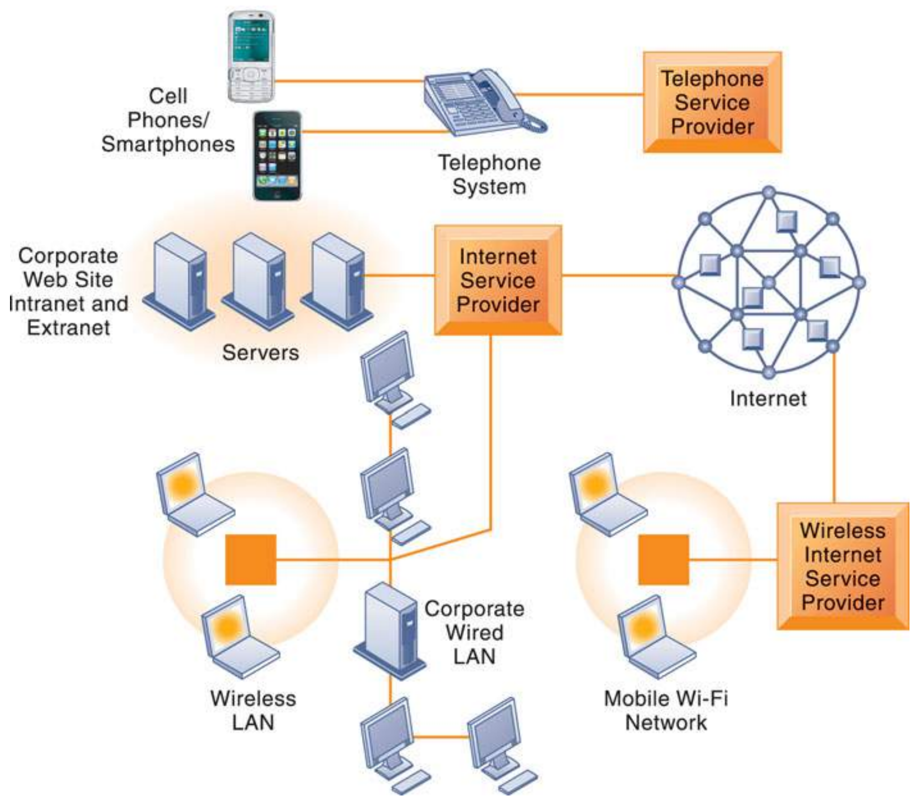
Networks in Large Companies

The network we've just described might be suitable for a small business. But what about large companies with many different locations and thousands of employees? As a firm grows, and collects hundreds of small local area networks, these 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 Web site, 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 you can see that the corporate network infrastructure supports a mobile sales force using cell phones and smartphones, mobile employees linking to the company Web site, internal company networks using mobile wireless local area networks (Wi-Fi networks), and a videoconferencing system to support managers across the world. In addition to these computer networks, the firm's infrastructure usually includes 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 cell phones.

FIGURE 7-2 CORPORATE NETWORK INFRASTRUCTURE



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

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. As more and more communication networks become digital, and based on Internet technologies, it will become easier to integrate them.

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

We introduced client/server computing in Chapter 5. Client/server computing is a distributed computing model in which some of the processing power is located within small, inexpensive client computers, and resides literally on desktops, 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 of 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. The Internet is the largest implementation of client/server computing.

Packet Switching

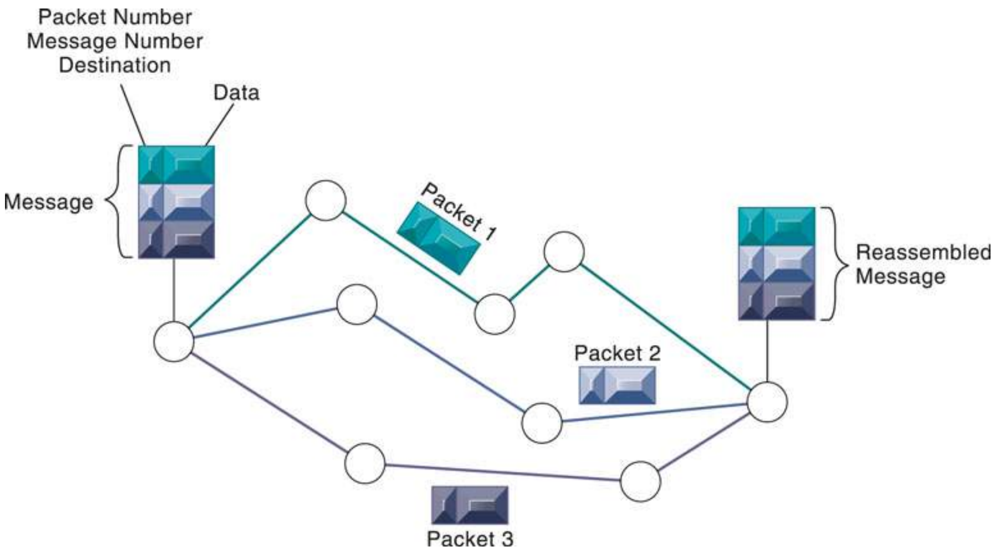
Packet switching is a method of slicing digital messages into parcels called packets, sending the packets along different communication paths as they become available, and then reassembling the packets once they arrive at their destinations (see Figure 7-3). Prior to the development of packet switching, 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 makes much more efficient use of the communications capacity of a network. In packet-switched networks, 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 using routers, each packet traveling independently. Packets of data originating at one source will be routed through many different paths and networks before being reassembled into the original message when they reach their destinations.

TCP/IP and Connectivity

In a typical telecommunications network, diverse hardware and software components need to work together to transmit information. Different com-

FIGURE 7-3 PACKED-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.

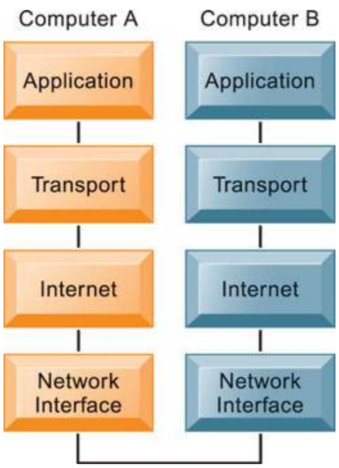
ponents in a network communicate with each other only by adhering to a common set of rules called protocols. A **protocol** is a set of rules and procedures governing transmission of information between two points in a network.

In the past, many diverse proprietary and incompatible protocols often forced business firms to purchase computing and communications equipment from a single vendor. But today, 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 U.S. 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 (TCP), 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.

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.

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

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 are able to 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.

7.2 Communications Networks

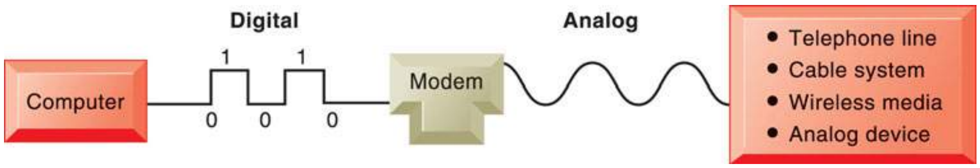
Let's look more closely at alternative networking technologies available to businesses.

SIGNALS: DIGITAL VS. ANALOG

There are two ways to communicate a message in a network: either using 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 voice communication. The most common analog devices are the telephone handset, the speaker on your computer, or your iPod earphone, all of which create analog wave forms 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: one bit and zero 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

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.

modulator-demodulator. Cable modems connect your computer to the Internet using a cable network. DSL modems connect your computer to the Internet using a telephone company's land line 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. Without modems, computers could not communicate with one another using analog networks (which include the telephone system and cable networks).

TYPES OF NETWORKS

There are many different 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 file 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, Linux, and Novell. Each of these network operating systems supports TCP/IP as their default networking protocol.

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 transcontinental or global area

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 used to carry data over the system. Originally, Ethernet supported a data transfer rate of 10 megabits per second (Mbps). Newer versions, such as Fast Ethernet and Gigabit Ethernet, support data transfer rates of 100 Mbps and 1 gigabits per second (Gbps), respectively, and are used in network backbones.

The LAN illustrated in Figure 7-1 uses a client/server architecture where the network operating system resides primarily on a single file 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 10 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.

In LANs using the Windows Server family of operating systems, the peer-to-peer architecture is called the *workgroup network model,* in which a small group of computers can share resources, such as files, folders, and printers, over the network without a dedicated server. The Windows *domain network model*, in contrast, uses a dedicated server to manage the computers in the network.

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 e-mail (mail servers), or storing and managing Web pages (Web servers).

Sometimes LANs are described in terms of the way their components are connected together, or their **topology**. There are three major LAN topologies: star, bus, and ring (see Figure 7-6).

In a **star topology**, all devices on the network connect to a single hub. Figure 7-6 illustrates a simple star topology in which all network traffic flows through the hub. In an *extended star network*, multiple layers of hubs are organized into a hierarchy.

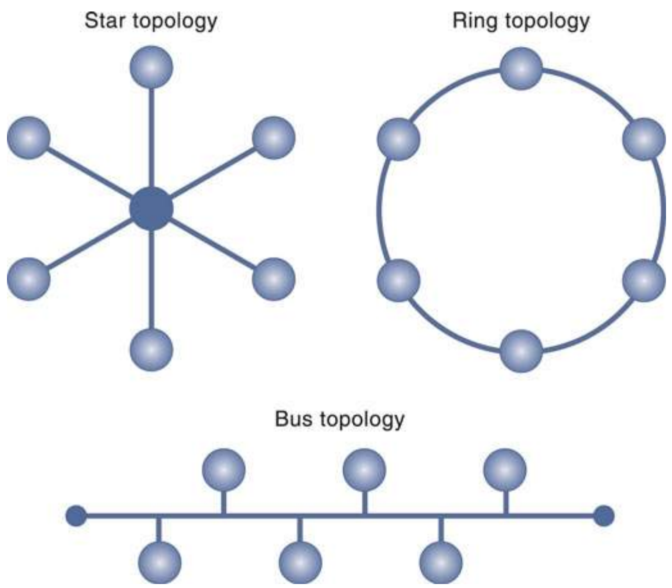
In a **bus topology**, one station transmits signals, which travel in both directions along a single transmission segment. All of the signals are broadcast in both directions to the entire network. All machines on the network receive the same signals, and software installed on the client computers enables each client to listen for messages addressed specifically to it. The bus topology is the most common Ethernet topology.

A **ring topology** connects network components in a closed loop. Messages pass from computer to computer in only one direction around the loop, and only one station at a time may transmit. The ring topology is primarily found in older LANs using Token Ring networking software.

Metropolitan and Wide Area Networks

Wide area networks (WANs) span broad geographical distances—entire 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.

FIGURE 7-6 NETWORK TOPOLOGIES



The three basic network topologies are the star, bus, and ring.

PHYSICAL TRANSMISSION MEDIA

Networks use different kinds of physical transmission media, including twisted wire, coaxial cable, fiber optics, 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.

Twisted Wire

Twisted wire consists of strands of copper wire twisted in pairs and is an older type of transmission medium. Many of the telephone systems in buildings had twisted wires installed for analog communication, but they can be used for digital communication as well. Although an older physical transmission medium, the twisted wires used in today's LANs, such as CAT5, can obtain speeds up to 1 Gbps. Twisted-pair cabling is limited to a maximum recommended run of 100 meters (328 feet).

Coaxial Cable

Coaxial cable, similar to that used for cable television, consists of thickly insulated copper wire that can transmit a larger volume of data than twisted wire. Cable was used in early LANs and is still used today for longer (more than 100 meters) runs in large buildings. Coaxial has speeds up to 1 Gbps.

Fiber Optics and Optical Networks

Fiber-optic cable consists of bound strands of clear glass fiber, each the thickness of a human hair. Data are transformed into pulses of light, which are sent through the fiber-optic cable by a laser device at rates varying from 500 kilobits to several trillion bits per second in experimental settings. Fiber-optic cable is considerably faster, lighter, and more durable than wire media, and is well suited to systems requiring transfers of large volumes of data. However, fiber-optic cable is more expensive than other physical transmission media and harder to install.

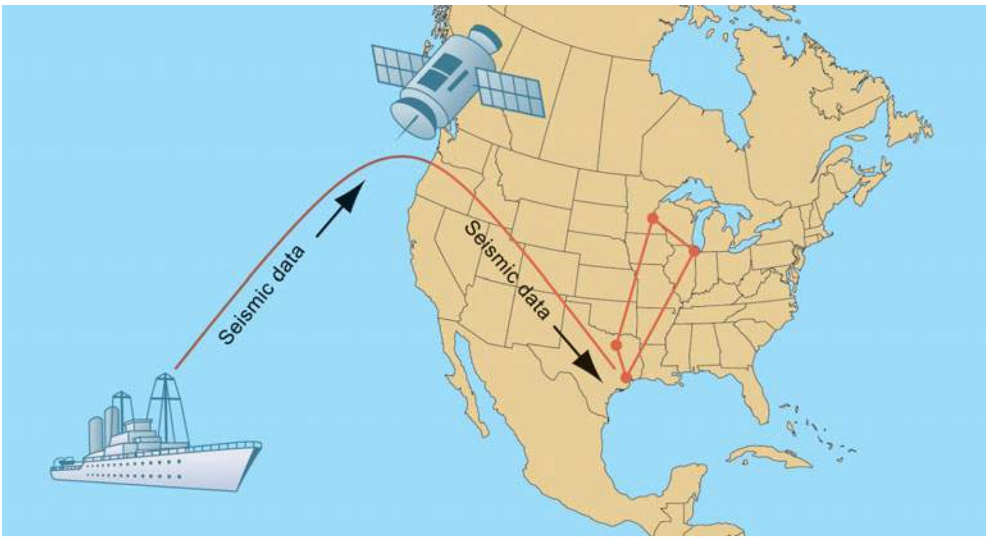
Until recently, fiber-optic cable had been used primarily for the high-speed network backbone, which handles the major traffic. Now cellular phone companies such as Verizon are starting to bring fiber lines into the home for new types of services, such as Verizon's Fiber Optic Services (FiOS) Internet service that provides up 50 Mbps download speeds.

Wireless Transmission Media

Wireless transmission is based on radio signals of various frequencies. There are three kinds of wireless networks used by computers: microwave, cellular, and Wi-Fi. **Microwave** systems, both terrestrial and celestial, transmit high-frequency radio signals through the atmosphere and are widely used for high-volume, long-distance, point-to-point communication. Microwave signals follow a straight line and do not bend with the curvature of the earth. Therefore, long-distance terrestrial transmission systems require that transmission stations be positioned about 37 miles apart. Long-distance transmission is also possible by using communication satellites as relay stations for microwave signals transmitted from terrestrial stations.

Communication satellites use microwave transmission and are typically used for transmission in large, geographically dispersed organizations that would be difficult to network using cabling media or terrestrial microwave, as well as for home Internet service, especially in rural areas. For instance, the global energy company BP p.l.c. uses satellites for real-time data transfer of oil field exploration data gathered from searches of the ocean floor. Using geosynchronous satellites, exploration ships transfer these data to central computing centers in the United States for use by researchers in Houston, Tulsa, and suburban Chicago. Figure 7-7 illustrates how this system works. Satellites are also used for home television and Internet service. The two major satellite Internet providers (Dish Network and DirectTV) have about 30 million subscribers, and about 17 percent of all U.S. households access the Internet using satellite services (eMarketer, 2010).

FIGURE 7-7 **BP'S SATELLITE TRANSMISSION SYSTEM**



Communication satellites help BP transfer seismic data between oil exploration ships and research centers in the United States.

Cellular systems also use radio waves and a variety of different protocols to communicate with radio antennas (towers) placed within adjacent geographic areas called cells. Communications transmitted from a **cell phone** to a local cell pass from antenna to antenna—cell to cell—until they reach their final destination.

Wireless networks are supplanting traditional wired networks for many applications and creating new applications, services, and business models. In Section 7.4, we provide a detailed description of the applications and technology standards driving the "wireless revolution."

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 The Global Internet

We all use the Internet, and many of us can't do without it. It's 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 has become the world's most extensive, public communication system that now rivals the global telephone system in reach and range. 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 U.S. Department of Defense network 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. EarthLink, NetZero, AT&T, and Time Warner are ISPs. Individuals also connect to the Internet through their business firms, universities, or research centers that have designated Internet domains.

There are 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 it has been largely replaced by broadband connections. Digital subscriber line (DSL), 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 9 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 15 Mbps. In areas 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 computer on the Internet is assigned a unique **Internet Protocol (IP) address**, which currently is a 32-bit number represented by four strings of numbers ranging from 0 to 255 separated by periods. For instance, the IP address of www.microsoft.com is 207.46.250.119.

When a user sends a message to another user on the Internet, the message is first decomposed into packets using the TCP protocol. 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.

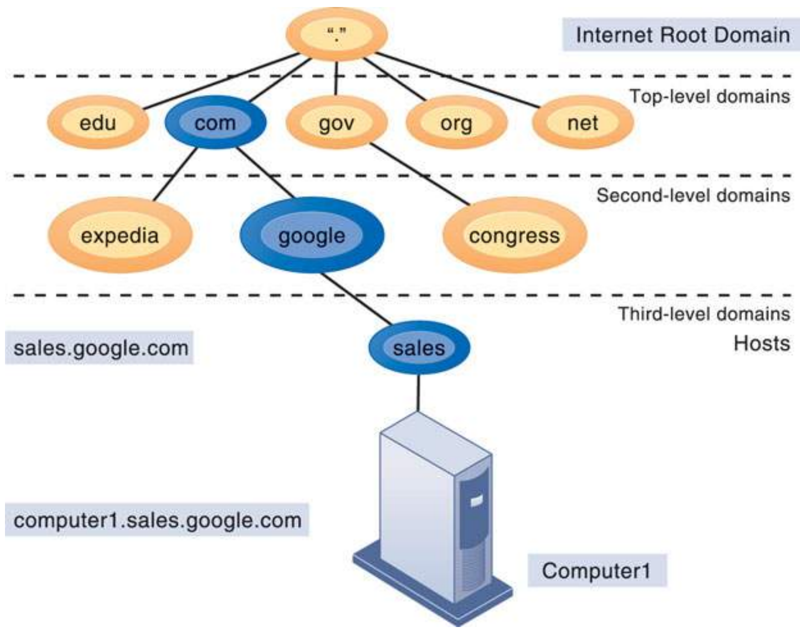
The Domain Name System

Because it would be incredibly difficult for Internet users to remember strings of 12 numbers, the **Domain Name System (DNS)** converts domain names to IP addresses. The **domain name** is the English-like name that corresponds to the unique 32-bit numeric IP address for each computer connected to the Internet. 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.

DNS has a hierarchical structure (see Figure 7-8). 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 is 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 most common domain extensions currently available and officially approved are shown in the following list. 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 (ICANN, 2010). In the future, this list will expand to include many more types of organizations and industries.

FIGURE 7-8 **THE DOMAIN NAME SYSTEM**



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

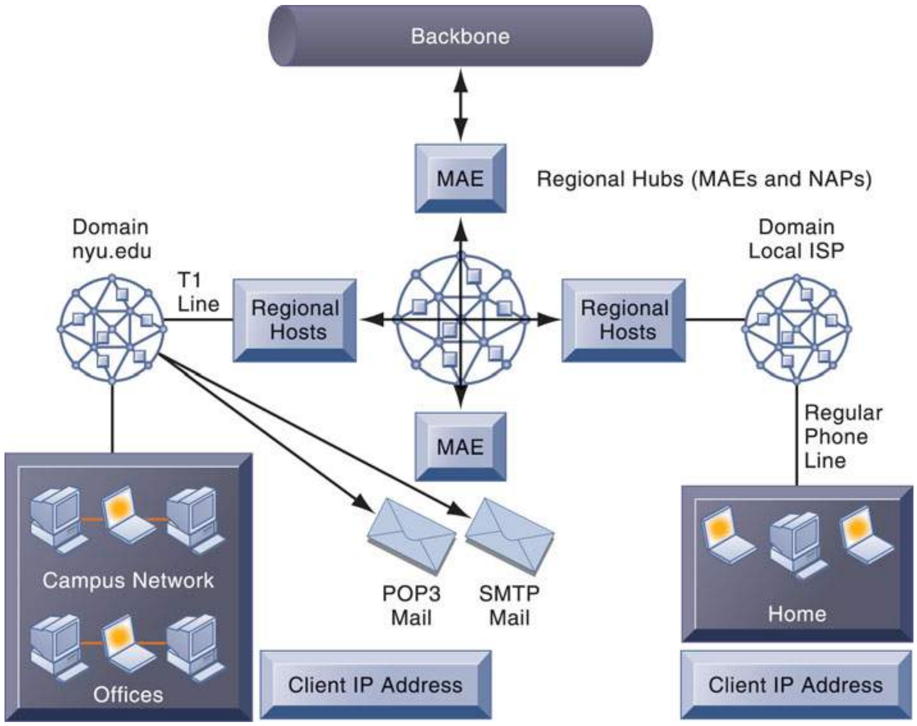
.com	Commercial organizations/businesses
.edu	Educational institutions
.gov	U.S. government agencies
.mil	U.S. military
.net	Network computers
.org	Nonprofit organizations and foundations
.biz	Business firms
.info	Information providers

Internet Architecture and Governance

Internet data traffic is carried over transcontinental high-speed backbone networks that generally operate today in the range of 45 Mbps to 2.5 Gbps (see Figure 7-9). 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 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. A debate is now raging on whether this arrangement should continue or whether heavy Internet users who download large video and music files should pay more for the bandwidth they consume. The Interactive Session on Organizations explores this topic, as it examines the pros and cons of network neutrality.

FIGURE 7-9 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.

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 assigns IP addresses; 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 the technical infrastructures that exist within the nation-states. Although in the early years of the Internet and the Web there was very 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.

The Future Internet: IPv6 and Internet2

The Internet was not originally designed to handle the transmission of massive quantities of data and billions of users. Because many corporations and governments have been given large blocks of millions of IP addresses to accommodate current and future workforces, and because of sheer Internet population growth, the world will run out of available IP addresses using the existing addressing convention by 2012 or 2013. Under development is a new version of the IP addressing schema called *Internet Protocol version 6 (IPv6)*, which contains 128-bit addresses (2 to the power of 128), or more than a quadrillion possible unique addresses.

Internet2 and Next-Generation Internet (NGI) are consortia representing 200 universities, private businesses, and government agencies in the United States that are working on a new, robust, high-bandwidth version of the Internet. They have established several new high-performance backbone networks with bandwidths reaching as much as 100 Gbps. Internet2 research groups are developing and implementing new technologies for more effective routing practices; different levels of service, depending on the type and importance of the data being transmitted; and advanced applications for distributed computation, virtual laboratories, digital libraries, distributed learning, and tele-immersion. These networks do not replace the public Internet, but they do provide test beds for leading-edge technology that may eventually migrate to the public Internet.

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 e-mail 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. Chapters 5 and 6 describe how Web servers work with application servers and database servers to access information from an organization's internal information systems applications and their associated databases. Client platforms today include not only PCs and other computers but also cell phones, small handheld digital devices, and other information appliances.

Internet Services

A client computer connecting to the Internet has access to a variety of services. These services include e-mail, electronic discussion groups, chatting and instant messaging, **Telnet**, **File Transfer Protocol (FTP)**, and the Web. Table 7-2 provides a brief description of these services.

Each Internet service is implemented by one or more software programs. All of the services may run on a single server computer, or different services may

TABLE 7-2 MAJOR INTERNET SERVICES

CAPABILITY	FUNCTIONS SUPPORTED
E-mail	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) using hypertext links

INTERACTIVE SESSION: ORGANIZATIONS

THE BATTLE OVER NET NEUTRALITY

What kind of Internet user are you? Do you primarily use the Net to do a little e-mail and look up phone numbers? Or are you online all day, watching YouTube videos, downloading music files, or playing massively multiplayer online games? If you're the latter, you are consuming a great deal of bandwidth, and hundreds of millions of people like you might start to slow the Internet down. YouTube consumed as much bandwidth in 2007 as the entire Internet did in 2000. That's one of the arguments being made today for charging Internet users based on the amount of transmission capacity they use.

If user demand for the Internet overwhelms network capacity, the Internet might not come to a screeching halt, but users would be faced with very sluggish download speeds and slow performance of YouTube, Facebook, and other data-heavy services. (Heavy use of iPhones in urban areas such as New York and San Francisco has already degraded service on the AT&T wireless network. AT&T reports that 3 percent of its subscriber base accounts for 40 percent of its data traffic.)

Other researchers believe that as digital traffic on the Internet grows, even at a rate of 50 percent per year, the technology for handling all this traffic is advancing at an equally rapid pace.

In addition to these technical issues, the debate about metering Internet use centers around the concept of network neutrality. Network neutrality is the idea that Internet service providers must allow customers equal access to content and applications, regardless of the source or nature of the content. Presently, the Internet is indeed neutral: all Internet traffic is treated equally on a first-come, first-served basis by Internet backbone owners.

However, telecommunications and cable companies are unhappy with this arrangement. They want to be able to charge differentiated prices based on the amount of bandwidth consumed by content being delivered over the Internet. These companies believe that differentiated pricing is "the fairest way" to finance necessary investments in their network infrastructures.

Internet service providers point to the upsurge in piracy of copyrighted materials over the Internet. Comcast, the second largest Internet service provider in the United States, reported that illegal file sharing of copyrighted material was consuming 50 percent of its network capacity. In 2008, the company slowed down transmission of BitTorrent files, used extensively for piracy and illegal sharing of copyrighted materials, including video. The Federal Communications Commission (FCC) ruled that Comcast had to stop slowing peer-to-peer traffic in the name of network management. Comcast then filed a lawsuit challenging the FCC's authority to enforce network neutrality. In April 2010, a federal appeals court ruled in favor of Comcast that the FCC did not have the authority to regulate how an Internet provider manages its network.

Advocates of net neutrality are pushing Congress to find ways to regulate the industry to prevent network providers from adopting Comcast-like practices. The strange alliance of net neutrality advocates includes MoveOn.org, the Christian Coalition, the American Library Association, every major consumer group, many bloggers and small businesses, and some large Internet companies like Google and Amazon.

Net neutrality advocates argue that the risk of censorship increases when network operators can selectively block or slow access to certain content such as Hulu videos or access to competing low-cost services such as Skype and Vonage. There are already many examples of Internet providers restricting access to sensitive materials (such as Pakistan's government blocking access to anti-Muslim sites and YouTube as a whole in response to content it deemed defamatory to Islam.)

Proponents of net neutrality also argue that a neutral Internet encourages everyone to innovate without permission from the phone and cable companies or other authorities, and this level playing field has spawned countless new businesses. Allowing unrestricted information flow becomes essential to free markets and democracy as commerce and society increasingly move online.

Network owners believe regulation to enforce net neutrality will impede U.S. competitiveness by stifling innovation, discouraging capital expenditures for new networks, and curbing their networks' ability to cope with the exploding demand for Internet and wireless traffic. U.S. Internet service lags behind many other nations in overall speed, cost, and quality of service, adding credibility to this argument.

And with enough options for Internet access, regulation would not be essential for promoting net neutrality. Dissatisfied consumers could simply switch to providers who enforce net neutrality and allow unlimited Internet use.

Since the Comcast ruling was overturned, FCC efforts to support net neutrality have been in a holding pattern as it searches for some means of regulating broadband Internet service within the constraints of current law and current court rulings. One proposal is to reclassify broadband Internet transmission as a telecommunications service so the FCC could apply decades-old regulations for traditional telephone networks.

In August 2010, Verizon and Google issued a policy statement proposing that regulators enforce net neutrality on wired connections, but not on wireless networks, which are becoming the dominant Internet platform. The proposal was an effort to define some sort of middle ground that would safeguard net neutrality while giving carriers the flexibility they needed to manage their networks and generate revenue from them. None of the major players in the net neutrality debate showed support and both sides remain dug in.

Sources: Joe Nocera, "The Struggle for What We Already Have," *The New York Times*, September 4, 2010; Claire Cain Miller, "Web Plan is Dividing Companies," *The New York Times*, August 11, 2010; Wayne Rash, "Net Neutrality Looks Dead in the Clutches of Congress," *eWeek*, June 13 2010; Amy Schatz and Spencer E. Ante, "FCC Web Rules Create Pushback," *The Wall Street Journal*, May 6, 2010; Amy Schatz, "New U.S. Push to Regulate Internet Access," *The Wall Street Journal*, May 5, 2010; and Joanie Wexler: "Net Neutrality: Can We Find Common Ground?" *Network World*, April 1, 2009.

CASE STUDY QUESTIONS

1. What is network neutrality? Why has the Internet operated under net neutrality up to this point in time?
2. Who's in favor of net neutrality? Who's opposed? Why?
3. What would be the impact on individual users, businesses, and government if Internet providers switched to a tiered service model?
4. Are you in favor of legislation enforcing network neutrality? Why or why not?

MIS IN ACTION

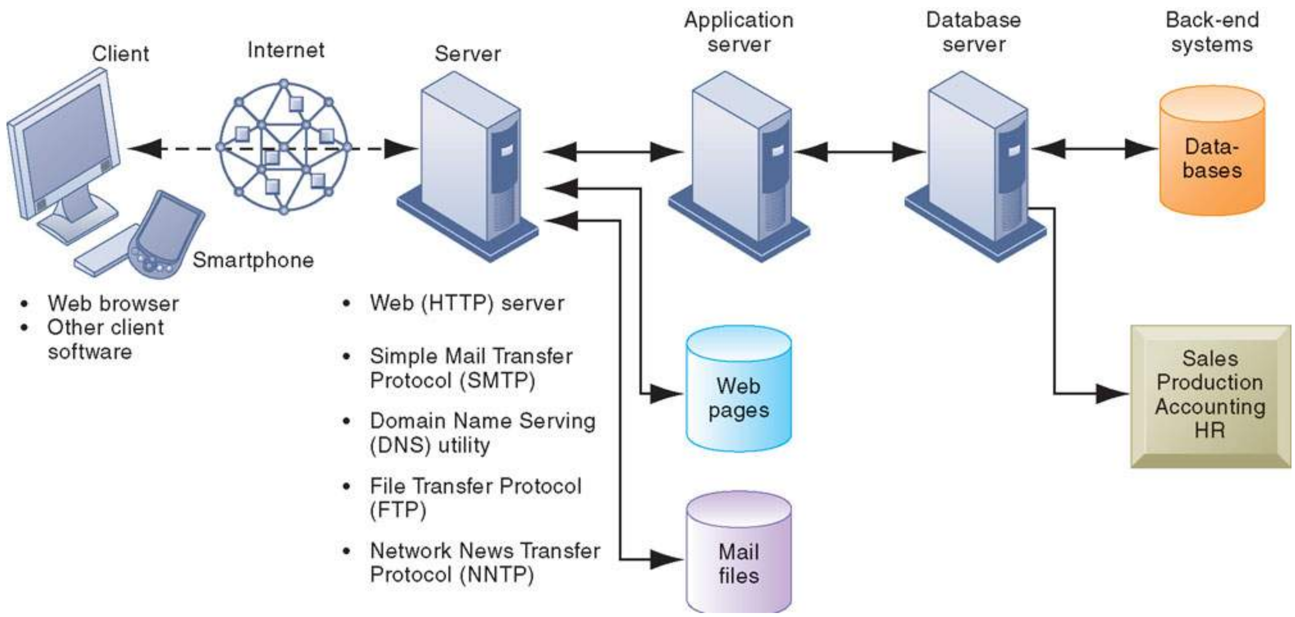
1. Visit the Web site of the Open Internet Coalition and select five member organizations. Then visit the Web site of each of these organizations or surf the Web to find out more information about each. Write a short essay explaining why each organization is in favor of network neutrality.
2. Calculate how much bandwidth you consume when using the Internet every day. How many e-mails do you send daily and what is the size of each? (Your e-mail program may have e-mail file size information.) How many music and video clips do you download daily and what is the size of each? If you view YouTube often, surf the Web to find out the size of a typical YouTube file. Add up the number of e-mail, audio, and video files you transmit or receive on a typical day.

be allocated to different machines. Figure 7-10 illustrates one way that these services can be arranged in a multitiered client/server architecture.

E-mail 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. Although some organizations operate their own internal electronic mail systems, most e-mail today is sent through the Internet. The costs of e-mail is far lower than equivalent voice, postal, or overnight delivery costs, making the Internet a very inexpensive and rapid communications medium. Most e-mail messages arrive anywhere in the world in a matter of seconds.

Nearly 90 percent of U.S. workplaces have employees communicating interactively using **chat** or instant messaging tools. Chatting enables two or

FIGURE 7-10 CLIENT/SERVER COMPUTING ON THE INTERNET



Client computers running Web browser 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.

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 Web sites 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 Talk, and Windows Live Messenger. Companies concerned with security use proprietary instant messaging systems such as Lotus 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. Many thousands of groups exist that discuss almost all conceivable topics.

Employee use of e-mail, instant messaging, and the Internet is supposed to increase worker productivity, but the accompanying Interactive Session on Management shows that 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 why companies may need to monitor their employees' e-mail 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 7-11). Calls that would ordinarily be transmitted over public telephone networks travel over the corporate network based on the Internet Protocol, or 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.

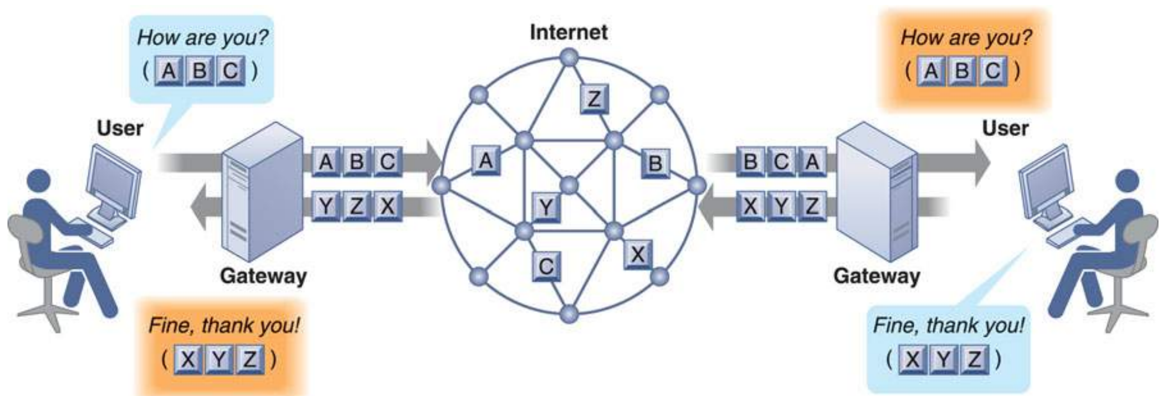
Although there are up-front investments required for an IP phone system, VoIP can reduce communication and network management costs by 20 to 30 percent. For example, VoIP saves Virgin Entertainment Group $700,000 per year in long-distance bills. In addition to lowering long-distance costs and eliminating 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 different type of network.

Another advantage of VoIP is its flexibility. Unlike the traditional telephone network, phones can be added or moved to different offices without rewiring or reconfiguring the network. With VoIP, a conference call is arranged by a simple click-and-drag operation on the computer screen to select the names of the conferees. Voice mail and e-mail can be combined into a single directory.

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 are able to 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, e-mail, and electronic conferencing into a single experience where users can seamlessly switch back and forth between different communication modes. Presence technology shows whether a person is available to receive a call. Companies will need to examine

FIGURE 7-11 **HOW VOICE OVER IP WORKS**



An 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.

INTERACTIVE SESSION: MANAGEMENT

MONITORING EMPLOYEES ON NETWORKS: UNETHICAL OR GOOD BUSINESS?

When you were at work, how many minutes (or hours) did you spend on Facebook today? Did you send personal e-mail or visit some sports Web sites? If so, you're not alone. According to a Nucleus Research study, 77 percent of workers with Facebook accounts use them during work hours. An IDC Research study shows that as much as 40 percent of Internet surfing occurring during work hours is personal, while other studies report as many as 90 percent of employees receive or send personal e-mail at work.

This behavior creates serious business problems. Checking e-mail, responding to instant messages, and sneaking in a brief YouTube video create a series of nonstop interruptions that divert employee attention from the job tasks they are supposed to be performing. According to Basex, a New York City business research company, these distractions take up as much as 28 percent of the average U.S. worker's day and result in $650 billion in lost productivity each year!

Many companies have begun monitoring their employee use of e-mail, blogs, and the Internet, sometimes without their knowledge. A recent American Management Association (AMA) survey of 304 U.S. companies of all sizes found that 66 percent of these companies monitor employee e-mail messages and Web connections. Although U.S. companies have the legal right to monitor employee Internet and e-mail activity while they are at work, is such monitoring unethical, or is it simply good business?

Managers worry about the loss of time and employee productivity when employees are focusing on personal rather than company business. Too much time on personal business, on the Internet or not, can mean lost revenue. Some employees may even be billing time they spend pursuing personal interests online to clients, thus overcharging them.

If personal traffic on company networks is too high, it can also clog the company's network so that legitimate business work cannot be performed. Schemmer Associates, an architecture firm in Omaha, Nebraska, and Potomac Hospital in Woodridge, Virginia, found that computing resources were limited by a lack of bandwidth caused by employees using corporate Internet connections to watch and download video files.

When employees use e-mail or the Web (including social networks) at employer facilities or with employer equipment, anything they do, including anything illegal, carries the company's name. Therefore, the employer can be traced and held liable. Management in many firms fear that racist, sexually explicit, or other potentially offensive material accessed or traded by their employees could result in adverse publicity and even lawsuits for the firm. Even if the company is found not to be liable, responding to lawsuits could cost the company tens of thousands of dollars.

Companies also fear leakage of confidential information and trade secrets through e-mail or blogs. A recent survey conducted by the American Management Association and the ePolicy Institute found that 14 percent of the employees polled admitted they had sent confidential or potentially embarrassing company e-mails to outsiders.

U.S. companies have the legal right to monitor what employees are doing with company equipment during business hours. The question is whether electronic surveillance is an appropriate tool for maintaining an efficient and positive workplace. Some companies try to ban all personal activities on corporate networks—zero tolerance. Others block employee access to specific Web sites or social sites or limit personal time on the Web.

For example, Enterprise Rent-A-Car blocks employee access to certain social sites and monitors the Web for employees' online postings about the company. Ajax Boiler in Santa Ana, California, uses software from SpectorSoft Corporation that records all the Web sites employees visit, time spent at each site, and all e-mails sent. Flushing Financial Corporation installed software that prevents employees from sending e-mail to specified addresses and scans e-mail attachments for sensitive information. Schemmer Associates uses OpenDNS to categorize and filter Web content and block unwanted video.

Some firms have fired employees who have stepped out of bounds. One-third of the companies surveyed in the AMA study had fired workers for misusing the Internet on the job. Among managers who fired employees for Internet misuse, 64 percent did so because the employees' e-mail contained inappropriate or offensive language, and more than 25 percent fired workers for excessive personal use of e-mail.

No solution is problem free, but many consultants believe companies should write corporate policies on employee e-mail and Internet use. The policies should include explicit ground rules that state, by position or level, under what circumstances employees can use company facilities for e-mail, blogging, or Web surfing. The policies should also inform employees whether these activities are monitored and explain why.

IBM now has "social computing guidelines" that cover employee activity on sites such as Facebook and Twitter. The guidelines urge employees not to conceal their identities, to remember that they are personally responsible for what they publish, and to refrain from discussing controversial topics that are not related to their IBM role.

The rules should be tailored to specific business needs and organizational cultures. For example, although some companies may exclude all employees from visiting sites that have explicit sexual material, law firm or hospital employees may require access to these sites. Investment firms will need to allow many of their employees access to other investment sites. A company dependent on widespread information sharing, innovation, and independence could very well find that monitoring creates more problems than it solves.

Sources: Joan Goodchild, "Not Safe for Work: What's Acceptable for Office Computer Use," *CIO Australia*, June 17, 2010; Sarah E. Needleman, "Monitoring the Monitors," *The Wall Street Journal*, August 16, 2010; Michelle Conline and Douglas MacMillan, "Web 2.0: Managing Corporate Reputations," *Business Week*, May 20, 2009; James Wong, "Drafting Trouble-Free Social Media Policies," Law.com, June 15, 2009; and Maggie Jackson, "May We Have Your Attention, Please?" *Business Week*, June 23, 2008.

CASE STUDY QUESTIONS

1. Should managers monitor employee e-mail and Internet usage? Why or why not?
2. Describe an effective e-mail and Web use policy for a company.
3. Should managers inform employees that their Web behavior is being monitored? Or should managers monitor secretly? Why or why not?

MIS IN ACTION

Explore the Web site of online employee monitoring software such as Websense, Barracuda Networks, MessageLabs, or SpectorSoft, and answer the following questions:

1. What employee activities does this software track? What can an employer learn about an employee by using this software?
2. How can businesses benefit from using this software?
3. How would you feel if your employer used this software where you work to monitor what you are doing on the job? Explain your response.

how work flows and business processes will be altered by this technology in order to gauge its value.

CenterPoint Properties, a major Chicago area industrial real estate company, used unified communications technology to create collaborative Web sites for each of its real estate deals. Each Web site provides a single point for accessing structured and unstructured data. Integrated presence technology lets team members e-mail, 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 to be able to e-mail each other and communicate with the home office without any chance that outsiders could intercept the communications. In the past, one answer to this problem was to work with large private networking firms who offered secure, private, dedicated networks to customers. But this was an expensive solution. A much less-expensive solution is to create a virtual private network within the public Internet.

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 7-12). A VPN provides your firm with secure, encrypted communications at a much lower cost than the same capabilities offered by traditional non-Internet providers who 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 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.

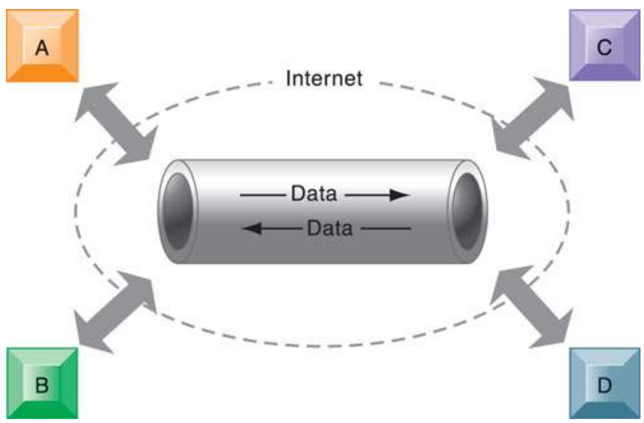
THE WEB

You've probably used the Web to download music, to find information for a term paper, or to obtain news and weather reports. The Web is the most popular Internet service. It's a system with universally accepted standards for storing, retrieving, formatting, and displaying information using a client/server architecture. Web pages are formatted using hypertext with 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 **Web site** 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 pictures stored in the same or remote computers (see Chapter 5). Web

FIGURE 7-12 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 (IP). By adding a wrapper around a network message to hide its content, organizations can create a private connection that travels through the public Internet.

pages are accessible through the Internet because Web browser software operating your computer can request Web pages stored on an Internet host server using the **Hypertext Transfer Protocol (HTTP)**. HTTP is the communications standard used to transfer pages on the Web. For example, when you type a Web address in your browser, such as 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 document. Most companies have a domain name that is the same as or closely related to their official corporate name. The directory path and document 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 used to display 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 document 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 requested by a user 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 most common Web server in use today is Apache HTTP Server, which controls 54 percent of the market. Apache is an open source product that is free of charge and can be downloaded from the Web. Microsoft Internet Information Services is the second most commonly used Web server, with a 25 percent market share.

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 visited about 100 billion pages in 2010, and this reflects a large portion of the publicly accessible Web page population. But there is a "deep Web" that contains an estimated 900 billion additional pages, many of them proprietary (such as the pages of *The Wall Street Journal Online*, which cannot be visited without an access code) or that are stored in protected corporate databases.

Search Engines Obviously, with so many Web pages, finding specific Web pages 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, as well as audio, video, and image files. There are hundreds of different search engines in the world, but the vast majority of search results are supplied by three top providers: Google, Yahoo!, and Microsoft's Bing 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 the user 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 Web sites organized by categories the editors found useful, but it has since developed its own search engine capabilities.

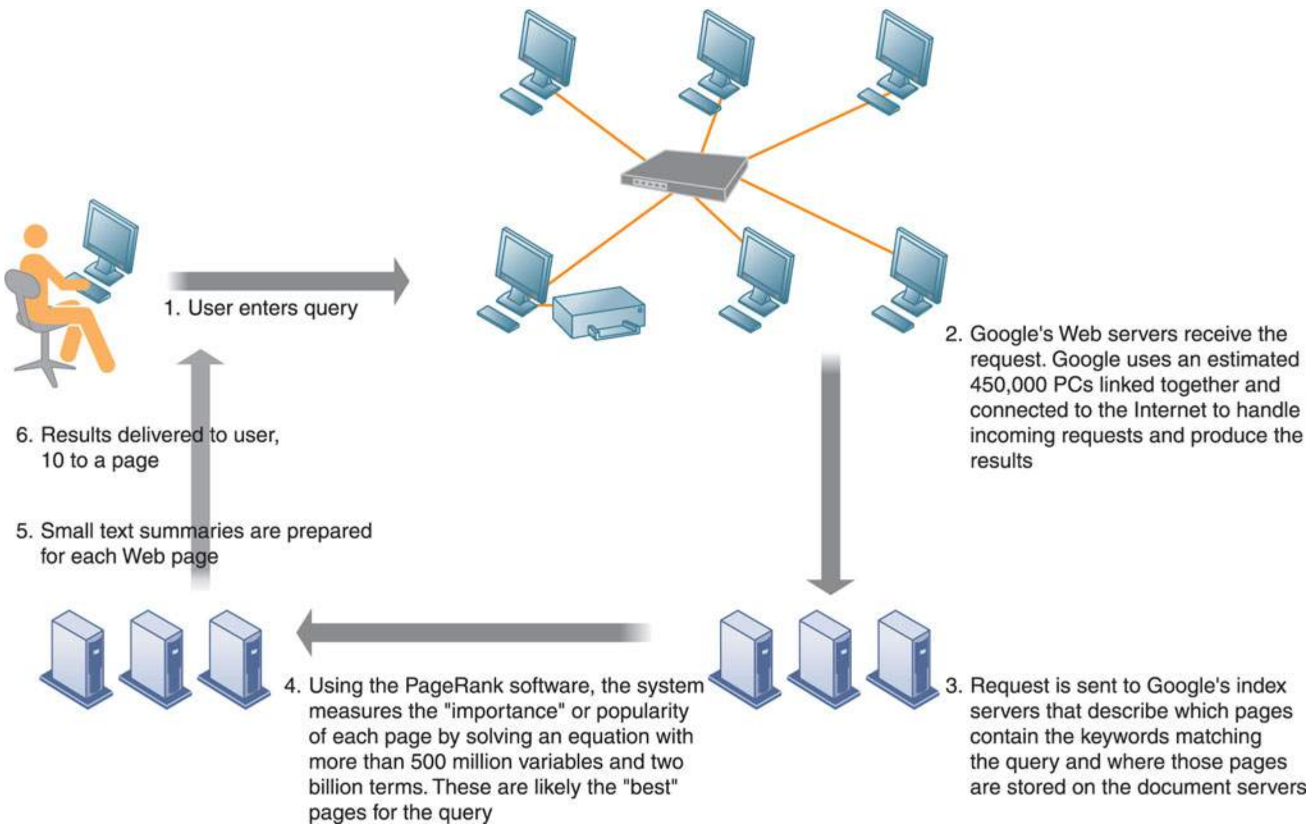
In 1998, Larry Page and Sergey Brin, two other Stanford computer science students, released their first version of Google. This search engine was different: Not only did it index each Web page's words but it also ranked search results based on the relevance of each page. Page patented the idea of a page ranking system (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 which it links to. 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 7-13 illustrates how Google works.

Search engine Web sites are so popular that many people use them as their home page, the page where they start surfing the Web(see Chapter 10). As useful as they are, no one expected search engines to be big money makers. Today, however, search engines are the foundation for the fastest growing form of marketing and advertising, search engine marketing.

Search engines have become major shopping tools by offering what is now called **search engine marketing**. When users enter a search term at 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 2010, search engine marketing generated $12.3 billion in revenue, half of all online advertising ($25.6 billion). Ninety seven percent of Google's annual revenue of $23.6 billion comes from search engine marketing (eMarketer, 2010).

Because search engine marketing is so effective, companies are starting to optimize their Web sites 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 Web site by employing a series of techniques that help a Web site achieve a higher ranking with the major search engines when certain keywords and phrases are put in the search field. One technique is to make sure that the keywords used in the Web site description match the keywords likely to be used as search terms by prospective customers. For example, your Web site is more likely to be among the first ranked by search engines

FIGURE 7-13 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 one-half second.

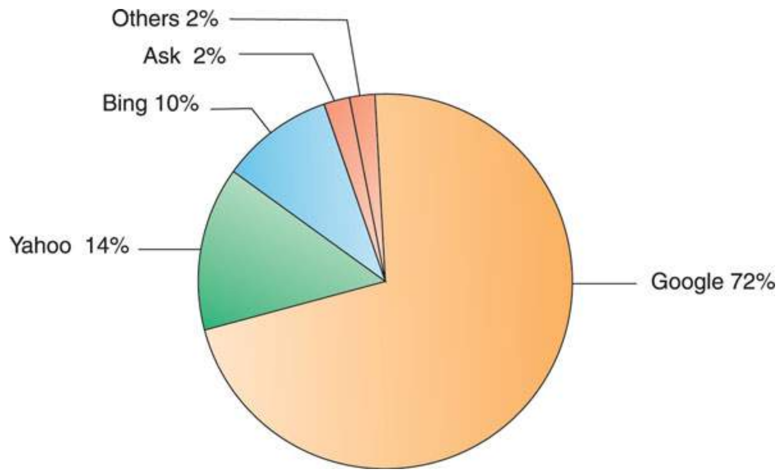
if it uses the keyword "lighting" rather than "lamps" if most prospective customers are searching for "lighting." It is also advantageous to link your Web site to as many other Web sites as possible because search engines evaluate such links to determine the popularity of a Web page and how it is linked to other content on the Web. The assumption is the more links there are to a Web site, the more useful the Web site must be.

In 2010, about 110 million people each day in the United States alone used a search engine, producing over 17 billion searches a month. There are hundreds of search engines, but the top three (Google, Yahoo!, and Bing) account for over 90 percent of all searches (see Figure 7-14).

Although search engines were originally built to search text documents, the explosion in online video and images has created a demand for search engines that can quickly find specific videos. The words "dance," "love," "music," and "girl" are all exceedingly popular in titles of YouTube videos, and searching on these keywords produces a flood of responses even though the actual contents of the video may have nothing to do with the search term. Searching videos is challenging because computers are not very good or quick at recognizing digital images. Some search engines have started indexing movie scripts so it will be possible to search on dialogue to find a movie. Blinkx.com is a popular video search service and Google has added video search capabilities.

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

FIGURE 7-14 TOP U.S. WEB SEARCH ENGINES



Google is the most popular search engine on the Web, handling 72 percent of all Web searches.

Sources: Based on data from SeoConsultants.com, August 28, 2010.

software for searching the Internet for shopping information. Shopping bots such as MySimon or Google Product Search can help people interested in making a purchase filter and retrieve information about products of interest, evaluate competing products according to criteria the users have established, and negotiate with vendors for price and delivery terms. Many of these shopping agents search the Web for pricing and availability of products specified by the user and return a list of sites that sell the item along with pricing information and a purchase link.

Web 2.0

Today's Web sites don't just contain static content—they enable people to collaborate, share information, and create new services and content online. These second-generation interactive Internet-based services are referred to as **Web 2.0**. If you have shared photos over the Internet at Flickr or another photo site, posted a video to YouTube, created a blog, used Wikipedia, or added a widget to your Facebook page, you've used some of these Web 2.0 services.

Web 2.0 has four defining features: 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 widgets, blogs, RSS, wikis, and social networks.

Mashups and widgets, which we introduced in Chapter 5, are software services that enable users and system developers to mix and match content or software components to create something entirely new. For example, Yahoo's photo storage and sharing site Flickr combines photos with other information about the images provided by users and tools to make it usable within other programming environments.

These software applications run on the Web itself instead of the desktop. With Web 2.0, the Web is not just a collection of destination sites, but a source of data and services that can be combined to create applications users need. Web 2.0 tools and services have fueled the creation of social networks and other online communities where people can interact with one another in the manner of their choosing.

A **blog**, the popular term for a Weblog, is a personal Web site 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 other 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 are either hosted by a third-party site such as Blogger.com, LiveJournal.com, TypePad.com, and Xanga.com, or prospective bloggers can download software such as Movable Type to create a blog that is housed by the user's ISP.

Blog pages are usually variations 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 Web sites is often referred to as the **blogosphere**. Although blogs have become popular personal publishing tools, they also have business uses (see Chapters 9 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 Rich Site Summary or Really Simple Syndication, syndicates Web site content so that it can be used in another setting. RSS technology pulls specified content from Web sites and feeds it automatically to users' computers, where it can be stored for later viewing.

To receive an RSS information feed, you need to install aggregator or news reader software that can be downloaded from the Web. (Most current Web browsers include RSS reading capabilities.) Alternatively, you can establish an account with an aggregator Web site. You tell the aggregator to collect all updates from a given Web page, or list of pages, or gather information on a given subject by conducting Web searches at regular intervals. Once subscribed, you automatically receive new content as it is posted to the specified Web site.

A number of businesses use RSS internally to distribute updated corporate information. Wells Fargo uses RSS to deliver news feeds that employees can customize to see the business news of greatest relevance to their jobs. RSS feeds are so popular that online publishers are developing ways to present advertising along with content.

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 Web sites where visitors can add, delete, or modify content on the site, 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. For example, Motorola sales representatives use wikis for sharing sales information. Instead of developing a different pitch for every client, reps reuse the information posted on the wiki. The U.S. Department of Homeland Security's National Cyber Security Center deployed a wiki to facilitate collaboration among federal agencies on cybersecurity. NCSC and other agencies use the wiki for real-time information sharing on threats, attacks, and responses and as a repository for technical and standards information.

Social networking sites enable users to build communities of friends and professional colleagues. Members each typically create a "profile," a Web page for posting photos, videos, MP3 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, MySpace (with 500 million and 180 million global members respectively in 2010), and LinkedIn (for professional contacts).

For many, social networking sites are the defining Web 2.0 application, and one that will radically change 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 morphing into application development platforms where members can create and sell software applications to other members of the community. Facebook alone had over 1 million developers who created over 550,000 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 the text. You can also find a more detailed discussion of Web 2.0 in our Learning Tracks.

Web 3.0: The Future Web

Every day about 110 million Americans enter 500 million queries search engines. How many of these 500 million queries produce a meaningful result (a useful answer in the first three listings)? Arguably, fewer than half. Google, Yahoo, Microsoft, and Amazon are all trying to increase the odds of people finding meaningful answers to search engine queries. But with over 100 billion Web pages indexed, the means available for finding the information you really want are quite primitive, based on the words used on the pages, and the relative popularity of the page among people who use those same search terms. In other words, it's hit and miss.

To a large extent, the future of the Web involves developing techniques to make searching the 100 billion public Web pages more productive and meaningful for ordinary people. Web 1.0 solved the problem of obtaining access to information. Web 2.0 solved the problem of sharing that information with others, and building new Web experiences. **Web 3.0** is the promise of a future Web where all this digital information, all these contacts, can be woven together into a single meaningful experience.

Sometimes this is referred to as the **Semantic Web**. "Semantic" refers to meaning. Most of the Web's content today is designed for humans to read and for computers to display, not for computer programs to analyze and manipulate. Search engines can discover when a particular term or keyword appears in a Web document, but they do not really understand its meaning or how it relates to other information on the Web. You can check this out on Google by entering two searches. First, enter "Paris Hilton". Next, enter "Hilton in Paris". Because Google does not understand ordinary English, it has no idea that you are interested in the Hilton Hotel in Paris in the second search. Because it cannot understand the meaning of pages it has indexed, Google's search engine returns the most popular pages for those queries where "Hilton" and "Paris" appear on the pages.

First described in a 2001 *Scientific American* article, the Semantic Web is a collaborative effort led by the World Wide Web Consortium to add a layer of meaning atop the existing Web to reduce the amount of human involvement in searching for and processing Web information (Berners-Lee et al., 2001).

Views on the future of the Web vary, but they generally focus on ways to make the Web more "intelligent," with machine-facilitated understanding of information promoting a more intuitive and effective user experience. For instance, let's say you want to set up a party with your tennis buddies at a local restaurant Friday night after work. One problem is that you had earlier scheduled to go to a movie with another friend. In a Semantic Web 3.0 environment, you would be able to coordinate this change in plans with the schedules of your tennis buddies, the schedule of your movie friend, and make a reservation at the restaurant all with a single set of commands issued as text or voice to your handheld smartphone. Right now, this capability is beyond our grasp.

Work proceeds slowly on making the Web a more intelligent experience, in large part because it is difficult to make machines, including software programs, that are truly intelligent like humans. But there are other views of the future Web. Some see a 3-D Web where you can walk through pages in a 3-D environment. Others point to the idea of a pervasive Web that controls everything from the lights in your living room, to your car's rear view mirror, not to mention managing your calendar and appointments.

Other complementary trends leading toward a future Web 3.0 include more widespread use of cloud computing and 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. These more modest visions of the future Web 3.0 are more likely to be realized in the near term.

7.4 The Wireless Revolution

If you have a cell phone, do you use it for taking and sending photos, sending text messages, or downloading music clips? Do you take your laptop to class or to the library to link up to the Internet? If so, you're part of the wireless revolution! Cell phones, laptops, and small handheld devices have morphed into portable computing platforms that let you perform some of the computing tasks you used to do at your desk.

Wireless communication helps businesses more easily stay in touch with customers, suppliers, and employees and provides more flexible arrangements for organizing work. Wireless technology has also created new products, services, and sales channels, which we discuss in Chapter 10.

If you require mobile communication and computing power or remote access to corporate systems, you can work with an array of wireless devices, including cell phones, **smartphones**, and wireless-enabled personal computers. We introduced smartphones in our discussions of the mobile digital platform in Chapters 1 and 5. In addition to voice transmission, they feature capabilities for e-mail, messaging, wireless Internet access, digital photography, and personal information management. The features of the iPhone and BlackBerry illustrate the extent to which cellphones have evolved into small mobile computers.

CELLULAR SYSTEMS

Digital cellular service uses several competing standards. In Europe and much of the rest of the world outside the United Sates, the standard is Global System for Mobile Communication (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 Wireless.

The major standard in the United States is Code Division Multiple Access (CDMA), which is the system used by Verizon and Sprint. 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.

Earlier generations of cellular systems were designed primarily for voice and limited data transmission in the form of short text messages. Wireless carriers now offer more powerful cellular networks called third-generation or **3G** networks, with transmission speeds ranging from 144 Kbps for mobile users in, say, a car, to more than 2 Mbps for stationary users. This is sufficient transmission capacity for video, graphics, and other rich media, in addition to voice, making 3G networks suitable for wireless broadband Internet access. Many of the cellular handsets available today are 3G-enabled.

High-speed cellular networks are widely used in Japan, South Korea, Taiwan, Hong Kong, Singapore, and parts of northern Europe. In U.S. locations without full 3G coverage, U.S. cellular carriers have upgraded their networks to support higher-speed transmission, enabling cell phones to be used for Web access, music downloads, and other broadband services. PCs equipped with a special card can use these broadband cellular services for anytime, anywhere wireless Internet access.

The next evolution in wireless communication, called **4G networks**, is entirely packet switched and capable of 100 Mbps transmission speed (which can reach 1 Gbps under optimal conditions), with premium quality and high security. Voice, data, and high-quality streaming video will be available to users anywhere, anytime. Pre-4G technologies currently include Long Term Evolution (LTE) and the mobile WiMax. (See the discussion of WiMax in the following section.) You can find out more about cellular generations in the Learning Tracks for this chapter.

WIRELESS COMPUTER NETWORKS AND INTERNET ACCESS

If you have a laptop computer, you might be able to use it to access the Internet as you move from room to room in your dorm, or table to table in your university library. An array of technologies provide high-speed wireless access to the Internet for PCs and other wireless handheld devices as well as for cell phones. These new high-speed services have extended Internet access to numerous locations that could not be covered by traditional wired Internet services.

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 7-15). 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, cell phones, or PDAs.

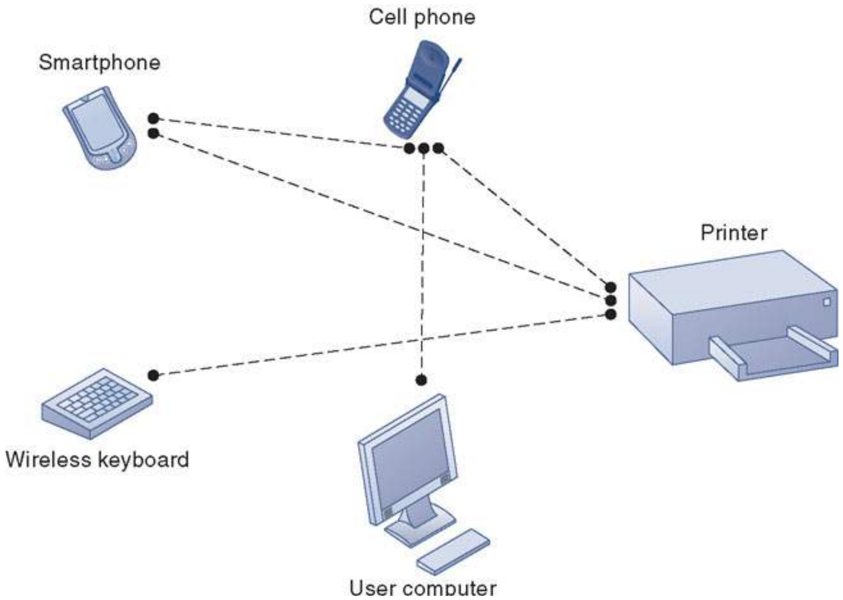
Although Bluetooth lends itself to personal networking, it has uses in large corporations. For example, FedEx drivers use Bluetooth to transmit the delivery data captured by their handheld PowerPad computers to cellular transmitters, which forward the data to corporate computers. Drivers no longer need 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 netbooks have built-in support for Wi-Fi, as do the iPhone, iPad, and other smartphones.

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. Mobile access points such as Virgin Mobile's MiFi use the existing cellular network to create Wi-Fi connections.

FIGURE 7-15 **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.

Figure 7-16 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. (A bridge connects two LANs based on different technologies.) The access point also controls the wireless stations.

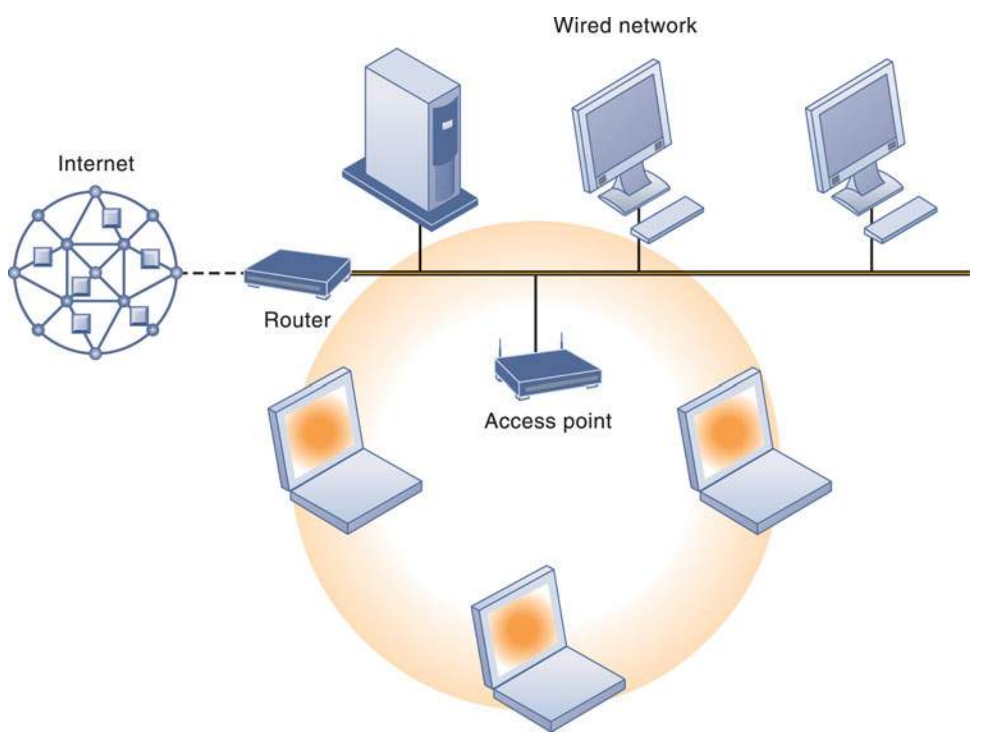
The most popular use for Wi-Fi today is for high-speed wireless Internet service. In this instance, the access point plugs into an Internet connection, which could come from a cable TV line or DSL telephone service. Computers within range of the access point use it to link wirelessly to the Internet.

Hotspots typically consist of one or more access points providing wireless Internet access in a public place. 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.

FIGURE 7-16 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 into 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.

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. However, wireless networks based on the 802.11n standard are able to 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 IEEE developed a new 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 up to 75 Mbps.

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 pre-4G network technologies we discussed earlier in this chapter. Clearwire, which is owned by Sprint-Nextel, is using WiMax technology as the foundation for the 4G networks it is deploying throughout the United States.

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)

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. Embedded in the tag is a microchip for storing the data. The rest of the tag is an antenna that transmits data to the reader.

The reader unit consists of an antenna and radio transmitter with a decoding capability attached to a stationary or handheld device. The reader emits radio waves in ranges anywhere from 1 inch to 100 feet, depending on its power output, the radio frequency employed, and surrounding environmental conditions. When an RFID tag comes within the range of the reader, the tag is activated and starts sending data. The reader captures these data, decodes them, and sends them back over a wired or wireless network to a host computer for further processing (see Figure 7-17). Both RFID tags and antennas come in a variety of shapes and sizes.

Active RFID tags are powered by an internal battery and typically enable data to be rewritten and modified. Active tags can transmit for hundreds of feet but may cost several dollars per tag. Automated toll-collection systems such as New York's E-ZPass use active RFID tags.

Passive RFID tags do not have their own power source and obtain their operating power from the radio frequency energy transmitted by the RFID reader. They are smaller, lighter, and less expensive than active tags, but only have a range of several feet.

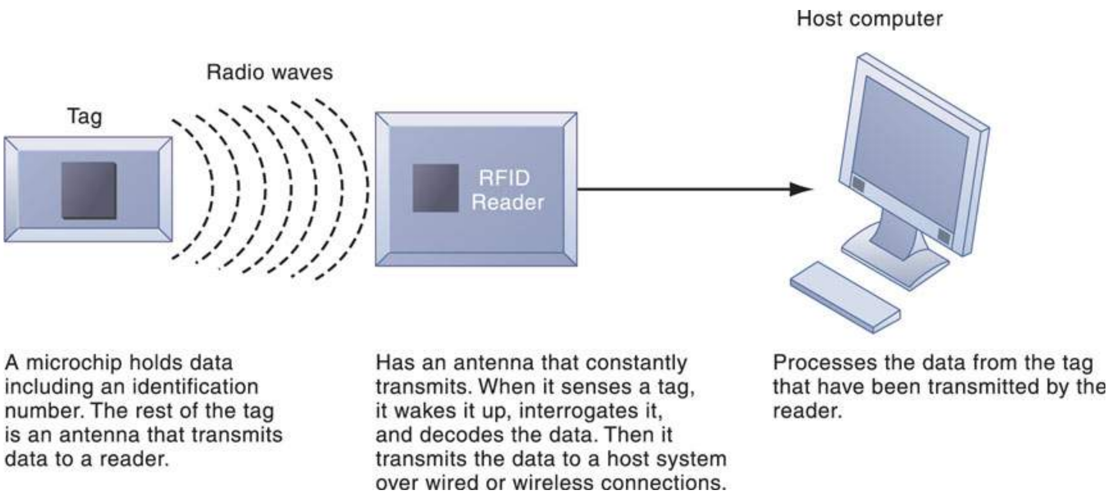
In inventory control and supply chain management, RFID systems capture and manage more detailed information about items in warehouses or in production than bar coding systems. If a large number of items are shipped together, RFID systems track each pallet, lot, or even unit item in the shipment. This 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 is less than 10 cents per passive tag in the United States. As the price decreases, RFID is starting to become cost-effective for some 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.

FIGURE 7-17 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.

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, including SAP and Oracle-PeopleSoft, now offer RFID-ready versions of their supply chain management applications.

Wireless Sensor Networks

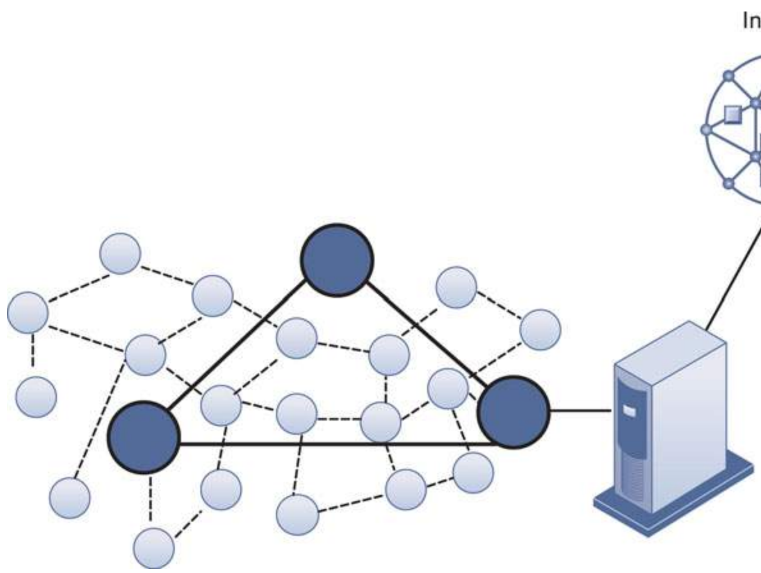
If your company wanted state-of-the art technology to monitor building security or detect hazardous substances in the air, it might deploy a wireless sensor network. **Wireless sensor networks (WSNs)** are networks of interconnected wireless devices that are embedded into the physical environment to 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. Because wireless sensor devices are placed in the field for years at a time without any maintenance or human intervention, they must have very low power requirements and batteries capable of lasting for years.

Figure 7-18 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 in areas 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.

FIGURE 7-18 A WIRELESS SENSOR NETWORK



The small circles represent lower-level nodes and the larger circles represent high-end nodes. Lower-level nodes forward data to each other or to higher-level nodes, which transmit data more rapidly and speed up network performance.

7.5 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.

Management Decision Problems

1. Your company supplies ceramic floor tiles to Home Depot, Lowe's, and other home improvement stores. You have been asked to start using radio frequency identification tags on each case of tiles you ship to help your customers improve the management of your products and those of other suppliers in their warehouses. Use the Web to identify the cost of hardware, software, and networking components for an RFID system for your company. What factors should be considered? What are the key decisions that have to be made in determining whether your firm should adopt this technology?
2. BestMed Medical Supplies Corporation sells medical and surgical products and equipment from over 700 different manufacturers to hospitals, health clinics, and medical offices. The company employs 500 people at seven different locations in western and midwestern states, including account managers, customer service and support representatives, and warehouse staff. Employees communicate via traditional telephone voice services, e-mail, 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 have to 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

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, and taking and sending photos. Use the Web to select a wireless service provider that provides nationwide service as well as good service in your home area. Examine the features of the mobile handsets offered by each of these vendors. Assume that each of the 35 salespeople will need to spend three hours per day during business hours (8 a.m. to 6 p.m.) on mobile voice communication, send 30 text messages per day, and five photos per week. 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 the 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

This project will help develop your Internet skills in using Web search engines for business research.

You want to learn more about ethanol as an alternative fuel for motor vehicles. Use the following search engines to obtain that information: Yahoo!, Google, and Bing. 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?

Learning Track Modules

The following Learning Tracks provide content relevant to topics covered in this chapter:

1. Computing and Communications Services Provided by Commercial Communications Vendors
2. Broadband Network Services and Technologies
3. Cellular System Generations
4. WAP and I-Mode: Wireless Cellular Standards for Web Access
5. Wireless Applications for Customer Relationship Management, Supply Chain Management, and Health care
6. Web 2.0

Review Summary

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 Web site, 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.

2. ***What are the main telecommunications transmission media and types of networks?***

The principal physical transmission media are twisted copper telephone wire, coaxial copper cable, fiber-optic cable, and wireless transmission. Twisted wire enables companies to use existing wiring for telephone systems for digital communication, although it is relatively slow. Fiber-optic and coaxial cable are used for high-volume transmission but are expensive to install. Microwave and communications satellites are used for wireless communication over long distances.

local area networks (LANs) connect PCs and other digital devices together within a 500-meter radius and are used today for many corporate computing tasks. Network components may be connected together using a star, bus, or ring topology. Wide area networks (WANs) span broad geographical distances, ranging from several miles to continents, and are 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.

Cable Internet connections provide high-speed access to the Web or corporate intranets at speeds of up to 10 Mbps. A T1 line supports a data transmission rate of 1.544 Mbps.

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 e-mail, newgroups, 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. Web site directories, search engines, and RSS technology help users locate the information they need on the Web. RSS, blogs, social networking, and wikis are features of Web 2.0.

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

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. Broadband 3G networks are capable of transmitting data at speeds ranging from 144 Kbps to more than 2 Mbps. 4G networks capable of transmission speeds that could reach 1 Gbps 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).

5. *Why are radio frequency identification (RFID) and wireless sensor networks valuable for business?*
   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 into the physical environment to provide measurements of many points over large spaces.

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Wireless sensor networks (WSNs), 281

Review Questions

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.
2. What are the main telecommunications transmission media and types of networks?
   - Name the different types of physical transmission media and compare them in terms of speed and cost.
   - Define a LAN, and describe its components and the functions of each component.
   - Name and describe the principal network topologies.
3. How do the Internet and Internet technology work, and how do they support communication and e-business?
   - Define the Internet, describe how it works, and explain how it provides business value.
   - Explain how the Domain Name System (DNS) and IP addressing system work.
   - List and describe the principal Internet services.
   - Define and describe VoIP and virtual private networks, and explain how they provide value to businesses.
   - List and describe alternative ways of locating information on the Web.
   - Compare Web 2.0 and Web 3.0.
4. What are the principal technologies and standards for wireless networking, communications, and Internet access?
   - Define Bluetooth, Wi-Fi, WiMax, 3G and 4G networks.
   - Describe the capabilities of each and for which types of applications each is best suited.
5. Why are RFID and wireless sensor networks (WSNs) valuable for business?
   - 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.

Discussion Questions

1. 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.
2. Should all major retailing and manufacturing companies switch to RFID? Why or why not?
3. Compare Wi-Fi and high-speed cellular systems for accessing the Internet. What are the advantages and disadvantages of each?

Video Cases

Video Cases and Instructional Videos illustrating some of the concepts in this chapter are available. Contact your instructor to access these videos.

Collaboration and Teamwork: Evaluating Smartphones

Form a group with three or four of your classmates. Compare the capabilities of Apple's iPhone with a smartphone handset from another vendor with similar features. Your analysis should consider the purchase cost of each device, the wireless networks where each device can operate, service plan and handset costs, and the services available for each device.

You should also consider other capabilities of each device, including the ability to integrate with existing corporate or PC applications. Which device would you select? What criteria would you use to guide your selection? If possible, use Google Sites to post links to Web pages, team communication announcements, and work assignments; to brainstorm; and to work collaboratively on project documents. Try to use Google Docs to develop a -presentation of your findings for the class.

Google, Apple, and Microsoft Struggle for Your Internet Experience
CASE STUDY

In what looks like a college food fight, the three Internet titans—Google, Microsoft, and Apple—are in an epic struggle to dominate your Internet experience. What's at stake is where you search, buy, find your music and videos, and what device you will use to do all these things. The prize is a projected 2015 $400 billion e-commerce marketplace where the major access device will be a mobile smartphone or tablet computer. Each firm generates extraordinary amounts of cash based on different business models. Each firm brings billions of dollars of spare cash to the fight.

In this triangular fight, at one point or another, each firm has befriended one of the other firms to combat the other firm. Two of the firms—Google and Apple—are determined to prevent Microsoft from expanding its dominance beyond the PC desktop. So Google and Apple are friends. But when it comes to mobile phones and apps, Goggle and Apple are enemies: each want to dominate the mobile market. Apple and Microsoft are determined to prevent Google from extending beyond its dominance in search and advertising. So Apple and Microsoft are friends. But when it comes to the mobile marketplace for devices and apps, Apple and Microsoft are enemies. Google and Microsoft are just plain enemies in a variety of battles. Google is trying to weaken Microsoft's PC software dominance, and Microsoft is trying to break into the search advertising market with Bing.

Today the Internet, along with hardware devices and software applications, is going through a major expansion. Mobile devices with advanced functionality and ubiquitous Internet access are rapidly gaining on traditional desktop computing as the most popular form of computing, changing the basis for competition throughout the industry. Research firm Gartner predicts that by 2013, mobile phones will surpass PCs as the way most people access the Internet. Today, mobile devices account for 5 percent of all searches performed on the Internet; in 2016, they are expected to account for 23.5% of searches.

These mobile Internet devices are made possible by a growing cloud of computing capacity available to anyone with a smartphone and Internet connectivity. Who needs a desktop PC anymore when you can listen to music and watch videos 24/7? It's no surprise, then, that today's tech titans are so aggressively battling for control of this brave new mobile world.

Apple, Google, and Microsoft already compete in an assortment of fields. Google has a huge edge in advertising, thanks to its dominance in Internet search. Microsoft's offering, Bing, has grown to about 10 percent of the search market, and the rest essentially belongs to Google. Apple is the leader in mobile software applications, thanks to the popularity of the App Store for its iPhones. Google and Microsoft have less popular app offerings on the Web.

Microsoft is still the leader in PC operating systems and desktop productivity software, but has failed miserably with smartphone hardware and software, mobile computing, cloud-based software apps, its Internet portal, and even its game machines and software. All contribute less than 5 percent to Microsoft's revenue (the rest comes from Windows, Office, and network software). While Windows is still the operating system on 95 percent of the world's 2 billion PCs, Google's Android OS and Apple's iOS are the dominant players in the mobile computing market. The companies also compete in music, Internet browsers, online video, and social networking.

For both Apple and Google, the most critical battleground is mobile computing. Apple has several advantages that will serve it well in the battle for mobile supremacy. It's no coincidence that since the Internet exploded in size and popularity, so too did the company's revenue, which totaled well over $40 billion in 2009. The iMac, iPod, and iPhone have all contributed to the company's enormous success in the Internet era, and the company hopes that the iPad will follow the trend of profitability set by these products. Apple has a loyal user base that has steadily grown and is very likely to buy future product offerings. Apple is hopeful that the iPad will be as successful as the iPhone, which already accounts for over 30 percentof Apple's revenue. So far, the iPad appears to be living up to this expectation.

Part of the reason for the popularity of the Apple iPhone, and for the optimism surrounding Internet-equipped smartphones in general, has been the success of the App Store. A vibrant selection of applications (apps) distinguishes Apple's offerings from its competitors', and gives the company a measurable head start in this marketplace. Apple already offers over 250,000 apps for its devices, and Apple takes a 30% cut of all app sales. Apps greatly enrich the experience of using a mobile device, and without them, the predictions for the future of mobile Internet would not be nearly as bright. Whoever creates the most appealing set of devices and applications will derive a significant competitive advantage over rival companies. Right now, that company is Apple.

But the development of smartphones and mobile Internet is still in its infancy. Google has acted swiftly to enter the battle for mobile supremacy while it can still 'win', irreparably damaging its relationship with Apple, its former ally, in the process. As more people switch to mobile computing as their primary method for accessing the Internet, Google is aggressively following the eyeballs. Google is as strong as the size of its advertising network. With the impending shift towards mobile computing looming, it's no certainty that it will be able to maintain its dominant position in search. That's why the dominant online search company began developing a mobile operating system and its Nexus One entry into the smartphone marketplace. Google hopes to control its own destiny in an increasingly mobile world.

Google's efforts to take on Apple began when it acquired Android, Inc., the developer of the mobile operating system of the same name. Google's original goal was to counter Microsoft's attempts to enter the mobile device market, but Microsoft was largely unsuccessful. Instead, Apple and Research In Motion, makers of the popular BlackBerry series of smartphones, filled the void. Google continued to develop Android, adding features that Apple's offerings lacked, such as the ability to run multiple apps at once. After an initial series of blocky, unappealing prototypes, there are now Android-equipped phones that are functionally and aesthetically competitive with the iPhone. For example, the Motorola Droid was heavily advertised, using the slogan "Everything iDon't...Droid Does."

Google has been particularly aggressive with its entry into the mobile computing market because it is concerned about Apple's preference for 'closed', proprietary standards on its phones. It would like smartphones to have open nonproprietary platforms where users can freely roam the Web and pull in apps that work on many different devices.

Apple believes devices such as smartphones and tablets should have proprietary standards and be tightly controlled, with customers using applications on these devices that have been downloaded from the its App Store. Thus Apple retains the final say over whether or not its mobile users can access various services on the Web, and that includes services provided by Google. Google doesn't want Apple to be able to block it from providing its services on iPhones, or any other smartphone. A high- profile example of Apple's desire to fend off Google occurred after Google attempted to place its voice mail management program, Google Voice, onto the iPhone. Apple cited privacy concerns in preventing Google's effort.

Soon after, Google CEO Eric Schmidt stepped down from his post on Apple's board of directors. Since Schmidt's departure from Apple's board, the two companies have been in an all-out war. They've battled over high-profile acquisitions, including mobile advertising firm AdMob, which was highly sought after by both companies. AdMob sells banner ads that appear inside mobile applications, and the company is on the cutting edge of developing new methods of mobile advertising. Apple was close to a deal with the start-up when Google swooped in and bought AdMob for $750 million in stock. Google doesn't expect to earn anything close to that in returns from the deal, but it was willing to pay a premium to disrupt Apple's mobile advertising effort.

Undeterred, Apple bought top competitor Quattro Wireless for $275 million in January 2010. It then shuttered the service in September of that year in favor of its own iAd advertising platform. IAd allows developers of the programs in Apple's App Store for the iPhone, iPad, and iPod Touch to embed ads in their software. Apple will sell the ads and give the app developers 60 percent of the ad revenue.

Apple has been more than willing to use similarly combative tactics to slow its competition down. Apple sued HTC, the Taiwanese mobile phone manufacturer of Android-equipped phones, citing patent infringement. Apple CEO Steve Jobs has consistently bashed Google in the press, characterizing the company as a bully and questioning its ethics. Many analysts speculate that Apple may take a shot at Google by teaming up with a partner that would have been unthinkable just a few years ago: Microsoft. News reports suggest that Apple is considering striking a deal with Microsoft to make Bing its default search engine on both the iPhone and Apple's Web browser. This would be a blow to Google, and a boon to Microsoft, which would receive a much needed boost to its fledgling search service.

The struggle between Apple and Google wouldn't matter much if there wasn't so much potential money at stake. Billions of dollars hang in the balance, and the majority of that money will come from advertising. App sales are another important component, especially for Apple. Apple has the edge in selection and quality of apps, but while sales have been brisk, developers have complained that making money is too difficult. A quarter of the 250,000 apps available in early 2010 were free, which makes no money for developers or for Apple but it does bring consumers to the Apple marketplace where they can be sold other apps or entertainment services.

Google in the meantime is moving aggressively to support manufacturers of handsets that run its Android operating system and can access its services online. Apple relies on sales of its devices to remain profitable. It has had no problems with this so far, but Google only needs to spread its advertising networks onto these devices to make a profit. In fact, some analysts speculate that Google envisions a future where mobile phones cost a fraction of what they do today, or are even free, requiring only the advertising revenue generated by the devices to turn a profit. Apple would struggle to remain competitive in this environment. Jobs has kept the Apple garden closed for a simple reason: you need an Apple device to play there.

The three-way struggle between Microsoft, Apple, and Google really has no precedent in the history of computing platforms. In early contests it was typically a single firm that rode the crest of a new technology to become the dominant player. Examples include IBM's dominance of the mainframe market, Digital Euipment's dominance of minicomputers, Microsoft's dominance of PC operating systems and productivity applications, and Cisco Systems' dominance of the Internet router market. In the current struggle are three firms trying to dominate the customer experience on the Internet. Each firm brings certain strengths and weaknesses to the fray. Will a single firm "win," or will all three survive the contest for the consumer Internet experience? It's still too early to tell.

Sources: Jennifer LeClaire, "Quattro Wireless to be Closed as Apple Focuses on IAd," *Top Tech News*, August 20, 2010; Yukari Iwatani Kane and Emily Steel, "Apple Fights Rival Google on New Turf," *The Wall Street Journal*, April 8, 2010; Brad Stone and Miguel Helft, "Apple's Spat with Google Is Getting Personal," *The New York Times*, March 12, 2010; Peter Burrows, "Apple vs. Google," *BusinessWeek*, January 14, 2010; Holman W. Jenkins, Jr., "The Microsofting of Apple?", *The Wall Street Journal*, February 10, 2010; Jessica E. Vascellaro and Ethan Smith, "Google and Microsoft Crank Up Rivalry," *The Wall Street Journal*, October 21, 2009; Jessica E. Vascellaro and Don Clark, "Google Targets Microsoft's Turf," *The Wall Street Journal*, July 9, 2009; Miguel Helft, "Google Set to Acquire AdMob for $750 Million," *The New York Times*, November 10, 2009; Jessica E. Vascellaro, "Google Rolls Out New Tools as it Battles Rival," *The Wall Street Journal*, December 8, 2009; and Jessica E. Vascellaro and Yukari Iwatani Kane, "Apple, Google Rivalry Heats Up," *The Wall Street Journal*, December 10, 2009.

CASE STUDY QUESTIONS

1. Compare the business models and areas of strength of Apple, Google, and Microsoft.
2. Why is mobile computing so important to these three firms? Evaluate the mobile platform offerings of each firm.
3. What is the significance of applications and app stores to the success or failure of mobile computing?
4. Which company and business model do you think will prevail in this epic struggle? Explain your answer.
5. What difference would it make to you as a manager or individual consumer if Apple, Google, or Microsoft dominated the Internet experience? Explain your answer.