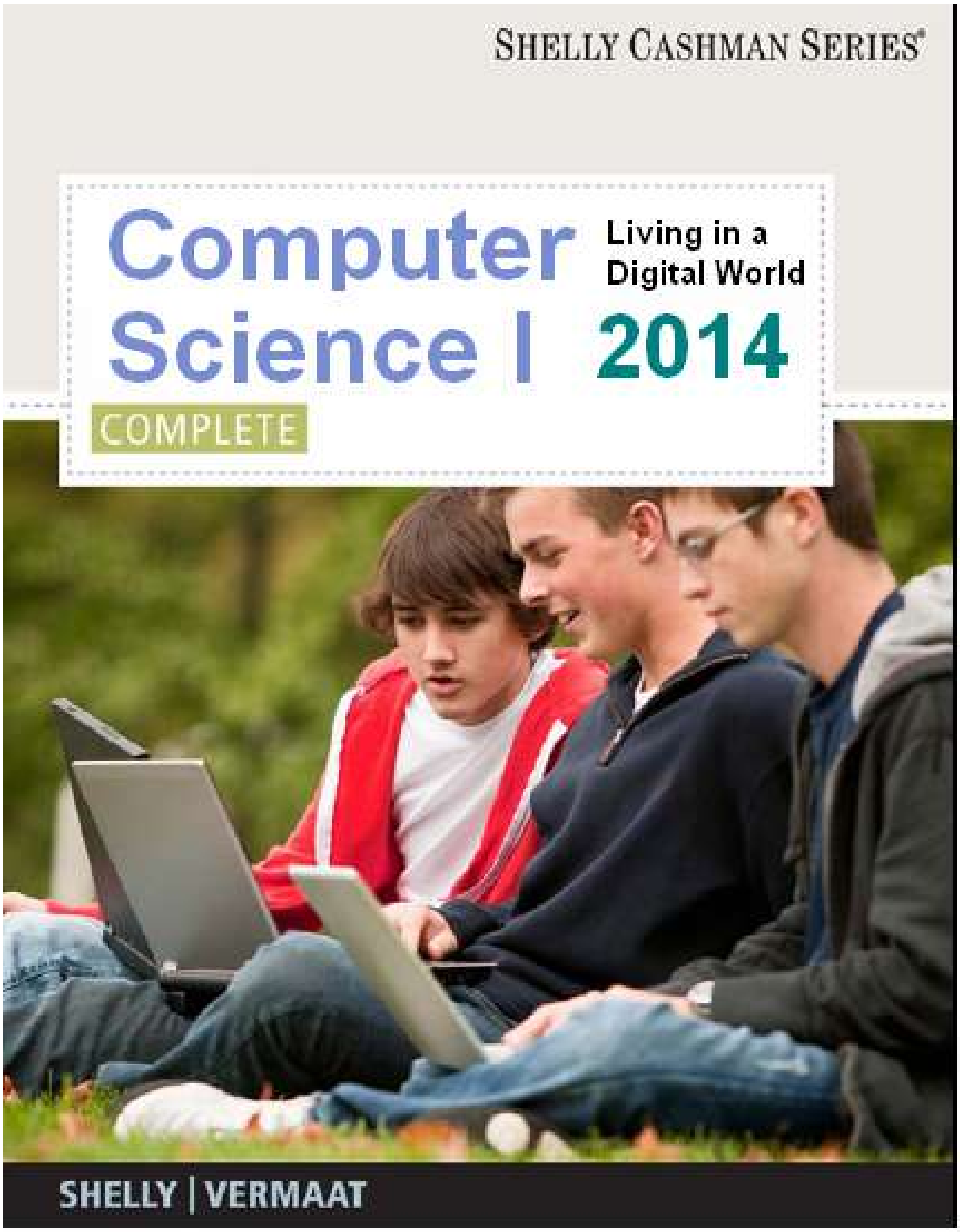

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Chapter One

Introduction to Computers

A World of Computers

Computers are everywhere: at work, at school, and at home. As shown in Figure 1-1, people use all types and sizes of computers for a variety of reasons and in a range of places. While some computers sit on top of a desk or on the floor, mobile computers and mobile devices are small enough to carry. Mobile devices, such as many cell phones, often are classified as computers.

Computers are a primary means of local and global communication for billions of people. Consumers use computers to correspond with businesses, employees with other employees and customers, students with classmates and teachers, and family members and military personnel with friends and other family members. In addition to sending simple notes, people use computers to share photos, drawings, documents, calendars, journals, music, and videos.

Through computers, society has instant access to information from around the globe. Local and national news, weather reports, sports scores, airline schedules, telephone directories, maps and directions, job listings, credit reports, and countless forms of educational material always are accessible. From the computer, you can make a telephone call, meet new friends, share opinions or life stories, book flights, shop, fill prescriptions, file taxes, take a course, receive alerts, and automate your home.

At home or while on the road, people use computers to manage schedules and contacts, listen to voice mail messages, balance checkbooks, pay bills, transfer funds, and buy or sell stocks. Banks place ATMs (automated teller machines) all over the world, so that customers can deposit.

What Is a Computer?

A **computer** is an electronic device, operating under the control of instructions stored in its own memory, that can accept data, process the data according to specified rules, produce results, and store the results for future use.

Data and Information

Computers process data into information. **Data** is a collection of unprocessed items, which an include text, numbers, images, audio, and video. **Information** conveys meaning and is useful to people. Many daily activities either involve the use of or depend on information from a computer. As shown in Figure 1-2, for example, computers process several data items to print information in the form of a cash register receipt.

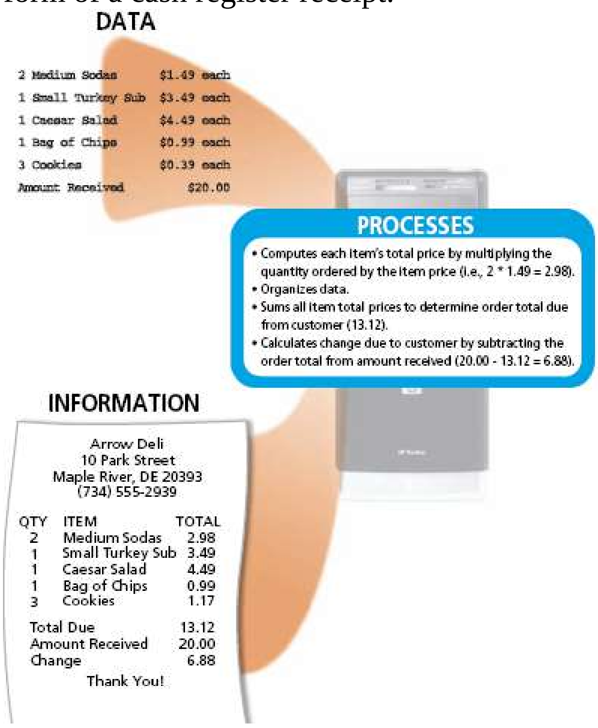

Figure 1-2 A computer processes data into information. In this simplified example, the item ordered, item price, quantity ordered, and amount received all represent data. The computer processes the data to produce the cash register receipt (information).

Information Processing Cycle

Computers process data (input) into information (output). Computers carry out processes using *instructions*, which are the steps that tell the computer how to perform a particular task. A collection of related instructions organized for a common purpose is referred to as software. A computer often holds data, information, and instructions in storage for future use. Some people refer to the series of input, process, output, and storage activities as the *information processing cycle*.

Most computers today communicate with other computers. As a result, communications also has become an essential element of the information processing cycle.

The Components of a Computer

A computer contains many electric, electronic, and mechanical components known as **hardware**. These components include input devices, output devices, a system unit, storage devices, and communications devices. Figure 1-3 shows some common computer hardware components.

Input Devices

An **input device** is any hardware component that allows you to enter data and instructions into a computer. Five widely used input devices are the keyboard, mouse, microphone, scanner, and Web cam (Figure 1-3).

A computer keyboard contains keys you press to enter data into the computer. For security purposes, some keyboards include a fingerprint reader, which allows you to work with the computer only if your fingerprint is recognized.

A mouse is a small handheld device. With the mouse, you control movement of a small symbol on the screen, called the pointer, and you make selections from the screen.

A microphone allows you to speak into the computer. A scanner convert's printed material (such as text and pictures) into a form the computer can use.

A Web cam is a digital video camera that allows you to create movies or take pictures and store them on the computer instead of on tape or film.

Output Devices

An **output device** is any hardware component that conveys information to one or more people. Three commonly used output devices are a printer, a monitor, and speakers (Figure 1-3).

A printer produces text and graphics on a physical medium such as paper. A monitor displays text, graphics, and videos on a screen. Speakers allow you to hear music, voice, and other audio (sounds).

System Unit

The **system unit** is a case that contains the electronic components of the computer that are used to process data (Figure 1-3). The circuitry of the system unit usually is part of or is connected to a circuit board called the motherboard.

Two main components on the motherboard are the processor and memory. The *processor*, also called a *CPU* (*central processing unit*), is the electronic component that interprets and carries out the basic instructions that operate the computer. *Memory* consists of electronic components that store instructions waiting to be executed and data needed by those instructions.

Although some forms of memory are permanent, most memory keeps data and instructions temporarily, which means its contents are erased when the computer is shut off.

Figure 1-3 Common computer hardware components include a keyboard, mouse, microphone, scanner, Web cam, printer, monitor, speakers, system unit, hard disk drive, external hard disk, optical disc drive(s), USB flash drive, card reader/writer, memory cards, and modem.

Storage Devices

Storage holds data, instructions, and information for future use. For example, computers can store hundreds or millions of customer names and addresses. Storage holds these items permanently.

A computer keeps data, instructions, and information on **storage media.** Examples of storage media are USB flash drives, hard disks, optical discs, and memory cards. A **storage device** records (writes) and/or retrieves (reads) items to and from storage media. Drives and readers/writers, which are types of storage devices (Figure 1-3 on the previous page), accept a specific kind of storage media. For example, a DVD drive (storage device) accepts a DVD (storage media). Storage devices often function as a source of input because they transfer items from storage to memory.

A USB flash drive is a portable storage device that is small and lightweight enough to be transported on a keychain or in a pocket (Figure 1-3). The average USB flash drive can hold about 4 billion characters. You plug a USB flash drive in a special, easily accessible opening on the computer.
A hard disk provides much greater storage capacity than a USB flash drive. The average hard disk can hold more than 320 billion characters. Hard disks are enclosed in an airtight, sealed case. Although some are portable, most are housed inside the system unit (Figure 1-4). Portable hard disks are either external or removable. An external hard disk is a separate,

Figure 1-4 Hard disks are self-contained devices. The hard disk shown here must be installed in the system unit before it can be used.

freestanding unit, whereas you insert and remove a removable hard disk from the computer or a device connected to the computer. An optical disc is a flat, round, portable metal disc with a plastic coating. CDs, DVDs, and Blu-ray Discs are three types of optical discs. A CD can hold from 650 mil lion to 1 billion characters. Some DVDs can store two full-length movies or 17 billion characters (Figure 1-5). Blu-ray Discs can store about 46 hours of standard video, or 100 billion characters.
Some mobile devices, such as digital cameras, use memory cards as the storage media. You can use a card reader/writer (Figure 1-3) to transfer the stored items, such as digital photos, from the memory card to a computer or printer.

Figure 1-5 A DVD in a DVD drive.

Communications Devices
A **communications device** is a hardware component that enables a computer to send (transmit) and receive data, instructions, and information to and from one or more computers or mobile devices. A widely used communications device is a modem (Figure 1-3). Communications occur over cables, telephone lines, cellular radio networks, satellites, and other transmission media. Some transmission media, such as satellites and cellular radio networks, are wireless, which means they have no physical lines or wires.

Advantages and Disadvantages of Using Computers

Society has reaped many benefits from using computers. A **user** is anyone who communicates with a computer or utilizes the information it generates. Both business and home users can make well-informed decisions because they have instant access to information from anywhere in the world. Students, another type of user, have more tools to assist them in the learning process.

Advantages of Using Computers

Benefits from using computers are possible because computers have the advantages of speed, reliability, consistency, storage, and communications.

- **Speed:** When data, instructions, and information flow along electronic circuits in a computer, they travel at incredibly fast speeds. Many computers process billions or trillions of operations in a single second. Processing involves computing (e.g., adding, subtracting), sorting (e.g., alphabetizing), organizing, displaying images, recording audio, playing music, and showing a movie or video.
- **Reliability:** The electronic components in modern computers are dependable and reliable because they rarely break or fail.
- **Consistency:** Given the same input and processes, a computer will produce the same results — consistently. A computing phrase — known as *garbage in, garbage out* — points out that the accuracy of a computer's output depends on the accuracy of the input. For example, if you do not use the flash on a digital camera when indoors, the resulting pictures that are displayed on the computer screen may be unusable because they are too dark.
- **Storage:** A computer can transfer data quickly from storage to memory, process it, and then store it again for future use. Many computers store enormous amounts of data and make this data available for processing anytime it is needed.
- **Communications:** Most computers today can communicate with other computers, often wirelessly. Computers with this capability can share any of the four information processing cycle operations — input, process, output, and storage — with another computer or a user.

Disadvantages of Using Computers

Some disadvantages of computers relate to health risks, the violation of privacy, public safety, the impact on the labor force, and the impact on the environment.

- **Health Risks:** Prolonged or improper computer use can lead to injuries or disorders of the hands, wrists, elbows, eyes, neck, and back. Computer users can protect themselves from these health risks through proper workplace design, good posture while at the computer, and appropriately spaced work breaks. Two behavioral health risks are computer addiction and technology overload. Computer addiction occurs when someone becomes obsessed with using a computer. Individuals suffering from technology overload feel distressed when deprived of computers and mobile devices. Once recognized, both computer addiction and technology overload are treatable disorders.

- **Violation of Privacy:** Nearly every life event is stored in a computer somewhere . . . in medical records, credit reports, tax records, etc. In many instances, where personal and confidential records were not protected properly, individuals have found their privacy violated and identities stolen.
- **Public Safety:** Adults, teens, and children around the world are using computers to share publicly their photos, videos, journals, music, and other personal information. Some of these unsuspecting, innocent computer users have fallen victim to crimes committed by dangerous strangers. Protect yourself and your dependents from these criminals by being cautious in e-mail messages and on Web sites. For example, do not share information that would allow others to identify or locate you and do not disclose identification numbers, passwords, or other personal security details.
- **Impact on Labor Force:** Although computers have improved productivity in many ways and created an entire industry with hundreds of thousands of new jobs, the skills of millions of employees have been replaced by computers. Thus, it is crucial that workers keep their education up-to-date. A separate impact on the labor force is that some companies are outsourcing jobs to foreign countries instead of keeping their homeland labor force employed.

- **Impact on Environment:** Computer manufacturing processes and computer waste are depleting natural resources and polluting the environment. When computers are discarded in landfills, they can release toxic materials and potentially dangerous levels of lead, mercury, and flame retardants.

Green computing involves reducing the electricity consumed and environmental waste generated when using a computer. Strategies that support green computing include recycling, regulating manufacturing processes, extending the life of computers, and immediately donating or properly disposing of replaced computers. When you purchase a new computer, some retailers offer to dispose of your old computer properly.

Networks and the Internet

A **network** is a collection of computers and devices connected together, often wirelessly, via communications devices and transmission media. When a computer connects to a network, it is **online**.
Networks allow computers to share *resources*, such as hardware, software, data, and information. Sharing resources saves time and money. In many networks, one or more computers act as a server. The *server* controls access to the resources on a network. The other computers on the network, each called a *client* or workstation, request resources from the server (Figure 1-6). The major differences between the server and client computers are that the server ordinarily has more power, more storage space, and expanded communications capabilities. Many homes and most businesses and schools network their computers and devices. Most allow users to connect their computers wirelessly to the network. Home networks usually are small, existing within a single structure. Business and school networks can be small, such as in a room or building, or widespread, connecting computers and devices across a city, country, or the globe. The world's largest computer network is the Internet.

Figure 1-6 A server manages the resources on a network, and clients access the resources on the server. This network enables three separate computers to share the same printer, one wirelessly.

The Internet

The **Internet** is a worldwide collection of networks that connects millions of businesses, government agencies, educational institutions, and individuals (Figure 1-7).

Figure 1-7 The Internet is the largest computer network, connecting millions of computers and devices around the world.

More than one billion people around the world use the Internet daily for a variety of reasons, some of which are listed below and shown in Figure 1-8:

- Communicate with and meet other people
- Conduct research and access a wealth of information and news
- Shop for goods and services
- Bank and invest
- Participate in online training
- Engage in entertaining activities, such as planning vacations, playing online games, listening to music, watching or editing videos, and reading books and magazines
- Download music and videos
- Share information, photos, and videos
- Access and interact with Web applications

People connect to the Internet to share information with others around the world. E-mail allows you to send and receive messages to and from other users. With instant messaging, you can have a live conversation with another connected user. In a chat room, you can communicate with multiple users at the same time — much like a group discussion. You also can use the Internet to make a telephone call. Businesses, called access providers, offer users and organizations access to the Internet free or for a fee. By subscribing to an access provider, you can use your computer and a communications device, such as a modem, to connect to the many services of the Internet. The Web, short for World Wide Web, is one of the more popular services on the Internet. Think of the Web as a global library of information available to anyone connected to the Internet.

Figure 1-8 Home and business users access the Internet for a variety of reasons.

The **Web** contains billions of documents called Web pages. A **Web page** can contain text, graphics, animation, audio, and video. The nine screens shown in Figure 1-8 are examples of Web pages. Web pages often have built-in connections, or links, to other documents, graphics, other Web pages, or Web sites. A **Web site** is a collection of related Web pages. Some Web sites allow users to access music and videos that can be downloaded, or transferred to storage media in a computer or portable media player. Once downloaded, you can listen to the music through speakers, headphones, or earbuds, or view the videos on a display device. Many people use the Web as a means to share personal information, photo s, and videos with the world. For example, you can create a Web page and then make it available, You also can join millions of people worldwide in an online community, called a **social networking Web site** or an *online social network*, that encourages members to share their interests, ideas, stories, photos, music, and videos with other registered users (Figure 1-9). Some social networking Web sites are college oriented, some business oriented, and others are more focused. A **photo sharing community,** for example, is a specific type of social networking Web site that allows users to create an online photo album and store and share their digital photos. Similarly, a **video sharing community** is a type of social networking Web site that allows users to store and share their personal videos. Hundreds of thousands of people today also use blogs to publish their thoughts on the Web. A *blog* is an informal Web site consisting of time stamped articles in a diary or journal format, usually listed in reverse chronological order. As others read the articles in a blog, they reply with their own thoughts. A blog that contains video clips is called a *video blog*. A *microblog,* such as Twitter, allows users to publish short messages, usually between 100 and 200 characters, for others to read. To learn more about creating and using blogs, complete the Learn How To 2 activity on pages 50 and 51. Podcasts are a popular way people verbally share information on the Web. A *podcast* is recorded audio stored on a Web site that can be downloaded to a computer or a portable media player such as an iPod. A video podcast is a podcast that contains video and usually audio. At a convenient time and location, the user listens to or watches the downloaded podcast.

A **Web application** is a Web site that allows users to access and interact with software from any computer or device that is connected to the Internet. Examples of software available as Web applications include those that allow you to send and receive e-mail messages, prepare your taxes, organize digital photos, create documents, and play games. Web sites such as social networking Web sites, blogs, and Web applications are categorized as Web 2.0 sites. The term **Web 2.0** refers to Web sites that provide a means for users to share personal information (such as social networking Web sites), allow users to modify the Web site contents (such as some blogs), and/or have software built into the site for users to access (such as Web applications).

Figure 1-9 Facebook is a popular social networking Web site.

Computer Software

Software, also called a **program**, consists of a series of related instructions, organized for a common purpose, that tells the computer what tasks to perform and how to perform them. You interact with a program through its user interface. The user interface controls how you enter data and instructions and how information is displayed on the screen.

Software today often has a graphical user interface. With a **graphical user interface** (**GUI** pronounced gooey), you interact with the software using text, graphics, and visual images such as icons. An *icon* is a miniature image that represents a program, an instruction, or some other object. You can use the mouse to select icons that perform operations such as starting a program. The two categories of software are system software and application software. Figure 1-10 shows an example of each of these categories of software, which are explained in the following sections.

System Software

System software consists of the programs that control or maintain the operations of the computer and its devices. System software serves as the interface between the user, the application software, and the computer's hardware. Two types of system software are the operating system and utility programs.

Operating System An *operating system* is a set of programs that coordinates all the activities among computer hardware devices. It provides a means for users to communicate with the computer and other software. Many of today's computers use Microsoft's Windows, the latest version of which is shown in Figure 1-10, or Mac OS, Apple's operating system. When a user starts a computer, portions of the operating system are copied into memory from the computer's hard disk. These parts of the operating system remain in memory while the computer is on.

Utility Program A *utility program* allows a user to perform maintenance-type tasks usually related to managing a computer, its devices, or its programs. For example, you can use a utility program to transfer digital photos to an optical disc. Most operating systems include several utility programs for managing disk drives, printers, and other devices and media. You also can buy utility programs that allow you to perform additional computer management functions.

Figure 1-10 Today's system software and application software usually have a graphical user interface.

Application Software

Application software consists of programs designed to make users more productive and/ or assist them with personal tasks. A widely used type of application software related to communications is a Web browser, which allows users with an Internet connection to access and view Web pages or access programs. Other popular application software includes word processing software, spreadsheet software, database software, and presentation software. Many other types of application software exist that enable users to perform a variety of tasks. These include personal information management, note taking, project management, accounting, document management, computer aided design, desktop publishing, paint/image editing, photo editing, audio and video editing, multimedia authoring, Web page authoring, personal finance, legal, tax preparation, home design/landscaping, travel and mapping, education, reference, and entertainment (e.g., games or simulations, etc.). Software is available at stores that sell computer products (Figure 1-11) and also online at many Web sites.

Installing and Running Programs

When purchasing software from a retailer, you typically receive a box that includes an optical disc(s) that contains the program. If you acquire software from a Web site on the Internet, you may be able to download the program; that is, the program transfers from the Web site to the hard disk in your computer. The instructions in software are placed on storage media, either locally or online. To use software that is stored locally, such as on a hard disk or optical disc, you usually need to install the software. Web applications that are stored online, by contrast, usually do not need to be installed.

Installing is the process of setting up software to work with the computer, printer, and other hardware. When you buy a computer, it usually has some software pre installed on its hard disk. This enables you to use the computer the first time you turn it on. To begin installing additional software from an optical disc, insert the program disc in an optical disc drive and follow the instructions to begin installation. To install downloaded software, the Web site typically provides instructions for how to install the program on your hard disk.

Figure 1-11 Stores that sell computer products have shelves stocked with software for sale.

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Software Development
A *programmer*, sometimes called a computer programmer or *developer*, is someone who develops software or writes the instructions that direct the computer to process data into information. When writing instructions, a programmer must be sure the program works properly so that the computer generates the desired results. Complex programs can require thousands to millions of instructions. Programmers use a programming language or program development tool to create computer programs. Popular programming languages include C++, Java, JavaScript, Visual C#, and Visual Basic. Figure 1-13 shows some of the Visual Basic instructions a programmer may write to create a simple payroll program.

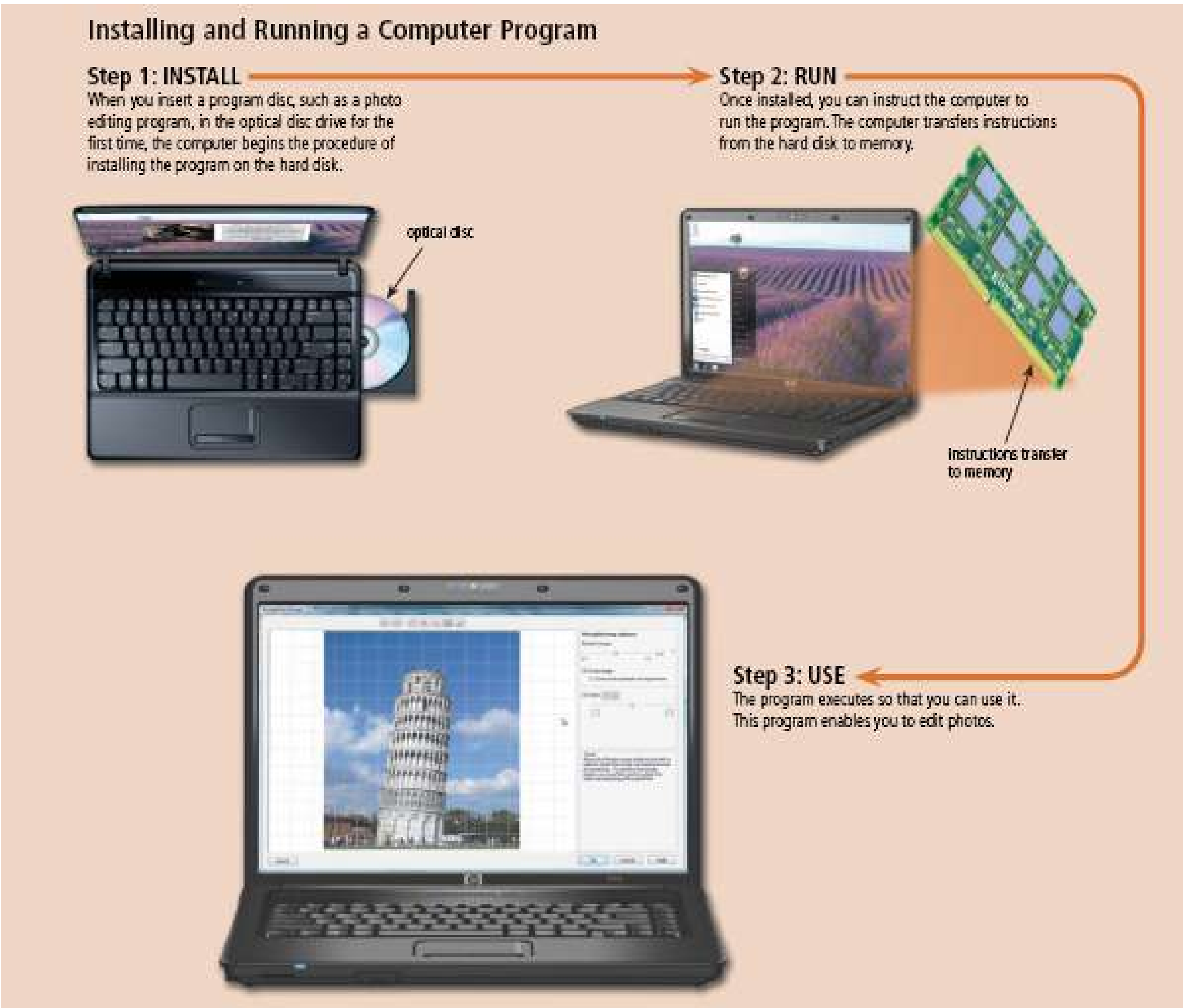
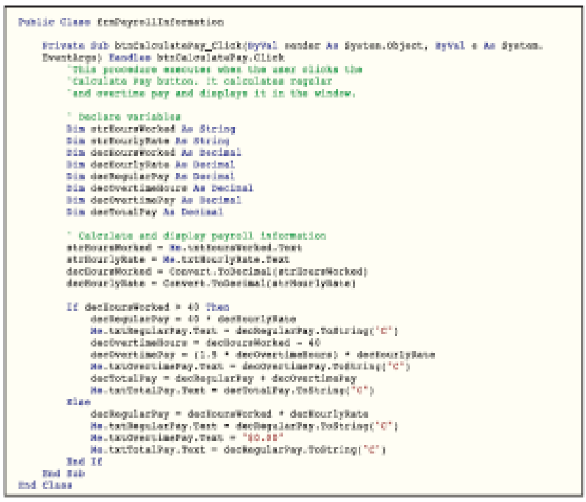


Figure 1-12 This figure shows how to install and run a computer program.



```
Public Class frmPayrollInformation

    Private Sub btnCalculatePay_Click(ByVal sender As System.Object, ByVal e As System.
    EventArgs) Handles btnCalculatePay.Click
        'This procedure executes when the user clicks the
        'Calculate Pay button. It calculates regular
        'and overtime pay and displays it in the window.

        ' Declare variables
        Dim strHoursWorked As String
        Dim strHourlyRate As String
        Dim decHoursWorked As Decimal
        Dim decHourlyRate As Decimal
        Dim decRegularPay As Decimal
        Dim decOvertimeHours As Decimal
        Dim decOvertimePay As Decimal
        Dim decTotalPay As Decimal

        ' Calculate and display payroll information
        strHoursWorked = Me.txtHoursWorked.Text
        strHourlyRate = Me.txtHourlyRate.Text
        decHoursWorked = Convert.ToDecimal(strHoursWorked)
        decHourlyRate = Convert.ToDecimal(strHourlyRate)

        If decHoursWorked > 40 Then
            decRegularPay = 40 * decHourlyRate
            Me.txtRegularPay.Text = decRegularPay.ToString("C")
            decOvertimeHours = decHoursWorked - 40
            decOvertimePay = (1.5 * decOvertimeHours) * decHourlyRate
            Me.txtOvertimePay.Text = decOvertimePay.ToString("C")
            decTotalPay = decRegularPay + decOvertimePay
            Me.txtTotalPay.Text = decTotalPay.ToString("C")
        Else
            decRegularPay = decHoursWorked * decHourlyRate
            Me.txtRegularPay.Text = decRegularPay.ToString("C")
            Me.txtOvertimePay.Text = "$0.00"
            Me.txtTotalPay.Text = decRegularPay.ToString("C")
        End If
    End Sub
End Class
```

Figure 1-13a (Visual Basic program instructions)

Figure 1-13b (window appears when user runs program)

Figure 1-13 A programmer writes Visual Basic instructions to create the Payroll Information window.

Categories of Computers

Industry experts typically classify computers in seven categories: personal computers (desktop), mobile computers and mobile devices, game consoles, servers, mainframes, supercomputers, and embedded computers. A computer's size, speed, processing power, and price determine the category it best fits. Due to rapidly changing technology, however, the distinction among categories is not always clear-cut. This trend of computers and devices with technologies that overlap, called *convergence*, leads to computer manufacturers continually releasing newer models that include similar functionality and features. For example, newer cell phones often include media player, camera, and Web browsing capabilities. As devices converge, users need fewer devices for the functionality that they require. When consumers replace outdated computers and devices, they should dispose of them properly. Figure 1-14 summarizes the seven categories of computers. The following pages discuss computers and devices that fall in each category.

Categories of Computers

Category	Physical Size	Number of Simultaneously Connected Users	General Price Range
Personal computers (desktop)	Fits on a desk	Usually one (can be more if networked)	Several hundred to several thousand dollars
Mobile computers and mobile devices	Fits on your lap or in your hand	Usually one	Less than a hundred dollars to several thousand dollars
Game consoles	Small box or handheld device	One to several	Several hundred dollars or less
Servers	Small cabinet	Two to thousands	Several hundred to a million dollars
Mainframes	Partial room to a full room of equipment	Hundreds to thousands	$300,000 to several million dollars
Supercomputers	Full room of equipment	Hundreds to thousands	$500,000 to several billion dollars
Embedded computers	Miniature	Usually one	Embedded in the price of the product

Figure 1-14 This table summarizes some of the differences among the categories of computers. These should be considered general guidelines only because of rapid changes in technology.

Personal Computers

A **personal computer** is a computer that can perform all of its input, processing, output, and storage activities by itself. A personal computer contains a processor, memory, and one or more input, output, and storage devices. Personal computers also often contain a communications device. Two popular architectures of personal computers are the PC (Figure 1-15) and the Apple (Figure 1-16). The term, *PC-compatible*, refers to any personal computer based on the original IBM personal computer design. Companies such as Dell, HP, and Toshiba sell PC-compatible computers. PC and PC-compatible computers usually use a Windows operating system. Apple computers usually use a Macintosh operating system (Mac OS). Two types of personal computers are desktop computers and notebook computers

Figure 1-15 PC and PC-compatible computers usually use a Windows operating system.

Figure 1-16 Apple computers, such as the iMac, usually use a Macintosh operating system.

Desktop Computers

A **desktop computer** is designed so that the system unit, input devices, output devices, and any other devices fit entirely on or under a desk or table (Figures 1-15 and 1-16 on the previous page). In many models, the system unit is a tall and narrow *tower*, which can sit on the floor vertically — if desktop space is limited. Some desktop computers function as a server on a network. Others, such as a gaming desktop computer and home theater PC, target a specific audience. The *gaming desktop computer* offers high-quality audio, video, and graphics with optimal performance for sophisticated single-user and networked or Internet multiplayer games. A *home theater PC* (*HTPC*) combines the features of a high-definition video/audio entertainment system with a desktop computer that is designed to be connected to a television and includes a Blu-ray Disc, digital video recorder, and digital cable television connectivity. These high-end computers cost more than the basic desktop computer.

Another expensive, powerful desktop computer is the workstation, which is geared for work that requires intense calculations and graphics capabilities. An architect uses a workstation to design buildings and homes. A graphic artist uses a workstation to create computer-animated special effects for full-length motion pictures and video games.

Mobile Computers and Mobile Devices

A **mobile computer** is a personal computer you can carry from place to place. Similarly, a **mobile device** is a computing device small enough to hold in your hand. The most popular type of mobile computer is the notebook computer. The following sections discuss the notebook computer and widely used mobile devices.

Notebook Computers

A **notebook computer**, also called a **laptop computer**, is a portable, personal computer often designed to fit on your lap. Notebook computers are thin and lightweight, yet they can be as powerful as the average desktop computer. A *netbook*, which is a type of notebook computer, is smaller, lighter, and often not as powerful as a traditional notebook computer. Most netbooks cost less than traditional notebook computers, usually only a few hundred dollars. An ultra-thin is another type of notebook computer that is lightweight and usually less than one-inch thick. Some notebook computers have touch screens, allowing you to interact with the device by touching the screen, usually with the tip of a finger. On a typical notebook computer, the keyboard is on top of the system unit, and the monitor attaches to the system unit with hinges (Figure 1-17). These computers weigh on average from 2.5 to more than 10 pounds (depending on configuration), which allows users to transport the computers from place to place. Most notebook computers can operate on batteries or a power supply or both.

Figure 1-17 On a typical notebook computer, the keyboard is on top of the system unit, and the display attaches to the system unit with hinges.

Tablet PCs Resembling a letter-sized slate, the **Tablet PC** is a special type of notebook computer that allows you to write or draw on the screen using a digital pen (Figure 1-18). With a *digital pen*, users write or draw by pressing the pen on the screen, and issue instructions to the Tablet PC by tapping on the screen. For users who prefer typing instead of handwriting, some Tablet PC designs have an attached keyboard; others allow you to connect a separate keyboard to the device. Most Tablet PCs have touch screens. Tablet PCs also support voice input so that users can enter text and issue instructions by speaking into the computer. Tablet PCs are useful especially for taking notes in lectures, at meetings, conferences, and other forums where the standard notebook computer is not practical.

Figure 1-18 A Tablet PC combines the features of a traditional notebook computer with the simplicity of pencil and paper.

Mobile Devices

Mobile devices, which are small enough to carry in a pocket, usually do not have disk drives. Instead, these devices store programs and data permanently on special memory inside the system unit or on small storage media such as memory cards. You often can connect a mobile device to a personal computer to exchange information between the computer and the mobile device. Some mobile devices are **Internet-enabled**, meaning they can connect to the Internet wirelessly. With an Internet-enabled device, users can chat, send e-mail and instant messages, and access the Web. Because of their reduced size, the screens on mobile devices are small, but usually are in color. Five popular types of mobile devices are smart phones, PDAs, handheld computers, portable media players, and digital cameras.

Smart Phones Offering the convenience of one-handed operation, a **smart phone** (Figure 1-19) is an Internet-enabled phone that usually also provides personal information management functions such as a calendar, an appointment book, an address book, a calculator, and a notepad. In addition to basic phone capabilities, a smart phone allows you to send and receive e-mail messages and access the Web — usually for an additional fee. Some smart phones communicate wirelessly with other devices or computers. Many also function as a portable media player and include built-in digital cameras so that you can share photos or videos with others as soon as you capture the image.

Many smart phones also offer a variety of application software such as word processing, spreadsheet, and games, and the capability of conducting live video conferences. Many smart phones have keypads that contain both numbers and letters so that you can use the same keypad to dial phone numbers and enter messages. Others have a built-in mini keyboard on the front of the phone or a keyboard that slides in and out from behind the phone. Some have touch screens, where you press objects on the screen to make selections and enter text through an on-screen keyboard.

Figure 1-19 Some smart phones have touch screens; others have mini keyboards.

Instead of calling someone's smart phone or cell phone, users often send messages to others by pressing buttons on their phone's keypad, keys on the mini keyboard, or images on an on-screen keyboard. Types of messages users send with smart phones include text messages, instant messages, picture messages, and video messages.

- A *text message* is a short note, typically fewer than 300 characters, sent to or from a smart phone or other mobile device.
- An *instant message* is a real-time Internet communication, where you exchange messages with other connected users.
- A *picture message* is a photo or other image, sometimes along with sound and text, sent to or from a smart phone or other mobile device. A phone that can send picture messages often is called a *camera phone*.
- A *video message* is a short video clip, usually about 30 seconds, sent to or from a smart phone or other mobile device. A phone that can send video messages often is called a *video phone*.

PDAs A **PDA** (*personal digital assistant*) provides personal information management functions such as a calendar, an appointment book, an address book, a calculator, and a notepad (Figure 1-20). Most PDAs also offer a variety of other application software such as word processing, spreadsheet, personal finance, and games.
A common input device for a PDA is a stylus. Some PDAs have a built-in miniature keyboard or an on-screen keyboard. Some PDAs also support voice input, have built-in cameras, and can function as a portable media player. Many PDAs are Internet-enabled so that users can check e-mail and access the Web. Some also provide phone capabilities. As smart phones and PDAs continue a trend of convergence, it is becoming increasingly difficult to differentiate between the two devices. This has led some manufacturers to refer to PDAs and smart phones simply as *handhelds*.

Figure 1-20 A PDA.

Handheld Computers A **handheld computer**, sometimes referred to as an *Ultra-Mobile PC* (*UMPC*), is a computer small enough to fit in one hand. Many handheld computers communicate wirelessly with other devices or computers and also include a digital pen or stylus for input. Some handheld computers have miniature or specialized keyboards. Many handheld computers are industry-specific and serve the needs of mobile employees, such as meter readers and parcel delivery people (Figure 1-21), whose jobs require them to move from place to place.

Figure 1-21 This handheld computer is a lightweight computer that enables delivery people to obtain and record information about their deliveries.

Portable Media Players A **portable media player** is a mobile device on which you can store, organize, and play digital media (Figure 1-22). For example, you can listen to music; watch videos, movies, and television shows; and view photos on the device's screen. With most, you download the digital media from a computer to the portable media player or to media that you insert in the device.

Figure 1-22 The iPod, shown here, is a popular portable media player.

Some portable media players are Internet enabled so that you can access Web sites and send e-mail messages directly from the device. Many offer personal information management functions such as a calendar and address book, and include a variety of games and other application software.
Portable media players usually include a set of earbuds, which are small speakers that rest inside each ear canal. Some portable media players have a touch screen, while others have a touch-sensitive pad that you operate with a thumb or finger, to navigate through digital media, adjust volume, and customize settings.

Digital Cameras A **digital camera** is a device that allows users to take pictures and store the photographed images digitally, instead of on traditional film (Figure 1-23). While many digital cameras look like a traditional camera, some are built into smart phones and other mobile devices. Although digital cameras usually have some amount of internal storage to hold images, most users store images on small storage media such as memory cards. Digital cameras typically allow users to review, and sometimes modify, images while they are in the camera. Some digital cameras connect to or communicate wirelessly with a computer or printer, allowing users to print or view images directly from the printer. Some memory cards can connect to a network wirelessly, so that you can transfer photos directly from the memory card in the camera to the Internet without requiring a computer. Often users prefer to download images from the digital camera to the computer. Or, you can remove the storage media such as a memory card from the digital camera and insert it in a card reader in or attached to the computer.

Figure 1-23 With a digital camera, users can view photographed images immediately through a small screen on the camera to see if the picture is worth keeping.

Game Consoles

A **game console** is a mobile computing device designed for single-player or multiplayer video games (Figure 1-24). Standard game consoles use a handheld controller(s) as an input device(s); a television screen as an output device; and hard disks, optical discs, and/or memory cards for storage. Weighing on average between two and nine pounds, the compact size of game consoles makes them easy to use at home, in the car, in a hotel, or any location that has an electrical outlet. Three popular models are Microsoft's Xbox 360, Nintendo's Wii (pronounced wee), and Sony's PlayStation 3.

Figure 1-24 Game consoles provide hours of video game entertainment.

A handheld game console is small enough to fit in one hand, making it more portable than the standard game console. With the handheld game console, the controls screen, and speakers are built into the device. Because of their reduced size, the screens are small — three to four inches. Some models use cartridges to store games; others use a memory card or a miniature optical disc. Many handheld game consoles can communicate wirelessly with other similar consoles for multiplayer gaming. Two popular models are Nintendo DS Lite and Sony's PlayStation Portable (PSP). In addition to gaming, many game console models allow users to listen to music, watch movies, keep fit, and connect to the Internet. Game consoles can cost from a couple hundred dollars to more than $500.

Servers

A **server** controls access to the hardware, software, and other resources on a network and provides a centralized storage area for programs, data, and information (Figure 1-25). Servers can support from two to several thousand connected computers at the same time. In many cases, one server accesses data, information, and programs on another server. In other cases, people use personal computers or terminals to access data, information, and programs on a server. A terminal is a device with a monitor, keyboard, and memory.

Mainframes

A **mainframe** is a large, expensive, powerful computer that can handle hundreds or thousands of connected users simultaneously (Figure 1-26). Mainframes store tremendous amounts of data, instructions, and information. Most major corporations use mainframes for business activities. With mainframes, enterprises are able to bill millions of customers, prepare payroll for thousands of employees, and manage thousands of items in inventory. One study reported that mainframes process more than 83 percent of transactions around the world. Mainframes also can act as servers in a network environment. Servers and other mainframes can access data and information from a mainframe. People also can access programs on the mainframe using terminals or personal computers.

Supercomputers

A supercomputer is the fastest, most powerful computer — and the most expensive (Figure 1-27). The fastest supercomputers are capable of processing more than one quadrillion instructions in a single second. With weights that exceed 100 tons, these computers can store more than 20,000 times the data and information of an average desktop computer. Applications requiring complex, sophisticated mathematical calculations use supercomputers. Large-scale simulations and applications in medicine, aerospace, automotive design, online banking, weather forecasting, nuclear energy research, and petroleum exploration use a supercomputer.

Figure 1-25 A server controls access to resources on a network.

Figure 1-26 Mainframe computers can handle thousands of connected computers and process   millions of instructions per second.

Figure 1-27 This supercomputer, IBM's Roadrunner, can process more than one quadrillion instructions in a single second.

Embedded Computers

An embedded computer is a special-purpose computer that functions as a component in a larger product. Embedded computers are everywhere — at home, in your car, and at work. The following list identifies a variety of everyday products that contain embedded computers.

Consumer Electronics: mobile and digital telephones, digital televisions, cameras, video recorders, DVD players and recorders, answering machines. Home Automation Devices: thermostats, sprinkling systems, security monitoring systems, appliances, lights. Automobiles: antilock brakes, engine control modules, airbag controller, cruise control Process Controllers and Robotics: remote monitoring systems, power monitors, machine controllers, medical devices Computer Devices and Office Machines: keyboards, printers, fax and copy machines Because embedded computers are components in larger products, they usually are small and have limited hardware. These computers perform various functions, depending on the requirements of the product in which they reside. Embedded computers in printers, for example, monitor the amount of paper in the tray, check the ink or toner level, signal if a paper jam has occurred, and so on. Figure 1-28 shows some of the many embedded computers in cars.

Figure 1-28 Some of the embedded computers designed to improve your safety, security, and performance in today's automobiles.

Elements of an Information System

To be valuable, information must be accurate, organized, timely, accessible, useful, and cost effective to produce. Generating information from a computer requires the following five elements:

- Hardware
- Software
- Data
- People
- Procedures

Together, these elements (hardware, software, data, people, and procedures) comprise an *information system*. Figure 1-29 shows how each of the elements of an information system in an enterprise might interact.

The hardware must be reliable and capable of handling the expected workload. The software must be developed carefully and tested thoroughly.

The data entered into the computer must be accurate. Most companies with mid-sized and large computers have an IT (information technology) department. Staff in the IT department should be skilled and up-to-date on the latest technology.

IT staff also should train users so that they understand how to use the computer properly. Today's users also work closely with IT staff in the development of computer applications that relate to their areas of work. Finally, all the IT applications should have readily available documented procedures that address operating the computer and using its programs.

Figure 1-29 This figure shows how the elements of an information system in an enterprise might interact.

Examples of Computer Usage

Every day, people around the world rely on different types of computers for a variety of applications. To illustrate the range of uses for computers, this section takes you on a visual and narrative tour of five categories of users:

- Home user
- Small office/home office (SOHO) user
- Mobile user
- Power user
- Enterprise user

Home User

In an increasing number of homes, the computer no longer is a convenience. Instead, it is a basic necessity. Each family member, or **home user**, spends time on the computer for different reasons that include personal financial management, Web access, communications, and entertainment (Figure 1-30).

On the Internet, home users access a huge amount of information, conduct research, take college classes, pay bills, manage investments, shop, listen to the radio, watch movies, read books, file taxes, book airline reservations, make telephone calls, and play games They also communicate with others around the world through e-mail, blogs, instant messages, and chat rooms using personal computers, smart phones, and other mobile devices. Home users share ideas, interests, photos, music, and videos on social networking Web sites. With a digital camera, home users take photos and then send the electronic images to others. Using a Web cam, home users easily have live video calls with friends, family members, and others. Many home users have a portable media player, so that they can download music or podcasts, and listen to the music and/or audio at a later time through earbuds attached to the player.

Figure 1-30 The home user spends time on a computer for a variety of reasons.

They also usually have one or more game consoles to play video games individually or with friends and family members.
Today's homes also typically have one or more desktop computers. Many home users network multiple desktop computers throughout the house, often wirelessly. These small networks allow family members to share an Internet connection and a printer.
Home users have a variety of software. They type letters, homework assignments, and other documents with word processing software. Personal finance software helps the home user with personal finances, investments, and family budgets. Other software assists with preparing taxes, keeping a household inventory, setting up maintenance schedules, and protecting home computers against threats and unauthorized intrusions.
Reference software, such as encyclopedias, medical dictionaries, or a road atlas, provides valuable information for everyone in the family. With entertainment software, the home user can play games, compose music, re search genealogy, or create greeting cards. Educational software helps adults learn to speak a foreign language and youngsters to read, write, count, and spell.

Small Office/Home Office User

Computers assist small business and home office users in managing their resources effectively. A **small office/home office** (*SOHO*) includes any company with fewer than 50 employees, as well as the self-employed who work from home. Small offices include local law practices, accounting firms, travel agencies, and florists. SOHO users typically have a desktop computer to perform some or all of their duties. Many also have smart phones or other mobile devices to manage appointments and contact information.
SOHO users access the Internet — often wirelessly — to look up information such as addresses, directions, postal codes, flights (Figure 1-31a), and package shipping rates or

to send and receive e-mail messages or make telephone calls.

Many have entered the *e-commerce* arena and conduct business on the Web. Their Web sites advertise products and services and may provide a means for taking orders. Small business Web sites sometimes use a *Web cam* to show the world a live view of some aspect of their business.

To save money on hardware and software, small offices often network their computers. For example, the small office connects one printer to a network for all employees to share. SOHO users often work with basic business software such as word processing and spreadsheet programs that assist with document preparation and finances (Figure 1-31b). They are likely to use other industry-specific types of software. An auto parts store, for example, will have software that allows for looking up parts, taking orders and payments, and updating inventory.

Figure 1-31a (Web access)

Figure 1-31b (spreadsheet program)

Figure 1-31 People with a home office and employees in small offices typically use a personal computer for some or all of their duties.

Mobile User

Today, businesses and schools are expanding to serve people across the country and around the world. Thus, increasingly more employees and students are **mobile users**, who work on a computer or mobile device while away from a main office, home office, or school (Figure 1-32). Examples of mobile users are sales representatives, real estate agents, insurance agents, meter readers, package delivery people, journalists, consultants, and students.

Mobile users often have mobile computers and/or mobile devices. With these computers and devices, the mobile user connects to other computers on a network or the Internet, often wirelessly accessing services such as e-mail and the Web. Mobile users can transfer information between their mobile device and another computer, such as one at the main office or school. For entertainment, the mobile user plays video games on a handheld game console and listens to music or watches movies on a portable media player.

The mobile user works with basic business software such as word processing. With presentation software, the mobile user can create and deliver presentations to a large audience by connecting a mobile computer or device to a video projector that displays the presentation on a full screen. Many scaled-down programs are available for mobile devices such as smart phones.

Power User

Another category of user, called a **power user**, requires the capabilities of a workstation or other type of powerful computer. Examples of power users include engineers, scientists, architects, desktop publishers, and graphic artists (Figure 1-33). Power users often work with *multimedia*, combining text, graphics, audio, and video into one application. These users need computers with extremely fast processors because of the nature of their work. The power user's workstation often contains industry-specific software. For example, engineers and architects use software to draft and design floor plans, mechanical assemblies, or vehicles. A desktop publisher uses software to prepare marketing literature. A graphic artist uses software to create sophisticated drawings. This software usually is expensive because of its specialized design. Power users exist in all types of businesses. Some work at home. Their computers typically have network connections and Internet access.

Figure 1-32 Mobile users have a variety of mobile computers and devices so that they can work, do homework, send messages, connect to the Internet, or play games while away from a wired connection.

Figure 1-33 This graphic artist uses a powerful computer to develop computer games.

Enterprise User

An enterprise has hundreds or thousands of employees or customers that work in or do business with offices across a region, the country, or the world. Each employee or customer who uses a computer in the enterprise is an **enterprise user** (Figure 1-34). Many large companies use the words, *enterprise computing*, to refer to the huge network of computers that meets their diverse computing needs. The network facilitates communications among employees at all locations. Users access the network of servers or mainframes through desktop computers, mobile computers, and mobile devices. Enterprises use computers and the computer network to process high volumes of transactions in a single day. Although they may differ in size and in the products or ser vices offered, all generally use computers for basic business activities. For example, they bill millions of customers, prepare payroll for thousands of employees, and manage thousands of items in inventory. Some enterprises use blogs to open communications among employees, customers, and/or vendors. Enterprises typically have e-commerce Web sites, allowing customers and vendors to conduct business online. The Web site also showcases products, services, and other company information. The marketing department in an enterprise uses desktop publishing software to prepare marketing literature. The accounting department uses software for accounts receivable, accounts payable, billing, general ledger, and payroll activities. The employees in the *information technology (IT) department* keep the computers and the network running. They determine when the company requires new hardware or software. Enterprise users work with word processing, spreadsheet, database, and presentation software. They also may use calendar programs to post their schedules on the network. And, they might use smart phones or mobile devices to maintain contact information. E-mail programs and Web browsers enable communications among employees, vendors, and customers. Many employees of enterprises telecommute.

Telecommuting is a work arrangement in which employees work away from a company's standard workplace and often communicate with the office through the computer. Employees who telecommute have flexible work schedules so that they can combine work and personal responsibilities, such as child care.

Putting It All Together

The previous pages discussed the hardware and software requirements for the home user, small office/home office user, mobile user, power user, and enterprise user. The table in Figure 1-35 summarizes these requirements

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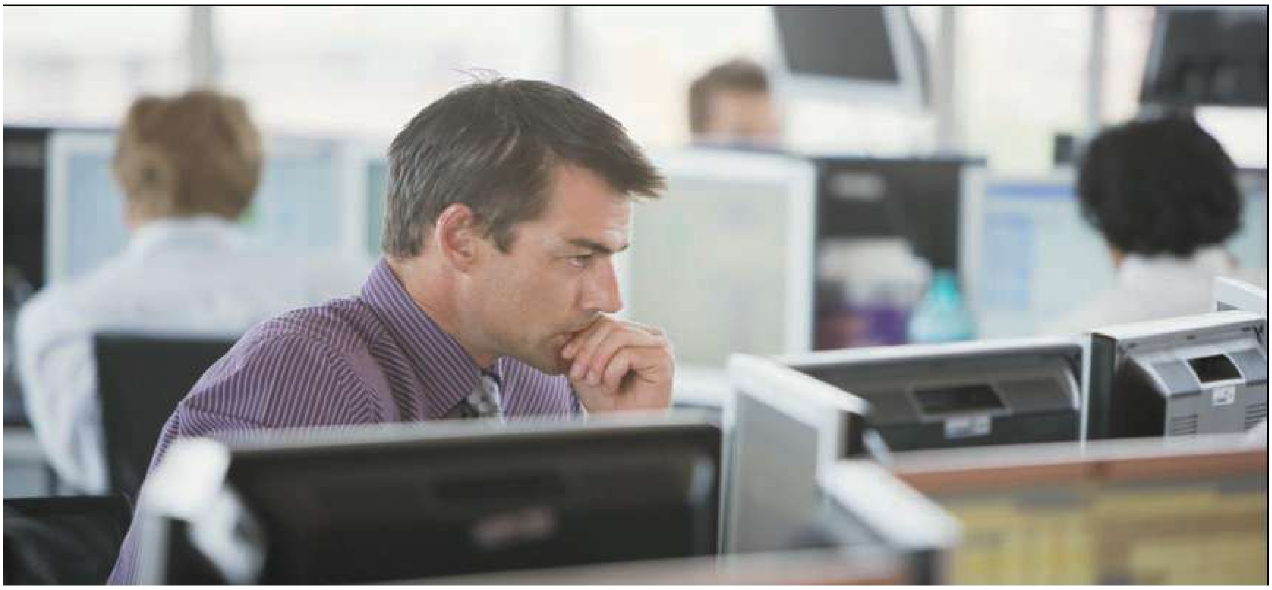


Figure 1-34 An enterprise can have hundreds or thousands of users in offices across a region, the country, or the world.

Computer Applications in Society

The computer has changed society today as much as the industrial revolution changed society in the eighteenth and nineteenth centuries. People interact directly with computers in fields such as education, finance, government, health care, science, publishing, travel, and manufacturing. In addition, they can reap the benefits from breakthroughs and advances in these fields. The following pages describe how computers have made a difference in people's interactions with these disciplines.

Education

Education is the process of acquiring knowledge. In the traditional model, people learn from other people such as parents, teachers, and employers. Many forms of printed material such as books and manuals are used as learning tools. Today, educators also are turning to computers to assist with education (Figure 1-36). Many schools and companies equip labs and classrooms with computers. Some schools require students to have a mobile computer or mobile device to access the school's network or Internet wirelessly. To promote education by computer, many vendors offer substantial student discounts on software. Sometimes, the delivery of education occurs at one place while the learning occurs at other locations. For example, students can take a class on the Web. Some classes are blended; that is, part of the learning occurs in a classroom and the other part occurs on the Web. More than 70 percent of colleges offer distance learning classes. A few even offer entire degrees online.

Figure 1-36 In some schools, students have mobile computers on their desks during classroom lectures.

Finance

Many people and companies use computers to help manage their finances. Some use finance software to balance checkbooks, pay bills, track personal income and expenses, manage investments, and evaluate financial plans. This software usually includes a variety of online services. For example, computer users can track investments and do online banking. With **online banking**, users access account balances, pay bills, and copy monthly transactions from the bank's computer right into their personal computers. Many financial institutions' Web sites also offer online banking. When using a Web site instead of finance software on your computer, all your account information is stored on the bank's computer. The advantage is you can access your financial records from anywhere in the world (Figure 1-37). Investors often use **online investing** to buy and sell stocks and bonds — without using a broker. With online investing, the transaction fee for each trade usually is much less than when trading through a broker.

Government

A government provides society with direction by making and administering policies. To provide citizens with up-to-date information, most government offices have Web sites. People in the United States access government Web sites to file taxes, apply for permits and licenses, pay parking tickets, buy stamps, report crimes, apply for financial aid, and renew vehicle registrations and driver's licenses. To provide these services, some Web sites require users provide personal information. Employees of government agencies use computers as part of their daily routine. North American 911 call centers use computers to dispatch calls for fire, police, and medical assistance. Military and other agency officials use the U.S. Department of Homeland Security's network of information about domestic security threats to help protect against terrorist attacks.
Law enforcement officers have online access to the FBI's National Crime Information Center (NCIC) through in-vehicle notebook computers, fingerprint readers, and mobile devices (Figure 1-38). The NCIC contains more than 52 million missing persons and criminal records, including names, fingerprints, parole/probation records, mug shots, and other information.

Figure 1-37 An online banking Web site.

Figure 1-38 Law enforcement officials have in-vehicle computers and mobile devices to access emergency, missing person, and criminal records in computer networks in local, state, and federal agencies.

Health Care

Nearly every area of health care today uses computers. Whether you are visiting a family doctor for a regular checkup, having lab work or an outpatient test, or being rushed in for emergency surgery, the medical staff around you will be using computers for various purposes: • Hospitals and doctors use computers and mobile devices to maintain and access patient records. • Computers monitor patients' vital signs in hospital rooms and at home. • Robots deliver medication to nurse stations in hospitals.

- Computers and computerized devices assist doctors, nurses, and technicians with medical tests (Figure 1-39).
- Doctors use the Web and medical software to assist with researching and diagnosing health conditions.
- Doctors use e-mail to correspond with patients.
- Pharmacists use computers to file insurance claims.
- Surgeons implant computerized devices, such as pacemakers, that allow patients to live longer.
- Surgeons use computer-controlled devices to provide them with greater precision during operations, such as for laser eye surgery and robot-assisted heart surgery.

Many Web sites provide up-to-date medical, fitness, nutrition, or exercise information. These Web sites also maintain lists of doctors and dentists to help you find the one that suits your needs. They have chat rooms, so that you can talk to others diagnosed with similar conditions. Some Web sites even allow you to order prescriptions online.

Two forms of long-distance health care are telemedicine and telesurgery. Through *telemedicine*, health-care professionals in separate locations conduct live conferences on the computer.

For example, a doctor at one location can have a conference with a doctor at another location to discuss a bone X-ray. Live images of each doctor, along with the X-ray, are displayed on each doctor's computer. With *telesurgery*, also called *remote surgery*, a surgeon performs an operation on a patient who is not located in the same physical room as the surgeon. Telesurgery enables surgeons to direct robots to perform an operation via computers connected to a high-speed network.

Science

All branches of science, from biology to astronomy to meteorology, use computers to assist them with collecting, analyzing, and modeling data. Scientists also use the Internet to communicate with colleagues around the world.

Breakthroughs in surgery, medicine, and treatments often result from scientists' use of computers. Tiny computers now imitate functions of the central nervous system, retina of the eye, and cochlea of the ear. A cochlear implant allows a deaf person to listen. Electrodes implanted in the brain stop tremors associated with Parkinson's disease. Cameras small enough to swallow — sometimes called a camera pill — take pictures inside your body to detect polyps, cancer, and other abnormalities (Figure 1-40). A *neural network* is a system that attempts to imitate the behavior of the human brain. Scientists create neural networks by connecting thousands of processors together much like the neurons in the brain are connected. The capability of a personal computer to recognize spoken words is a direct result of scientific experimentation with neural networks.

Figure 1-39 Doctors, nurses, technicians, and other medical staff use computers and computerized devices to assist with medical tests.

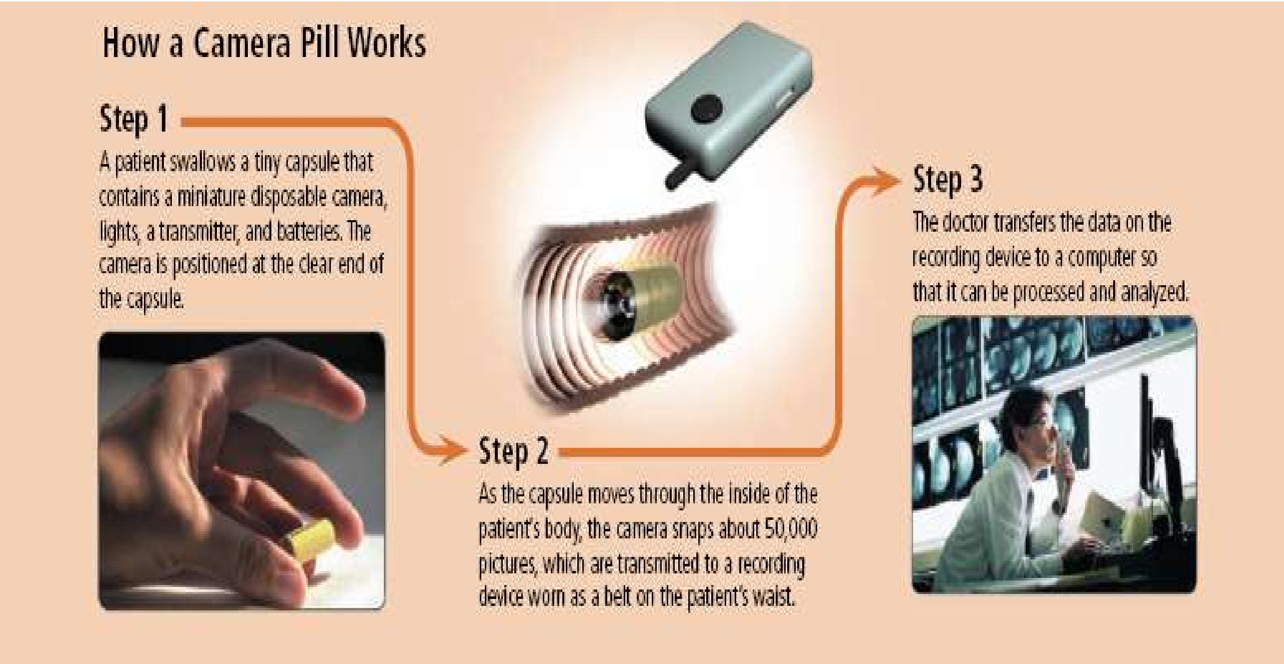


Figure 1-40 This figure shows how a camera pill works.

Publishing

Publishing is the process of making works available to the public. These works include books, magazines, newspapers, music, film, and video. Special software assists graphic designers in developing pages that include text, graphics, and photos; artists in com posing and enhancing songs; filmmakers in creating and editing film; and journalists and mobile users in capturing and modifying video clips. Many publishers make their works available online (Figure 1-41). Some Web sites allow you to copy the work, such as a book or music, to your desktop computer, mobile computer, smart phone, or other mobile device.

Figure 1-41 Many magazine and newspaper publishers make the content of their publications available online.

Travel

Whether traveling by car or airplane, your goal is to arrive safely at your destination. As you make the journey, you may interact with some of the latest technology. Vehicles manufactured today often include some type of onboard navigation system, such as OnStar. Many mobile devices such as smart phones have built-in navigation systems. Some mobile users prefer to carry specialized handheld navigation devices (Figure 1-42). For a technical discussion about how navigation devices determine your location, read the High-Tech Talk article on page 40. In preparing for a trip, you may need to reserve a car, hotel, or flight. Many Web sites offer these services to the public. For example, you can order airline tickets on the Web. If you plan to drive somewhere and are unsure of the road to take to your destination, you can print directions and a map from the Web.

Figure 1-42 This handheld navigation device gives users turn-by-turn voice-prompted directions to a destination.

Manufacturing

Computer-aided manufacturing (*CAM*) refers to the use of computers to assist with manufacturing processes such as fabrication and assembly. Industries use CAM to reduce product development costs, shorten a product's time to market, and stay ahead of the competition. Often, robots carry out processes in a CAM environment. CAM is used by a variety of industries, including oil drilling, power generation, food production, and automobile manufacturing. Automobile plants, for example, have an entire line of industrial robots that assemble a car (Figure 1-43). Special computers on the shop floor record actual labor, material, machine, and computer time used to manufacture a particular product. The computers process this data and automatically update inventory, production, payroll, and accounting records on the company's network.

Figure 1-43 Automotive factories use industrial robots to weld car bodies.

Chapter Exercises

True/False Mark T for True and F for False.

_____ 1. Many people believe that computer literacy is vital to success in today's world.

_____ 2. Hardware consists of a series of instructions that tells the computer what actions to perform and how to perform them.

_____ 3. The circuitry of the system unit usually is part of or is connected to a circuit board called the server.

_____ 4. Green computing involves reducing the electricity consumed and environmental waste generated when using a computer.

_____ 5. The client controls access to the resources on a network.

_____ 6. Web pages rarely have built-in connections, or links, to other documents, graphics, other Web pages, or Web sites.

_____ 7. A video sharing community is a type of social networking Web site that allows users to store and share their personal videos.

_____ 8. A text message is a short note, typically fewer than 300 characters, sent to or from a smart phone or other mobile device.

_____ 9. Because embedded computers are components in larger products, they usually are small and have limited hardware.

_____ 10. Telecommuting is a work arrangement in which employees work away from a company's standard workplace and often communicate with the office through the computer.

_____ 11. With online investing, the transaction fee for each trade usually is much more than when trading through a broker.

Multiple Choice Select the best answer.

1. Computer literacy, also known as digital literacy, involves having a current knowledge and understanding of _____.
a. computer programming b. computers and their uses
c. computer repair d. all of the above

2. _____ is/are a collection of unprocessed items, which can include text, numbers, images, audio, and video.
a. Data b. Instructions c. Programs d. Information

3. A _____ is a specific type of social networking Web site that allows users to create an online photo album and store and share their digital photos.
a. vodcast b. blog c. photo sharing community d. chat room

4. A _____ is recorded audio stored on a Web site that can be downloaded to a computer or portable media player.
a. podcast b. social networking Web site c. blog d. speaker

5. _____ consists of the programs that control or maintain the operations of the computer and its devices.
a. System software b. A communications device
c. A graphical user interface (GUI) d. Application software

6. A(n) _____ message is a real-time Internet communication, where you exchange messages with other connected users
a. text b. instant c. picture d. video

7. Many large companies use the word(s), _____, to refer to the huge network of computers that meets their diverse computing needs.
a. information technology b. enterprise computing
c. telecommuting d. multimedia

8. _____ is a system that attempts to imitate the behavior of the human brain.
a. Telemedicine b. A kiosk c. E-commerce d. A neural network

Matching Match the terms with their definitions.

_____ 1. processor	a. interprets and carries out basic instructions that operate a computer
_____ 2. storage device	b. carry out the instructions in a computer program
_____ 3. online social network	c. combines text, graphics, audio, and video into one application
_____ 4. application software	d. programs designed to make users more productive and/or assist them with personal tasks
_____ 5. install	e. a system that attempts to imitate the behavior of the human brain
_____ 6. execute	f. mobile device on which you can store, organize, and play digital media
_____ 7. portable media player	g. online community that encourages members to share their interests, ideas, stories, photos, music, and videos with other registered users
_____ 8. digital camera	h. set up software to work with a computer and other hardware components
_____ 9. multimedia	i. device that allows users to take pictures and store the photographed images digitally, instead of on traditional film
_____ 10. neural network	j. records (writes) and/or retrieves (reads) items to and from storage media

Short Answer Write a brief answer to each of the following questions.
1. What is a computer? ____________ What is the information processing cycle? ____________

2. Describe two health risks posed by computers. ____________ How might computers have a negative effect on the environment? ____________

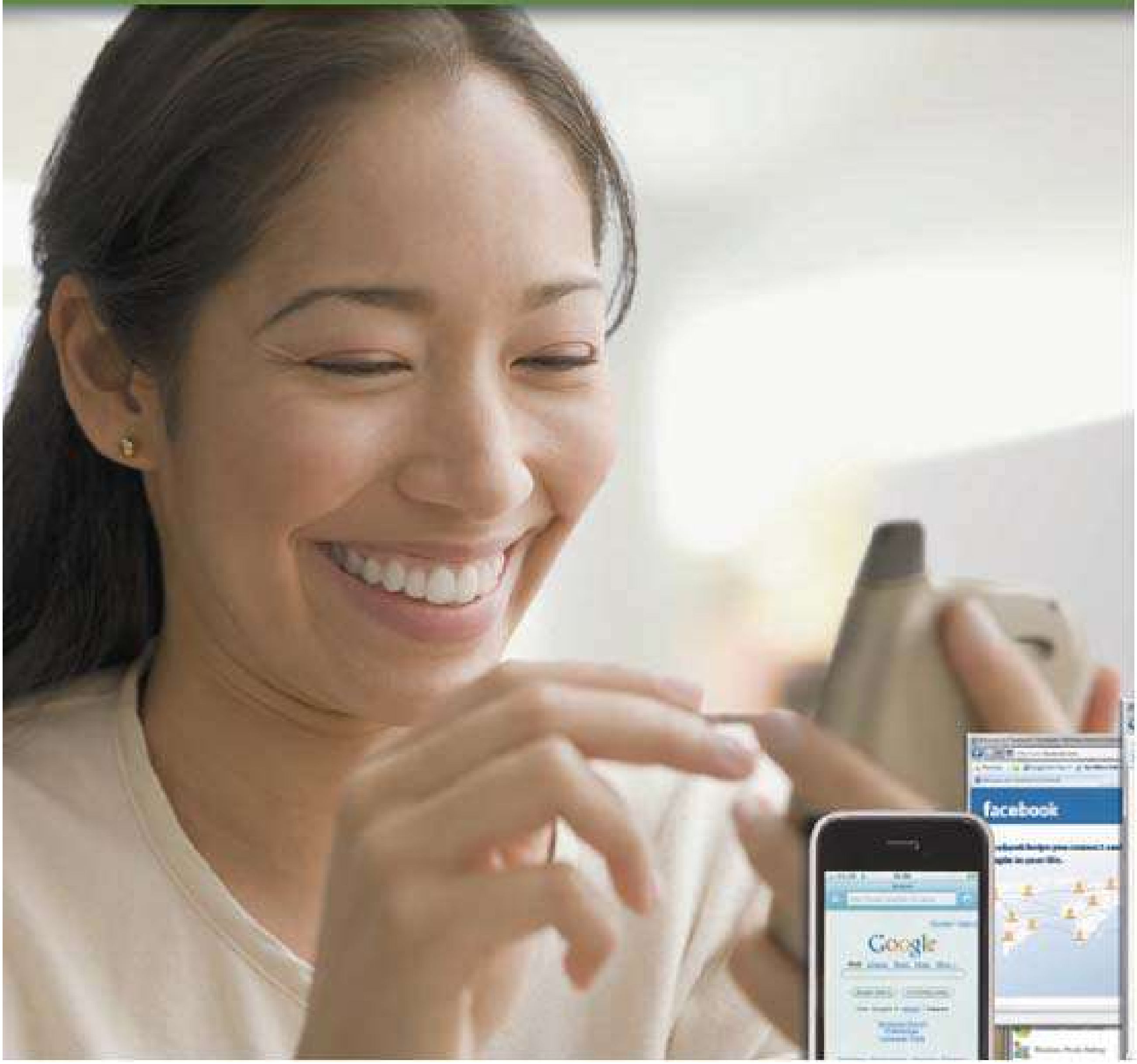
3. What is a Web application? ______ What are some features of a Web 2.0 site? ____________

4. What are seven categories of computers? ____________ What determines how a computer is categorized?____________

5. How do Web sites benefit individuals' health care? ____________ How does telesurgery differ from telemedicine?_________

Chapter Two

The Internet and World Wide Web



The Internet

One of the major reasons business, home, and other users purchase computers is for Internet access. The Internet is a widely used research tool, providing society with access to global information and instant communications. Further, access to the Internet can occur anytime from a computer anywhere: at home, at work, at school, in a restaurant, on an airplane, and at a park.

The **Internet**, also called the *Net*, is a worldwide collection of networks that links millions of businesses, government agencies, educational institutions, and individuals. Each of the networks on the Internet provides resources that add to the abundance of goods, services, and information accessible via the Internet. Today, more than one billion home and business users around the world access a variety of services on the Internet, some of which are shown in Figure 2-1. The World Wide Web, or simply the Web, and e-mail are two of the more widely used Internet services. Other services include chat rooms, instant messaging, and VoIP (Voice over Internet Protocol). To enhance your understanding of these Internet services, the chapter begins by discussing the history of the Internet and how the Internet works and then explains each of these services.

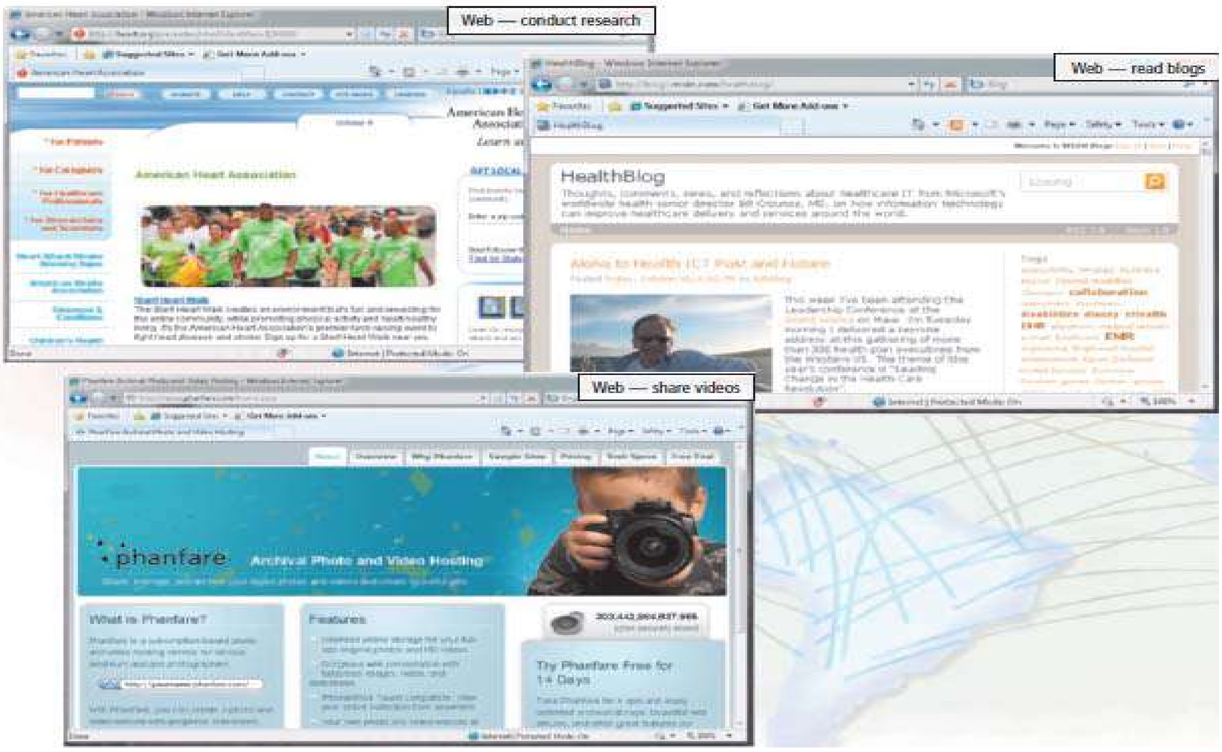


Figure 2-1 People around the world use a variety of Internet services in daily activities. Internet services allow home and business users to access the Web for activities such as conducting research, reading blogs, or sharing videos; to send e-mail messages; or to converse with others using chat rooms, instant messaging, or VoIP.

Evolution of the Internet

The Internet has its roots in a networking project started by the Pentagon's Advanced Research Projects Agency (*ARPA*), an agency of the U.S. Department of Defense. ARPA's goal was to build a network that (1) allowed scientists at different physical locations to share information and work together on military and scientific projects and (2) could function even if part of the network were disabled or destroyed by a disaster such as a nuclear attack. That network, called

ARPANET, became functional in September 1969, linking scientific and academic researchers across the United States. The original ARPANET consisted of four main computers, one each located at the University of California at Los Angeles, the University of California at Santa Barbara, the Stanford Research Institute, and the University of Utah. Each of these computers served as a host on the network. A *host*, more commonly known today as a server, is any computer that provides services and connections to other computers on a network. Hosts often use high-speed communications to transfer data and messages over a network. As researchers and others realized the great benefit of using ARPANET to share data and information, ARPANET underwent phenomenal growth. By 1984, ARPANET had more than 1,000 individual computers linked as hosts. Today, more than 550 million hosts connect to the Internet. Some organizations connected entire networks to ARPANET to take advantage of its high-speed communications. In 1986, the National Science Foundation (NSF) connected its huge network of five super computer centers, called *NSFnet*, to ARPANET. This configuration of complex networks and hosts became known as the Internet.

Until 1995, NSFnet handled the bulk of the communications activity, or **traffic**, on the Internet. In 1995, NSFnet terminated its network on the Internet and resumed its status as a research network. Today, the Internet consists of many local, regional, national, and international networks. Numerous corporations, commercial firms, and other companies such as IBM provide networks to handle Internet traffic. Both public and private organizations own networks on the Internet. These networks, along with telephone companies such as Verizon and AT&T, cable and satellite companies, and the government, all contribute toward the internal structure of the Internet. Each organization on the Internet is responsible only for maintaining its own network. No single person, company, institution, or government agency controls or owns the Internet. The World Wide Web Consortium (*W3C*), however, oversees research and sets standards and guidelines for many areas of the Internet. The mission of the W3C is to contribute to the growth of the Web. More than 350 organizations from around the world are members of the W3C, advising, defining standards, and addressing other issues.

Internet2

Internet2 is a not-for-profit research and development project that connects more than 200 universities and 115 companies via a high-speed private network. Founded in 1996, the goal of Internet2 is to develop and test advanced network technologies that will benefit Internet users in the short-term future. These technologies require an extremely high-speed network that exceeds the capabilities of today's Internet and networks. Examples of previous Internet2 projects that are now mainstream include telemedicine, digital libraries (online books, magazines, music, movies, speeches, etc.), and faster Internet services. Current Internet2 projects include interactive high-definition video and enhanced detection and resolution of network problems.

Connecting to the Internet

Many home and small business users connect to the Internet via high-speed *broadband* Internet service. With broadband Internet service, your computer or mobile device usually is connected to the Internet the entire time it is powered on. Examples of broadband Internet service include cable, DSL, fiber, radio signals, and satellite.

- Cable Internet service provides high-speed Internet access through the cable television network via a cable modem.

- DSL (digital subscriber line) provides high-speed Internet connections using regular copper telephone lines.

- Fiber to the Premises (FTTP) uses fiber-optic cable to provide high-speed Internet access to home and business users.

- Fixed wireless provides high-speed Internet connections using a dish-shaped antenna on your house or business to communicate with a tower location via radio signals.

- A cellular radio network offers high-speed Internet connections to devices with built-in compatible technology or computers with wireless modems.

- A Wi-Fi (wireless fidelity) network uses radio signals to provide high-speed Internet connections to compatible or properly equipped wireless computers and devices.

- Satellite Internet service provides high-speed Internet connections via satellite to a satellite dish that communicates with a satellite modem.

Employees and students typically connect their computers to the Internet through a business or school network. The business or school network connects to a high-speed broadband Internet service. Many home users set up a Wi-Fi network, which sends signals to a communications device that is connected to a high-speed Internet service such as cable or DSL. Instead of using broadband Internet service, however, some home users connect to the Internet via dial-up access, which is a slower-speed technology. *Dial-up access* takes place when the modem in your computer connects to the Internet via a standard telephone line that transmits data and information using an analog (continuous wave pattern) signal. Users may opt for dial-up access because of its lower price or because broadband access is not available in their area. Mobile users access the Internet using a variety of Internet services. Most hotels and airports provide wired or wireless Internet connections as a service to travelers. Wireless Internet services, such as Wi-Fi networks, allow mobile users to connect easily to the Internet with notebook computers, smart phones, and other mobile devices while away from a telephone, cable, or other wired connection. Many public locations, such as airports, hotels, schools, shopping malls, and coffee shops, are *hot spots* that provide Wi-Fi Internet connections to users with mobile computers or devices. At public locations, you may be required to agree to terms of service, obtain a password (for example, from the hotel's front desk), or perform some other action in order to connect to the Internet. Some cities provide free Wi-Fi Internet connections to all residents.

Access Providers

An **access provider** is a business that provides individuals and organizations access to the Internet free or for a fee. For example, some Wi-Fi networks provide free access while others charge a per use fee. Other access providers often charge a fixed amount for an Internet connection, offering faster speeds or more services for higher rates. Typical monthly rates range from about $5 to $24 per month for dial-up, $13 to $70 for DSL, $20 to $75 for cable, $40 to $150 for FTTP, $30 to $80 for fixed wireless, $60 to $80 for cellular networks, and $50 to $120 for satellite. Many Internet access providers offer services such as news, weather, financial data, games, travel guides, e-mail, photo communities, and online storage to hold digital photos and other files. (A *file* is a named unit of storage.) Access providers are categorized as regional or national ISPs, online service providers, and wireless Internet service providers (Figure 2-2).

Figure 2-2 Common ways to access the Internet are through a regional or national Internet service provider, an online service provider, or a wireless Internet service provider.

An **ISP** (**Internet service provider**) is a regional or national access provider. A *regional ISP* usually provides Internet access to a specific geographic area. A *national ISP* is a business that provides Internet access in cities and towns nationwide. For dial-up access, some national ISPs provide both local and toll-free telephone numbers. Due to their larger size, national ISPs usually offer more services and have a larger technical support staff than regional ISPs. Examples of national ISPs are AT&T and EarthLink. In addition to providing Internet access, an **online service provider** (**OSP**) also has many members-only features such as instant messaging or their own customized version of a Web browser. The two more popular OSPs are AOL (America Online) and MSN (Microsoft

Network). AOL differs from many OSPs in that it provides gateway functionality to the Internet, meaning it regulates the Internet services to which members have access. AOL also provides free access to its services to any user with a broadband Internet connection.
When selecting an ISP or OSP for dial-up access, ensure it pro vides at least one local telephone number. Otherwise, long-distance telephone charges will apply for the time you connect to the Internet.
A **wireless Internet service provider**, sometimes called a wireless data provider, is a company that provides wireless Internet access to desktop and notebook computers and mobile devices, such as smart phones and portable media players, with built-in wireless capability (such as Wi-Fi) or to computers using wireless modems or wireless access devices. Wireless modems, which usually are in the form of a USB flash drive or a card that inserts in a slot in a computer or mobile device, generally dial a telephone number to establish a connection with the wireless Internet service provider. An antenna on or built into the computer or device, wireless modem, or wireless access device typically sends signals through the airwaves to communicate with a wireless Internet service provider. Some examples of wireless Internet service providers include AT&T, Boingo Wireless, Sprint Broadband Direct, T-Mobile, and Verizon Wireless.

How Data and Information Travel the Internet

Computers connected to the Internet work together to transfer data and information around the world using servers and clients and various wired and wireless transmission media. On the Internet, your computer is a client that can access data, information, and services on a variety of servers.
The inner structure of the Internet works much like a transportation system. Just as interstate highways connect major cities and carry the bulk of the automotive traffic across the country, several main transmission media carry the heaviest amount of traffic on the Internet. These major carriers of network traffic are known collectively as the *Internet backbone*.
In the United States, the transmission media that make up the Internet backbone exchange data and information at several different major cities across the country. That is, they transfer data and information from one network to another until reaching the final destination (Figure 2-3). The Internet relies on an addressing system much like the postal service to send data and information to a computer at a specific destination.

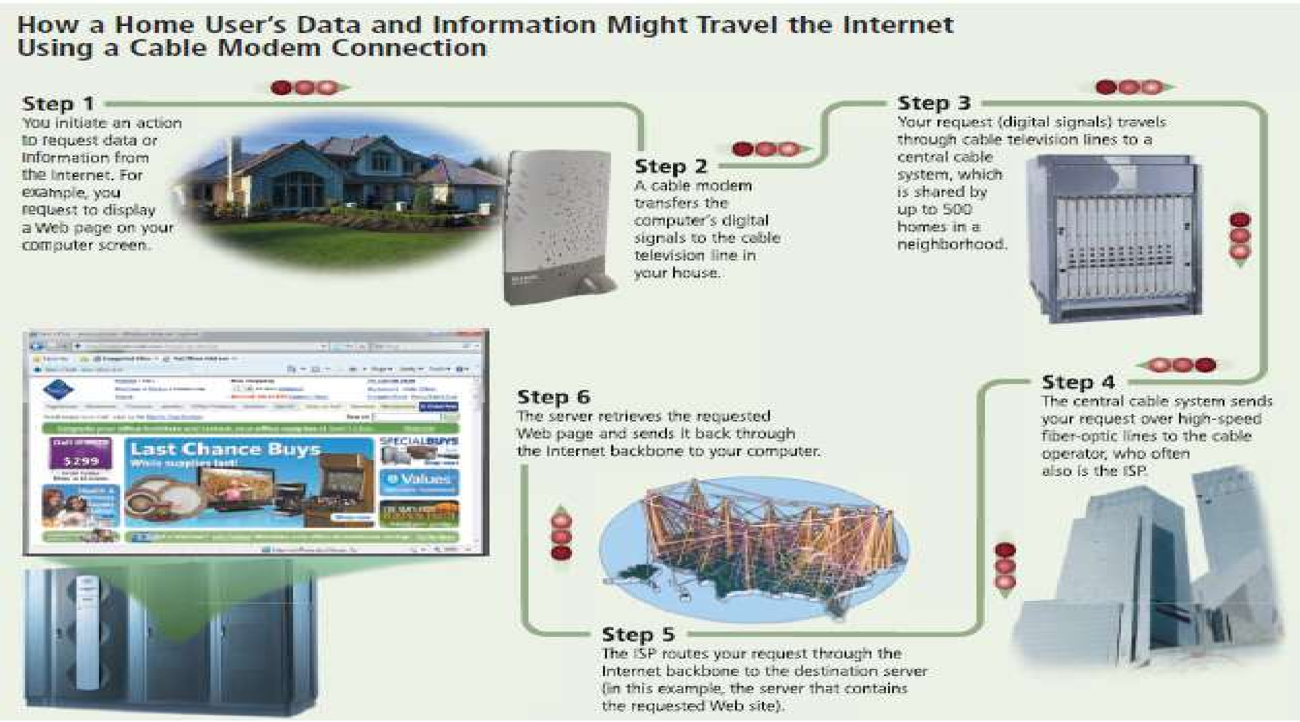


Figure 2-3 This figure shows how a home user's data and information might travel the Internet using a cable modem connection

Internet Addresses

An **IP address**, short for Internet Protocol address, is a number that uniquely identifies each computer or device connected to the Internet. The IP address usually consists of four groups of numbers, each separated by a period. The number in each group is between 0 and 255. For example, the numbers 72.14.207.99 are an IP address. In general, the first portion of each IP address identifies the network and the last portion identifies the specific computer. These all-numeric IP addresses are difficult to remember and use. Thus, the Internet supports the use of a text name that represents one or more IP addresses.

A **domain name** is the text version of an IP address. Figure 2-4 shows an IP address and its associated domain name. As with an IP address, the components of a domain name are separated by periods. The text in the domain name up to the first period identifies the type of Internet server. In Figure 2-4, for example, the www indicates a Web server.

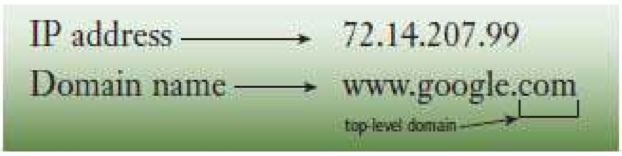


Figure 2-4 The IP address and domain name for the Google Web site

Every domain name contains a *top-level domain* (*TLD*), which is the last section of the domain name. A generic TLD (*gTLD*), such as the com in Figure 2-4 on the previous page, identifies the type of organization associated with the domain. The Internet server and gTLD portions of a domain name often are not required.
The organization that assigns and controls top-level domains is the Internet Corporation for Assigned Names and Numbers (*ICANN* pronounced EYE-can). Figure 2-5 lists some gTLDs. For TLDs such as biz, com, info, name, net, and org, you register for a domain name from a *registrar*, which is an organization that sells and manages domain names. For international Web sites outside the United States, the domain name also includes a country code TLD (*ccTLD*), which is a two-letter country code, such as au for Australia. For example, www.philips.com.au is the domain name for Philips Australia. Some smaller countries have granted use of their ccTLDs for commercial purposes, such as tv (Tuvalu) for the television/entertainment industry. The *domain name system* (*DNS*) is the method that the Internet uses to store domain names and their corresponding IP addresses. When you specify a domain name, a **DNS server** translates the domain name to its associated IP address so that data and information can be routed to the correct computer. A DNS server is an Internet server that usually is associated with an Internet access provider. For a more technical discussion about DNS servers, read the High-Tech Talk article on page 382. The growth of the Internet has led to a shortage of IP addresses. Thus, a new IP addressing scheme, called *IPv6*, may increase the number of available IP addresses. For a more technical discussion about Internet addresses and IPv6, read the High-Tech Talk article on page 110.

Examples of Generic Top-Level Domains

Generic TLD	Intended Purpose
Aero	Aviation community members
Biz	Businesses of all sizes
Cat	Catalan cultural community
Com	Commercial organizations, businesses, and companies
Coop	Business cooperatives such as credit unions and rural electric co-ops
Edu	Educational institutions
Gov	Government agencies
Info	Business organizations or individuals providing general information
jobs	Employment or human resource businesses
mil	Military organizations
mobi	Delivery and management of mobile Internet services
museum	Accredited museums
name	Individuals or families
net	Network providers or commercial companies
org	Nonprofit organizations
pro	Certified professionals such as doctors, lawyers, and accountants
tel	Internet communications
travel	Travel industry

Figure 2-5 In addition to the generic TLDs listed above, ICANN continually evaluates proposals for new TLDs.

The World Wide Web

Although many people use the terms World Wide Web and Internet interchangeably, the World Wide Web actually is a service of the Internet. While the Internet was developed in the late 1960s, the World Wide Web emerged in the early 1990s. Since then, it has grown phenomenally to become one of the more widely used Internet services.

The **World Wide Web** (*WWW*), or **Web**, consists of a worldwide collection of electronic documents. Each electronic document on the Web is called a **Web page**, which can contain text, graphics, animation, audio, and video. Additionally, Web pages usually have built-in connections to other documents.

Some Web pages are static (fixed); others are dynamic (changing). Visitors to a *static Web page* all see the same content. With a *dynamic Web page*, by contrast, visitors can customize some or all of the viewed content such as desired stock quotes, weather for a region, or ticket availability for flights.

A **Web site** is a collection of related Web pages and associated items, such as documents and pictures, stored on a Web server. A **Web server** is a computer that delivers requested Web pages to your computer. The same Web server can store multiple Web sites. Some industry experts use the term **Web 2.0** to refer to Web sites that provide a means for users to share personal information (such as social networking Web sites), allow users to modify Web site content (such as wikis, which are discussed later in this chapter), and have application software built into the site for visitors to use (such as e-mail and word processing programs).

Browsing the Web A **Web browser**, or **browser**, is application software that allows users to access and view Web pages or access Web 2.0 programs. To browse the Web, you need a computer or mobile device that is connected to the Internet and has a Web browser. The more widely used Web browsers for personal computers are Internet Explorer, Firefox, Opera, Safari, and Google Chrome. With an Internet connection established, you start a Web browser. The browser retrieves and displays a starting Web page, sometimes called the browser's home page (Figure 2-6). The initial home page that is displayed is one selected by your Web browser. You can change your browser's home page at anytime. Another use of the term, **home page**, refers to the first page that a Web site displays. Similar to a book cover or a table of contents for a Web site, the home page provides information about the Web site's purpose and content. Many Web sites, such as iGoogle, allow you to personalize the home page so that it contains areas of interest to you. The home page usually contains links to other documents, Web pages, or Web sites. A **link**, short for *hyperlink*, is a built-in connection to another related Web page or part of a Web page.

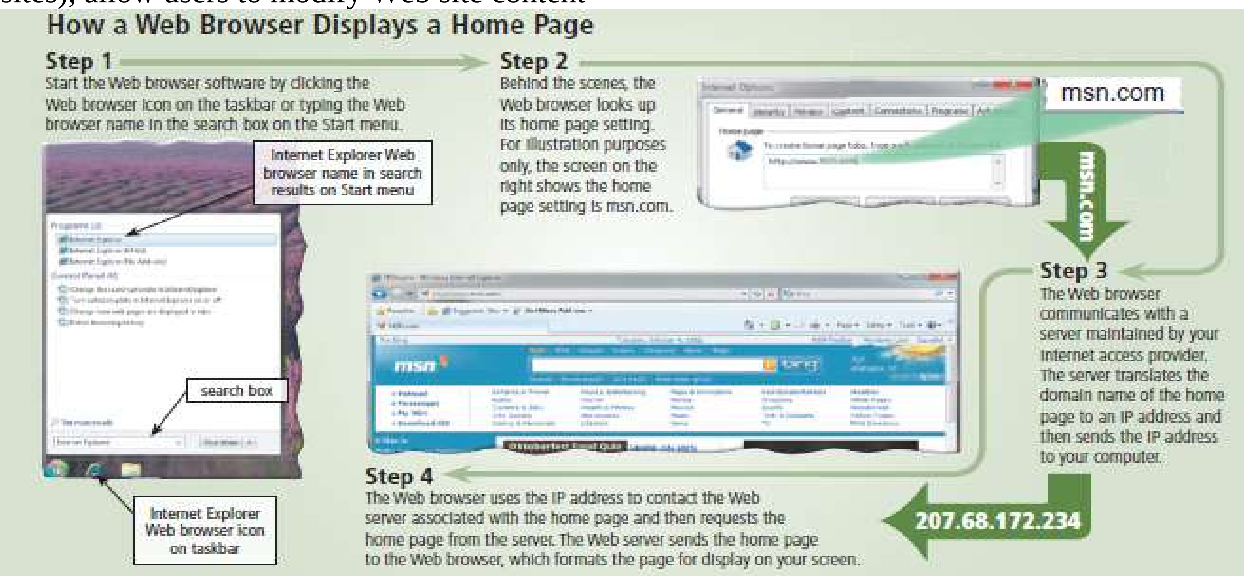


Figure 2-6 This figure shows how a Web browser displays a home page.

Internet-enabled mobile devices such as smart phones use a special type of browser, called a *microbrowser*, which is designed for their small screens and limited computing power. Many Web sites design Web pages specifically for display on a microbrowser (Figure 2-7).

For a computer or mobile device to display a Web page, the page must be downloaded. **Downloading** is the process of a computer or device receiving information, such as a Web page, from a server on the Internet. While a browser downloads a Web page, it typically displays an animated logo or icon in the browser window. The animation stops when the download is complete. The time required to download a Web page varies depending on the speed of your Internet connection and the amount of graphics involved.

Figure 2-7 Sample microbrowser screen shown on this iPhone.

Web Addresses

A Web page has a unique address, called a **URL** (*Uniform Resource Locator*) or **Web address**. For example, the home page for the United States National Park Service Web site has http://www.nps.gov as its Web address. A Web browser retrieves a Web page using its Web address.

If you know the Web address of a Web page, you can type it in the Address bar at the top of the browser window. For example, if you type the Web address http://www.nps.gov/ grsm/planyourvisit/wildlifeviewing.htm in the Address bar and then press the enter key, the browser downloads and displays the Web page shown in Figure 2-8.

A Web address consists of a protocol, domain name, and sometimes the path to a specific Web page or location on a Web page. Many Web page addresses begin with http://. The *http*, which stands for *Hypertext Transfer Protocol*, is a set of rules that de fines how pages transfer on the Internet.

To help minimize errors, many browsers and Web sites do not require you enter the http:// and www portions of the Web address in the Address bar. If you enter an incorrect Web address, the browser may display a list of similar addresses or related Web sites from which you can select. When you enter the Web address, http://www.nps.gov/grsm/planyourvisit/ wildlifeviewing.htm in the Web browser, it sends a request to the Web server that contains the nps.gov Web site. The server then retrieves the Web page named wildlifeviewing.htm that is located in the grsm/plan your visit path and delivers it to your browser, which then displays the Web page on the screen. To save time, many users create bookmarks for their frequently visited Web pages. A *bookmark*, or *favorite*, is a saved Web address that you access by clicking its name in a list. That is, instead of entering a Web address to display a Web page, you can click a previously saved bookmark.

When you enter a Web address in a browser, you request, or *pull*, information from a Web server. Some Web servers also can *push* content to your computer at regular intervals or whenever updates are made to the site. For example, some Web servers provide the capability of displaying current sporting event scores or weather reports on your computer screen. For information about useful Web sites and their associated Web addresses, read the Making Use of the Web feature that follows this chapter.

Navigating Web Pages

Most Web pages contain hypertext or hypermedia links. *Hypertext* refers to links in text-based documents, whereas *hypermedia* combines text-based links with graphic, audio, and video links. Links allow you to obtain information in a nonlinear way. That is, instead of accessing topics in a specified order, you move directly to a topic of interest. Branching from one related topic to another in a nonlinear fashion is what makes links so powerful. Some people use the phrase, **surfing the Web**, to refer to the activity of using links to explore the Web.

Figure 2-8 After entering http://www.nps.gov/grsm/planyourvisit/wildlifeviewing.htm as the Web address in the Address bar, this Web page at the United States National Park Service Web site is displayed.

A link can be text or an image. Text links may be underlined and/or displayed in a color different from other text on the Web page. Pointing to, or positioning the pointer on, a link on the screen typically changes the shape of the pointer to a small hand with a pointing index finger. Pointing to a link also sometimes causes the link to change in appearance or play a sound. For example, an underline may disappear, the text may change color, the image may change, etc. The Web page shown in Figure 2-9 contains a variety of link types, with the pointer on one of the links. Each link on a Web page corresponds to a Web address or a document. To activate a link, you *click* it, that is, point to the link and then press the left mouse button. Clicking a link causes the Web page or document associated with the link to be displayed on the screen. The linked object might be on the same Web page, a different Web page at the same Web site, or a separate Web page at a different Web site in another city or country. To remind you visually that you have clicked a link, a text link often changes color after you click it.

Most current Web browsers support **tabbed browsing**, where the top of the browser displays a tab (similar to a file folder tab) for each Web page you open (shown in Figure 2-9). To move from one open Web page to another, you click the tab in the Web browser. Tabbed browsing allows users to have multiple home pages that automatically open when the browser starts. You also can organize tabs in a group, called a tab group, and save the group as a favorite, so that at any time you can display all tabs at once. Because some Web sites attempt to track your browsing habits or gather personal information, some current Web browsers include a feature that allows you to disable and/or more tightly control the dissemination of your browsing habits and personal information.

Figure 2-9 This browser window has several open tabs. The current tab shows a Web page that has various types of links

Searching the Web

The Web is a worldwide resource of information. A primary reason that people use the Web is to search for specific information, including text, pictures, music, and video. The first step in successful searching is to identify the main idea or concept in the topic about which you are seeking information.

Determine any synonyms, alternate spellings, or variant word forms for the topic. Then, use a search tool to locate the information. Two types of search tools are search engines and subject directories. A **search engine** is a program that finds Web sites, Web pages, images, videos, news, maps, and other information related to a specific topic. A **subject directory** classifies Web pages in an organized set of categories, such as sports or shopping, and related subcategories.

Some Web sites offer the functionality of both a search engine and a subject directory. The table in Figure 2-10 lists the Web addresses of several popular general-purpose search engines and subject directories. **Search Engines** A search engine is helpful in locating information for which you do not know an exact Web address or are not seeking a particular Web site. Thousands of search engines are available. Some search through Web pages for all types of information. Other search engines can restrict their searches to a specific type of information, such as the following items:

• Images — pictures, diagrams, and drawings.
• Videos — home videos, music videos, television programs, and movie clips.
• Audio — music, songs, recordings, and sounds.
• Publications — news articles, journals, and books.
• Maps — maps of a business or address, or driving directions to a destination.

• People or Businesses — addresses and telephone numbers.
• Blogs — specific opinions and ideas of others.

Search engines require that you enter a word or phrase, called **search text** or *search query* that describes the item you want to find. Each word in the search text is known as a *keyword*. Your search text can be broad, such as spring break destinations, or more specific, such as Walt Disney World. Search engines often respond with thousands of results, whose content varies depending on the type of information you are seeking. Some results are links to Web pages or articles; other results are media, such as images or videos. You may find that many items that appear in the search results have little or no bearing on the item you are seeking. You can eliminate the superfluous items in your search results by carefully crafting search text that limits the search. If you misspell search text, many search engines identify alternative search text. Some also provide suggested keywords, links, and/or images as you begin typing your search text.

Widely Used Search Tools

Directory Search Tool	Web Address	Search Engine	Subject Directory
A9	a9.com	X	
AlltheWeb	alltheweb.com	X	
AltaVista	altavista.com	X	
AOL Search	search.aol.com	X	
Ask	ask.com	X	
Bing	bing.com	X	
Cuil(pronounced cool)	cuil.com	X	
Dogpile	dogpile.com	X	
Excite	excite.com	X	X
Gigablast	gigablast.com	X	X
Google	google.com	X	X
Lycos	lycos.com	X	
MSN	msn.com	X	X
Open Directory Project	dmoz.org	X	X
WebCrawler	webcrawler.com	X	
Yahoo!	yahoo.com	X	X

Figure 2-10 Popular search engines and subject directories.

Figure 2-11 shows one way to use the Google search engine to search for the text, Aspen Colorado ski resorts. The results of the search, called *hits*, shown in Step 3 include nearly 150,000 links to Web pages that reference Aspen Colorado ski resorts. Each hit in the list has a link that, when clicked, displays an associated Web site or Web page. Most search engines sequence the hits based on how close the words in the search text are to one another in the titles and descriptions of the hits. Thus, the first few links probably contain more relevant information.

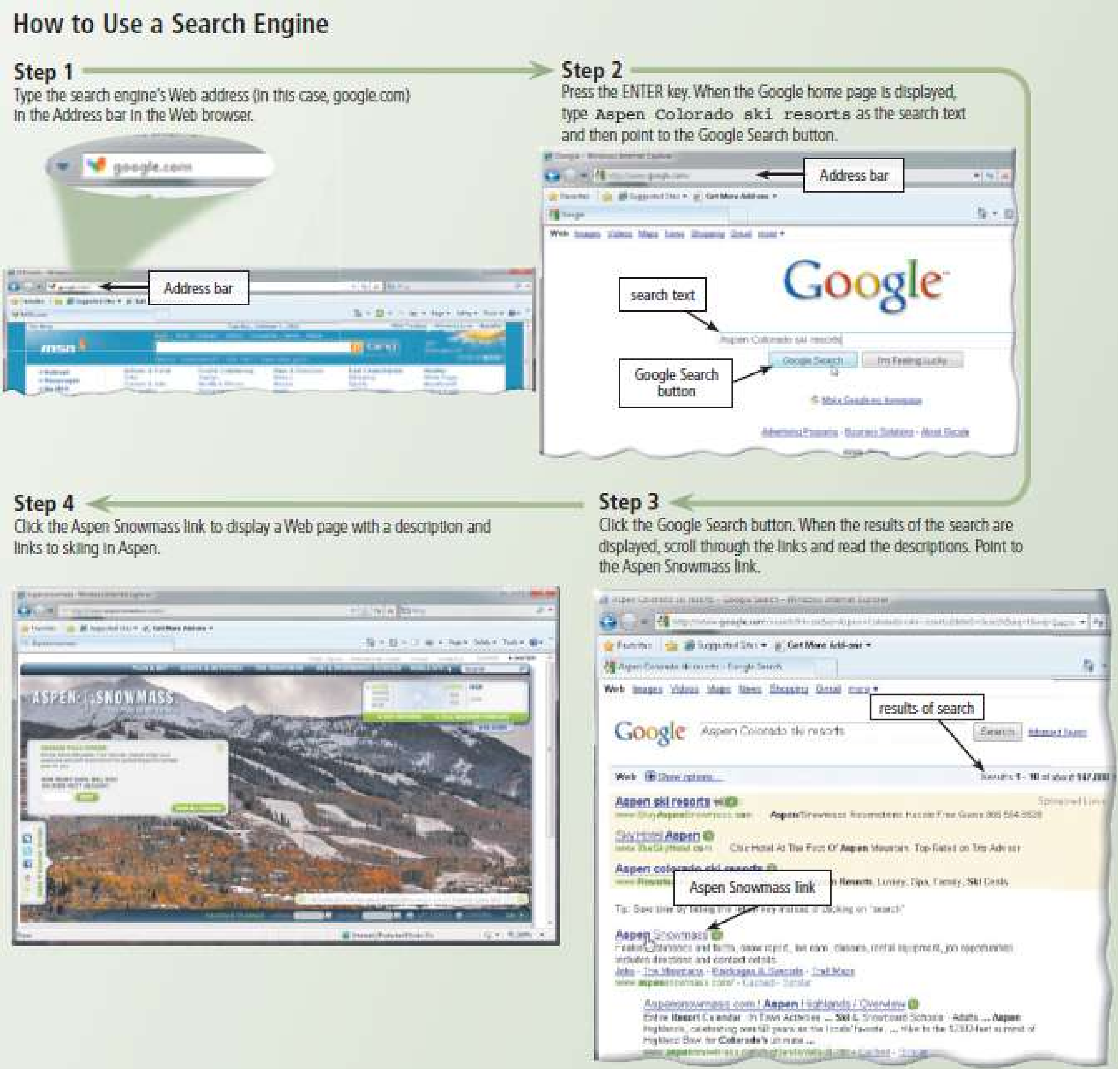


Figure 2-11 This figure shows how to use a search engine.

Some Web browsers contain an Instant Search box that, when filled in, uses a predefined or default search engine to perform searches (Figure 2-12). Using the Instant Search box eliminates the steps of displaying the search engine's Web page prior to entering the search text.

If you enter a phrase with spaces between the words in the search text, most search engines display results (hits) that include all of the words, except for common words (e.g., to, the, and). The table in Figure 2-13 lists some operators you can include in your search text to refine your search. Instead of using operators to refine your search text, many search engines have an Advanced Search feature that displays a form that assists with refining your search.

Figure 2-12 Using the Instant Search box combines Steps 1 and 2 in Figure 2-11.

Search Engine Operators			
Operator	**Description**	**Examples**	**Explanation**
Space or +	Display hits that include specific words.	art + music art music	Results have both words art and music — in any order.
OR	Display hits that include only one word from a list.	dog OR puppy dog OR puppy OR canine	Results have either the word dog or puppy. Results have the word dog or puppy or canine.
( )	Combine hits that include specific words with those that include only one word from a list.	Kalamazoo Michigan (pizza OR subs)	Results have both words Kalamazoo Michigan and either the word, pizza, or the word, subs.
-	Exclude a word from the search results.	automobile -convertible	Results include automobile but do not include convertible.
" "	Search for an exact phrase in a certain order.	"19th century literature"	Results have the exact phrase, 19th century literature.
*	Substitute characters in place of the asterisk.	writer*	Results include any word that begins with writer (e.g., writer, writers, writer's).

Figure 2-13 Use search engine operators to help refine a search.

Other techniques you can use to improve your searches include the following: • Use specific nouns. • Put the most important terms first in the search text.
• List all possible spellings, for example, email, e-mail.
• Before using a search engine, read its Help information.
• If the search is unsuccessful with one search engine, try another.
Some search engines that work with navigation devices are location based, meaning they display results related to the device's current geographical position. For example, your mobile device can display all gas stations within a certain distance of your current location. Many search engines use a program called a *spider* to build and maintain lists of words found on Web sites. When you enter search text, the search engine scans this prebuilt list for hits. The more sophisticated the search engine combined with precise search criteria, the more rapid the response and effective the search. To learn more about searching for information, complete the Learn How To 2 activity on pages 120 and 121.

Subject Directories A subject directory provides categorized lists of links arranged by subject (Figure 2-14). Using this search tool, you locate a particular topic by clicking links through different levels, moving from the general to the specific. Each time you click a category link, the subject directory displays a list of subcategory links, from which you again choose. You continue in this fashion until the search tool displays a list of Web pages about the desired topic. The major disadvantage with a subject directory is that users have difficulty deciding which categories to choose as they work through the menus of links presented.

Types of Web Sites

Thirteen types of Web sites are portal, news, informational, business/ marketing, blog, wiki, online social network, educational, entertainment, advocacy, Web application, content aggregator, and personal (Figure 2-15). Many Web sites fall in more than one of these categories.

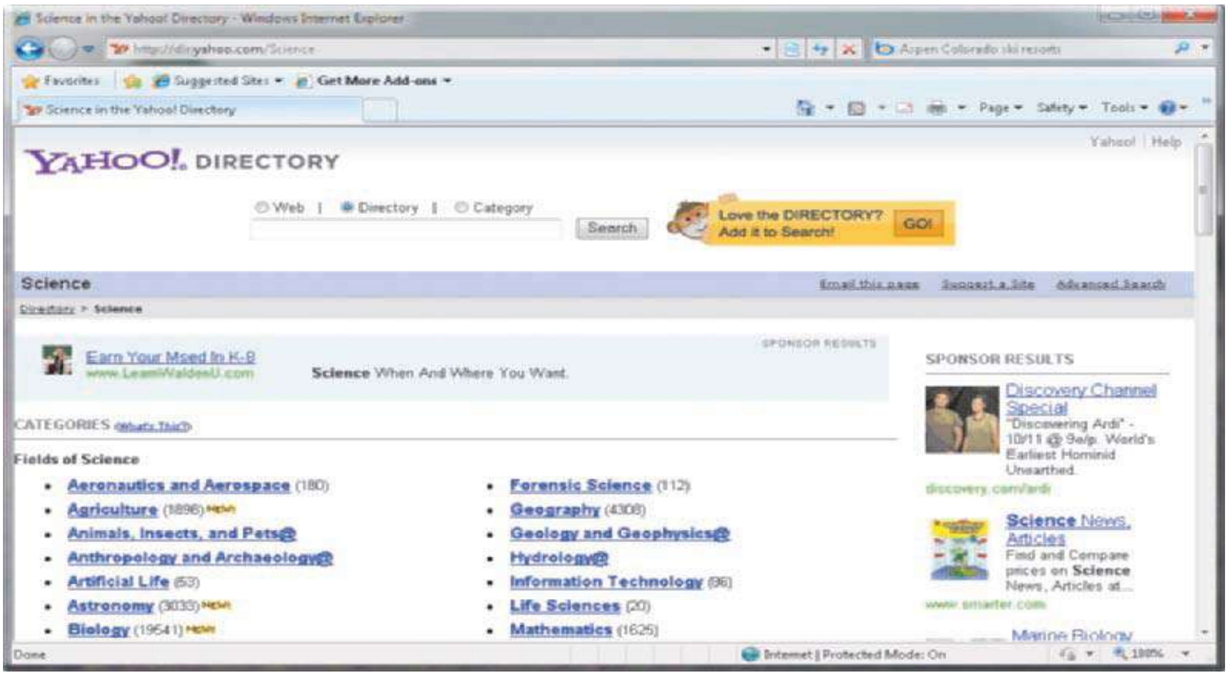


Figure 2-14 A subject directory provides categorized lists of links.

Portal A **portal** is a Web site that offers a variety of Internet services from a single, convenient location (Figure 2-15a). Most portals offer these free services: search engine; news; sports and weather; Web publishing; reference tools such as yellow pages, stock quotes, and maps; shopping; and e-mail and other communications services. Many portals have online communities. An **online community** is a Web site that joins a specific group of people with similar interests or relationships. These communities may offer online photo albums, chat rooms, and other services to facilitate communications among members. Popular portals include AltaVista, AOL, Excite, GO.com, iGoogle, Lycos, MSN, and Yahoo!. A *wireless portal* is a portal designed for Internet-enabled mobile devices.

News A news Web site contains newsworthy material including stories and articles relating to current events, life, money, sports, and the weather (Figure 2-15b). Many magazines and newspapers sponsor Web sites that provide summaries of printed articles, as well as articles not included in the printed versions. News papers and television and radio stations are some of the media that maintain news Web sites.

Informational An informational Web site contains factual information (Figure 2-15c). Many United States government agencies have informational Web sites providing information such as census data, tax codes, and the congressional budget. Other organizations provide information such as public transportation schedules and published research findings.

Business/Marketing A business/marketing Web site contains content that promotes or sells products or services (Figure 2-15d). Nearly every enterprise has a business/marketing Web site. Allstate Insurance Company, Dell Inc., General Motors Corporation, Kraft Foods Inc., and Walt Disney Company all have business/marketing Web sites. Many of these enterprises also allow you to purchase their products or services online.

Figure 2-15 Types of Web sites. *(Continued on next page)*

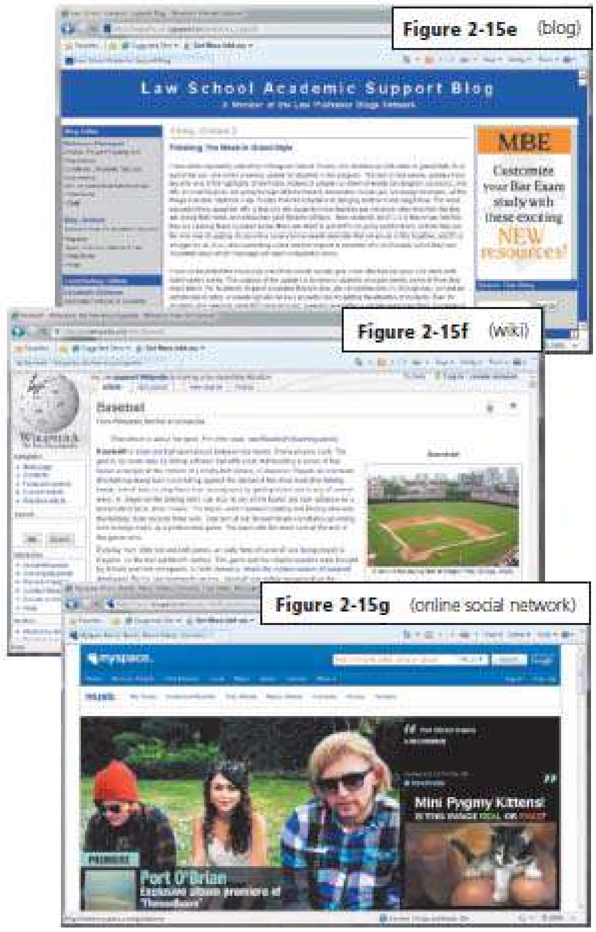


Figure 2-15 Types of Web sites. *(continued)*

Blog A **blog**, short for *Weblog*, is an informal Web site consisting of time-stamped articles, or posts, in a diary or journal format, usually listed in reverse chronological order (Figure 2-15e). A blog that contains video clips is called a **video blog**, or *vlog*. A **microblog** allows users to publish short messages, usually between 100 and 200 characters, for others to read. Twitter is a popular microblog. The term *blogosphere* refers to the worldwide collection of blogs, and the *vlogosphere* refers to all vlogs worldwide. Blogs reflect the interests, opinions, and personalities of the author, called the *blogger* or *vlogger* (for vlog author), and sometimes site visitors. Blogs have become an important means of worldwide communications. Businesses create blogs to communicate with employees, customers, and vendors. Teachers create blogs to collaborate with other teachers and students. Home users create blogs to share aspects of their personal life with family, friends, and others.

Wiki A **wiki** is a collaborative Web site that allows users to create, add to, modify, or delete the Web site content via their Web browser. Many wikis are open to modification by the general public. Wikis usually collect recent edits on a Web page so that someone can review them for accuracy. The difference between a wiki and a blog is that users cannot modify original posts made by the blogger. A popular wiki is Wikipedia, a free Web encyclopedia (Figure 2-15f).

Online Social Network
An **online social network**, also called a **social networking Web site**, is a Web site that encourages members in its online community to share their interests, ideas, stories, photos, music, and videos with other registered users (Figure 2-15g). Most include chat rooms, newsgroups, and other communications services.

Popular social networking Web sites include MySpace and Facebook, with Facebook alone boasting more than 300 million active users. In some social networking Web sites, such as Second Life, users assume an imaginary identity and interact with other users in a role-playing type of environment.

A **media sharing Web site** is a specific type of online social network that enables members to share media such as photos, music, and videos. Flickr, Fotki, and Webshots are popular photo sharing communities; PixelFish and YouTube are popular video sharing communities.

Educational An educational Web site offers exciting, challenging avenues for formal and informal teaching and learning (Figure 2-15h). On the Web, you can learn how airplanes fly or how to cook a meal. For a more structured learning experience, companies provide online training to employees; and colleges offer online classes and degrees. Instructors often use the Web to enhance classroom teaching by publishing course materials, grades, and other pertinent class information.

Entertainment An entertainment Web site offers an interactive and engaging environment (Figure 2-15i). Popular entertainment Web sites offer music, videos, sports, games, ongoing Web episodes, sweepstakes, chat rooms, and more. Sophisticated entertainment Web sites often partner with other technologies. For example, you can cast your vote about a topic on a television show.

Advocacy An advocacy Web site contains content that describes a cause, opinion, or idea (Figure 2-15j). These Web sites usually present views of a particular group or association. Sponsors of advocacy Web sites include the Democratic National Committee, the Republican National Committee, the Society for the Prevention of Cruelty to Animals, and the Society to Protect Human Rights.

Web Application A **Web application**, or *Web app*, is a Web site that allows users to access and interact with software through a Web browser on any computer or device that is connected to the Internet. Some Web applications provide free access to their software (Figure 2-15k). Others offer part of their software free and charge for access to more comprehensive features or when a particular action is requested. Examples of Web applications include Google Docs (word processing, spreadsheets, presentations), TurboTax Online (tax preparation), and Windows Live Hotmail (e-mail).

Content Aggregator A *content aggregator* is a business that gathers and organizes Web content and then distributes, or feeds, the content to subscribers for free or a fee (Figure 2-15l). Examples of distributed content include news, music, video, and pictures. Subscribers select content in which they are interested. Whenever the selected content changes, it is downloaded automatically (pushed) to the subscriber’s computer or mobile device.

Figure 2-15 Types of Web sites. *(continued on next page)*

RSS 2.0, which stands for *Really Simple Syndication*, is a specification that some content aggregators use to distribute content to subscribers. *Atom* is another specification sometimes used by content aggregators to distribute content. Some current browsers include a feature, such as Internet Explorer's *WebSlices*, that enables content aggregators to mark sections of their Web pages as feeds to which users can subscribe.

Personal A private individual or family not usually associated with any organization may maintain a personal Web site or just a single Web page (Figure 2-15m). People publish personal Web pages for a variety of reasons. Some are job hunting. Others simply want to share life experiences with the world.

Figure 2-15 Types of Web sites. *(continued)*

Evaluating a Web Site

Do not assume that information presented on the Web is correct or accurate. Any person, company, or organization can publish a Web page on the Internet. No one oversees the content of these Web pages. Figure 2-16 lists guidelines for assessing the value of a Web site or Web page before relying on its content.

Criteria for Evaluating a Web Site's Content

Evaluation Criteria	Reliable Web Sites
Affiliation	A reputable institution should support the Web site without bias in the information.
Audience	The Web site should be written at an appropriate level.
Authority	The Web site should list the author and the appropriate credentials.
Content	The Web site should be well organized and the links should work.
Currency	The information on the Web page should be current.
Design	The pages at the Web site should download quickly, be visually pleasing, and easy to navigate.
Objectivity	The Web site should contain little advertising and be free of preconceptions.

Figure 2-16 Criteria for evaluating a Web site's content.

Multimedia on the Web

Most Web pages include more than just formatted text and links. The more exciting Web pages use multimedia. **Multimedia** refers to any application that combines text with graphics, animation, audio, video, and/or virtual reality. Multimedia brings a Web page to life, increases the types of information available on the Web, expands the Web's potential uses, and makes the Internet a more entertaining place to explore. Multimedia Web pages often require specific hardware and software and take more time to download because they contain large graphics files and video or audio clips. Many Web sites have an option that allows visitors to disable multimedia, for example, if they have a slower-speed Internet connection. The sections that follow discuss how the Web uses graphics, animation, audio, video, and virtual reality.

Graphics A **graphic**, or *graphical image*, is a digital representation of nontext information such as a drawing, chart, or photo. Today, many Web pages use colorful graphical designs and images to convey messages (Figure 2-17). The Web contains countless images about a variety of subjects. You can download many of these images at no cost and use them for noncommercial purposes. Recall that downloading is the process of transferring an object from the Web to your computer. For example, you can insert images into greeting cards, announcements, and other documents. Of the graphics formats that exist on the Web (Figure 2-18), the two more common are JPEG and GIF formats. *JPEG* (pronounced JAY-peg) is a format that compresses graphics to reduce their file size, which means the file takes up less storage space. Smaller file sizes result in faster downloading of Web pages because small files transmit faster than large files. The more compressed the file, the smaller the image and the lower the quality. The goal with JPEG graphics is to reach a balance between image quality and file size. Digital photos often use the JPEG format. *GIF* (pronounced jiff) graphics also use compression techniques to reduce file sizes. The GIF format works best for images that have only a few distinct colors, such as company logos. The newer *PNG* (pronounced ping) graphics format improves upon the GIF format, and thus may eventually replace the GIF format. The BMP and TIFF formats listed in Figure 2-18 may require special viewer software, and they have larger file sizes. Thus, these formats are not used on the Web as frequently as JPEG, GIF, and PNG formats.

Figure 2-17 This Web page uses colorful graphical designs and images to convey its messages

Graphics Formats Used on the Web		
Abbreviation	**Name**	**Uses**
BMP	Bitmap	Desktop background, scanned images
GIF	Graphics Interchange Format	Simple diagrams, shapes, images with few colors
JPEG	Joint Photographic Experts Group	Digital camera photos
PNG	Portable Network Graphics	Web graphics
TIFF	Tagged Image File Format	Photos used by printing industry

Figure 2-18 The Web uses graphics file formats for images.

Some Web sites use thumbnails on their pages because graphics can be time-consuming to display. A *thumbnail* is a small version of a larger graphic. You usually can click a thumbnail to display a larger image (Figure 2-19).

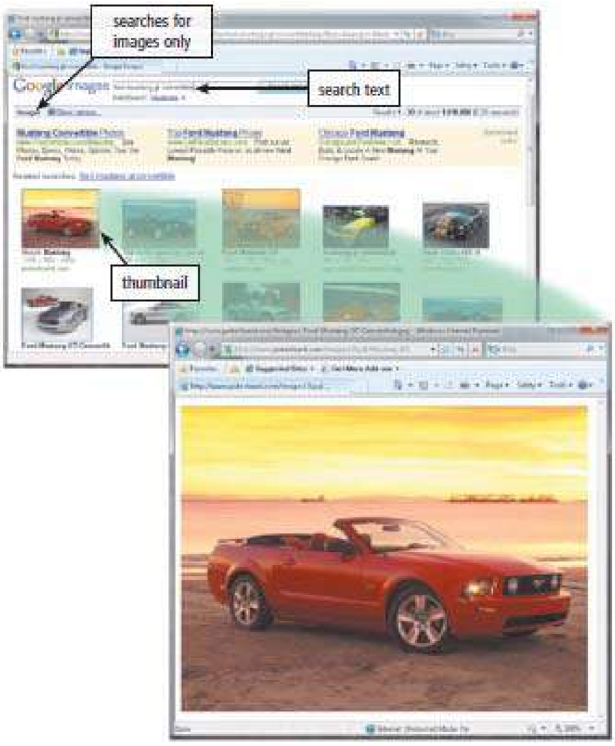


Figure 2-19 Clicking the thumbnail in the top screen displays a larger image in a separate window.

Animation Many Web pages use **animation**, which is the appearance of motion created by displaying a series of still images in sequence. Animation can make Web pages more visually interesting or draw attention to important information or links. For example, text that animates by scrolling across the screen can serve as a ticker to display stock updates, news, sports scores, weather, or other information. Web-based games often use animation. Web page developers add animation to Web pages using a variety of techniques. Web page authoring programs, such as Adobe Flash and Microsoft Expression Web, enable Web site developers to combine animation and interactivity in Web pages. Developers unfamiliar with Web page authoring programs can create an *animated GIF*, which combines several GIF images in a single GIF file.

Audio On the Web, you can listen to audio clips and live audio. **Audio** includes music, speech, or any other sound. Simple applications consist of individual audio files available for download to a computer or device. Once downloaded, you can play (listen to) the contents of these files. Some common Web audio file formats are listed in Figure 2-20. Audio files are compressed to reduce their file sizes. For example, the **MP3** format reduces an audio file to about one-tenth its original size, while preserving much of the original quality of the sound. Some music publishers have Web sites that allow users to download sample tracks free to persuade them to buy all the songs contained on the CD. Others allow a user to purchase and download an entire CD (Figure 2-21). It is legal to download copyrighted music only if the song's copyright holder has granted permission for users to download and play the song. To listen to an audio file on your computer, you need special software called a **player**. Most current operating systems contain a player, for example, Windows Media Player. Some audio files, however, might require you to download a player. Players available for download include iTunes and RealPlayer. You can download the players free from the Web; some are plug-ins, which are discussed later in this chapter. Some applications on the Web use streaming audio. **Streaming** is the process of transferring data in a continuous and even flow. Streaming allows users to access and use a file while it is transmitting. For example, *streaming audio* enables you to listen to music as it downloads to your computer. Many radio and television stations use streaming audio to broadcast music, interviews, talk shows, sporting events, music videos, news, live concerts, and other segments. Podcasting is another popular method of distributing audio. A *podcast* is recorded audio, usually an MP3 file, stored on a Web site that can be downloaded to a computer or a portable media player such as an iPod. Examples of podcasts include music, radio shows, news stories, classroom lectures, political messages, and television commentaries. Podcasters register their podcasts with content aggregators. Subscribers select podcast feeds they want to be downloaded automatically whenever they connect. Most smart phone users who subscribe to a wireless Internet service provider can listen to streaming audio and podcasts.

Graphics Formats Used on the Web

Format	Description	Format	Description
AAC	Advanced Audio Coding	WAV	Windows waveform
AIFF	Audio Interchange File Format	WMA	Windows Media Audio (part of Windows Media framework
ASF	Advanced Streaming (or Systems) Format (part of Windows Media framework)	RA	RealAudio sound file (supported by RealPlayer)
MP3	Moving Pictures Experts Group Audio Layer 3 (MPEG-3)	QT	QuickTime audio, video, or 3-D animation
Ogg	Free, unpatented audio and video format		

Figure 2-20 Popular Web audio file formats.

Figure 2-21 This figure shows how to purchase and download music using iTunes.

Video On the Web, you can view video clips or watch live video. **Video** consists of images displayed in motion. Most video also has accompanying audio. You can use the Internet to watch live and/or pre recorded coverage of your favorite television programs or enjoy a live performance of your favorite vocalist. You can upload, share, or view video clips at a video sharing Web site such as YouTube (Figure 2-22). Educators, politicians, and businesses are using video blogs and video podcasts to engage students, voters, and consumers. Simple video applications on the Web consist of individual video files, such as movie or television clips, that you must download completely before you can play them on the computer. Video files often are compressed because they are quite large in size. These clips also are short in length, usually less than 10 minutes, because they can take a long time to download. The Moving Pictures Experts Group (*MPEG*) defines a popular video compression standard, a widely used one called *MPEG-4* or *MP4.* Another popular video format is Adobe Flash. As with streaming audio, *streaming video* allows you to view longer or live video images as they download to your computer. Widely used standards supported by most Web browsers for transmitting streaming video data on the Internet are AVI (Audio Video Interleaved), QuickTime, Windows Media Format, and RealVideo. Like RealAudio, RealVideo is supported by RealPlayer.

Figure 2-22 A video of a horse race.

Virtual Reality Virtual reality (**VR**) is the use of computers to simulate a real or imagined environment that appears as a three-dimensional (3-D) space. VR involves the display of 3-D images that users explore and manipulate interactively. Using special VR software, a Web developer creates an entire 3-D environment that contains infinite space and depth, called a *VR world*. A VR world, for example, might show a house for sale. Potential buyers walk through rooms in the VR house by moving an input device forward, backward, or to the side.

Games and simulations on optical disc or on the Web often use VR (Figure 2-23). Many practical applications of VR also exist. Science educators create VR models of molecules, organisms, and other structures for students to examine. Companies use VR to showcase products or create advertisements. Architects create VR models of buildings and rooms so that clients can see how a completed construction project will look before it is built.

Plug-ins Most Web browsers have the capability of displaying basic multimedia elements on a Web page. Sometimes, a browser might need an additional program, called a plug-in. A **plug-in**, or *add-on*, is a program that extends the capability of a browser. You can download many plug-ins at no cost from various Web sites (Figure 2-24). Some plugins run on all sizes of personal computers and mobile devices. Others have special versions for mobile devices.

Web Publishing

Before the World Wide Web, the means to share opinions and ideas with others easily and inexpensively was limited to the media, classroom, work, or social environments. Generating an advertisement or publication that could reach a massive audience required much expense. Today, businesses and individuals convey information to millions of people by creating their own Web pages. The content of the Web pages ranges from news stories to product information to blogs

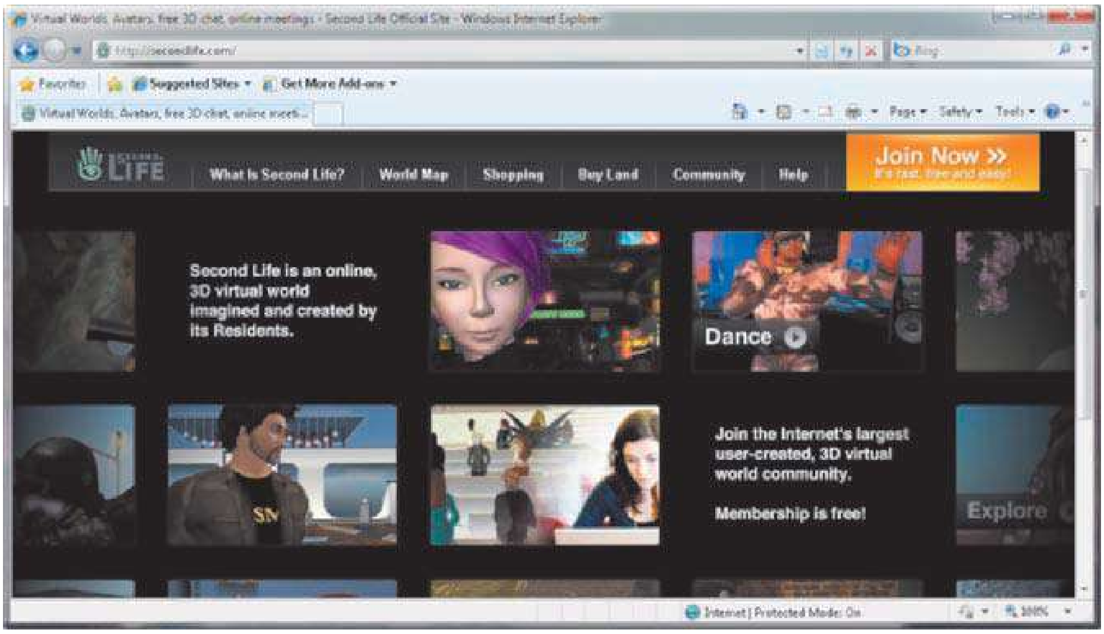


Figure 2-23 Residents (users) of the Second Life online social network interact with other online residents (users) in a VR world.

Popular Plug-Ins			
Plug-In Application	**Description**		**Web Address**
Acrobat Reader	Get ADOBE® READER®	View, navigate, and print Portable Document Format (PDF) files — documents formatted to look just as they look in print	adobe.com
Flash Player	Get ADOBE® FLASH® PLAYER	View dazzling graphics and animation, hear outstanding sound and music, display Web pages across an entire screen	adobe.com
Java	Get it Now	Enable Web browser to run programs written in Java, which add interactivity to Web pages	java.com
QuickTime	Get QuickTime	View animation, music, audio, video, and VR panoramas and objects directly on a Web page	apple.com
RealPlayer	real RealPlayer DOWNLOAD	Listen to live and on-demand near-CD-quality audio and newscast-quality video, stream audio and video content for faster viewing, play MP3 files, create music CDs	real.com
Shockwave Player	Get ADOBE® SHOCKWAVE® PLAYER	Experience dynamic interactive multimedia, 3-D graphics, and streaming audio	adobe.com
Silverlight	Install Microsoft® Silverlight™	Experience high-definition video, high-resolution interactive multimedia, and streaming audio and video	microsoft.com
Windows Media Player	Windows Media Player	Listen to live and on-demand audio, play or edit WMA and MP3 files, burn CDs, and watch DVD movies	microsoft.com

Figure 2-24 Most plug-ins can be downloaded free from the Web.

Web publishing is the development and maintenance of Web pages. To develop a Web page, you do not have to be a computer programmer. For the small business or home user, Web publishing is fairly easy as long as you have the proper tools. To learn more about how to publish a document on the Web, complete the Learn How To 3 activity on page 121.

The five major steps in Web publishing are as follows:

1. **Plan a Web site.**

Think about issues that could affect the design of the Web site. Identify the purpose of the

Web site and the characteristics of the people whom you want to visit the Web site. Determine ways to differentiate your Web site from other similar ones.

2. **Analyze and design a Web site.**
Design the layout of elements of the Web site such as links, text, graphics, animation, audio, video, and virtual reality. Required hardware may include a digital camera, Web cam, scanner, sound card, and microphone.

3. **Create a Web site.**
Use a word processing program to create basic Web pages that contain text and graphics. Use Web page authoring software to create more sophisticated Web sites that include text, graphics, animation, audio, video, and special effects. For advanced features such as managing users, passwords, chat rooms, and e-mail, you may need to purchase specialized Web site management software.

4. **Deploy a Web site.**
Transfer the Web pages from your computer to a Web server. Many Internet access providers offer their customers storage space on a Web server. Another option is a Web hosting service, which provides storage space on a Web server for a reasonable monthly fee. To help others locate your Web page, register your Web address with various search engines to ensure your site will appear in the hit lists for searches for certain keywords.

5. **Maintain a Web site.**
Visit the Web site regularly to ensure the Web site contents are current and all links work properly.

E-Commerce

E-commerce, short for *electronic commerce*, is a business transaction that occurs over an electronic network such as the Internet. Anyone with access to a computer or mobile device, an Internet connection, and a means to pay for purchased goods or services can participate in e-commerce. Some people use the term *m-commerce* (mobile commerce) to identify e-commerce that takes place using mobile devices.
Popular uses of e-commerce by consumers include retail, finance, travel, entertainment, and health. Users can purchase just about any product or service on the Web, including groceries, flowers, books, computers, music, movies, cars, airline tickets, and concert tickets. They also can pay bills, invest in stocks, make airline reservations, reserve a hotel or car, and fill prescriptions. Three types of e-commerce are businessto-consumer, consumer-to-consumer, and business-to-business. *Business-to-consumer (B2C) e-commerce* consists of the sale of goods and services to the general public. For example, Apple has a B2C Web site. Instead of visiting a retail store to purchase an iPod, customers can order one directly from Apple's Web site. A customer (consumer) visits an online business through an **electronic storefront**, which contains product descriptions, images, and a shopping cart. The **shopping cart** allows the customer to collect purchases. When ready to complete the sale, the customer enters personal data and the method of payment, which should be through a secure Internet connection. *E-retail*, short for electronic retail, occurs when businesses use the Web to sell products (Figure 2-25).

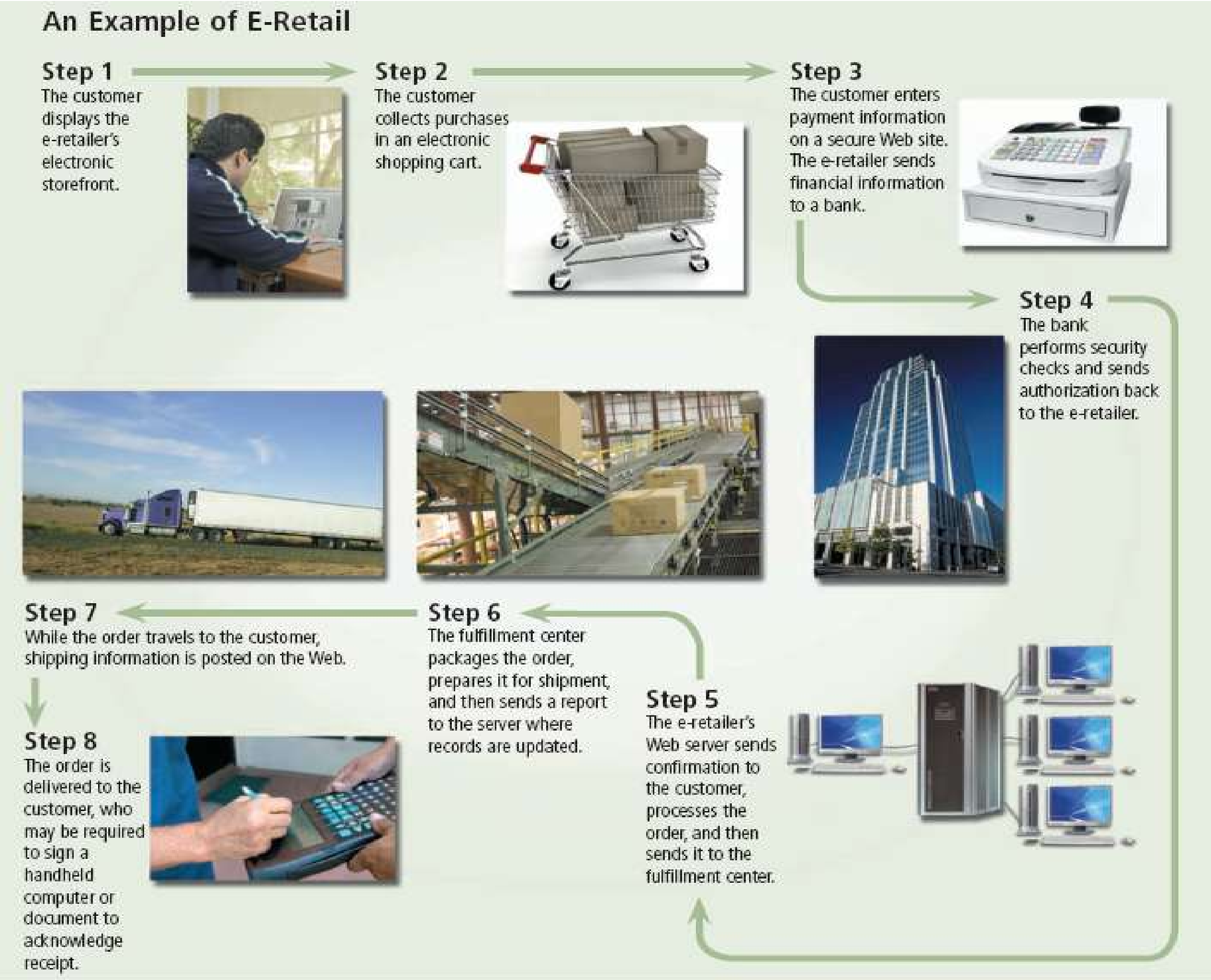


Figure 2-25 This figure shows an example of e-retail.

Consumer-to-consumer (*C2C*) *e-commerce* occurs when one consumer sells directly to another, such as in an online auction. With an **online auction**, users bid on an item being sold by someone else. The highest bidder at the end of the bidding period purchases the item. eBay is one of the more popular online auction Web sites. As an alternative to entering credit card, bank account, or other financial information online, some shopping and auction Web sites allow consumers to use an online payment service such as PayPal or Google Checkout. To use an online payment service, you create an account that is linked to your credit card or funds at a financial institution. When you make a purchase, you use your online payment service account, which transfers money for you without revealing your financial information.
Most e-commerce, though, actually takes place between businesses, which is called *business-to-business (B2B) e-commerce*. Businesses often provide goods and services to other businesses, such as online advertising, recruiting, credit, sales, market research, technical support, and training. For example, some MasterCard and Visa credit card companies provide corporations with Web-based purchasing, tracking, and transaction downloading capabilities.

Other Internet Services

The Web is only one of the many services on the Internet. The Web and other Internet services have changed the way we communicate. We use computers and mobile devices to send e-mail messages to the president, have a discussion with experts about the stock market, chat with someone in another country about genealogy, and talk about homework assignments with classmates via instant messages. Many times, these communications take place completely in writing — without the parties ever meeting each other. The following pages discuss these Internet services: e-mail, mailing lists, instant messaging, chat rooms, VoIP (Voice over IP), newsgroups and message boards, and FTP (File Transfer Protocol).

E-Mail

E-mail (short for *electronic mail*) is the transmission of messages and files via a computer network. E-mail was one of the original services on the Internet, enabling scientists and researchers working on government-sponsored projects to communicate with colleagues at other locations. Today, e-mail is a primary communications method for both personal and business use. You use an **e-mail program** to create, send, receive, forward, store, print, and delete e-mail messages. Outlook and Windows Live Mail are two popular desktop e-mail programs; Gmail and Windows Live Hotmail are two popular free e-mail Web applications. The steps in Figure 2-26 illustrate how to send an e-mail message using Outlook.

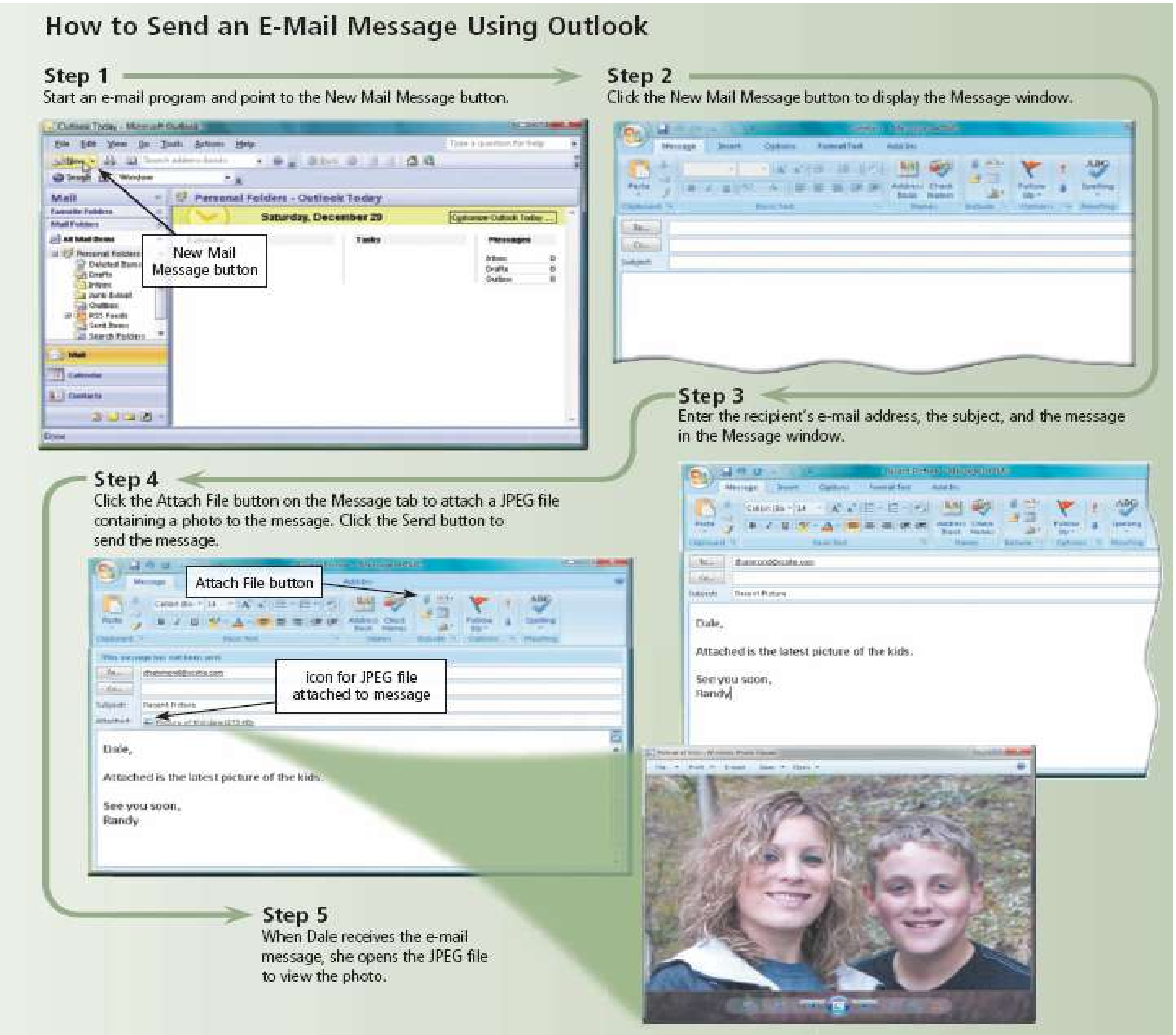


Figure 2-26 This figure shows how to send an e-mail message using Outlook.

The message can be simple text or can include an attachment such as a word processing document, a graphic, an audio clip, or a video clip. To learn more about how to attach a file to an e-mail message, complete the Learn How To 1 activity on page 120.

Just as you address a letter when using the postal system, you address an e-mail message with the e-mail address of your intended recipient. Likewise, when someone sends you a message, he or she must have your e-mail address.

An **e-mail address** is a combination of a user name and a domain name that identifies a user so that he or she can receive Internet e-mail.

A **user name** is a unique combination of characters, such as letters of the alphabet and/or numbers, that identifies a specific user. Your user name must be different from the other user names in the same domain. For example, a user named Kiley Barnhill whose server has a domain name of scsite.com might want to select kbarnhill as her user name. If scsite.com already has a kbarnhill (for Ken Barnhill), Kiley will have to select a different user name, such as kileybarnhill or k_barnhill. Sometimes, organizations decide user names for new users. In many cases, however, users select their own user names, often selecting a nickname or any other combination of characters for their user name. Many users select a combination of their first and last names so that others can remember it easily. In an Internet e-mail address, an @ (pronounced at) symbol separates the user name from the domain name. Your service provider supplies the domain name. A possible e-mail address for Kiley Barnhill would be kbarnhill@scsite.com, which would be read as follows: K Barnhill at s c site dot com. Most e-mail programs allow you to create an **address book**, or contacts folder, which contains a list of names and e-mail addresses. Figure 2-27 illustrates how an e-mail message may travel from a sender to a receiver using a desktop e-mail program. When you send an e-mail message, an out

Figure 2-27 This figure shows how an e-mail message may travel from a sender to a receiver.

going mail server that is operated by your Internet access provider determines how to route the message through the Internet and then sends the message. *SMTP* (simple mail transfer protocol) is a communications protocol used by some outgoing mail servers. As you receive e-mail messages, an incoming mail server — also operated by your Internet access provider — holds the messages in your mailbox until you use your e-mail program to retrieve them. *POP3*, the latest version of POP (*Post Office Protocol*), is a communications protocol used by some incoming mail servers. Most e-mail programs have a mail notification alert that informs you via a message and/or sound when you receive new mail.

Mailing Lists

A **mailing list**, also called an e-mail list or distribution list, is a group of e-mail names and addresses given a single name. When a message is sent to a mailing list, every person on the list receives a copy of the message in his or her mailbox. For example, your credit card company may add you to its mailing list in order to send you special offers. To add your e-mail name and address to a mailing list, you **subscribe** to it (Figure 2-28). To remove your name, you **unsubscribe** from the mailing list. Thousands of mailing lists exist about a variety of topics in areas of entertainment, business, computers, society, culture, health, recreation, and education. Many vendors use mailing lists to communicate with their customer base.

Figure 2-28 When you join a mailing list, you and all others on the mailing list receive e-mail messages from the Web site.

Instant Messaging

Instant messaging (IM) is a real-time Internet communications service that notifies you when one or more people are online and then allows you to exchange messages or files or join a private chat room with them. **Real time** means that you and the people with whom you are conversing are online at the same time. Some IM services support voice and video conversations (Figure 2-29). Many IM services also can alert you to information such as calendar appointments, stock quotes, weather, or sports scores. They also allow you to send photos or other documents to a recipient, listen to streaming music, and play games with another online party. For IM to work, both parties must be online at the same time. Also, the receiver of a message must be willing to accept messages. To use IM, you may have to install *instant messenger* software on the computer or mobile device, such as a smart phone, you plan to use. Some operating systems, such as Windows, include an instant messenger. Popular IM software includes AIM (AOL Instant Messenger), Google Talk, MySpace IM, Windows Live Messenger, and Yahoo! Messenger. Few IM programs follow IM standards. To ensure successful communications, all individuals on the contact list need to use the same or a compatible instant messenger.

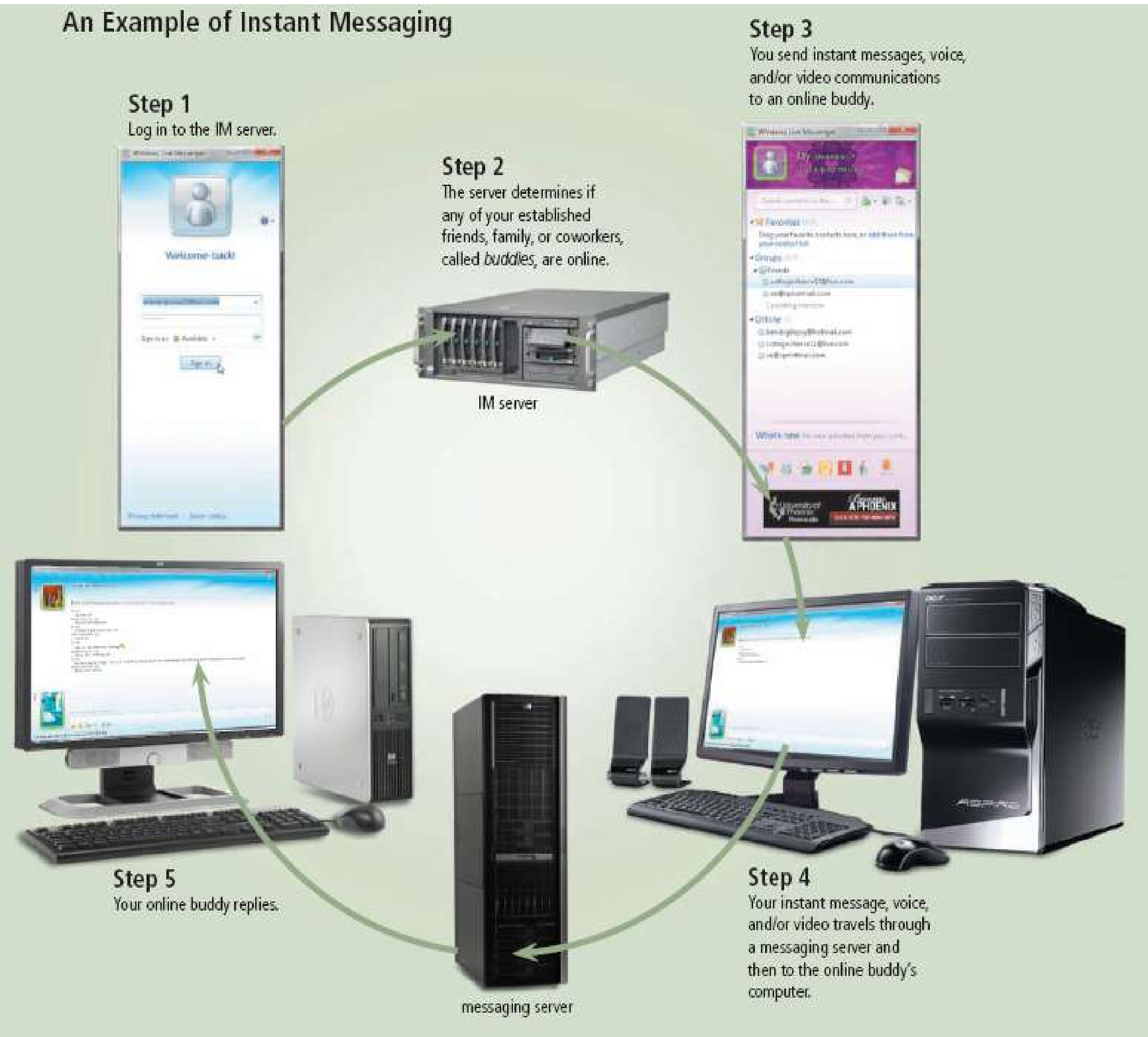


Figure 2-29 This figure shows an example of instant messaging.

Chat Rooms

A **chat** is a real-time typed conversation that takes place on a computer. A **chat room** is a location on an Internet server that permits users to chat with each other. Anyone in the chat room can participate in the conversation, which usually is specific to a particular topic. As you type on your keyboard, a line of characters and symbols is displayed on the computer screen. Others connected to the same chat room server also see what you have typed (Figure 2-30). Some chat rooms support voice chats and video chats, in which people hear or see each other as they chat. To start a chat session, you connect to a chat server through a program called a *chat client*. Today's browsers usually include a chat client. If yours does not, you can download a chat client from the Web. Some Web sites allow users to conduct chats without a chat client.

Once you have installed a chat client, you can create or join a conversation on the chat server to which you are connected. The chat room should indicate the discussion topic. The person who creates a chat room acts as the operator and has responsibility for monitoring the conversation and disconnecting anyone who becomes disruptive. Operator status can be shared or transferred to someone else.

Figure 2-30 As you type, the words and symbols you enter are displayed on the computer screens of other people in the same chat room. To save time many chat and IM users type abbreviations and acronyms for phrases, such as ‘r u there?’, which stands for ‘Are you there?’.

VoIP

VoIP, (*Voice over IP*, or Internet Protocol) also called *Internet telephony*, enables users to speak to other users over the Internet. That is, VoIP uses the Internet (instead of the public switched telephone network) to connect a calling party to one or more local or long distance called parties.

To place an Internet telephone call, you need a high-speed Internet connection (such as a DSL or cable modem); Internet telephone service; a microphone or telephone, depending on the Internet telephone service; and Internet telephone software or a VoIP router, or a telephone adapter, depending on the Internet telephone service. VoIP services also are available on some mobile devices that have wireless Internet service. Calls to other parties with the same Internet telephone service often are free, while calls that connect to the telephone network typically cost about $15 to $35 per month.

As you speak in a microphone connected to your computer or a telephone connected to the VoIP router or telephone adapter, the Internet telephone software and the computer’s sound card or the VoIP router or telephone adapter convert your spoken words (analog signals) to digital signals and then transmit the digitized audio over the Internet to the called parties. Software and equipment at the receiving end reverse the process so that the receiving parties can hear what you have said. Figure 2-31 illustrates one possible configuration for VoIP.

Figure 2-31 One type of equipment configuration for a user making a call via VoIP.

Newsgroups and Message Boards

A **newsgroup** is an online area in which users have written discussions about a particular subject (Figure 2-32). To participate in a discussion, a user posts a message, called an article, to the newsgroup, and other users in the newsgroup read and reply to the message. A *thread* or *threaded discussion* consists of the original article and all subsequent related replies. A computer that stores and distributes newsgroup messages is called a news server. Some newsgroups require you to enter a user name and password to participate in the discussion. For example, a newsgroup for students taking a college course may require a user name and password to access the newsgroup. This ensures that only students in the course participate in the discussion.

To participate in a newsgroup, typically you use a program called a *newsreader*. Windows Live Mail includes a newsreader. Some Web sites, such as Google Groups, that sponsor newsgroups have a built-in newsreader.

A popular Web-based type of discussion group that does not require a newsreader is a **message board**. Many Web sites use message boards instead of newsgroups because they are easier to use.

FTP

FTP (File Transfer Protocol) is an Internet standard that permits file uploading and downloading with other computers on the Internet. Uploading is the opposite of down loading; that is, **uploading** is the process of transferring documents, graphics, and other objects from your computer to a server on the Internet. Web page authors, for example, often use FTP to upload their Web pages to a Web server. Many operating systems include FTP capabilities. If yours does not, you can download FTP programs from the Web, usually for a small fee. An *FTP server* is a computer that allows users to upload and/or download files using FTP. An FTP site is a collection of files including text, graphics, audio clips, video clips, and program files that reside on an FTP server. Many FTP sites have *anonymous FTP*, whereby anyone can transfer some, if not all, available files. Some FTP sites restrict file transfers to those who have authorized accounts (user names and passwords) on the FTP server.

Large files on FTP sites often are compressed to reduce storage space and download time. Before you can use a compressed (zipped) file, you must uncompress (unzip) it. Chapter 8 discusses utilities that zip and unzip files.

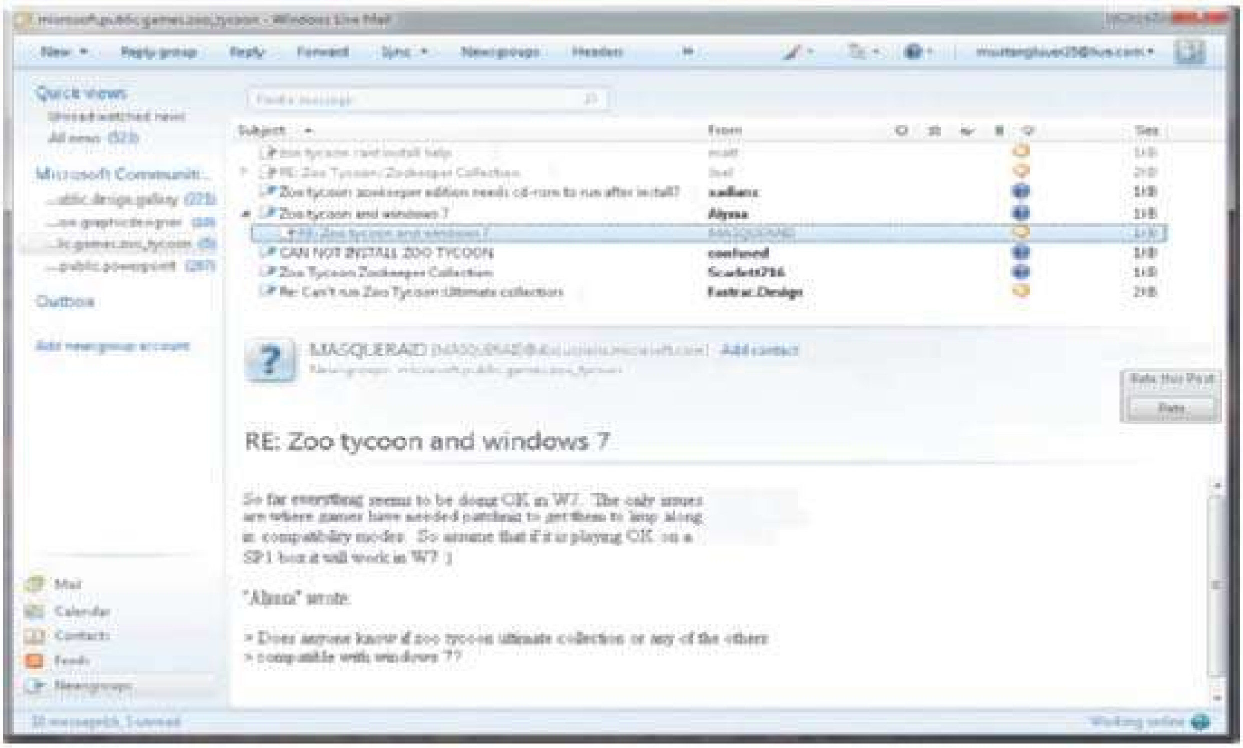


Figure 2-32 Users in a newsgroup read and reply to other users' messages.

Netiquette

Netiquette, which is short for Internet etiquette, is the code of acceptable behaviors users should follow while on the Internet; that is, it is the conduct expected of individuals while online. Netiquette includes rules for all aspects of the Internet, including the World Wide Web, e-mail, instant messaging, chat rooms, FTP, and newsgroups and message boards. Figure 2-33 outlines some of the rules of netiquette.

NETIQUETTE — Golden Rule: Treat others as you would like them to treat you.

1. In e-mail, chat rooms, and newsgroups:

- Keep messages brief. Use proper grammar, spelling, and punctuation.
- Be careful when using sarcasm and humor, as it might be misinterpreted.
- Be polite. Avoid offensive language.
- Read the message before you send it.
- Use meaningful subject lines.
- Avoid sending or posting flames, which are abusive or insulting messages. Do not participate in flame wars, which are exchanges of flames.
- Avoid sending spam, which is the Internet's version of junk mail. Spamis an unsolicited e-mail message or newsgroup posting sent to many recipients or newsgroups at once.
- Do not use all capital letters, which is the equivalent of SHOUTING!
- Use **emoticons** to express emotion. Popular emoticons include
  :) Smile :| Indifference :o Surprised
  :(Frown :\ Undecided
- Use abbreviations and acronyms for phrases:
  btw by the way
  imho in my humble opinion
  fyi for your information
  ttfn ta ta for now
  fwiw for what it's worth
  tyvm thank you very much
- Clearly identify a spoiler, which is a message that reveals a solution to a game or ending to a movie or program.

2. Many newsgroups and Web pages have an FAQ.

3. Do not assume material is accurate or up-to-date. Be forgiving of other's mistakes.

4. Never read someone's private e-mail.

Figure 2-33 Some of the rules of netiquette.

Chapter Exercises

True/False Mark T for True and F for False.

_____ 1. A single government agency owns and controls the Internet.

_____ 2. DSL provides high-speed Internet connections through the cable television network.

_____ 3. In general, the first portion of each IP address identifies the network and the last portion identifies the specific computer.

_____ 4. A Web 2.0 Web site can never allow users to modify Web site content.

_____ 5. A Web page has a unique address, called a URL or Web address.

_____ 6. Hypertext combines text-based links with graphic, audio, and video links.

_____ 7. The major disadvantage with a subject directory is that users have difficulty deciding which categories to choose as they work through the menus of links presented.

_____ 8. Most social networking Web sites include chat rooms, newsgroups, and other communications services.

_____ 9. Streaming disallows users from accessing and using a file while it is transmitting.

_____ 10. A plug-in is a program that extends the capability of an add-on.

_____ 11. Most e-commerce actually takes place between consumers, which is called consumer-to-consumer e-commerce.

_____ 12. Flames are abusive or insulting messages.

Multiple Choice Select the best answer.

1. _____ offers high-speed Internet connections to devices with built-in compatible technology or computers with wireless modems.

a. Cable Internet service
b. A digital subscriber line
c. A cellular radio network
d. Fiber to the Premises (FTTP)

2. As with an IP address, the components of a domain name are separated by _____.

a. commas b. periods c. colons d. semicolons

3. _____ combines text-based links with graphic, audio, and video links.

a. Hypertext b. Multi-linking c. Hypermedia d. Tabbed browsing

4. All of the following techniques can be used to improve Web searches except _____.

a. put the most important terms last
b. read a search engine's Help information
c. list all possible spellings
d. if a search is unsuccessful, try another search engine

5. A _____ is a Web site that allows users to post short text updates, usually between 100 and 200 characters.
a. microblog b. wiki c. portal d. podcast

6. A(n) _____ is a small version of a larger graphic.
a. thumbnail b. MP3 c. wiki d. portal

7. _____ is the process of transferring documents, graphics, and other objects from your computer to a server on the Internet.
a. Downloading b. Social networking c. Uploading d. Blogging

8. _____ is the code of acceptable behaviors users should follow while on the Internet.
a. Post Office Protocol b. The Golden Rule
c. Netiquette d. An FAQ

Matching Match the terms with their definitions.

_____	1. gTLD	a. built-in connection to another related Web page or part of a Web page
_____	2. ccTLD	b. a two-letter country code for international Web sites outside the United States
_____	3. DNS Server	c. enables users to speak to other users over the Internet
_____	4. IPv6	d. format that reduces an audio file to about one-tenth its original size
_____	5. link	e. new IP addressing scheme that may increase the number of available IP addresses
_____	6. search engine	f. translates the domain name to its associated IP address
_____	7. MP3	g. software used to listen to an audio file on a computer
_____	8. player	h. identifies the type of organization associated with a domain
_____	9. video	i. program that finds Web sites, Web pages, images, videos, news, maps, and other information related to a specific topic
_____	10. VoIP	j. full-motion images that are played back at various speeds

Short Answer Write a brief answer to each of the following questions.

1. Describe three different types of broadband Internet services. ____________ What is the difference between a regional ISP and a national ISP? ____________

2. How is a static Web page different from a dynamic Web page? ____________ What is a Web site? ____________

3. What is a Web application? ____________What are some features and examples of Web applications? ____________

4. What are three types of specifications used by content aggregators to distribute content? ____________ How might you evaluate the accuracy of a Web site? ____________

5. What is Web publishing? ____________ What are the five major steps in Web publishing? ____________

Chapter Three

Application Software

Application Software

With the proper software, a computer is a valuable tool. Software allows users to create letters, memos, reports, and other documents; develop multimedia presentations; design Web pages and diagrams; draw and alter images; record and enhance audio and video clips; prepare and file taxes; play single player or multiplayer games; compose e-mail messages and instant messages; and much more. To accomplish these and many other tasks, users work with application software.

Application software consists of programs designed to make users more productive and/or assist them with personal tasks. Application software has a variety of uses:

1. To make business activities more efficient
2. To assist with graphics and multimedia projects
3. To support home, personal, and educational tasks
4. To facilitate communications

The table in Figure 3-1 categorizes popular types of application software by their general use. Although many types of communications software exist, the ones listed in Figure 3-1 are application software oriented. The categories of application software in Figure 3-1 are not mutually exclusive. Software listed in one category may be used in other categories. For example, desktop publishing programs, which are categorized as graphics and multimedia software, often are used for business or personal reasons.

Application software is available in a variety of forms: packaged, custom, Web application, open source, shareware, freeware, and public domain.

• **Packaged software** is mass-produced, copyrighted retail software that meets the needs of a wide variety of users, not just a single user or company. Packaged software is available in retail stores or on the Web. Figure 3-1 shows some images of packaged software.

• **Custom software** performs functions specific to a business or industry. Sometimes a company cannot find packaged software that meets its unique requirements. In this case, the company may use programmers to develop tailor-made custom software, which usually costs more than packaged software.

• A **Web application** is a Web site that allows users to access and interact with software from any computer or device that is connected to the Internet. Many Web sites provide free access to their programs; some charge a fee. Types of Web applications include e-mail, word processing, tax preparation, and game programs. Web applications are discussed in more depth later in this chapter.

• **Open source software** is software provided for use, modification, and redistribution. This software has no restrictions from the copyright holder regarding modification of the software's internal instructions and its redistribution. Open source software usually can be downloaded from the Internet, often at no cost.

• **Shareware** is copyrighted software that is distributed at no cost for a trial period. To use a shareware program beyond that period, you send payment to the program developer. Shareware developers trust users to send payment if software use extends beyond the stated trial period. In some cases, a scaled-down version of the software is distributed free, and payment entitles the user to the fully functional product.

• **Freeware** is copyrighted software provided at no cost by an individual or a company that retains all rights to the software. Thus, programmers typically cannot incorporate freeware in applications they intend to sell. The word, free, in freeware indicates the software has no charge.

• **Public-domain** software has been donated for public use and has no copyright restrictions. Anyone can copy or distribute public-domain software to others at no cost.

Thousands of shareware, freeware, and public domain programs are available on the Internet for users to download. Examples include communications, graphics, and game programs. These programs usually have fewer

capabilities than packaged programs. Some packaged programs have trial versions, which you can use at no charge for a limited time, to see if the software meets your needs.
After you purchase or download software, you install it. During installation, the program may ask you to register and/or activate the software. (To learn more about installing software, complete the Learn How To 2 activity on pages 188 and 189.) Registering the software is optional and usually involves submitting your name and other personal information to the software manufacturer or developer. Registering the software often entitles you to product support. *Product activation* is a technique that some software manufacturers use to ensure the software is not installed on more

Four Categories of Application Software

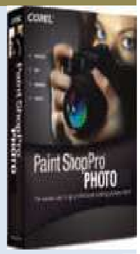
Home/Personal/Educational

- Word Processing
- Spreadsheet
- Database
- Presentation
- Note Taking
- Personal Information Manager (PIM(
- Business Software for Phones
- Business Software Suite
- Project Management
- Accounting
- Document Management
- Enterprise Computing

Graphics and Multimedia

- Computer-Aided Design (CAD)
- Desktop Publishing Professional)
- Paint/Image Editing (Professional)
- Photo Editing (Professional)
- Video and Audio Editing (professional)
- Multimedia Authoring
- Web Page Authoring

Business



- Software Suite (Personal)
- Personal Finance
- Legal
- Tax Preparation
- Desktop Publishing (Personal)
- Paint/Image Editing (Personal)
- Photo Editing and Photo Management(Personal)
- Clip Art/Image Gallery
- Video and Audio Editing (Personal)
- Home Design/Landscaping
- Travel and Mapping
- Reference and Educational
- Entertainment

Communications

- Web Browser
- E-Mail
- Instant Messaging
- Chat Room
- Text, Picture, Video Messaging
- RSS Aggregator
- Blogging
- Newsgroup/Message Board
- FTP
- VoIP
- Video Conferencing

Figure 3-1 The four major categories of popular application software are outlined in this table. Communications software often is bundled with other application or system software.

computers than legally licensed. Usually, the software does not function or has limited functionality until you activate it via the Internet or telephone. Thus, activation is a required process for programs requesting it. You can activate some software more than once, for example, to run a program on both a desktop and notebook computer. Registering and/or activating the software also usually entitles you to free program updates for a specified time period, such as a year.

The Role of System Software

System software serves as the interface between the user, the application software, and the computer's hardware (Figure 3-2). To use application software, such as a word processing program, your computer must be running system software — specifically, an operating system.

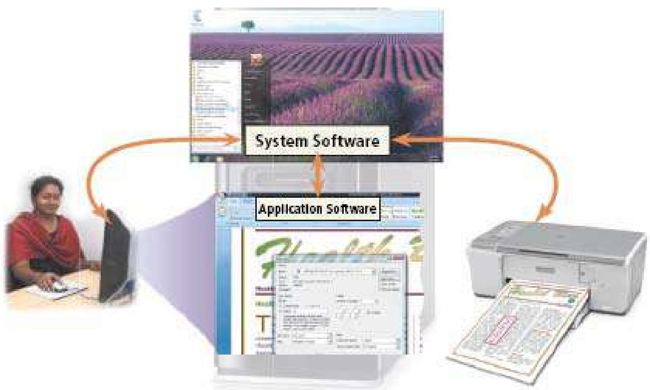


Figure 3-2 A user does not communicate directly with the computer hardware. Instead, system software is the interface between the

user, the application software, and the hardware. For example, when a user instructs the application software to print a document, the application software sends the print instruction to the system software, which in turn sends the print instruction to the hardware.

Three popular personal computer operating systems are Windows, Mac OS, and Linux. Each time you start a computer, the operating system is *loaded* (copied) from the computer's hard disk into memory. Once the operating system is loaded, it coordinates all the activities of the computer. This includes starting application software and transferring data among input and output devices and memory. While the computer is running, the operating system remains in memory. **Utility Programs** A utility program is a type of system software that assists users with controlling or maintaining the operation of a computer, its devices, or its software. Utility programs typically offer features that provide an environment conducive to successful use of application software. For example, utility programs protect a computer against malicious software and unauthorized intrusions, manage files and disks, compress files, play media files, and burn optical discs. (To learn more about how to compress files, complete the Learn How To 3 activity on page 189.) One of the more important utility programs protects a computer against malicious software, or *malware*, which is a program that acts without a user's knowledge and deliberately alters the computer's operations. A computer virus is a type of malicious software. For a technical discussion about viruses and other malicious software, Chapter 8 discusses system software and utility programs in more depth.

Working with Application Software

To use application software, you must instruct the operating system to start the program. The steps in Figure 3-3 illustrate one way to start and interact with the Paint program, which is included with the Windows operating system. The following paragraphs explain the steps in Figure 3-3. Personal computer operating systems often use the concept of a desktop to make the computer easier to use.

The **desktop** is an on-screen work area that has a graphical user interface. Step 1 of Figure 3-3 shows icons, a button, a pointer, and a menu on the Windows desktop.

An **icon** is a small image displayed on the screen that represents a program, a document, or some other object. A **button** is a graphical element that you activate to cause a specific action to occur. One way to activate a button is to click it.

To **click** a button on the screen requires moving the pointer to the button and then pressing and releasing a button on the mouse (usually the left mouse button).

The **pointer** is a small symbol displayed on the screen that moves as you interact with the mouse or other pointing device. Common pointer shapes are an I-beam (ï), a block arrow ( ), and a pointing hand ( ). The Windows desktop contains a Start button on the lower-left corner of the taskbar. When you click the Start button, the Start menu is displayed on the desktop.

A **menu** contains a list of commands from which you make selections.

A **command** is an instruction that causes a program to perform a specific action. As illustrated in Steps 1 and 2 of Figure 3-3, when you click the Start button and then click the All Programs command on the Start menu, the All Programs list is displayed on the Start menu. Clicking the Accessories folder in the All Programs list displays the Accessories list. To start a program, you can click its program name on a menu or in a list. This action instructs the operating system to start the program, which means the program's instructions load from a storage medium (such as a hard disk) into memory. For example, when you click Paint in the Accessories list, Windows loads the Paint program instructions from the computer's hard disk into memory. Once loaded into memory, the program appears in a window on the desktop (Step 3 of Figure 3-3).

A **window** is a rectangular area of the screen that displays data and information.

The top of a window has a **title bar**, which is a horizontal space that contains the window's name. With the program loaded, you can create a new file or open an existing one. A *file* is a named collection of stored data, instructions, or information. A file can contain text, images, audio, and video. To distinguish among various files, each file has a file name. A *file name* is a unique combination of letters of the alphabet, numbers, and other characters that identifies a file. The title bar of the document window usually displays a document's file name. Step 4 of Figure 3-3 shows the contents of the file, Baby Buffalo, displaying in the Paint window. The file contains an image photographed with a digital camera.

In some cases, when you instruct a program to perform an activity such as print, the program displays a dialog box. A *dialog box* is a window that provides information, presents available options, or requests a response. Dialog boxes, such as the one shown in Step 5 of Figure 3-3, often contain option buttons, text boxes, check boxes, and command buttons. In this case, clicking the Print button in the dialog box instructs the computer to print the photo.

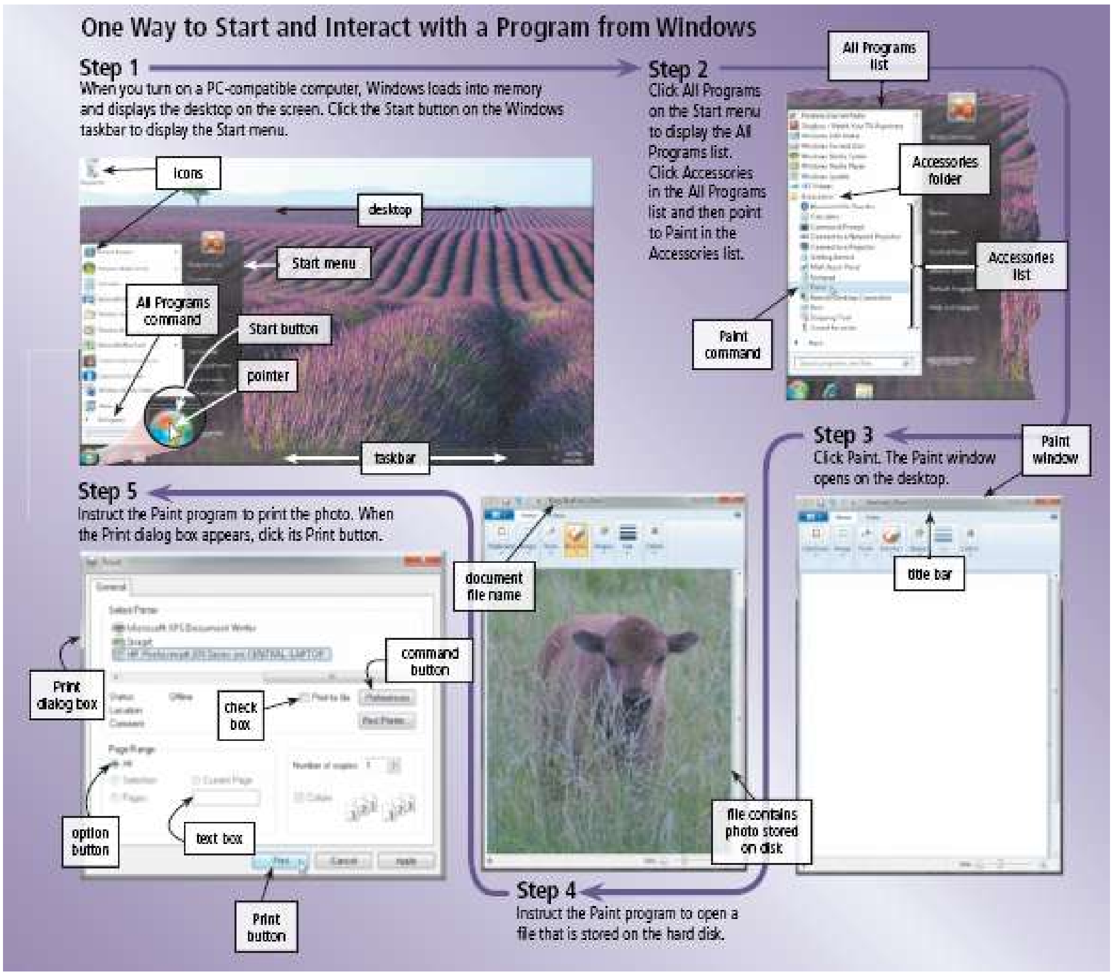


Figure 3-3 This figure shows one way to start and interact with a program from Windows.

Business Software

Business software is application software that assists people in becoming more effective and efficient while performing their daily business activities. Business software includes programs such as word processing, spreadsheet, database, presentation, note taking, personal information manager, business software for phones, business software suites, project management, accounting, document management, and enterprise computing software. Figure 3-4 lists popular programs for each of these categories.

Popular Business Programs

Application	Software Manufacturer	Program Name
Word Processing	Microsoft	Word
	Apple	Pages
	Corel	WordPerfect
Spreadsheet	Microsoft	Excel
	Apple	Numbers
	Corel	Quattro Pro
Database	Microsoft	Access
	Corel	Paradox
	Oracle	Oracle Database
	Sun	MySQL
Presentation	Microsoft	PowerPoint
	Apple	Keynote
	Corel	Presentations
Note Taking	Microsoft	OneNote
	Agilix	GoBinder
	Corel	Grafigo
	SnapFiles	KeyNote
Personal Information Manager (PIM)	Microsoft	Outlook
	Google	Calendar
	IBM	Lotus Organizer
	Palm	Desktop
	Mozilla	Thunderbird
Business Software for Phones	CNetX	Pocket SlideShow
	DataViz	Documents To Go
	Microsoft	Word Mobile
		Excel Mobile
		PowerPoint Mobile
		Outlook Mobile
	Mobile Systems	MobiSystems Office Suite
	Ultrasoft	Money

Application	Software Manufacturer	Program Name
Business Software Suite (for the Professional)	Microsoft	Office
		Office for Mac
	Apple	iWork
	Google	Google Docs
	Sun	OpenOffice.org
		StarOffice
	Corel	WordPerfect Office
	IBM	Lotus SmartSuite
Project Management	CS Odessa	ConceptDraw PROJECT
	Microsoft	Project
	Oracle	Primavera SureTrak Project Manager
Accounting	Intuit	QuickBooks
	Microsoft	Accounting
	Sage Software	Peachtree
Document Management	Adobe	Acrobat
	Enfocus	PitStop
	Nuance	PDF Converter
Enterprise Computing	Oracle	PeopleSoft Enterprise Human Capital Management
	Sage Software	Sage MAS 500
	MSC Software	MSC.SimManager
	Oracle	Oracle Manufacturing
	SAP	mySAP Customer Relationship Management
	NetSuite	NetERP
	Syntellect	Syntellect Interaction Management Suite

Figure 3-4 Popular business software.

The following sections discuss the features and functions of business software. Word processing and spreadsheet software have a heavier emphasis because of their predominant use.

Word Processing Software

Word processing software is one of the more widely used types of application software.

Word processing software, sometimes called a *word processor*, allows users to create and manipulate documents containing mostly text and sometimes graphics (Figure 3-5). Millions of people use word processing software every day to develop documents such as letters, memos, reports, mailing labels, newsletters, and Web pages.

A major advantage of using word processing software is that users easily can change what they have written. For example, you can insert, delete, or rearrange words, sentences, paragraphs, or entire sections. Word processing software also has many features to make documents look professional and visually appealing. For example, you can change the shape, size, and color of characters; apply special effects such as three-dimensional shadows; and organize text in newspaper-style columns. When using colors, however, they print as black or gray unless you have a color printer. Most word processing software allows users to incorporate graphical images, such as digital photos and clip art, in documents. **Clip art** is a collection of electronic drawings, photos, and other images. Word processing software usually includes public-domain images. You can find additional public-domain and proprietary images on the Web or purchase them on optical disc. In Figure 3-5, a user inserted an image of a baseball player in the document. With word processing software, you easily can modify the appearance of an image after inserting it in the document. With word processing software, you can define the size of the paper on which to print and specify the *margins* — that is, the portion of the page outside the main body of text, including the top, the bottom, and both sides of the paper. A feature, called *wordwrap*, allows users to type words in a paragraph continually without pressing the enter key at the end of each line. When you modify paper size or margins, the word processing software automatically rewraps text so that it fits in the adjusted paper size and margins.

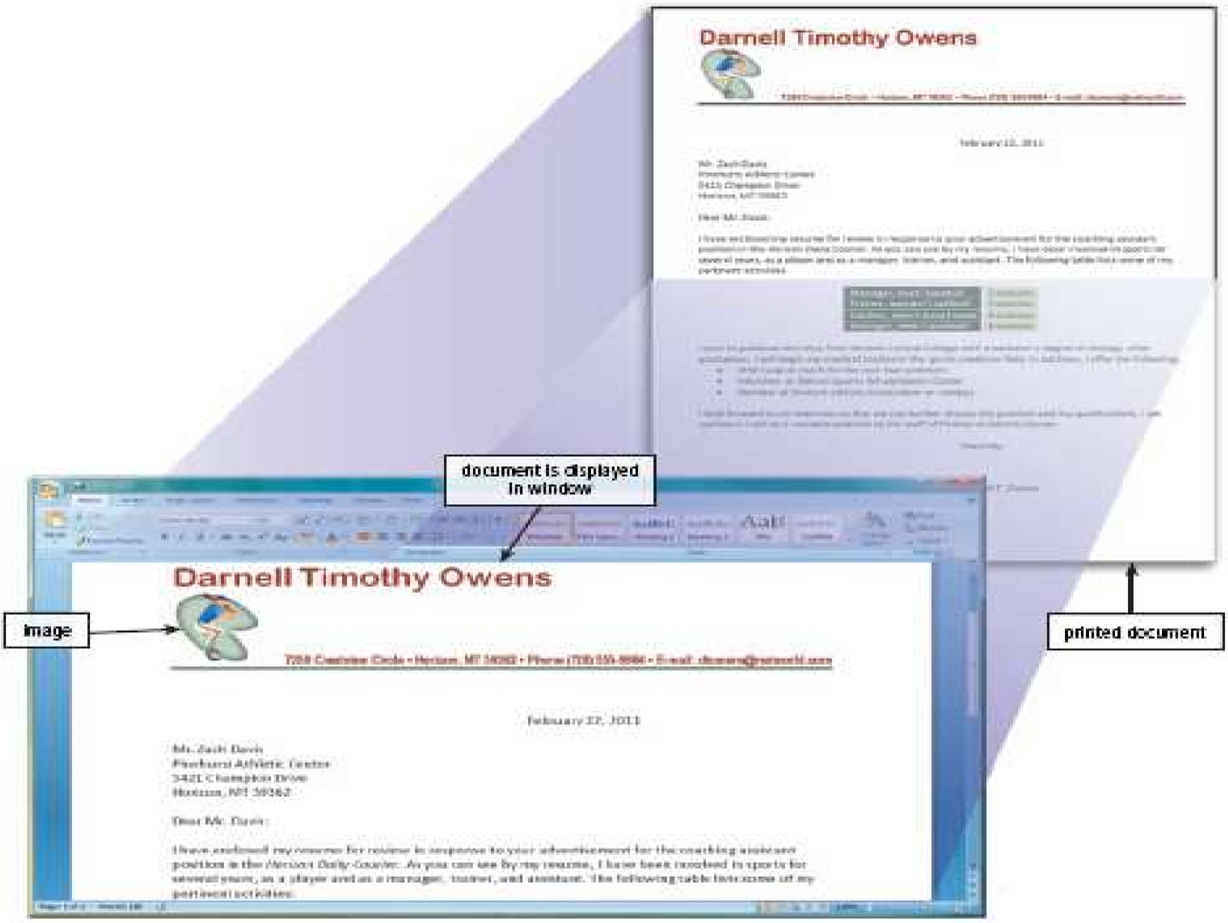


Figure 3-5 Word processing software enables users to create professional and visually appealing documents.

As you type more lines of text than can be displayed on the screen, the top portion of the document moves upward, or scrolls, off the screen. *Scrolling* is the process of moving different portions of the document on the screen into view.

Word processing software typically includes a *spelling checker*, which reviews the spelling of individual words, sections of a document, or the entire document. The spelling checker compares the words in the document with an electronic dictionary that is part of the word processing software. You can customize the electronic diction ary by adding words such as personal names. Some word processing programs also check for contextual spelling errors, such as a misuse of homophones (words pronounced the same but have different spellings or meanings, such as one and won).

Word processing software also enables you to insert headers and footers in a document. A *header* is text that appears at the top of each page, and a *footer* is text that appears at the bottom of each page. Page numbers, company names, report titles, and dates are examples of items included in headers and footers. In addition to these basic capabilities, most current word processing programs provide numerous additional features, which are listed in the table in Figure 3-6.

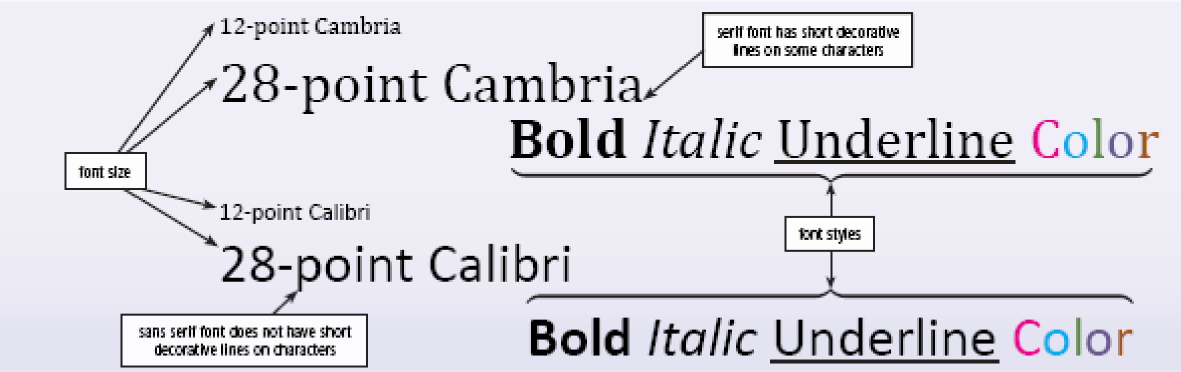
Additional Word Processing Features	
AutoCorrect	As you type words, the AutoCorrect feature corrects common spelling and capitalization errors.
AutoFormat	As you type, the AutoFormat feature automatically applies formatting to the text. For example, it automatically numbers a list or converts a Web address to a hyperlink.
Collaboration	Collaboration allows multiple users to enter comments in a document and read and reply to each other's comments.
Columns	Most word processing software can arrange text in two or more columns to look like text in a newspaper or magazine. The text from the bottom of one column automatically flows to the top of the next column.
Grammar Checker	The grammar checker proofreads documents for grammar, writing style, sentence structure errors, and reading statistics.
Ink Input	Supports input from a digital pen. Word processing software that supports ink input incorporates user's handwritten text and drawings in a word processing document. Ink input is popular on Tablet PCs.
Macros	A macro is a sequence of keystrokes and instructions that a user records and saves. When you want to execute the same series of instructions, execute the macro instead.
Mail Merge	Creates form letters, mailing labels, and envelopes.
Reading Layout	For users who prefer reading on the screen, reading layout increases the readability and legibility of an on-screen document by hiding unnecessary buttons and increasing the size of displayed characters.
Research	Allows you to search through various forms of Internet reference information — based on selected text in a document. Research services available include a thesaurus, English and bilingual dictionaries, encyclopedias, and Web sites that provide information such as stock quotes, news articles, and company profiles.
Search and Replace	The search feature finds all occurrences of a certain character, word, or phrase. The replace feature, which usually works in conjunction with the search feature, substitutes existing characters or words with new ones.
Smart Tags	Smart tags automatically appear on the screen when you perform a certain action. For example, typing an address causes a smart tag to appear. Clicking this smart tag provides options to display a map of the address or driving directions to or from the address.
Tables	Tables organize information into rows and columns.
Templates	A template is a document that contains the formatting necessary for a specific document type. Templates usually exist for memos, fax cover sheets, and letters. In addition to templates provided with the software, users have access to many online templates through the manufacturer's Web site.
Thesaurus	With a thesaurus, a user looks up a synonym (word with the same meaning) for a word in a document.
Tracking Changes	If multiple users work with a document, the word processing software highlights or color-codes changes made by various users.
Voice Recognition	With some word processing programs, users can speak into the computer's microphone and watch the spoken words appear on the screen as they talk. Users edit and format the document by speaking or spelling an instruction.
Web Page Development	Most word processing software allows users to create, edit, format, and convert documents so that they can be displayed on the Web.

Figure 3-6 Many additional features of word processing software.

Developing a Document

With application software, such as a word processing program, users create, edit, format, save, and print documents. During the process of developing a document, users likely will switch back and forth among all of these activities. When you **create** a document, you enter text or numbers, insert images, and perform other tasks using an input device such as a keyboard, mouse, digital pen, or microphone. If you are using Microsoft Word to design a flyer, for example, you are creating a document. To **edit** a document means to make changes to its existing content. Common editing tasks include inserting, deleting, cutting, copying, and pasting. Inserting text involves adding text to a document. Deleting text means that you are removing text or other content. Cutting is the process of removing a portion of the document and storing it in a temporary storage location, sometimes called a *clipboard*. A clipboard also contains items that you copy (duplicate) in a document. *Pasting* is the process of transferring an item from a clipboard to a specific location in a document. When users **format** a document, they change its appearance. Formatting is important because the overall look of a document significantly can affect its ability to communicate clearly. Examples of formatting tasks are changing the font, font size, and font style. A **font** is a name assigned to a specific design of characters. Two basic types of fonts are serif and sans serif. A *serif font* has short decorative lines at the upper and lower ends of some characters. Sans means without. Thus, a *sans serif font* does not have the short decorative lines at the upper and lower ends of the characters. Cambria is an example of a serif font. Calibri is an example of a sans serif font.

Font size indicates the size of the characters in a particular font. Font size is gauged by a measurement system called points. A single *point* is about 1/72 of an inch in height. The text you are reading in this book is about 10 point. Thus, each character is about 5/36 (10/72) of an inch in height. A *font style* adds emphasis to a font. Bold, italic, under line, and color are examples of font styles. Figure 3-7 illustrates fonts, font sizes, and font styles.



During the process of creating, editing, and formatting a document, the computer holds it in memory. To keep the document for future use requires that you save it. When you **save** a document, the computer transfers the document from memory to a storage medium such as a USB flash drive or hard disk. Once saved, a document is stored permanently as a file on the storage medium. To learn more about how to save a file, complete the Learn How To 1 activity on page 188.

When you **print** a document, the computer places the contents of the document on paper or some other medium. You can print the same document many times, with each copy looking just like the first. Instead of printing a document and physically distributing it, some users e-mail the document to others on a network such as the Internet.

Spreadsheet Software

Spreadsheet software is another widely used type of application software. **Spreadsheet software** allows users to organize data in rows and columns and perform calculations on the data. These rows and columns collectively are called a *worksheet*. For years, people used paper to organize data and perform calculations by hand. In an electronic worksheet, you organize data in the same manner, and the computer performs the calculations more quickly and accurately (Figure 3-8). Because of spreadsheet software's logical approach to organizing data, many people use this software to organize and present nonfinancial data, as well as financial data. Like word processing software, most spreadsheet software has basic features to help users create, edit, and format worksheets. Spreadsheet software also incorporates many of the features found in word processing software such as macros, checking spelling, changing fonts and font sizes, adding colors, tracking changes, inserting audio and video clips, providing research capabilities, recognizing handwritten text and drawings, and creating Web pages from existing spreadsheet documents.

The following sections describe the features of most spreadsheet programs.

Spreadsheet Organization A spreadsheet file is similar to a notebook that can contain more than 1,000 related individual worksheets. Data is organized vertically in columns and horizontally in rows on each worksheet (Figure 3-8). Each worksheet usually can have more than 16,000 columns and 1 million rows. One or more letters identify each column, and a number identifies each row. Only a small fraction of the columns and rows are visible on the screen at one time. Scrolling

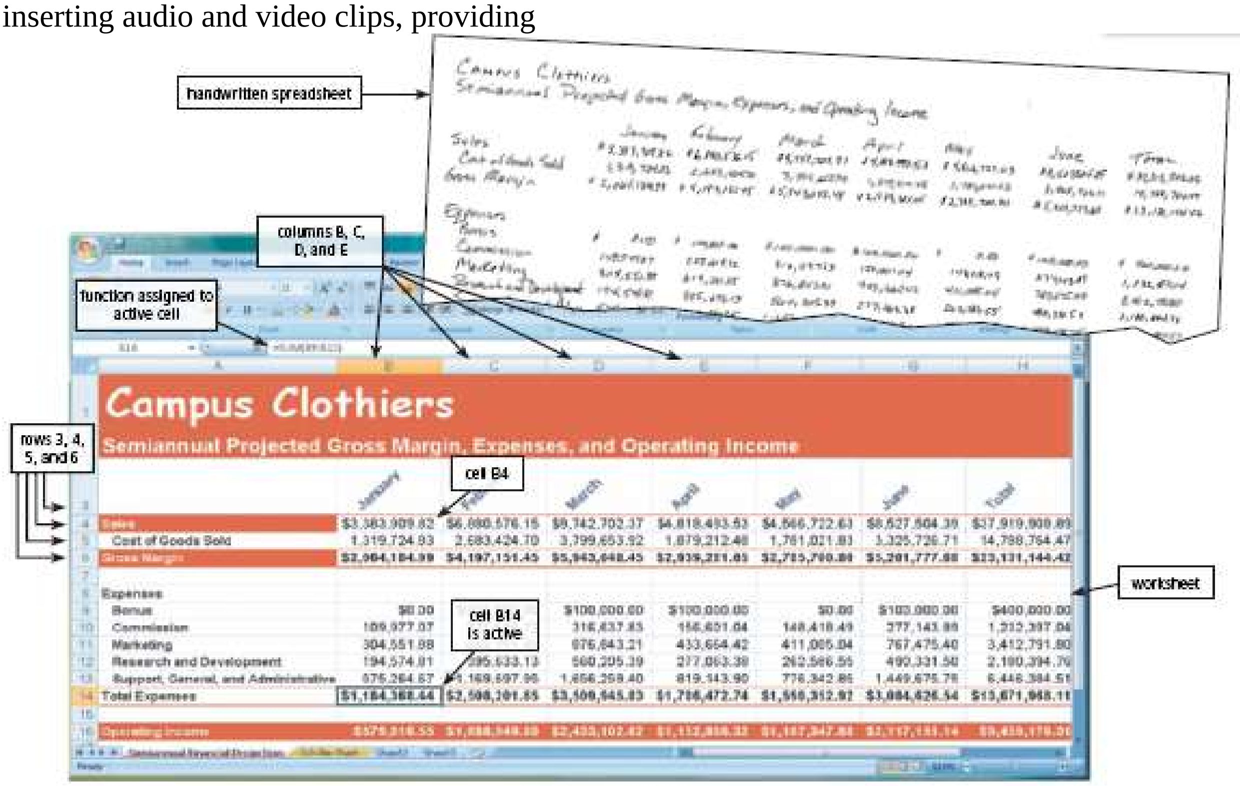


Figure 3-8 With spreadsheet software, you create worksheets that contain data arranged in rows and columns, and you perform calculations on the data in the worksheets.

through the worksheet displays different parts of it on the screen. A *cell* is the intersection of a column and row. Each worksheet has more than 17 billion cells in which you can enter data. The spreadsheet software identifies cells by the column and row in which they are located.

For example, the intersection of column B and row 4 is referred to as cell B4. As shown in Figure 3-8, cell B4 contains the number, $3,383,909.82, which represents the sales for January. Cells can contain three types of data: labels, values, and formulas. The text, or *label*, entered in a cell identifies the worksheet data and helps organize the worksheet. Using descriptive labels, such as Gross Margin and Total Expenses, helps make a worksheet more meaningful.

Calculations Many of the worksheet cells shown in Figure 3-8 contain a number, called a *value*, that can be used in a calculation. Other cells, however, contain formulas that generate values. A *formula* performs calculations on the data in the worksheet and displays the resulting value in a cell, usually the cell containing the formula.

Spreadsheet Functions	
FV (rate, number of periods, payment)	Calculates the future value of an investment
NPV (rate, range)	Calculates the net present value of an investment
PMT (rate, number of periods, present value)	Calculates the periodic payment for an annuity
PV (rate, number of periods, payment)	Calculates the present value of an investment
RATE (number of periods, payment, present value)	Calculates the periodic interest rate of an annuity
DATE	Returns the current date
NOW	Returns the current date and time
TIME	Returns the current time
ABS (number)	Returns the absolute value of a number
INT (number)	Rounds a number down to the nearest integer
LN (number)	Calculates the natural logarithm of a number
LOG (number, base)	Calculates the logarithm of a number to a specified base
ROUND (number, number of digits)	Rounds a number to a specified number of digits
SQRT (number)	Calculates the square root of a number
SUM (range)	Calculates the total of a range of numbers
AVERAGE (range)	Calculates the average value of a range of numbers
COUNT (range)	Counts how many cells in the range have numeric entries
MAX (range)	Returns the maximum value in a range
MIN (range)	Returns the minimum value in a range
STDEV (range)	Calculates the standard deviation of a range of numbers
IF (logical test, value if true, value if false)	Performs a test and returns one value if the result of the test is true and another value if the result is false

Figure 3-9 Functions typically found in spreadsheet software.

When creating a worksheet, you can enter your own formulas. In Figure 3-8, for example, cell B14 could contain the formula 5B91B101B111B121B13, which would add together (sum) the contents of cells B9, B10, B11, B12, and B13.
That is, this formula calculates the total expenses for January. A more efficient way to sum the contents of cells, however, is to use a special type of formula, called a function. A *function* is a predefined formula that performs common calculations such as adding the values in a group of cells or generating a value such as the time or date. For example, the function 5SUM(B9:B13) instructs the spreadsheet program to add all of the numbers in cells B9 through B13. Figure 3-9 lists functions commonly included in spreadsheet programs.

Recalculation One of the more powerful features of spreadsheet software is its capability of recalculating the rest of the worksheet when data in a worksheet changes. In Figure 3-8 on the previous page, for example, if you change the bonus for January from $0.00 to $100,000.00, the total expenses in cell B14 automatically change from $1,184,368.44 to $1,284,368.44. Spreadsheet software's capability of recalculating data also makes it a valuable budgeting, forecasting, and decision making tool. Most spread sheet software includes *what-if analysis* tools, where you change certain values in a spreadsheet to reveal the effects of those changes.

Charting Another standard feature of spreadsheet software is *charting*, which depicts the data in graphical form. A visual representation of data through charts often makes it easier for users to see at a glance the relationship among the numbers. Three popular chart types are line charts, column charts, and pie charts. Figure 3-10 shows examples of these charts that were plotted using the five types of expenses for each of the months shown in the worksheet in Figure 3-8 on the previous page. A *line chart* shows a trend during a period of time, as indicated by a rising or falling line. For example, a line chart could show the total expenses for each of the six months. A *column chart*, also called a *bar chart*, displays bars of various lengths to show the relationship of data. The bars can be horizontal, vertical, or stacked on top of one another. For example, a column chart might show the total expenses, with each bar representing a different category of expense in a given month. A *pie chart*, which has the shape of a round pie cut into slices, shows the relationship of parts to a whole. For example, you might use a pie chart to show the percentage each expense category contributed to the total expenditures. When you modify data in a worksheet, any associated charts automatically update to reflect the worksheet changes. Charts, as well as any other part of a worksheet, can be linked to or embedded in a word processing document.

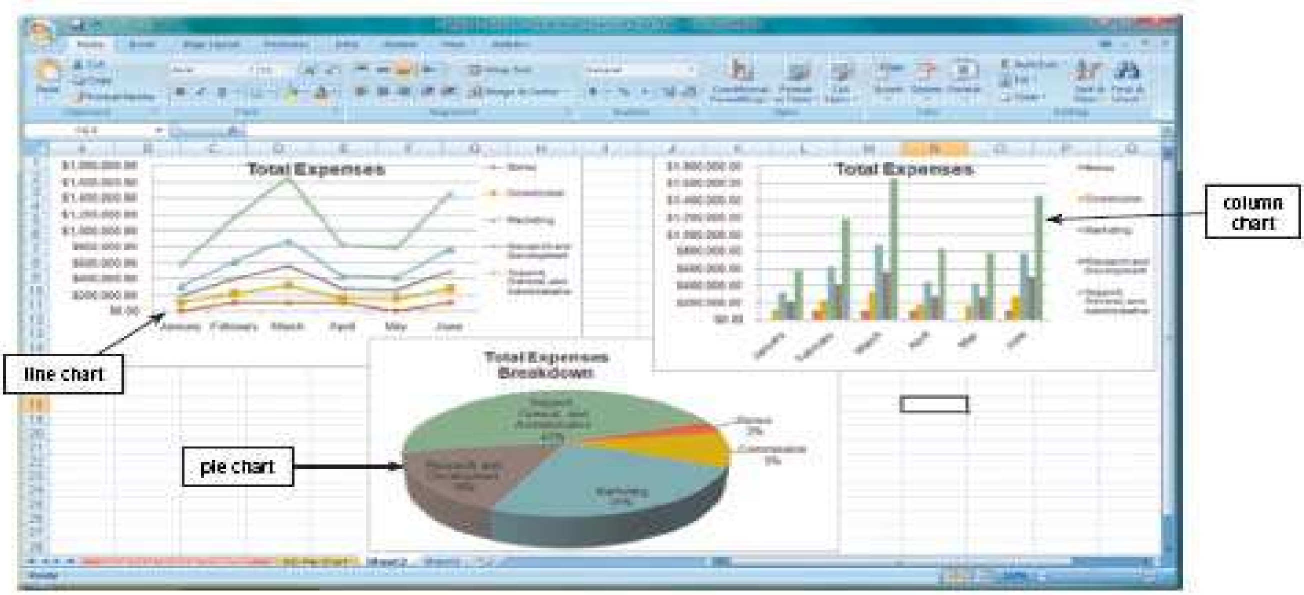


Figure 3-10 Three basic types of charts provided with spreadsheet software are line charts, column charts, and pie charts. The charts shown here were created using the data in the worksheet in Figure 3-8.

Database Software

A **database** is a collection of data organized in a manner that allows access, retrieval, and use of that data. In a manual database, you might record data on paper and store it in a filing cabinet. With a computerized database, such as the one shown in Figure 3-11, the computer stores the data in an electronic format
on a storage medium such as a hard disk.

Database software is application software that allows users to create, access, and manage a database. Using database software, you can add, change, and delete data in a database; sort and retrieve data from the database; and create forms and reports using the data in the database. With most personal computer database programs, a database consists of a collection of tables, organized in rows and columns. Each row, called a *record*, contains data about a given person, product, object, or event. Each column, called a *field*, contains a specific category of data within a record. The Fitness database shown in Figure 3-11 on the previous page consists of two tables: a Client table and a Trainer table. The Client table contains ten records (rows), each storing data about one client. The client data is grouped into eight fields (columns): Client Number, Last Name, First Name, Address, Telephone Number, Amount Paid, Balance, and Trainer Number. The Balance field, for instance, contains the balance due from the client. The Client and Trainer tables relate to one another through a common field, Trainer Number. Users run queries to retrieve data. A *query* is a request for specific data from the database. For example, a query might request clients whose balance is greater than $45. Database software can take the results of a query and present it in a window on the screen or send it to the printer.

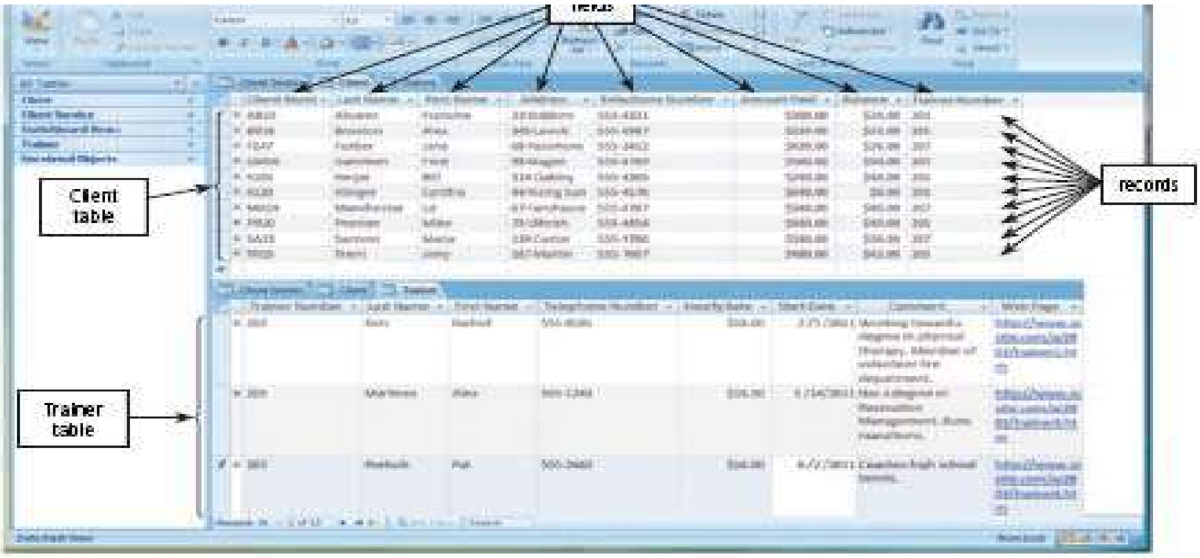


Figure 3-11 This database contains two tables: one for the clients and one for the trainers. The Client table has ten records and eight fields; the Trainer table has three records and eight fields.

Presentation Software

Presentation software is application software that allows users to create visual aids for presentations to communicate ideas, messages, and other information to a group. The presentations can be viewed as slides, sometimes called a *slide show*, that are displayed on a large monitor or on a projection screen (Figure 3-12).

Presentation software typically provides a variety of predefined presentation formats that define complementary colors for backgrounds, text, and graphical accents on the slides. This software also provides a variety of layouts for each individual slide such as a title slide, a two-column slide, and a slide with clip art, a picture, a chart, a table, or a diagram (Figure 3-13). In addition, you can enhance any text, charts, and graphical images on a slide with 3-D, animation, and other special effects such as shading, shadows, and textures. When building a presentation, users can set the slide timing so that the presentation automatically displays the next slide after a preset delay.

Presentation software allows you to apply special effects to the transition between slides. One slide, for example, might fade away as the next slide appears.

To help organize the presentation, you can view thumbnail versions of all the slides

Figure 3-12 This presentation created with presentation software consists of five slides.

similarly to how 35mm slides look on a photographer's light table. Presentation software typically includes a clip gallery that provides images, photos, video clips, and audio clips to enhance multimedia presentations. Users with an artistic ability can create their own graphics using paint/image editing software (discussed later in the chapter) and then *import* (bring in) the graphics into a slide. Some audio and video editing programs work with presentation software, providing users with an easy means to record and insert video, music, and audio commentary in a presentation. You can view or print a finished presentation in a variety of formats, including an outline of text from each slide, audience handouts that show completed slides, and speaker notes for each slide.

Current presentation software enables users to work with multiple monitors, for example, displaying the presentation on one monitor and the speaker notes on another. Presentation software incorporates some of the features found in word processing software such as checking spelling, formatting, providing research capabilities, recognizing handwritten text and drawings, and creating Web pages from existing slide shows.

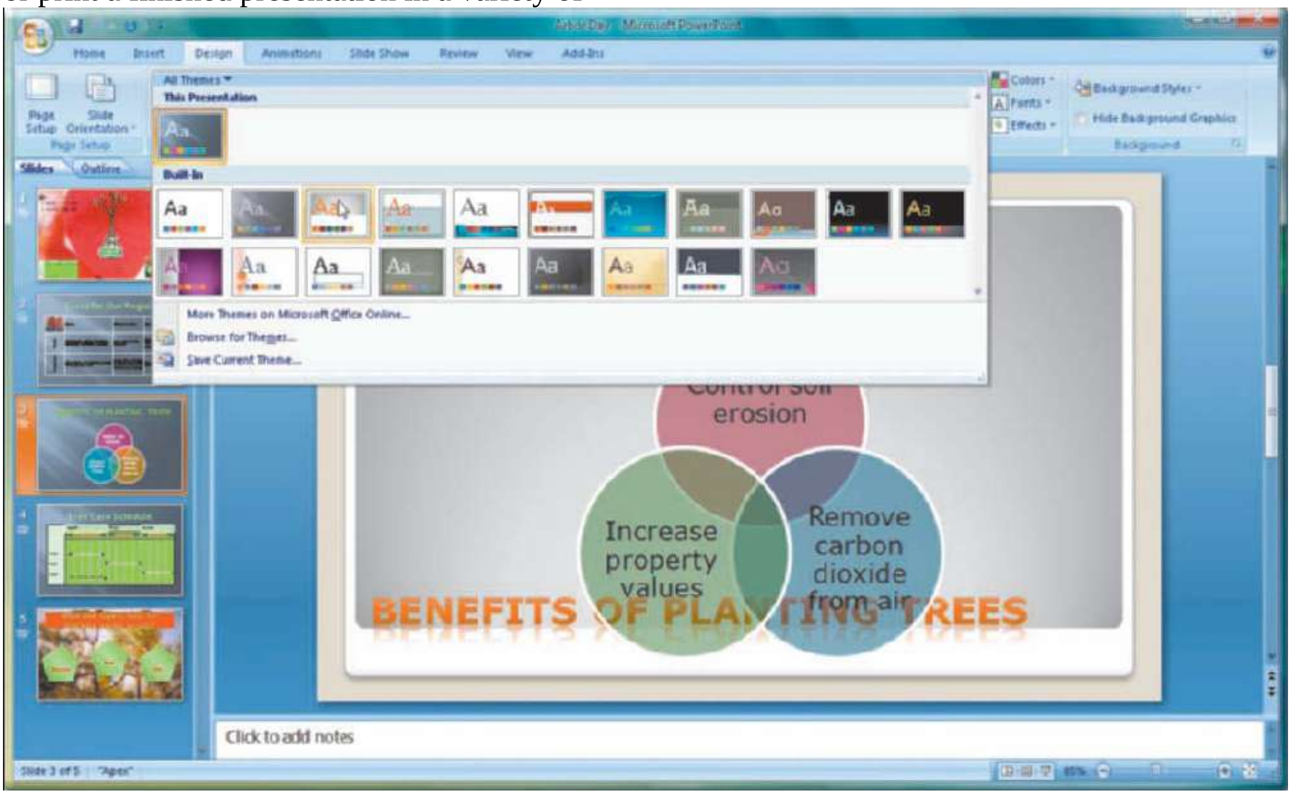


Figure 3-13 In presentation software, users can change the design and layout of any slide in a presentation.

Note Taking Software

Note taking software is application software that enables users to enter typed text, handwritten comments, drawings, or sketches anywhere on a page and then save the page as part of a notebook (Figure 3-14). The software can convert handwritten comments to typed text or store the notes in handwritten form. Users also can include audio recordings as part of their notes. Users find note taking software convenient during meetings, class lectures, conferences, in libraries, and other settings that previously required a pencil and tablet of paper for recording thoughts and discussions.

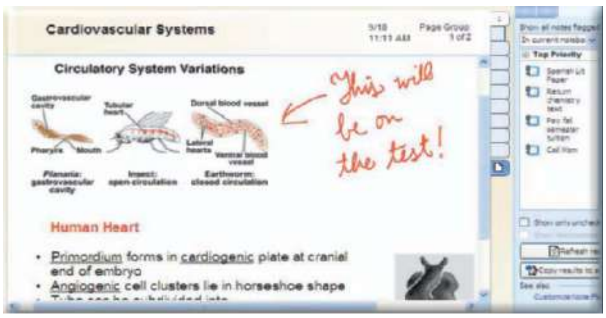


Figure 3-14 With note taking software, mobile users can handwrite notes, draw sketches, and type text.

Business Software Suite

A **software suite** is a collection of individual programs available together as a unit. Business software suites typically include, at a minimum, the following programs: word processing, spreadsheet, presentation, and e-mail. Popular business software suites include Microsoft Office, Apple iWork, Corel WordPerfect Office, and Google Docs. Software suites offer two major advantages: lower cost and ease of use. When you purchase a collection of programs as a software suite, the suite usually costs significantly less than purchasing the programs individually. Software suites provide ease of use because the programs in the suite normally use a similar interface and share features such as clip art and spelling checker. For example, once you learn how to print using the software suite's word processing program, you can apply the same skill to the spreadsheet and presentation programs in the suite.

Personal Information Manager Software

A **personal information manager** (**PIM**) is application software that includes an appointment calendar, address book, notepad, and other features to help users organize personal information. With a PIM, you can take information previously tracked in a weekly or daily calendar, and organize and store it on your computer. Mobile devices such as smart phones and PDAs include, among many other features, PIM functionality. You can synchronize, or coordinate, information so that both the mobile device and your personal computer and/or organization's server have the latest version of any updated information. Some mobile devices synchronize with the computer wirelessly. With others, you connect the mobile device to the computer with a cable, or you insert the device in a cradle, which has a cable that plugs in the computer.

Business Software for Phones

In addition to PIM software, a huge variety of business and other software is available for phones (Figure 3-15). Some software is preloaded on the phone, while other programs can be downloaded or accessed on memory cards that you insert in a slot on the device. Business software available for phones enables users to create documents and worksheets, manage databases and lists, create slide shows, take notes, manage budgets and finances, view and edit photos, read electronic books, plan travel routes, compose and read e-mail messages, send instant messages, send text and picture messages, view maps and directions, read the latest news articles, and browse the Web. Many of the programs discussed in this chapter have scaled-down versions that work with smart phones and other mobile devices.

Figure 3-15 In addition to appointment, calendar, address book, and notepad, current phones include business and other software such as e-mail, spreadsheet, presentation, and travel and mapping.

Project Management Software

Project management software allows a user to plan, schedule, track, and analyze the events, resources, and costs of a project. Project management software helps users manage project variables, allowing them to complete a project on time and within budget. An engineer, for example, might use project management software to manage new product development to schedule timing of market analysis, product design, marketing, and public relations activities. A customer service manager might use this software to schedule the process of administering customer surveys, evaluating responses, and presenting recommendations (Figure 3-16).

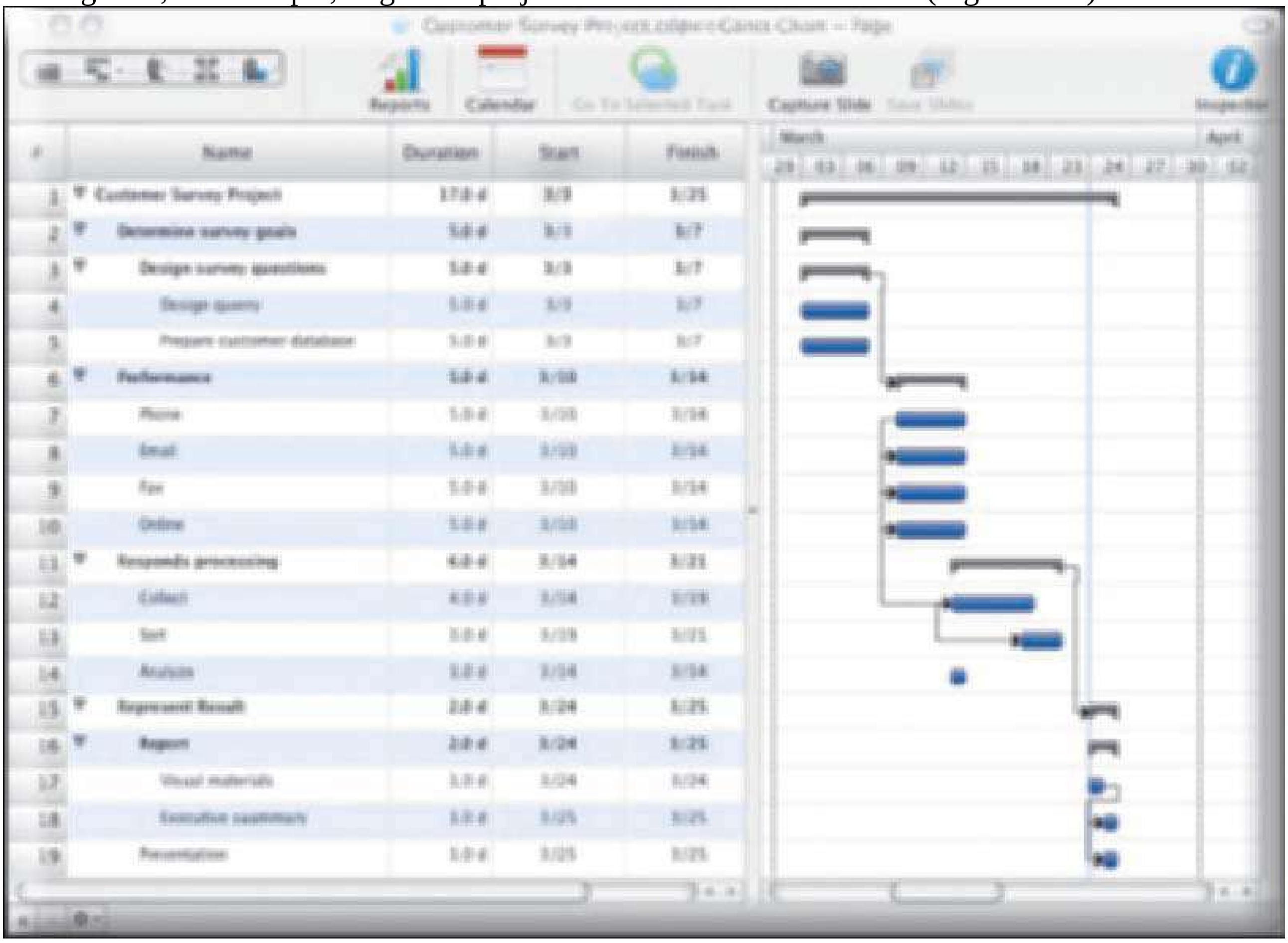


Figure 3-16 With project management software, you can plan and schedule a project.

Accounting Software

Accounting software helps companies record and report their financial transactions (Figure 3-17). With accounting software, business users perform accounting activities related to the general ledger, accounts receivable, accounts payable, purchasing, invoicing, and payroll functions. Accounting software also enables business users to write and print checks, track checking account activity, and update and reconcile balances on demand. Most accounting software supports online credit checks, invoicing, bill payment, direct deposit,

Figure 3-17 Accounting software helps companies record and report their financial transactions.

and payroll services. Some accounting software offers more complex features such as job costing and estimating, time tracking, multiple company reporting, foreign currency reporting, and forecasting the amount of raw materials needed for products. The cost of accounting software for small businesses ranges from less than one hundred to several thousand dollars. Accounting software for large businesses can cost several hundred thousand dollars.

Document Management Software

Document management software provides a means for sharing, distributing, and searching through documents by converting them into a format that can be viewed by any user. The converted document, which mirrors the original document's appearance, can be viewed and printed without the software that created the original document. Some document management software allows users to edit and add comments to the converted document. A popular file format that document management software uses to save converted documents is *PDF* (Portable Document Format), developed by Adobe Systems. Because of the widespread use of PDF files, some current business programs such as Microsoft Office include a feature that allows users to save their documents as PDF files. To view and print a PDF file, you need Acrobat Reader software (Figure 3-18), which can be downloaded free from Adobe's Web site.

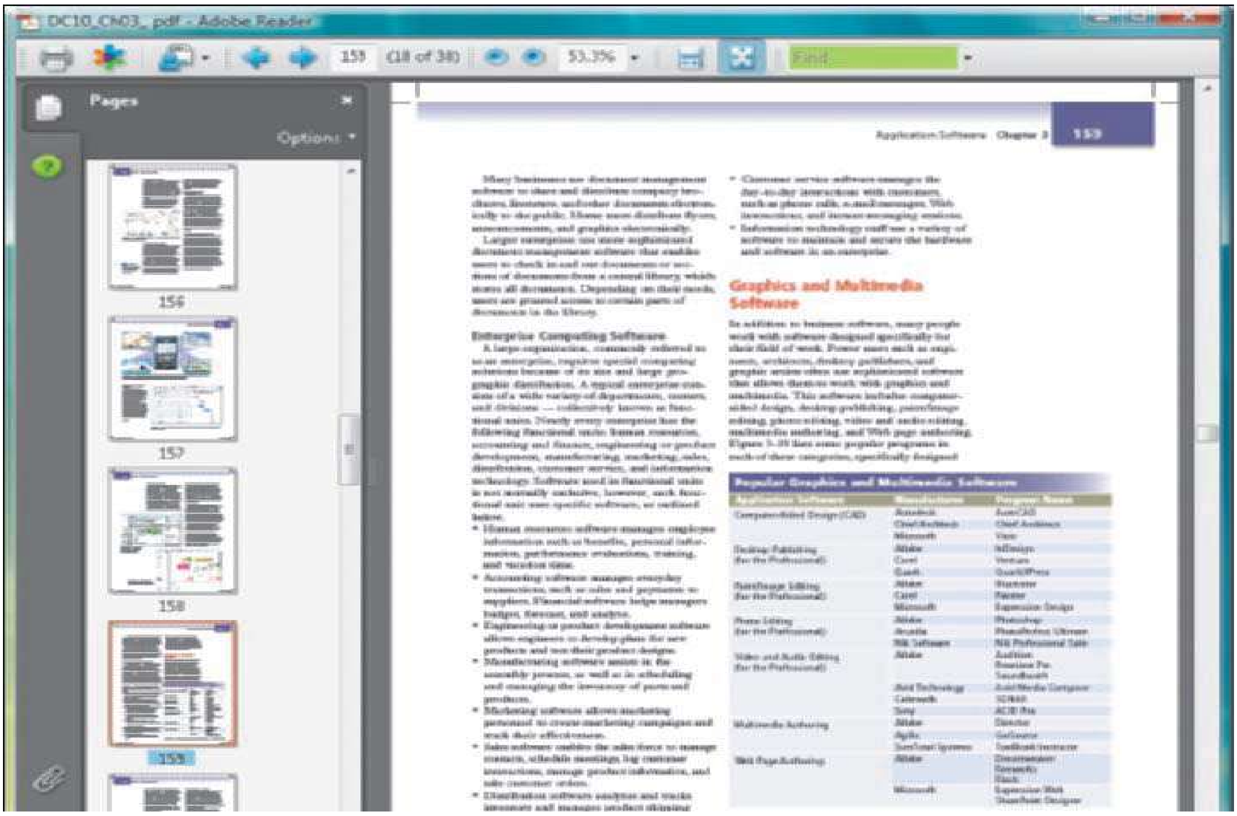


Figure 3-18 With Adobe Reader, you can view any PDF file, such as the page from this book shown in this figure.

Many businesses use document management software to share and distribute company brochures, literature, and other documents electronically to the public. Home users distribute flyers, announcements, and graphics electronically. Larger enterprises use more sophisticated document management software that enables users to check in and out documents or sections of documents from a central library, which stores all documents. Depending on their needs, users are granted access to certain parts of documents in the library.

Enterprise Computing Software

A large organization, commonly referred to as an enterprise, requires special computing solutions because of its size and large geographic distribution. A typical enterprise consists of a wide variety of departments, centers, and divisions — collectively known as functional units. Nearly every enterprise has the following functional units: human resources, accounting and finance, engineering or product development, manufacturing, marketing, sales, distribution, customer service, and information technology. Software used in functional units is not mutually exclusive; however, each functional unit uses specific software, as outlined below.

- Human resources software manages employee information such as benefits, personal information, performance evaluations, training, and vacation time.
- Accounting software manages everyday transactions, such as sales and payments to suppliers. Financial software helps managers budget, forecast, and analyze.
- Engineering or product development software allows engineers to develop plans for new products and test their product designs.
- Manufacturing software assists in the assembly process, as well as in scheduling and managing the inventory of parts and products.
- Marketing software allows marketing personnel to create marketing campaigns and track their effectiveness.
- Sales software enables the sales force to manage contacts, schedule meetings, log customer interactions, manage product informa tion, and take customer orders.
- Distribution software analyzes and tracks inventory and manages product shipping status.
- Customer service software manages the day-to-day interactions with customers, such as phone calls, e-mail messages, Web interactions, and instant messaging sessions.
- Information technology staff use a variety of software to maintain and secure the hardware and software in an enterprise.

Graphics and Multimedia Software

In addition to business software, many people work with software designed specifically for their field of work. Power users such as engineers, architects, desktop publishers, and graphic artists often use sophisticated software that allows them to work with graphics and multimedia. This software includes computer aided design, desktop publishing, paint/image editing, photo editing, video and audio editing, multimedia authoring, and Web page authoring. Figure 3-19 lists some popular programs in each of these categories, specifically designed for professional or more

Popular Graphics and Multimedia Software		
Application Software	**Manufacturer**	**Program Name**
Computer-Aided Design (CAD)	Autodesk	AutoCAD
	Chief Architect	Chief Architect
	Microsoft	Visio
Desktop Publishing (Professional)	Adobe	InDesign
	Corel	Ventura
	Quark	QuarkXPress
Paint/Image Editing (Professional)	Adobe	Illustrator
	Corel	Painter
	Microsoft	Expression Design
Photo Editing (Professional)	Adobe	Photoshop
	Arcadia	Photo Perfect Ultimate
	Nik Software	Nik Professional Suite
Video and Audio Editing (Professional)	Adobe	Audition Premiere Pro Soundbooth
	Avid Technology	Avid Media Composer
	Cakewalk	SONAR
	Sony	ACID Pro
Multimedia Authoring	Adobe	Director
	Agilix	GoCourse
	SumTotal Systems	ToolBook Instructor
Web Page Authoring	Adobe	Dreamweaver Fireworks Flash
	Microsoft	Expression Web SharePoint Designer

Figure 3-19 Popular graphics and multimedia programs — for the professional.

technically astute users. These programs often cost several hundred dollars or more.

Many graphics and multimedia programs incorporate user-friendly interfaces and/or have scaled-down versions, making it possible for the home and small business users to create documents using these programs. The following sections discuss the features and functions of graphics and multimedia software.

Computer-Aided Design

Computer-aided design (**CAD**) **software** is a sophisticated type of application software that assists a professional user in creating engineering, architectural, and scientific designs. For example, engineers create design plans for vehicles and security systems. Architects design building structures and floor plans (Figure 3-20). Scientists design drawings of molecular structures.
CAD software eliminates the laborious manual drafting that design processes can require. Three-dimensional CAD programs allow designers to rotate designs of 3-D objects to view them from any angle. Some CAD software even can generate material lists for building designs.

Figure 3-20 Architects use CAD software to design building structures.

Desktop Publishing Software (for the Professional)

Desktop publishing (**DTP**) **software** enables professional designers to create sophisticated documents that contain text, graphics, and many colors (Figure 3-21). Professional DTP software is ideal for the production of high-quality color documents such as textbooks, corporate newsletters, marketing literature, product catalogs, and annual reports.
Although many word processing programs have some of the capabilities of DTP software, professional designers and graphic artists use DTP software because it supports page layout. *Page layout* is the process of arranging text and graphics in a document

Figure 3-21 Professional designers and graphic artists use DTP software to produce sophisticated publications such as a printed magazine article.

on a page-by-page basis. DTP software includes color libraries to assist in color selections for text and graphics. A *color library* is a standard set of colors used by designers and printers to ensure that colors will print exactly as specified. Designers and graphic artists can print finished publications on a color printer, take them to a professional printer, or post them on the Web in a format that can be viewed by those without DTP software.

Paint/Image Editing Software (for the Professional)
Graphic artists, multimedia professionals, technical illustrators, and desktop publishers use paint software and image editing software to create and modify graphical images such as those used in DTP documents and Web pages.

Paint software, also called *illustration software*, allows users to draw pictures (Figure 3-22), shapes, and other graphical images with various on-screen tools such as a pen, brush, eyedropper, and paint bucket.

Image editing software provides the capabilities of paint software and also includes the capability to enhance and modify existing images and pictures. Modifications can include adjusting or enhancing image colors, adding special effects such as shadows and glows, creating animations, and *image stitching*, which is the process of combining multiple images into a larger image.

Figure 3-22 This graphic artist uses paint software to draw characters in a computer game.

Photo Editing Software (for the Professional)

Professional photo editing software is a type of image editing software that allows photo graphers, videographers, engineers, scientists, and other high-volume digital photo users to edit and customize digital photos (Figure 3-23). Professional photo editing software allows users to save images in a wide variety of file formats. With professional photo editing software, users can retouch photos, crop images, remove red-eye, change image shapes, color-correct images, straighten images, remove or rearrange objects in a photo, and apply filters.

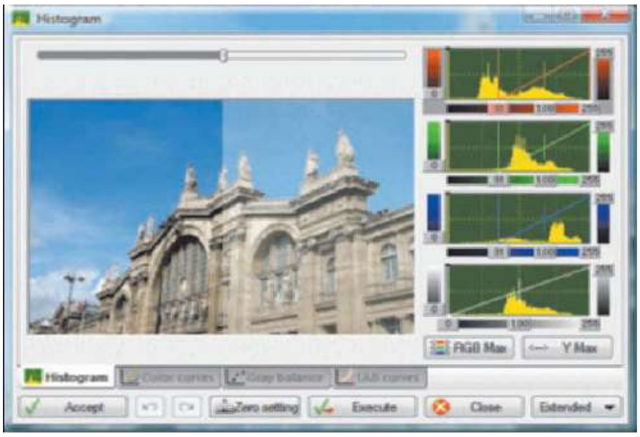


Figure 3-23 With professional photo editing software, users can edit and customize digital photos, such as by adjusting lighting as shown here.

Video and Audio Editing Software (for the Professional)
Video editing software allows professionals to modify a segment of a video, called a clip. For example, users can reduce the length of a video clip, reorder a series of clips, or add special effects such as words that move horizontally across the screen.
Video editing software typically includes audio editing capabilities. **Audio editing software** lets users modify audio clips, produce studio-quality soundtracks, and add audio to video clips (Figure 3-24). Audio editing software usually includes *filters*, which are designed to enhance audio quality. For example, a filter might remove a distracting background noise from the audio clip. Most television shows and movies are

created or enhanced using video and audio editing software.

Multimedia Authoring Software

Multimedia authoring software allows users to combine text, graphics, audio, video, and animation in an interactive application (Figure 3-25). With this software, users control the placement of text and images and the duration of sounds, video, and animation. Once created, multimedia presentations often take the form of interactive computer-based presentations or Web-based presentations designed to facilitate learning, demonstrate product functionality, and elicit direct-user participation. Training centers, educational institutions, and online magazine publishers all use multimedia authoring software to develop interactive applications. These applications may be available on an optical disc, over a local area network, or via the Internet.

Figure 3-24 With audio editing software, users modify audio clips.

Figure 3-25 Multimedia authoring software allows you to create dynamic presentations that include text, graphics, video, sound, and animation.

Web Page Authoring Software

Web page authoring software helps users of all skill levels create Web pages that include graphical images, video, audio, animation, and other special effects with interactive content (Figure 3-26). In addition, many Web page authoring programs allow users to organize, manage, and maintain Web sites. Application software, such as Word and Excel, often includes Web page authoring features. This allows home and small business users to create basic Web pages using application software they already own. For more sophisticated Web pages, users work with Web page authoring software. Many Web page developers also use multimedia authoring software along with, or instead of, Web page authoring software for Web page development.

Figure 3-26 With Web page authoring software, users create sophisticated Web pages.

Software for Home, Personal, and Educational Use

A large amount of application software is designed specifically for home, personal, and educational use. Most of the programs in this category are relatively inexpensive, often priced less than $100 and sometimes free. Figure 3-27 lists popular programs for many of these categories. The following pages discuss the features and functions of this application software.

Software for Home, Personal, and Educational		
Application Software	**Manufacturer**	**Program Name**
Personal Finance	IGG Software	iBank
	Intuit	Quicken
Legal	Broderbund	Home and Business Lawyer; WillWriter
	Cosmi	Perfect Attorney
	Nolo	Quicken Legal Business; Quicken WillMaker
Tax Preparation	2nd Story Software	TaxACT
	H&R Block	TaxCut
	Intuit	TurboTax
Desktop Publishing (for Personal Use)	Broderbund	The Print Shop; PrintMaster
	Microsoft	Publisher
Paint/Image Editing (Personal)	Corel	Corel DRAW; Painter Essentials
	The GIMP Team	The Gimp
Photo Editing and Photo Management (Personal)	Adobe	Photoshop Elements; Photoshop Express
	Corel	Paint Shop Pro Photo; Ulead Photo Impact; Media One Plus
	Yahoo!	Flickr
	Google	Picasa
	Microsoft	Windows Live Photo Gallery
	Roxio	Photo Show
Clip Art/Image Gallery	Broderbund	ClickArt
	Nova Development	Art Explosion
	Cool Archive	Cool Archive
Video and Audio Editing (for Personal Use)	Corel	Video Studio
	Microsoft	Windows Live Movie Maker
	Pinnacle Systems	Studio
	Roxio	Buzz
Home Design/Landscaping	Broderbund	Instant Architect
	Chief Architect	Better Homes and Gardens Home Designer
	IMSI/Design	Turbo FLOORPLAN
Travel and Mapping	DeLorme	Street Atlas
	Microsoft	Streets & Trips
	Google	Earth; Maps
Reference	Fogware Publishing	Merriam-Webster Collegiate Dictionary & Thesaurus
	Microsoft	MSN Encarta

Figure 3-27 Many popular programs are available for home, personal, and educational use.

Personal Finance Software

Personal finance software is a simplified accounting program that helps home users and small office/home office users balance their checkbooks, pay bills, track personal income and expenses (Figure 3-28), set up budgets, manage home inventory, track investments, and evaluate financial plans. Personal finance software helps determine where, and for what purpose, you are spending money so that you can manage your finances. Reports can summarize transactions by category (such as dining), by payee (such as the electric company), or by time (such as the last two months). Financial planning features include analyzing home and personal loans, preparing income taxes, and managing retirement savings. Most of these personal finance programs also offer a variety of online services, which require access to the Internet.

For example, users can track investments online, compare insurance rates from leading insurance companies, and bank online. **Online banking** offers access to account balances, provides bill payment services, and allows you to download monthly transactions and statements from the Web directly to your computer.

Figure 3-28 Personal finance software assists home users with tracking personal accounts, such as the savings account shown here.

Legal Software

Legal software assists in the preparation of legal documents and provides legal information to individuals, families, and small businesses (Figure 3-29). Legal software provides standard contracts and documents associated with buying, selling, and renting property; estate planning; marriage and divorce; and preparing a will or living trust. By answering a series of questions or completing a form, the legal software tailors the legal document to specific needs. Once the legal document is created, you can file the paperwork with the appropriate agency, court, or office; or take the document to your attorney for his or her review and signature.

Tax Preparation Software

Tax preparation software, which is available both as packaged software and as Web applications, can guide individuals, families, or small businesses through the process of filing federal taxes (Figure 3-30). These programs forecast tax liability and offer money-saving tax tips, designed to lower your tax bill. After you answer a series of questions and complete basic forms, the software creates and analyzes your tax forms to search for potential errors and deduction opportunities. Once the forms are complete, you can print any necessary paperwork, and then they are ready for filing. Instead of mailing forms through the postal service, the IRS allows taxpayers to file their state and federal tax returns online, called *e-filing*.

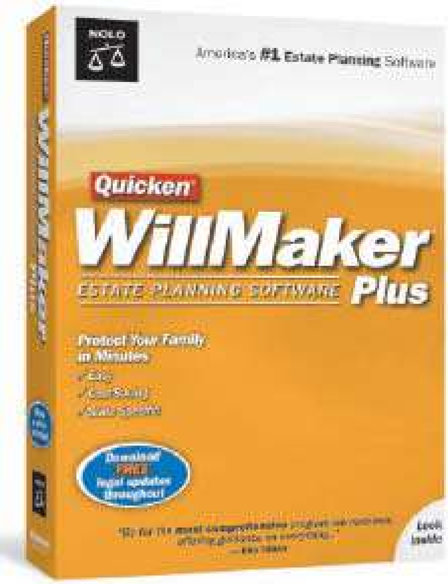


Figure 3-29 Legal software provides legal information to individuals, families, and small businesses and assists in record keeping and the preparation of legal documents.

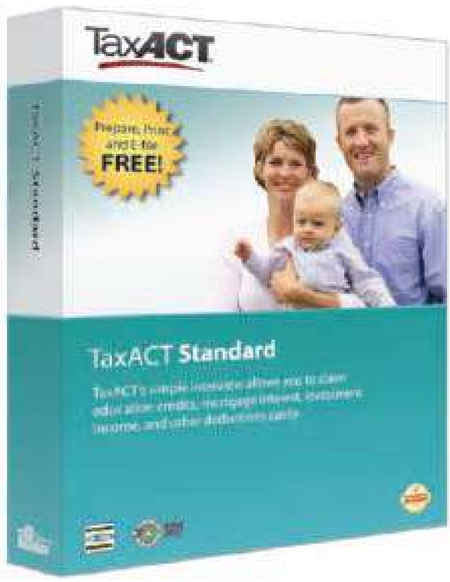


Figure 3-30 Tax preparation software guides individuals, families, or small businesses through the process of filing federal taxes.

Desktop Publishing Software (for Personal Use)

Instead of using professional DTP software (as discussed earlier in this chapter), many home and small business users work with simpler, easy-to-understand DTP software designed for smaller-scale desktop publishing projects. **Personal DTP software** helps home and small business users create newsletters, brochures, flyers (Figure 3-31), advertisements, postcards, greeting cards, letterhead, business cards, banners, calendars, logos, and Web pages. Although many word processing programs include DTP features, users often prefer to create DTP documents using DTP software because of its enhanced features. For example, personal DTP programs provide hundreds of thousands of graphical images. You also can import (bring in) your own digital photos into the documents. These programs typically guide you through the development of a document by asking a series of questions, offering numerous predefined layouts, and providing standard text you can add to documents. Then, you can print a finished publication on a color printer or post it on the Web in a format that can be viewed by those without DTP software. Many personal DTP programs also include paint/image editing software and photo editing and photo management software.

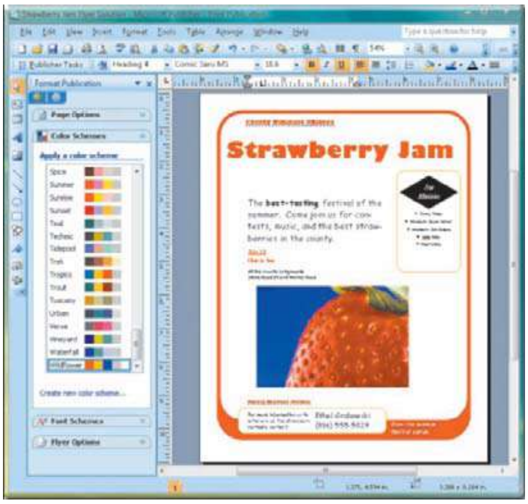


Figure 3-31 With desktop publishing software, home and small business users can create flyers.

Paint/Image Editing Software (for Personal Use)

Personal paint/image editing software provides an easy-to-use interface, usually with more simplified capabilities than its professional counterpart, including functions tailored to meet the needs of the home and small business user. As with the professional versions, personal paint software includes various simplified tools that allow you to draw pictures (Figure 3-32), shapes, and other images. Personal image editing software provides the capabilities of paint software and the ability to modify existing graphics and photos. These programs also include many templates to assist you in adding images to documents such as greeting cards, banners, calendars, signs, labels, business cards, and letterhead. Some operating systems include a basic paint/image editing program.

Figure 3-32 Home users can purchase affordable paint/image editing programs that enable them to draw images.

Photo Editing and Photo Management Software

Instead of professional photo editing software, many home and small business users work with easier-to-use personal photo editing software, which is available both as packaged software and as Web applications.

Personal photo editing software allows users to edit digital photos by removing red-eye, erasing blemishes, restoring aged photos, adding special effects, enhancing image quality, or creating electronic photo albums. When you purchase a digital camera, it usually includes photo editing software (Figure 3-33). Some digital cameras

Figure 3-33 As shown here, home users can adjust color on their digital photos with personal photo editing software.

even have basic photo editing software built in so that you can edit the image directly on the camera. You can print edited photos on labels, calendars, business cards, and banners, or you can post them on the Web. Some photo editing software allows users to send digital photos to an online print service, which will deliver high-resolution printed images through the postal service or allow you to pick them up at a local store. Many online print services also have a photo community where users can post photos on the Web for others to view and purchase, if desired.
With *photo management software*, you can view, organize, sort, catalog, print, and share digital photos. Some photo editing software includes photo management functionality (Figure 3-34).

Clip Art/Image Gallery

Application software often includes a **clip art/image gallery**, which is a collection of clip art and photos. Some programs have links to additional clips available on the Web or are available as Web applications. You also can purchase clip art/image gallery software that contains thousands of images (Figure 3-35). In addition to clip art, many clip art/image galleries provide fonts, animations, sounds, video clips, and audio clips. You can use the images, fonts, and other items from the clip art/image gallery in all types of documents, including word processing, desktop publishing, spreadsheet, and presentations.

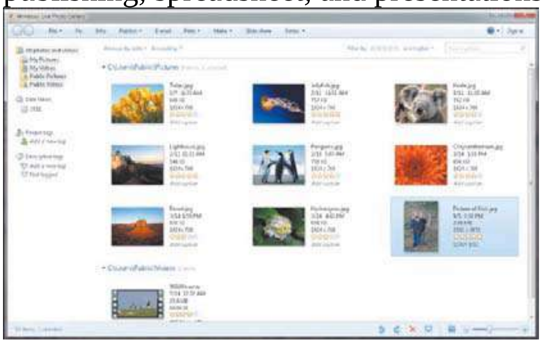


Figure 3-34 Photo management software enables you quickly to view thumbnails of all your digital photos.

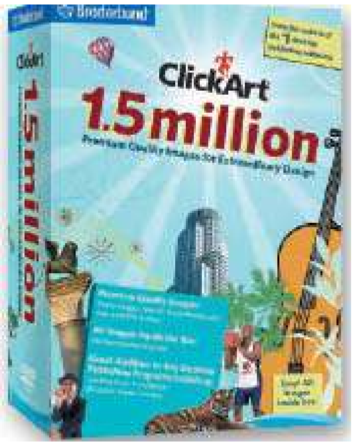


Figure 3-35 Clip art/image gallery software contains thousands of images.

Video and Audio Editing Software (for Personal Use)
Many home users work with easy-to-use video and audio editing software, which is much simpler to use than its professional counterpart, for small-scale movie making projects (Figure 3-36). With these programs, home users can edit home movies, add music or other sounds to the video, and share their movies on the Web. Some operating systems include video editing and audio editing software.

Figure 3-36 With personal video and audio editing software, home users can edit their home movies.

Home Design/Landscaping Software
Homeowners or potential homeowners can use **home design/landscaping software** to assist them with the design, remodeling, or improvement of a home, deck, or landscape (Figure 3-37).

Figure 3-37 Home design/ landscaping software can help you design or remodel a home, deck, or landscape.

Home design/landscaping software includes hundreds of predrawn plans that you can customize to meet your needs. These programs show changes to home designs and landscapes, allowing homeowners to preview proposed modifications. Once designed, many home design/ landscaping programs print a materials list outlining costs and quantities for the entire project.

Travel and Mapping Software
Travel and mapping software enables users to view maps, determine route directions, and locate points of interest (Figure 3-38). Using travel and mapping software, which is available both as packaged software and as Web applications, you can display maps by searching for an address, postal code, telephone number, or point of interest (such as airports, lodging, and historical sites). This software often provides driving directions when a user enters a starting and destination point. Most programs also allow you to download construction reports and calculate mileage, time, and expenses. Many are compatible with mobile devices such as smart phones and portable media players. Many navigation devices, including those in vehicles, have travel and mapping software.

Reference and Educational Software
Reference software provides valuable and thorough information for all individuals. Popular reference software includes

encyclopedias, dictionaries, and health/ medical guides.

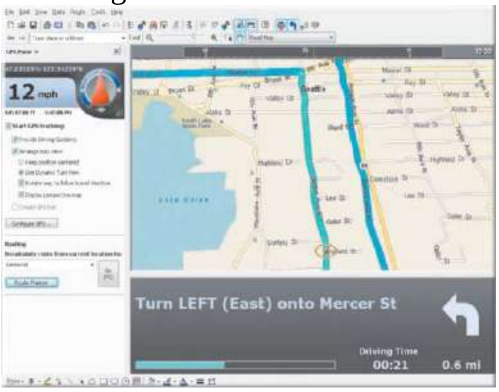


Figure 3-38 This software provides turn-by-turn directions, along with estimated travel times.

Educational software is software that teaches a particular skill. Educational software exists for just about any subject, from learning how to type (Figure 3-39) to learning how to cook. Preschool to high-school learners use educational software to assist them with subjects such as reading and math or to prepare them for class or college entrance exams. Educational software often includes games and other content to make the learning experience more fun. Many educational programs use a computer-based training approach.

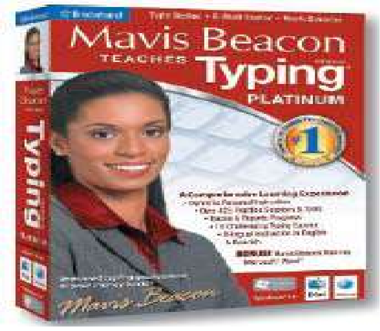


Figure 3-39 Educational software can teach a skill.

Computer-based training (**CBT**), also called computer-aided instruction (CAI), is a type of education in which students learn by using and completing exercises with instructional software. CBT typically consists of self-directed, self-paced instruction about a topic. Beginning athletes, for example, use CBT programs to learn the intricacies of baseball, football, soccer, tennis, and golf. The military and airlines use CBT simulations to train pilots to fly in various conditions and environments (Figure 3-40).

Figure 3-40 Military pilots use CBT simulations for flight training.

Entertainment Software

Entertainment software for personal computers, game consoles, and mobile devices includes interactive games, videos, and other programs designed to support a hobby or provide amusement and enjoyment. For example, you might use entertainment software to play games individually (Figure 3-41) or with others online, make a family tree, or fly an aircraft. Many games are available as Web applications, allowing you to play individually or with other online players.

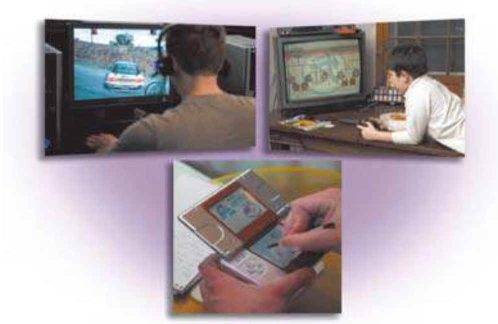


Figure 3-41 Entertainment software can provide hours of recreation on personal computers, game consoles, and mobile devices.

Web Applications

As discussed earlier in this chapter, users can purchase application software from a software vendor, retail store, or Web-based business. Users typically install purchased application software on a computer before they run it. Installed software has two disadvantages: (1) it requires disk space on your computer, and (2) it can be costly to upgrade as vendors release new versions. As an alternative, some users opt to access Web applications. As previously mentioned, a Web application, or *Web app*, is a Web site that allows users to access and interact with software from any computer or device that is connected to the Internet. Users often interact with Web applications, directly at the Web site, referred to as the host, through their Web browser. Some Web sites, however, require you download the software to your local computer or device. Web application hosts often store users' data and information on their servers, which sometimes is called *cloud storage*. Users concerned with data security may shy away from this type of Web application. Thus, some Web applications provide users with an option of storing data locally on their own personal computer or mobile device. Many of the previously discussed types of application software are available as Web applications. Figure 3-42 identifies the more popular Web applications. In addition, thousands of games are available as Web applications. Many Web application hosts provide free access to their software, such as Google Docs shown in Figure 3-43. Others, such as Google Earth, offer part of their Web application free and charge for access to a more comprehensive program. Some Web applications, such as online tax preparation programs, allow you to use the Web application free and pay a fee when a certain action occurs. For example, you can prepare your tax return free, but if you elect to print it or file it electronically, you pay a minimal fee. Experts often use the term Web 2.0 to describe Web applications. Recall that Web 2.0 refers to Web sites that provide users with a means to share personal information, allow users to modify Web site content, and/or have application software built into the site for visitors to use.

Popular Web Applications	
Program Name	**Type of Application Software**
Britannica.com	Reference
Dictionary.com	Reference
Flickr	Photo Editing and Photo Management
Gmail	E-Mail
Google Docs	Productivity Suite
Google Earth	Travel and Mapping
Google Maps	Travel and Mapping
MSN Encarta	Reference
Photoshop Express	Photo Editing
Picnik	Photo Editing
TaxACT Online	Tax Preparation
TurboTax Online	Tax Preparation
Windows Live Calendar	Personal Information Manager
Windows Live Hotmail	E-Mail
YouSendIt	File Transfer and E-Mail

Figure 3-42 Some popular Web applications. For practice using Web applications, complete the last Learn It Online exercise in each chapter.

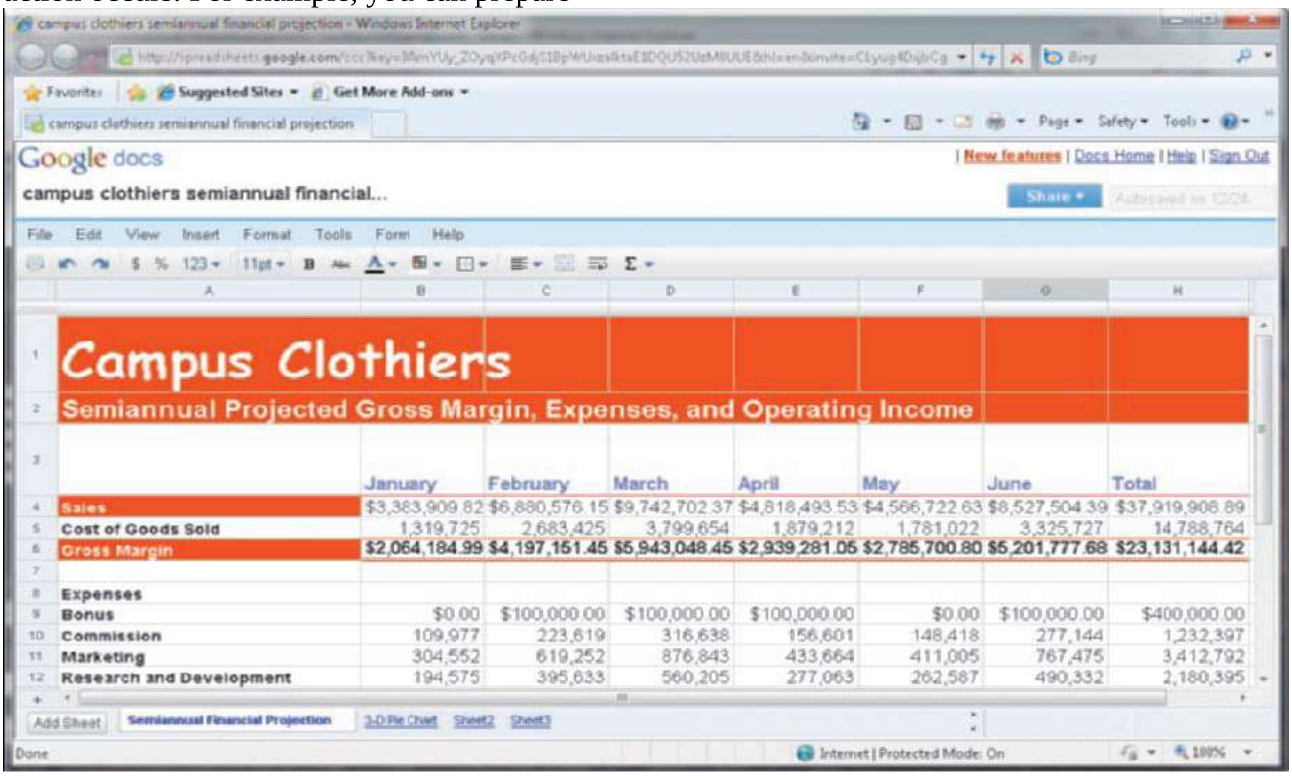


Figure 3-43 The spreadsheet shown here in Google Docs is the same Microsoft Excel spreadsheet that is shown in Figure 3-8. Differences between the two figures are due to different features in the two programs.

Application Software for Communications

One of the main reasons people use computers is to communicate and share information with others. Some communications software is considered system software because it works with hardware and transmission media. Other communications software makes users more productive and/or assists them with personal tasks, and thus, is considered application software. Chapter 2 presented a variety of application software for communications, which is summarized in the table in Figure 3-44.

Application Software for Communications	
Web Browser ▪ Allows users to access and view Web pages on the Internet ▪ Requires a Web browser program -Integrated in some operating systems -Available for download on the Web free or for a fee	**RSS Aggregator** ▪ Keeps track of changes made to Web sites by checking RSS feeds ▪ Requires RSS aggregator program -Integrated in some e-mail programs and Web browsers -Available for download on the Web, usually at no cost Blogging ▪ Time-stamped articles, or posts, in a diary or journal format, usually listed in reverse chronological order ▪ Blogger needs blog software, or blogware, to create/maintain blog -Some Web sites do not require installation of blog software
E-Mail ▪ Messages and files sent via a network such as the Internet ▪ Requires an e-mail program -Integrated in many software suites and operating systems -Available free at portals on the Web -Included with paid Internet access service -Can be purchased separately from retailers	**Newsgroup/Message Board** ▪ Online area where users have written discussions ▪ Newsgroup may require a newsreader program -Integrated in some operating systems, e-mail programs, and Web browsers
Instant Messaging ▪ Real-time exchange of messages, files, audio, and/or video with another online user ▪ Requires instant messenger software -Integrated in some operating systems -Available for download on the Web, usually at no cost -Included with some paid Internet access services	**FTP** ▪ Method of uploading and downloading files with other computers on the Internet ▪ May require an FTP program -Integrated in some operating systems -Available for download on the Web for a small fee
Chat Room ▪ Real-time, online typed conversation ▪ Requires chat client software -Integrated in some operating systems and Web browsers -Available for download on the Web, usually at no cost -Included with some paid Internet access services -Built into some Web sites	**VoIP (Internet Telephony)** ▪ Allows users to speak to other users over the Internet ▪ Requires Internet connection, Internet telephone service, microphone or telephone, and Internet telephone software or telephone adapter
Text, Picture, Video Messaging ▪ Short text, picture, or video messages sent and received, mainly on mobile devices ▪ Requires text, picture, video messenger software -Integrated in most mobile devices -Available for download on the Web, usually at no cost, for personal computers	**Video Conferencing** ▪ Meeting between geographically separated people who use a network such as the Internet to transmit video/audio ▪ Requires video conferencing software, a microphone, speakers, and sometimes a video camera attached to your computer

Figure 3-44 A summary of application software for home and business communications.

Learning Tools for Application Software

Learning how to use application software effectively involves time and practice. To assist in the learning process, many programs include an integrated Help feature.

Online Help is the electronic equivalent of a user manual (Figure 3-45a). When working with a program, you can use online Help to ask a question or access the Help topics in subject or alphabetical order. Most online Help also links to Web sites that offer *Web-based Help*, which provides updates and more comprehensive resources to respond to technical issues about software (Figure 3-45b). If you want to learn more about a particular program from a printed manual, many books are available to help you learn to use the features of personal computer programs. These books typically are available in bookstores and software stores. Many colleges and schools provide training on several of the programs discussed in this chapter. For more information, contact your local school for a list of class offerings.

Figure 3-45a (online Help)

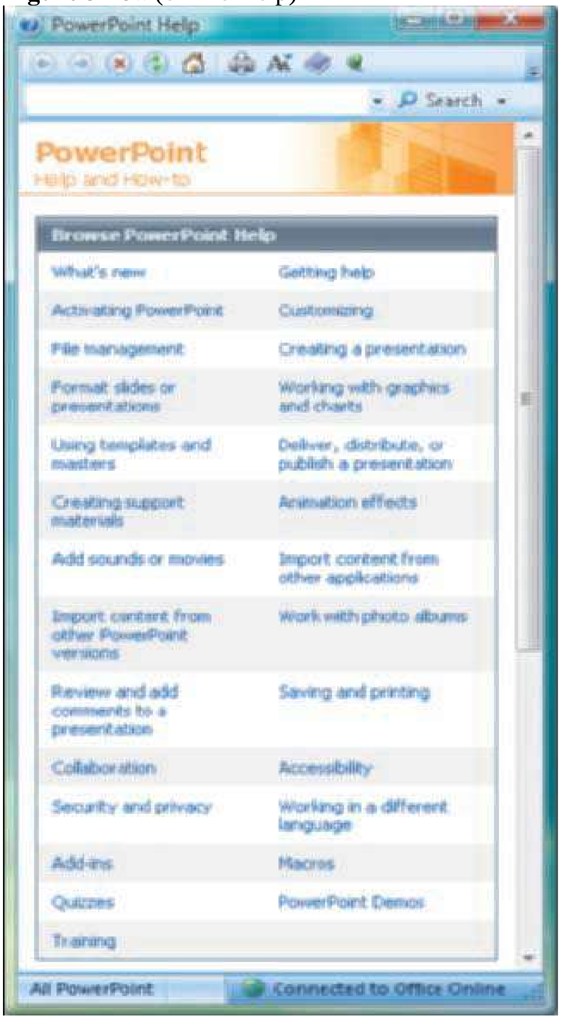


Figure 3-45b (Web-based Help)

Figure 3-45 Many programs include online Help and Web-based Help.

Web-Based Training

Web-based training (*WBT*) is a type of CBT (computer-based training) that uses Internet technology and consists of application software on the Web. Similar to CBT, WBT typically consists of self-directed, self-paced instruction about a topic. WBT is popular in business, industry, and schools for teaching new skills or enhancing existing skills of employees, teachers, or students. When using a WBT product, students actively become involved in the learning process instead of remaining passive recipients of information. Many Web sites offer WBT to the general public. Such training covers a wide range of topics, from how to change a flat tire to creating documents in Word. Many of these Web sites are free. Others require registration and payment to take the complete Web-based course. WBT often is combined with other materials for distance learning and e-learning. **Distance learning** (**DL**) is the delivery of education at one location while the learning takes place at other locations. DL courses provide time, distance, and place advantages for students who live far from a college campus or work full time. These courses enable students to attend class from anywhere in the world and at times that fit their schedules. Many national and international companies offer DL training. These training courses eliminate the costs of airfare, hotels, and meals for centralized training sessions. *E-learning*, short for electronic learning, is the delivery of education via some electronic method such as the Internet, networks, or optical discs. To enhance communications, e-learning systems also may include video conferencing, e-mail, blogs, wikis, newsgroups, chat rooms, and groupware. E-learning providers often specialize in presenting instructors with the tools for preparation, distribution, and management of DL courses (Figure 3-46). These tools enable instructors to create rich, educational Webbased training sites and allow the students to interact with a powerful Web learning environment. Through the training site, students can check their progress, take practice tests, search for topics, send e-mail messages, and participate in discussions and chats.

Figure 3-46 E-learning systems enable instructors to post course materials for their students.

Chapter Exercises

True/False **Mark T for True and F for False.**

_____ 1. The categories of application software are mutually exclusive.

_____ 2. Public-domain software is available to the public for a fee.

_____ 3. To click a button on the screen requires moving the pointer to the button and then pressing and holding down a button on the mouse (usually the right mouse button).

_____ 4. A dialog box is a window that provides information, presents available options, or requests a response.

_____ 5. A font is a name assigned to a specific design of characters.

_____ 6. In a spreadsheet program, a function is a predefined formula that performs common calculations such as adding the values in a group of cells or generating a value such as the time or date.

_____ 7. Computer-aided design (CAD) software is a sophisticated type of application software that assists a professional user in creating engineering, architectural, and scientific designs.

_____ 8. Image stitching is the process of adjusting or enhancing image colors and/or adding special effects such as shadows and glows.

_____ 9. Although many word processing programs include desktop publishing (DTP) software features, users often prefer to create DTP documents using DTP software because of its enhanced features.

_____ 10. Some Web sites require you to download software in order to run their Web applications.

_____ 11. Some communications software is considered system software because it works with hardware and transmission media.

_____ 12. An RSS aggregator includes time-stamped articles, or posts, in a diary or journal format, usually listed in reverse chronological order.

Multiple Choice Select the best answer.

1. _____ is mass-produced, copyrighted retail software that meets the needs of a wide variety of users, not just a single user or company.
a. Packaged software　　b. A Web application
c. Open source software　　d. Custom software

2. _____ is a collection of individual programs available together as a unit.
a. A software suite　b. Shareware　c. Packaged software　d. Custom software

3. _____ allows a user to plan, schedule, track, and analyze the events, resources, and costs of a project.
a. Accounting software　　b. Project management software
c. CAD software　　d. Document management software

4. _____ software provides a means for sharing, distributing, and searching through documents by converting them into a format that can be viewed by any user.
a. Database b. Portable Document Format (PDF)
c. Document management d. Word processing

5. _____ helps home and small business users create newsletters, brochures, advertisements, postcards, greeting cards, letterhead, business cards, banners, calendars, logos, and Web pages.
a. Blogware b. A personal information manager
c. Personal DTP software d. Note taking software

6. With _____, you can view, organize, sort, catalog, print, and share digital photos.
a. spreadsheet software b. photo management software
c. clip art d. desktop publishing software

7. A(n) _____ is an online area where users have written discussions.
a. FTP program b. text message
c. newsgroup/message board d. Web browser

8. _____ is the electronic equivalent of a user manual.
a. Web-based training b. Online Help
c. E-learning d. Distance learning

Matching Match the terms with their definitions.

_____	1. button	a. popular file format that document management software uses to save converted documents
_____	2. window	b. the process of transferring an item from a clipboard to a specific location in a document
_____	3. title bar	c. Web site that allows users to access and interact with software from any computer or device that is connected to the Internet
_____	4. pasting	d. intersection of a row and column in a spreadsheet
_____	5. cell	e. rectangular area of the screen that displays data and information
_____	6. database	f. small symbol on the screen that moves as you move the mouse
_____	7. PDF	g. simplified accounting program that helps home users and small office/home office users balance their checkbooks, pay bills, track personal income and expenses, set up budgets, manage home inventory, track investments, and evaluate financial plans
_____	8. personal finance software	h. text that appears at the bottom of every page
_____	9. online banking	i. graphical image activated to cause a specific action to occur
_____	10. Web app	j. horizontal space that contains the window's name
		k. offers access to account balances, provides bill payment services, and allows you to download monthly transactions and statements from the Web directly to your computer
		l. collection of data organized in a manner that allows access, retrieval, and use of that data

Short Answer Write a brief answer to each of the following questions.
1. Describe some types of utility programs. ____________ What is malware? ____________

2. What are the features of presentation software? _____________ What types of media might a person use to enhance a presentation? _____________

3. How is travel and mapping software used? _____________ What are some examples of reference software? _____________

4. What is computer-based training (CBT)? _____________ List a few examples of CBT usage. _____________

5. Describe how many Web sites utilize Web-based training. _____________ What are some ways that e-learning enhances communications? _____________

Chapter Four

The Components of the System Unit

The System Unit

Whether you are a home user or a business user, you most likely will purchase a new computer or upgrade an existing computer at some time in the future. Thus, you should understand the purpose of each component in a computer. As Chapter 1 discussed, a computer includes devices used for input, processing, output, storage, and communications. Many of these components are part of the system unit.

The **system unit** is a case that contains electronic components of the computer used to process data. System units are available in a variety of shapes and sizes. The case of the system unit, sometimes called the *chassis*, is made of metal or plastic and protects the internal electronic components from damage. All computers and mobile devices have a system unit (Figure 4-1). On desktop personal computers, the electronic components and most storage devices are part of the system unit. Other devices, such as the keyboard, mouse, microphone, monitor, printer, USB flash drive, scanner, Web cam, and speakers, normally occupy space outside the system unit. An all-in-one desktop personal computer is an exception, which houses the monitor and the system unit in the same case. The trend is toward a smaller *form factor*, or size and shape, of the desktop personal computer system unit.

Figure 4-1 All sizes of computers and mobile devices have a system unit.

On most notebook computers, including netbooks, the keyboard and pointing device often occupy the area on the top of the system unit, and the display attaches to the system unit by hinges. The location of the system unit on a Tablet PC varies, depending on the design of the Tablet PC. With the slate Tablet PC (shown in Figure 4-35 on page 236), which typically does not include a keyboard, the system unit is behind the display. On a convertible Tablet PC (shown in lower-left corner of Figure 4-1), by contrast, the system unit is positioned below a keyboard, providing functionality similar to a traditional notebook computer or netbook. The difference is the display attaches to the system unit with a swivel-type hinge, which enables a user to rotate the display and fold it down over the keyboard to look like a slate Tablet PC. The system unit on an Ultra-Mobile PC, a smart phone, and a PDA usually consumes the entire device. On these mobile computers and devices, the display often is built into the system unit. With game consoles, the input and output devices, such as controllers and a television, reside outside the system unit. On handheld game consoles, portable media players, and digital cameras, by contrast, the packaging around the system unit houses the input devices and display. At some point, you might have to open the system unit on a desktop personal computer to replace or install a new electronic component. For this reason, you should be familiar with the electronic components of a system unit. Figure 4-2 identifies some of these components, which include the processor, memory, adapter cards, drive bays, and the power supply. The processor interprets and carries out the basic instructions that operate a computer. Memory typically holds data waiting to be processed and instructions waiting to be executed. The electronic components and circuitry of the system unit, such as the processor and memory, usually are part of or are connected to a circuit

Figure 4-2 The system unit on a typical personal computer consists of numerous electronic components, some of which are shown in this figure. The sound card and video card are two types of adapter cards.

board called the motherboard. Many current motherboards also integrate sound, video, and networking capabilities. Adapter cards are circuit boards that provide connections and functions not built into the motherboard or expand on the capability of features integrated into the motherboard. For example, a sound card and a video card are two types of adapter cards found in some desktop personal computers today. Devices outside the system unit often attach to ports on the system unit by a connector on a cable. These devices may include a keyboard, mouse, microphone, monitor, printer, scanner, USB flash drive, card reader/writer, Web cam, and speakers. A drive bay holds one or more disk drives. The power supply converts electricity from a power cord plugged in a wall outlet into a form that can be used by the computer.

The Motherboard

The **motherboard**, sometimes called a *system board*, is the main circuit board of the system unit. Many electronic components attach to the motherboard; others are built into it. Figure 4-3 shows a photo of a current desktop personal computer motherboard and identi fies its slots for adapter cards, the processor chip, and memory. Memory chips are installed on memory cards (modules) that fit in a slot on the motherboard.

A computer **chip** is a small piece of semiconducting material, usually silicon, on which integrated circuits are etched. An *integrated circuit* contains many microscopic pathways capable of carrying electrical current. Each integrated circuit can contain millions of elements such as resistors, capacitors, and transistors. A *transistor*, for example, can act as an electronic switch that opens or closes the circuit for electrical charges. Today's computer chips contain millions or billions of transistors. Most chips are no bigger than one-half-inch square. Manufacturers package chips so that the chips can be attached to a circuit board, such as a motherboard or an adapter card. Specific types of processor, memory, and other chips are discussed later in the chapter.

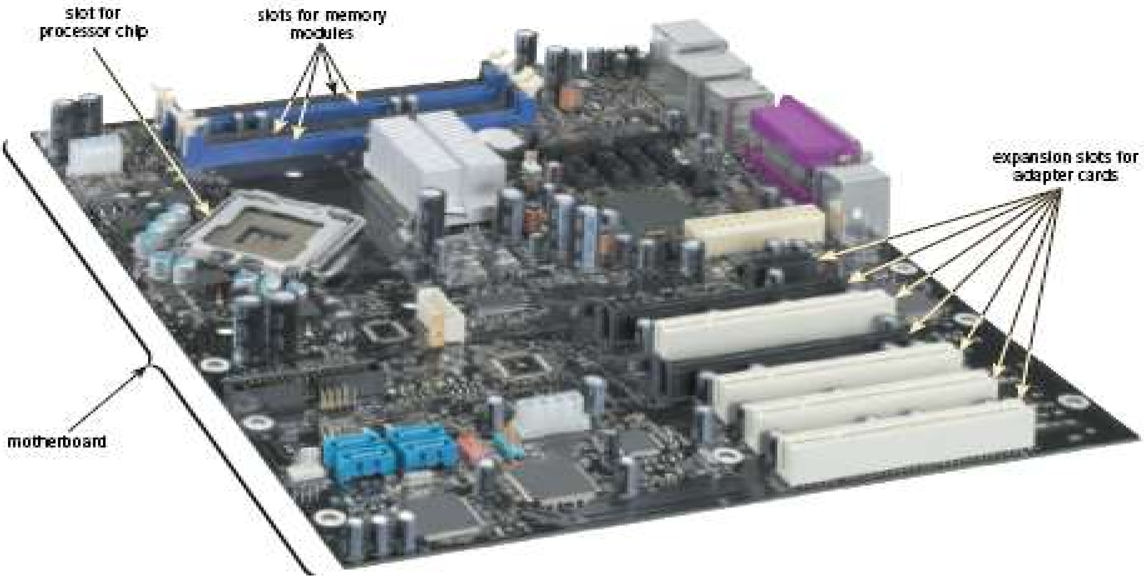


Figure 4-3 Many electronic components attach to the motherboard in a desktop personal computer, including a processor chip, memory modules, and adapter cards.

Processor

The **processor**, also called the **central processing unit** (**CPU**), interprets and carries out the basic instructions that operate a computer. The processor significantly impacts overall computing power and manages most of a computer's operations. On larger computers, such as mainframes and supercomputers, the various functions performed by the processor extend over many separate chips and often multiple circuit boards. On a personal computer, all functions of the processor usually are on a single chip. Some computer and chip manufacturers use the term *microprocessor* to refer to a personal computer processor chip.

Most processor chip manufacturers now offer multi-core processors. A processor core, or simply core, contains the circuitry necessary to execute instructions. The operating system views each processor core as a separate processor. A **multi-core processor** is a single chip with two or more separate processor cores. Two common multi-core processors are dual-core and quad-core. A **dual-core processor** is a chip that contains two separate processor cores. Similarly, a **quad-core processor** is a chip with four separate processor cores.

Each processor core on a multi-core processor generally runs at a slower clock speed than a single-core processor, but multi-core processors typically increase overall performance. For example, although a dual-core processor does not double the processing speed of a single-core processor, it can approach those speeds. The performance increase is especially noticeable when users are running multiple programs simultaneously such as antivirus software, spyware remover, e-mail program, instant messaging, media player, disc burning software, and photo editing software. Multi-core processors also are more energy efficient than separate multiple processors, requiring lower levels of power consumption and emitting less heat in the system unit.

Processors contain a control unit and an arithmetic logic unit (ALU). These two components work together to perform processing operations. Figure 4-4 illustrates how other devices connected to the computer communicate with the processor to carry out a task.

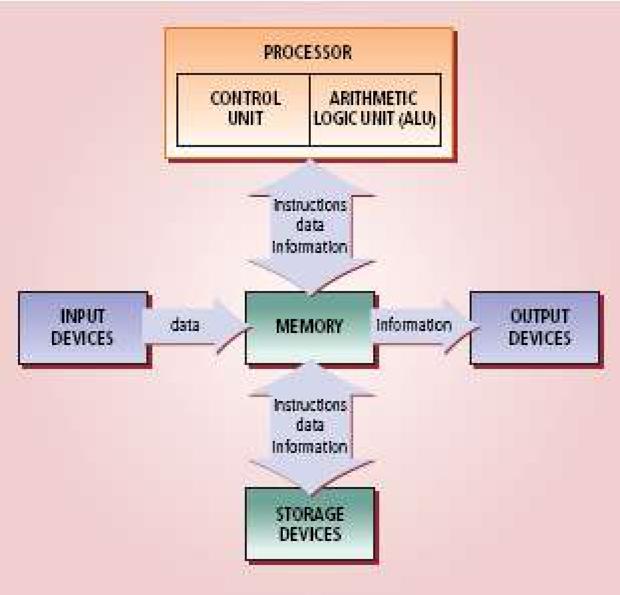


Figure 4-4 Most devices connected to the computer communicate with the processor to carry out a task. When a user starts a program, for example, its instructions transfer from a storage device to memory. Data needed by programs enters memory from either an input device or a storage device. The control unit interprets and executes instructions in memory, and the ALU performs calculations on the data in memory. Resulting information is stored in memory, from which it can be sent to an output device or a storage device for future access, as needed.

The Control Unit

The **control unit** is the component of the processor that directs and coordinates most of the operations in the computer. The control unit has a role much like a traffic cop: it interprets each instruction issued by a program and then initiates the appropriate action to carry out the instruction. Types of internal components that the control unit directs include the arithmetic/logic unit, registers, and buses, each discussed later in this chapter.

The Arithmetic Logic Unit

The **arithmetic logic unit** (*ALU*), another component of the processor, performs arithmetic, comparison, and other operations.

Arithmetic operations include basic calculations such as addition, subtraction, multiplication, and division. *Comparison operations* involve comparing one data item with another to determine whether the first item is greater than, equal to, or less than the other item. Depending on the result of the comparison, different actions may occur. For example, to determine if an employee should receive overtime pay, software instructs the ALU to compare the number of hours an employee worked during the week with the regular time hours allowed (e.g., 40 hours). If the hours worked exceed 40, for example, software instructs the ALU to perform calculations that compute the overtime wage.

Machine Cycle

For every instruction, a processor repeats a set of four basic operations, which comprise a *machine cycle* (Figure 4-5): (1) fetching, (2) decoding, (3) executing, and, if necessary, (4) storing. *Fetching* is the process of obtaining a program instruction or data item from memory. The term *decoding* refers to the process of translating the instruction into signals the computer can execute. *Executing* is the process of carrying out the commands. *Storing*, in this context, means writing the result to memory (not to a storage medium).

In some computers, the processor fetches, decodes, executes, and stores only one instruction at a time. In these computers, the processor waits until an instruction completes all four stages of the machine cycle (fetch, decode, execute, and store) before beginning work on the next instruction. Most of today's personal computers support a concept called pipelining. With *pipelining*, the processor begins fetching a second instruction before it completes the machine cycle for the first instruction. Processors that use pipelining are faster because they do not have to wait for one instruction to complete the machine cycle before fetching the next. Think of a pipeline as an assembly line. By the time the first instruction is in the last stage of the machine cycle, three other instructions could have been fetched and started through the machine cycle (Figure 4-6).

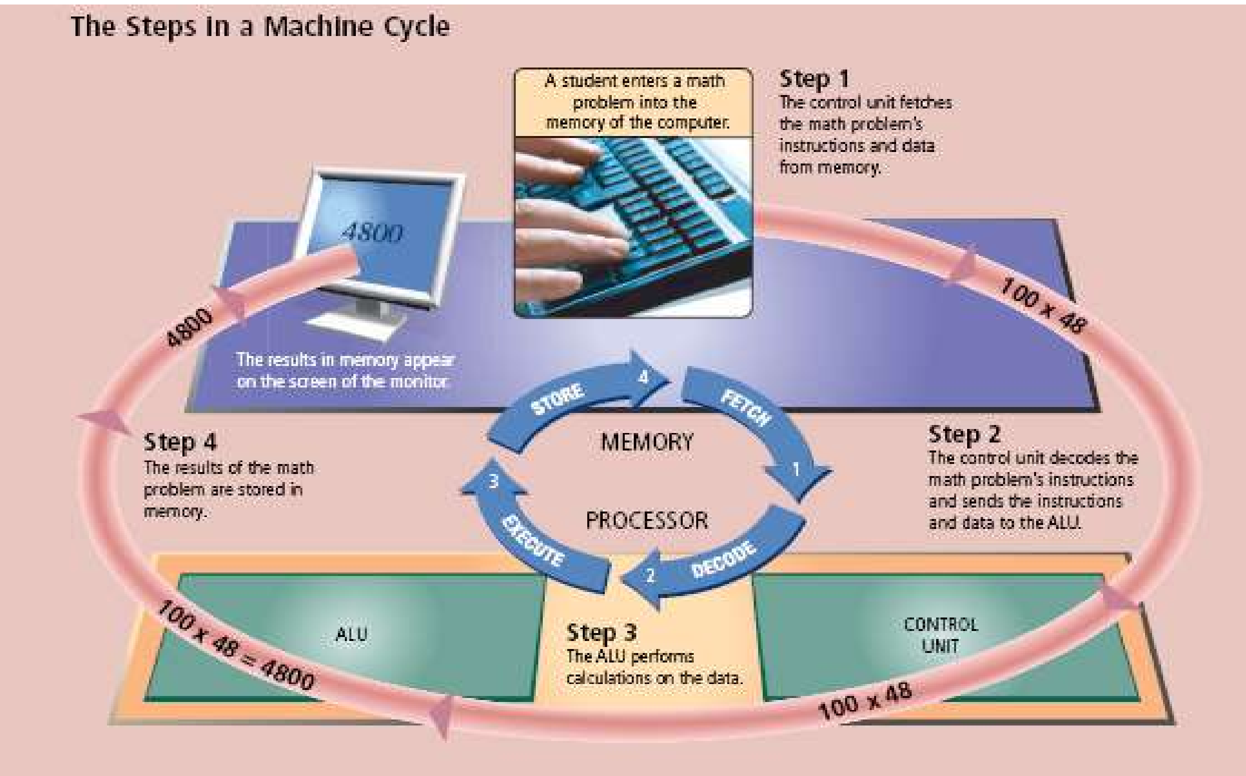


Figure 4-5 This figure shows the steps in a machine cycle.

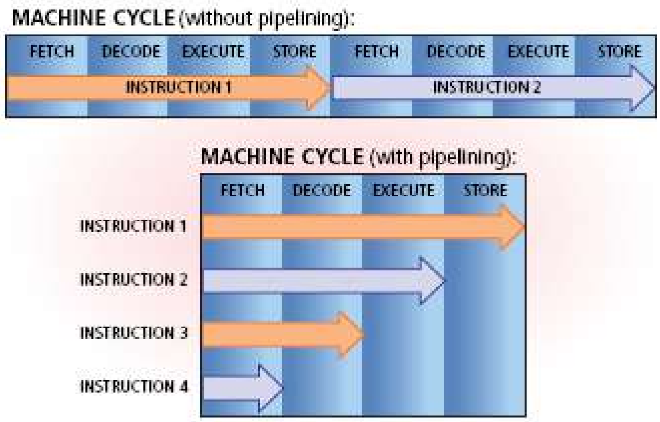


Figure 4-6 With pipelining, the processor fetches a second instruction before the first instruction is completed. The result is faster processing.

Registers

A processor contains small, high-speed storage locations, called *registers*, that temporarily hold data and instructions. Registers are part of the processor, not part of memory or a permanent storage device. Processors have many different types of registers, each with a specific storage function. Register functions include storing the location from where an instruction was fetched, storing an instruction while the control unit decodes it, storing data while the ALU computes it, and storing the results of a calculation.

The System Clock

The processor relies on a small quartz crystal circuit called the **system clock** to control the timing of all computer operations. Just as your heart beats at a regular rate to keep your body functioning, the system clock generates regular electronic pulses, or ticks, that set the operating pace of components of the system unit. Each tick equates to a *clock cycle*. In the past, processors used one or more clock cycles to execute each instruction. Processors today often are *superscalar*, which means they can execute more than one instruction per clock cycle.

The pace of the system clock, called the **clock speed**, is measured by the number of ticks per second. Current personal computer processors have clock speeds in the gigahertz range. Giga is a prefix that stands for billion, and a *hertz* is one cycle per second. Thus, one **gigahertz** (**GHz**) equals one billion ticks of the system clock per second. A computer that operates at 3 GHz has 3 billion (giga) clock cycles in one second (hertz). The faster the clock speed, the more instructions the processor can execute per second. The speed of the system clock has no effect on devices such as a printer or disk drive. The speed of the system clock is just one factor that influences a computer's performance. Other factors, such as the type of processor chip, amount of cache, memory access time, bus width, and bus clock speed, are discussed later in this chapter.

Comparison of Personal Computer Processors

The leading manufacturers of personal computer processor chips are Intel and AMD. These manufacturers often identify their processor chips by a model name or model number (Figure 4-7). High-performance personal computers today may use a processor in the Intel **Core** family. Less expensive, basic personal computers may use a brand of Intel processor in the **Pentium** or **Celeron** family. The **Xeon** and **Itanium** families of processors are ideal for workstations and low-end servers. AMD is the leading manufacturer of *Intelcompatible processors*, which have an internal design similar to Intel processors, perform the same functions, and can be as powerful, but often are less expensive.

In the past, chip manufacturers listed a processor's clock speed in marketing literature and advertisements. As previously mentioned, though, clock speed is only one factor that impacts processing speed in today's computers. To help consumers evaluate various processors, manufacturers such as Intel and AMD now use a numbering scheme that more accurately reflects the processing speed of their chips. Processor chips include technologies to improve processing performance, for example, to improve performance of multimedia and 3-D graphics. Most of Intel's processor chips also include *vPro technology*, which provides the capability to track computer hardware and software, diagnose and resolve computer problems, and secure computers from outside threats.

As mentioned earlier, many personal computer processors are multi-core, with the processor cores working simultaneously on related instructions. These related instructions, called a thread, can be independent or part of a larger task. Software written to support multiple threads, called a *multi-threaded program*, runs much faster than those in nonthreaded environments.

Comparison of Currently Available Personal Computer Processors

	Name	Multi-Core Availability	Manufacturer
SERVER PROCESSORS	Xeon	Quad Core, Dual Core	Intel
	Itanium	Dual Core	Intel
	Opteron	6 Core, Quad Core	AMD
DESKTOP PERSONAL COMPUTER PROCESSORS	Core i7 Extreme	Quad Core	Intel
	Core i7	Quad Core	Intel
	Core 2 Extreme	Quad Core, Dual Core	Intel
	Core 2	Quad Core, Dual Core	Intel
	Pentium Dual-Core	Dual Core	Intel
	Celeron	Dual Core	Intel
	Phenom	Quad Core, Triple Core	AMD
	Athlon	Dual Core	AMD
	Sempron		AMD
NOTEBOOK COMPUTER PROCESSORS	Core 2 Extreme	Quad Core	Intel
	Core 2	Quad Core, Dual Core	Intel
	Atom		Intel
	Turion	Dual Core	AMD
	Athlon	Dual Core	AMD
	Sempron		AMD

Figure 4-7 Most of today's processors are multi-core.

Processors for traditional notebook computers and Tablet PCs also include technology to optimize and extend battery life, enhance security, and integrate wireless capabilities. For example, Intel's *Centrino 2* mobile technology, which may have a Pro designator depending on its capabilities, integrates wireless functionality in notebook computers and Tablet PCs. Netbooks, smart phones, and other smaller mobile devices often use more compact processors that consume less power, yet offer high performance.

Another type of processor, called *system-ona-chip*, integrates the functions of a processor, memory, and a video card on a single chip. Lower-priced personal computers, Tablet PCs, networking devices, portable media players, and game consoles sometimes have a system on- a-chip processor. The goal of system-on-achip manufacturers is to create processors that have faster clock speeds, consume less power,
are small, and are cost effective.

Buying a Personal Computer

If you are ready to buy a new computer, the processor you select should depend on how you plan to use the computer (Figure 4-8). To realize greater processing performance, you may want to choose a multi-core processor. Instead of buying an entirely new computer, you might be able to upgrade your processor to increase the computer's performance. Be certain the processor you buy is compatible with your computer's motherboard; otherwise, you will have to replace the motherboard, too. Replacing a processor is a fairly simple process, whereas replacing a motherboard is much more complicated.

Guidelines for Selecting a Personal Computer Processor

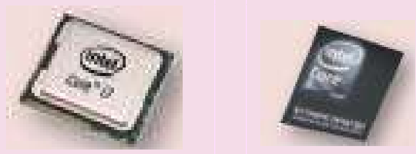
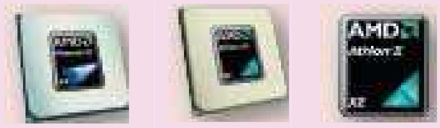
USE		
	• Power users with workstations • Low-end servers on a network	Tanium2 — Xeon — Opteron 
	▪ Power users or users who design professional drawings, produce and edit videos, record and edit music, participate in video conferences, create professional Web sites, play graphic-intensive multiplayer Internet games ▪ Users who design professional documents containing graphics such as newsletters or number-intensive spreadsheets, produce multimedia presentations, use the Web as an intensive research tool, send documents and graphics via the Web, watch videos, play graphic-intensive games on optical discs, create personal Web site ▪ Home users who manage personal finances, create basic documents with word processing and spreadsheet software, edit photos, communicate with others on the Web via e-mail, chat rooms, and discussions, shop on the Web, create basic Web pages, use the computer as a digital entertainment unit	**Core i7** — **Core i7 Extreme**  Phenom II — Athlon X2 — Athlon II X2 Dual-Core 
	▪ Home users who manage personal finances, create basic documents with word processing and spreadsheet software, edit photos, make greeting cards and calendars, use educational or entertainment CDs, communicate with others on the Web via e-mail, chat rooms, and discussions	Core i7 — Core 2 Duo — Sempron 
	▪ Users with traditional notebook computers and Tablet PCs	Core 2 Extreme — Turion X2 — Core 2 Duo Ultra Low Voltage 
	▪ Users with netbooks	Atom — Celeron — Athlon 

Figure 4-8 Determining which processor to obtain when you purchase a computer depends on Computer usage.

Processor Cooling
Processor chips generate quite a bit of heat, which could cause the chip to burn up. Although the computer's main fan generates airflow, many of today's personal computer processors
require additional cooling. Heat sinks/ pipes and liquid cooling technologies often are used to help dissipate processor heat.

A *heat sink* is a small ceramic or metal component with fins on its surface that absorbs and disperses heat produced by electrical components such as a processor (Figure 4-9). Some heat sinks are packaged as part of a processor chip. Others are installed on the top or the side of the chip. Because a heat sink consumes extra space, a smaller device called a *heat pipe* cools processors in notebook computers, including netbooks and Tablet PCs.

Some computers use liquid cooling technology to reduce the temperature of a processor. *Liquid cooling technology* uses a continuous flow of fluid(s), such as water and glycol, in a process that transfers the heated fluid away from the processor to a radiator-type grill, which cools the liquid, and then returns the cooled fluid to the processor (Figure 4-10).

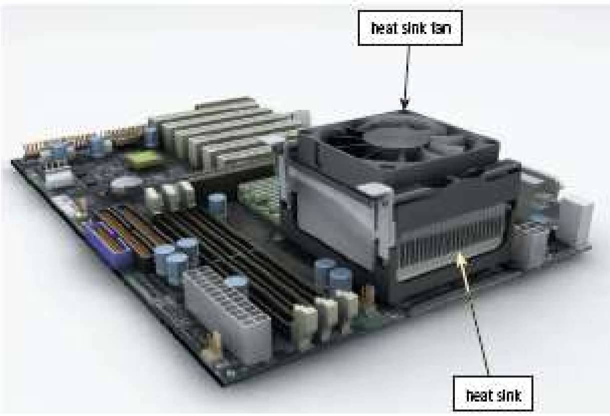


Figure 4-9 A heat sink, which in this photo is attached to the top of a processor, prevents the chip from overheating. The heat sink fan, which attaches to the top of the heat sink, helps distribute air dissipated by the heat sink.

Some mobile computers and devices often have Low Voltage or Ultra Low Voltage (ULV) processors, which have such low power demands that they do not require additional cooling.

Parallel Processing
Parallel processing is a method that uses multiple processors simultaneously to execute a single program or task (Figure 4-11). Parallel processing divides a single problem into portions so that multiple processors work on their assigned portion of the problem at the same time. Parallel processing requires special software that recognizes how to divide the problem and then bring the results back together again. Some personal computers implement parallel processing with dual-core processors or multi-core processors. Others have two or more separate processor chips, respectively called dual processor or multiprocessor computers.

Massively parallel processing is large scale parallel processing that involves hundreds or thousands of processors. Supercomputers use massively parallel processing for applications such as artificial intelligence and weather forecasting.

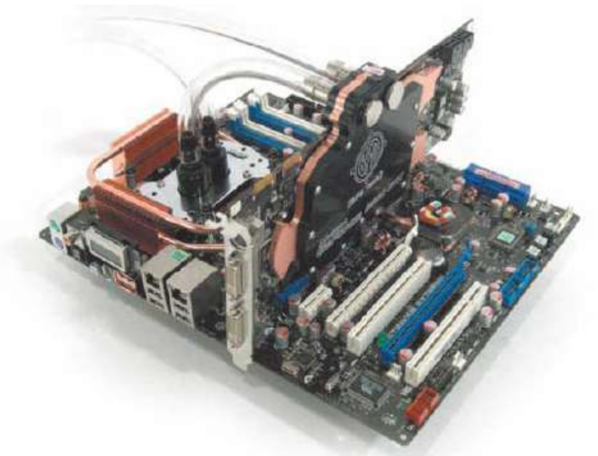


Figure 4-10 With liquid cooling technology, heat transfers from a processor through a copper plate, which is attached to the processor and also to tubing that contains liquid. The liquid travels away from the processor to a radiator-type grill, where it is cooled before traveling back to the plate attached to the processor.

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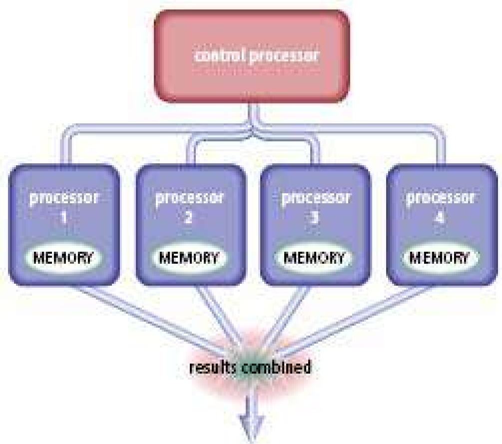


Figure 4-11 Parallel processing divides a problem into portions so that multiple processors work on their assigned portion of a problem at the same time. In this illustration, one processor, called the control processor, is managing the operations of four other processors.

Data Representation

To understand how a computer processes data, you should know how a computer represents data. People communicate through speech by combining words into sentences. Human speech is **analog** because it uses continuous (wave form) signals that vary in strength and quality. Most computers are **digital**. They recognize only two discrete states: on and off. This is because computers are electronic devices powered by electricity, which also has only two states: on and off. The two digits, 0 and 1, easily can represent these two states (Figure 4-12). The digit 0 represents the electronic state of off (absence of an electronic charge). The digit 1 represents the electronic state of on (presence of an electronic charge).

When people count, they use the digits in the decimal system (0 through 9). The computer, by contrast, uses a binary system because it recognizes only two states. The **binary system** is a number system that has just two unique digits, 0 and 1, called bits. A **bit** (short for *binary digit*) is the smallest unit of data the computer can process. By itself, a bit is not very informative. When 8 bits are grouped together as a unit, they form a **byte**. A byte provides enough different combinations of 0s and 1s to represent 256 individual characters. These characters include numbers, uppercase and lowercase letters of the alphabet, punctuation marks, and others, such as the letters of the Greek alphabet.

The combinations of 0s and 1s that represent characters are defined by patterns called a coding scheme. In one coding scheme, the number 4 is represented as 00110100, the number 6 as 00110110, and the capital letter E as 01000101 (Figure 4-13). *ASCII* (pronounced ASK-ee), which stands for American Standard Code for Information Interchange, is the most widely used coding scheme to represent data (Figure 4-14).

The ASCII coding scheme is sufficient for English and Western European languages but is not large enough for Asian and other languages that use different alphabets. *Unicode* is a 16-bit coding scheme that has the capacity of representing more than 65,000 characters and symbols. The Unicode coding scheme is capable of representing almost all the world's current written languages, as well as classic and historical languages. To allow for expansion, Unicode reserves 30,000 codes for future

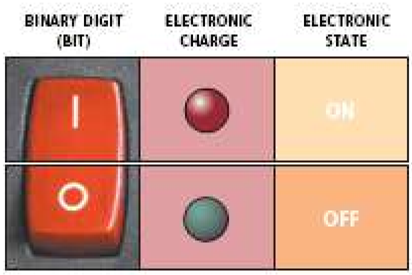


Figure 4-12 A computer circuit represents the 0 or the 1 electronically by the presence or absence of an electronic charge.

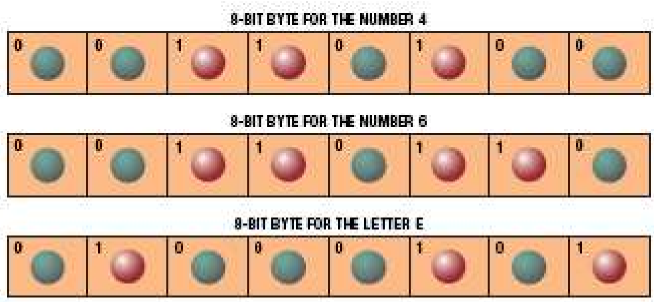


Figure 4-13 Eight bits grouped together as a unit are called a byte. A byte represents a single character in the computer.

ASCII	SYMBOL	ASCII	SYMBOL
00110000	0	01001110	N
00110001	1	01001111	O
00110010	2	01010000	P
00110011	3	01010001	Q
00110100	4	01010010	R
00110101	5	01010011	S
00110110	6	01010100	T
00110111	7	01010101	U
00111000	8	01010110	V
00111001	9	01010111	W
01000001	A	01011000	X
01000010	B	01011001	Y
01000011	C	01011010	Z
01000100	D	00100001	!
01000101	E	00100010	"
01000110	F	00100011	#
01000111	G	00100100	$
01001000	H	00100101	%
01001001	I	00100110	&
01001010	J	00101000	(
01001011	K	00101001	)
01001100	L	00101010	*
01001101	M	00101011	+

Figure 4-14 ASCII is a widely used coding scheme.

use and 6,000 codes for private use. Unicode is implemented in several operating systems, including Windows, Mac OS, and Linux. Unicode-enabled programming languages and software include Java, XML, Microsoft Office, and Oracle.

Coding schemes make it possible for humans to interact with a digital computer that processes only bits. When you press a key on a keyboard, a chip in the keyboard converts the key's electronic signal into a special code that is sent to the system unit. Then, the system unit converts the code into a binary form the computer can process and stores it in memory. Every character is converted to its corresponding byte.

The computer then processes the data as bytes, which actually is a series of on/off electrical states. When processing is finished, software converts the byte into a human-recognizable number, letter of the alphabet, or special character that is displayed on a screen or is printed (Figure 4-15). All of these conversions take place so quickly that you do not realize they are occurring.

Standards, such as those defined by ASCII and Unicode, also make it possible for components in computers to communicate with each other successfully. By following these and other standards, manufacturers can produce a component and be assured that it will operate correctly in a computer. Appendix C at the back of this book discusses the ASCII and Unicode schemes in more depth, along with the parity bit and number systems.

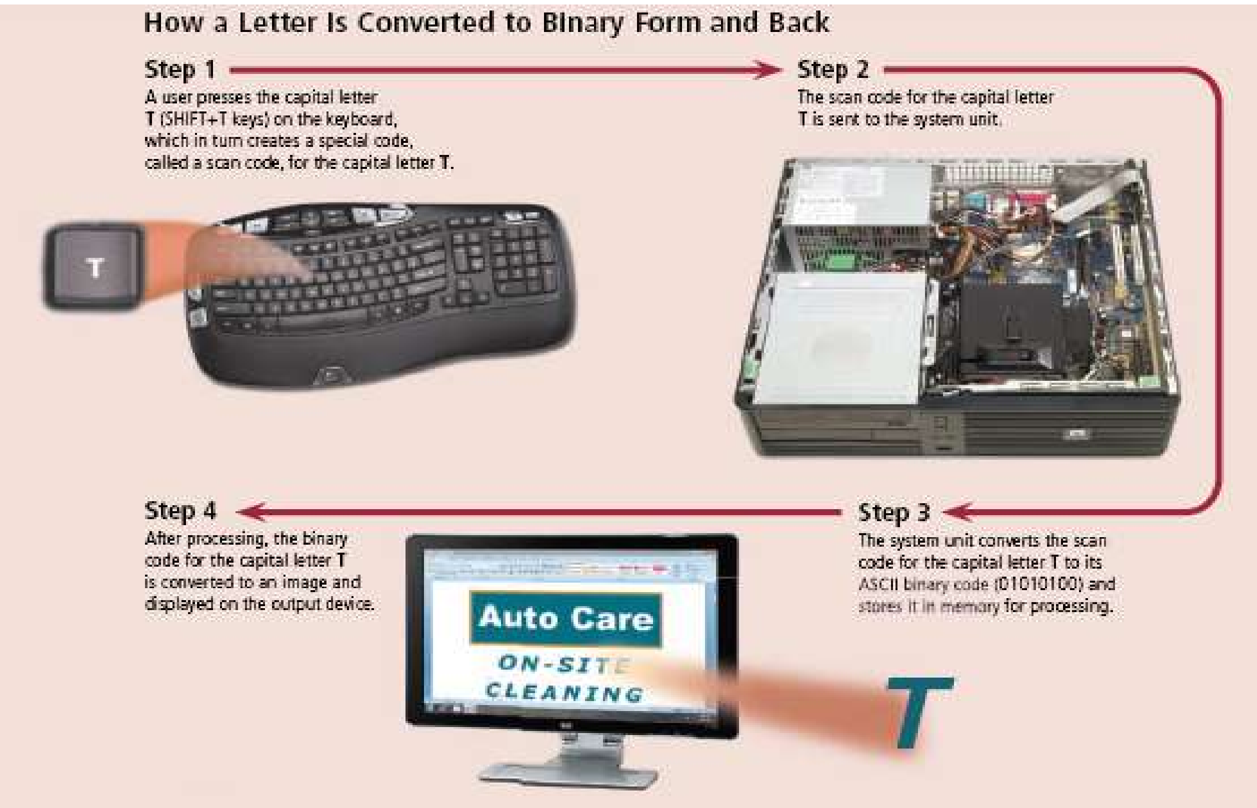


Figure 4-15 This figure shows how a letter is converted to binary form and back.

Memory

Memory consists of electronic components that store instructions waiting to be executed by the processor, data needed by those instructions, and the results of processing the data (information). Memory usually consists of one or more chips on the motherboard or some other circuit board in the computer. Memory stores three basic categories of items: (1) the operating system and other system software that control or maintain the computer and its devices; (2) application programs that carry out a specific task such as word processing; and (3) the data being processed by the application programs and resulting information. This role of memory to store both data and programs is known as the *stored program concept*.

Bytes and Addressable Memory

A byte (character) is the basic storage unit in memory. When application program instructions and data are transferred to memory from storage devices, the instructions and data exist as bytes. Each byte resides temporarily in a location in memory that has an *address*. An address simply is a unique number that identifies the location of a byte in memory. The illustration in Figure 4-16 shows how seats in an opera house are similar to addresses in memory: (1) a seat, which is identified by a unique seat number, holds one person at a time, and a location in memory, which is identified by a unique address, holds a single byte; and (2) both a seat, identified by a seat number, and a byte, identified by an address, can be empty. To access data or instructions in memory, the computer references the addresses that contain bytes of data.

Memory Sizes

Manufacturers state the size of memory (Figure 4-17) and storage devices in terms of the number of bytes the chip or device has available for storage. Recall that storage devices hold data, instructions, and information for future use, while most memory holds these items temporarily. A **kilobyte** (**KB** or **K**) is equal to exactly 1,024 bytes. To simplify memory and storage definitions, computer users often round a kilobyte down to 1,000 bytes. For example, if a memory chip can store 100 KB, it can hold approximately 100,000 bytes (characters). A **megabyte** (**MB**) is equal to approximately 1 million bytes. A **gigabyte** (**GB**) equals approximately 1 billion bytes. A **terabyte** (**TB**) is equal to approximately 1 trillion bytes.

Figure 4-16 Seats in an opera house are similar to addresses in memory: a seat holds one person at a time, and a location in memory holds a single byte; and both a seat and a byte can be empty.

Memory Sizes

Term	Abbreviation	Approximate Number of Bytes	Exact Number of Bytes	Approximate Number of Pages of Text
Kilobyte	KB or K	1 thousand	1,024	1/2
Megabyte	MB	1 million	1,048,576	500
Gigabyte	GB	1 billion	1,073,741,824	500,000
Terabyte	TB	1 trillion	1,099,511,627,776	500,000,000

Figure 4-17 Terms commonly used to define memory sizes.

Types of Memory

The system unit contains two types of memory: volatile and nonvolatile. When the computer's power is turned off, *volatile memory* loses its contents. *Nonvolatile memory*, by contrast, does not lose its contents when power is removed from the computer. Thus, volatile memory is temporary and nonvolatile memory is permanent. RAM is the most common type of volatile memory. Examples of nonvolatile memory include ROM, flash memory, and CMOS. The following sections discuss these types of memory.

RAM

Users typically are referring to RAM when discussing computer memory. **RAM** (*random access memory*), also called *main memory*, consists of memory chips that can be read from and written to by the processor and other devices. When you turn on power to a computer, certain operating system files (such as the files that determine how the desktop appears) load into RAM from a storage device such as a hard disk. These files remain in RAM as long as the computer has continuous power. As additional programs and data are requested, they also load into RAM from storage.

The processor interprets and executes a program's instructions while the program is in RAM. During this time, the contents of RAM may change (Figure 4-18). RAM can accommodate multiple programs simultaneously.

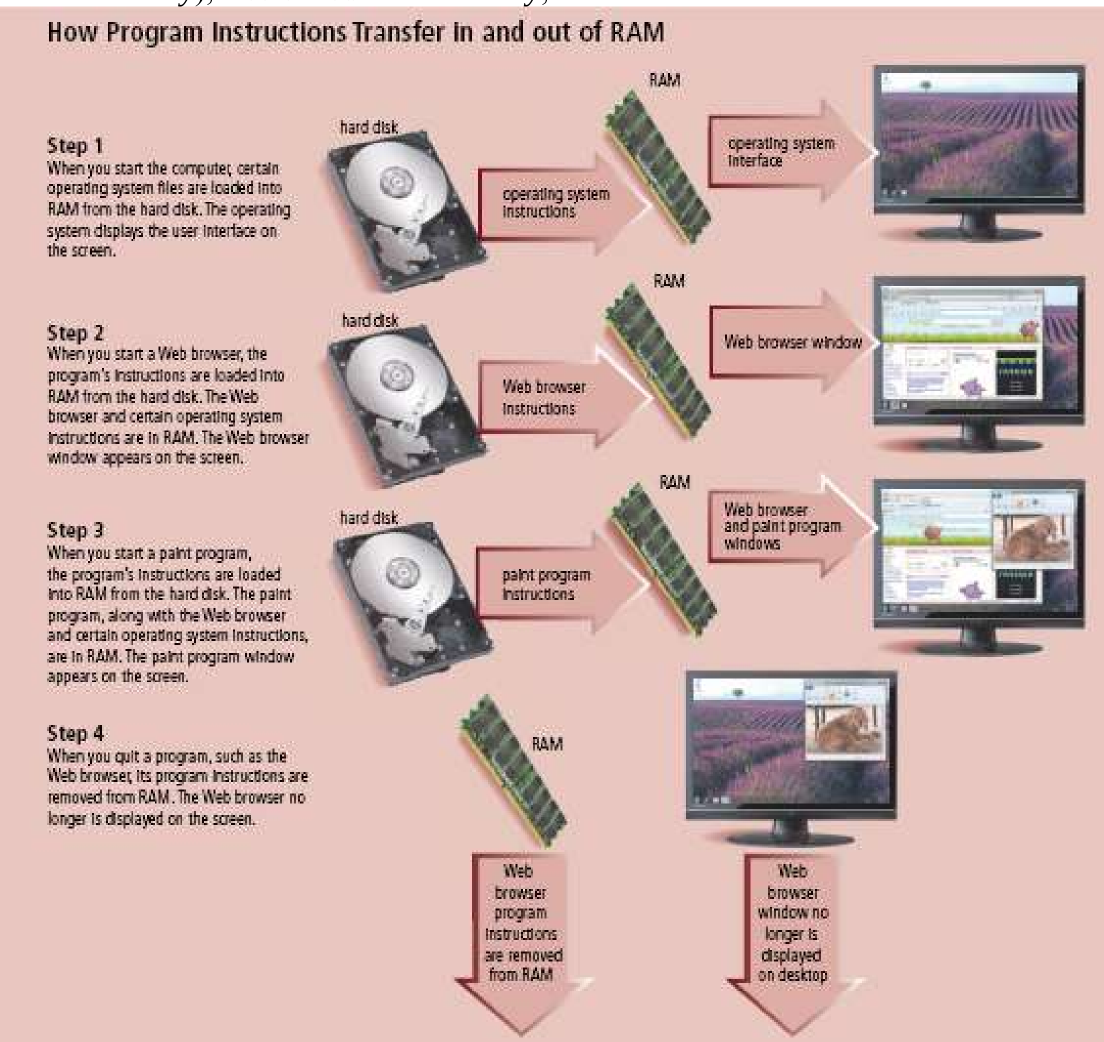


Figure 4-18 This figure shows how program instructions transfer in and out of RAM.

Most RAM is volatile, which means it loses its contents when the power is removed from the computer. For this reason, you must save any data, instructions, and information you may need in the future. Saving is the process of copying data, instructions, and information from RAM to a storage device such as a hard disk. Three basic types of RAM chips exist: dynamic RAM, static RAM, and magnetoresistive RAM.

• *Dynamic RAM* (*DRAM* pronounced DEE-ram) chips must be re-energized constantly or they lose their contents. Many variations of DRAM chips exist, most of which are faster than the basic DRAM (Figure 4-19). Most personal computers today use some form of SDRAM chips or RDRAM chips.

• *Static RAM* (*SRAM* pronounced ESS-ram) chips are faster and more reliable than any variation of DRAM chips. These chips do not have to be re-energized as often as DRAM chips, thus, the term static. SRAM chips, however, are much more expensive than DRAM chips. Special applications such as cache use SRAM chips. A later section in this chapter discusses cache.

• A newer type of RAM, called *magnetoresistive RAM* (*MRAM* pronounced EM-ram), stores data using magnetic charges instead of electrical charges. Manufacturers claim that MRAM has greater storage capacity, consumes less power, and has faster access times than electronic RAM. Also, MRAM retains its contents after power is removed from the computer, which could prevent loss of data for users. As the cost of MRAM declines, experts predict MRAM could replace both DRAM and SRAM.

RAM chips usually reside on a **memory module**, which is a small circuit board. **Memory slots** on the motherboard hold memory modules (Figure 4-20). Three types of memory modules are SIMMs, DIMMs, and RIMMs. A *SIMM* (*single inline memory module*) has pins on opposite sides of the circuit board that connect together to form a single set of contacts. With a *DIMM* (*dual inline memory module*), by contrast, the pins on opposite sides of the circuit board do not connect and thus form two sets of contacts. SIMMs and DIMMs typically hold SDRAM chips. A *RIMM* (*Rambus inline memory module*) houses RDRAM chips.

DRAM Variations

Name	Comments
SDRAM (Synchronous DRAM)	▪ synchronized to the system clock ▪ much faster than DRAM
DDR SDRAM (Double Data Rate SDRAM)	▪ transfers data twice, instead of once, for each clock cycle ▪ faster than SDRAM
DDR2	▪ second generation of DDR ▪ faster than DDR
DDR3	▪ third generation of DDR ▪ designed for computers with multi-core processors ▪ faster than DDR2
RDRAM (Rambus DRAM)	▪ uses pipelining techniques ▪ much faster than SDRAM

Figure 4-19 This table shows variations of DRAM chips.

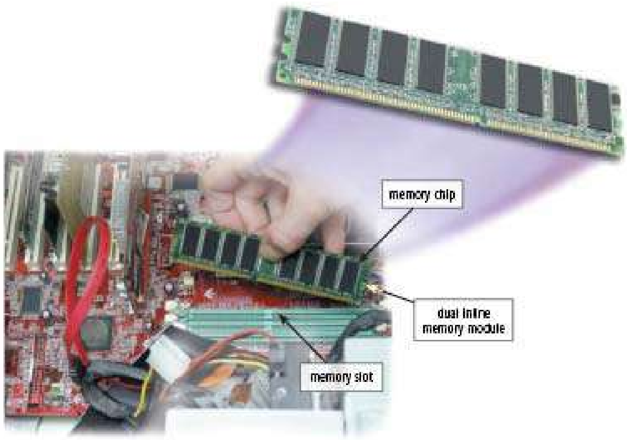


Figure 4-20 This photo shows a memory module being inserted in a motherboard.

RAM Configurations The amount of RAM necessary in a computer often depends on the types of software you plan to use. A computer executes programs that are in RAM. Think of RAM as the workspace on the top of your desk. Just as the top of your desk needs a certain amount of space to hold papers, a computer needs a certain amount of memory to store programs, data, and information. The more RAM a computer has, the faster the computer will respond. Retail software typically indicates the minimum amount of RAM it requires. If you want the software to perform optimally, usually you need more than the minimum specifications for the software.

Figure 4-21 lists guidelines for the amount of RAM for various types of users. Advertisements normally list the type of processor and the amount of RAM in the computer. The amount of RAM in computers purchased today ranges from 1 GB to 128 GB. (A computer with more than 4 GB of RAM should have a 64-bit processor, which is discussed later in this chapter, and an operating system that can utilize the RAM.) In an advertisement, manufacturers typically specify the maximum amount of RAM a computer can hold, for example, 4 GB expandable to 32 GB.

RAM	2 GB or less	2 GB to 8 GB	8 GB and up
Use	Home and business users managing personal finances; using standard application software such as word processing; using educational or entertainment optical discs; communicating with others on the Web	Users requiring more advanced multimedia capabilities; running number-intensive accounting, financial, or spreadsheet programs; using voice recognition; working with videos, music, and digital imaging; creating Web sites; participating in video conferences; playing Internet games	Power users creating professional Web sites; running sophisticated CAD, 3-D design, or other graphics-intensive software

Figure 4-21 Determining how much RAM you need depends on the programs you intend to run on your computer.

Cache

Most of today's computers improve their processing times with **cache** (pronounced cash). Two types of cache are memory cache and disk cache. This chapter discusses memory cache. Chapter 7 discusses disk cache.

Memory cache helps speed the processes of the computer because it stores frequently used instructions and data. Most personal computers today have two types of memory cache: L1 cache and L2 cache. Some also have L3 cache.

• *L1 cache* is built directly in the processor chip. L1 cache usually has a very small capacity, ranging from 8 KB to 128 KB. The more common sizes for personal computers are 32 KB or 64 KB.

• *L2 cache* is slightly slower than L1 cache but has a much larger capacity, ranging from 64 KB to 16 MB. When discussing cache, most users are referring to L2 cache. Current processors include *advanced transfer cache (ATC)*, a type of L2 cache built directly on the processor chip.

Processors that use ATC perform at much faster rates than those that do not use it. Personal computers today typically have from 512 KB to 12 MB of advanced transfer cache. Servers and workstations have from 12 MB to 16 MB of advanced transfer cache.

L3 cache is a cache on the motherboard that is separate from the processor chip. L3 cache exists only on computers that use L2 advanced transfer cache. Personal computers often have up to 8 MB of L3 cache; servers and work stations have from 8 MB to 24 MB of L3 cache.

Cache speeds up processing time because it stores frequently used instructions and data. When the processor needs an instruction or data, it searches memory in this order: L1 cache, then L2 cache, then L3 cache (if it exists), then RAM — with a greater delay in processing for each level of memory it must search (Figure 4-22). If the instruction or data is not found in memory, then it must search a slower speed storage medium such as a hard disk or optical disc.

Windows users can increase the size of cache through *Windows ReadyBoost*, which can allocate available storage space on removable flash memory devices as additional cache. Examples of removable flash memory include USB flash drives, CompactFlash cards, and SD (Secure Digital) cards. Removable flash memory is discussed in more depth later in the book.

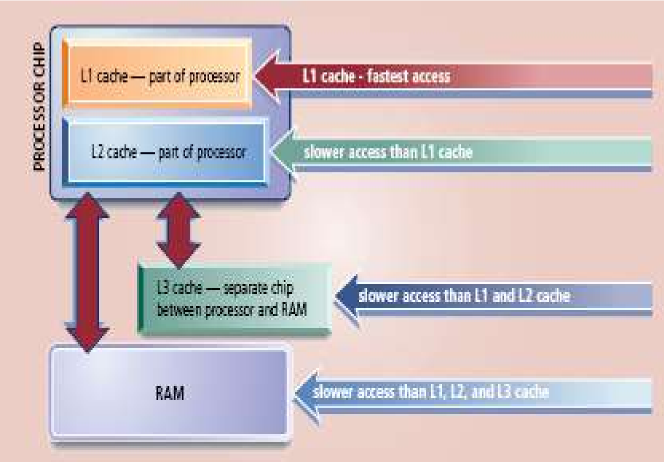


Figure 4-22 Cache helps speed processing times when the processor requests data, instructions, or information.

ROM

Read-only memory (**ROM** pronounced rahm) refers to memory chips storing permanent data and instructions. The data on most ROM chips cannot be modified — hence, the name read-only. ROM is nonvolatile, which means its contents are not lost when power is removed from the computer. In addition to computers, many devices contain ROM chips. For example, ROM chips in printers contain data for fonts.

Manufacturers of ROM chips often record data, instructions, or information on the chips when they manufacture the chips. These ROM chips, called **firmware**, contain permanently written data, instructions, or information.

A *PROM* (*programmable read-only memory*) *chip* is a blank ROM chip on which a programmer can write permanently. Programmers use *microcode* instructions to program a PROM chip. Once a programmer writes the microcode on the PROM chip, it functions like a regular ROM chip and cannot be erased or changed.

A variation of the PROM chip, called an *EEPROM* (electrically erasable programmable read-only memory) *chip*, allows a programmer to erase the microcode with an electric signal.

Flash Memory

Flash memory is a type of nonvolatile memory that can be erased electronically and rewritten, similar to EEPROM. Most computers use flash memory to hold their startup instructions because it allows the computer easily to update its contents. For example, when the computer changes from standard time to daylight savings time, the contents of a flash memory chip (and the real-time clock chip) change to reflect the new time.

Flash memory chips also store data and programs on many mobile computers and devices, such as smart phones, portable media players, PDAs, printers, digital cameras, automotive devices, digital voice recorders, and pagers. When you enter names and addresses in a smart phone or PDA, a flash memory chip stores the data. Some portable media players store music on flash memory chips (Figure 4-23); others store music on tiny hard disks or flash memory cards. Flash memory cards contain flash memory on a removable device instead of a chip.

CMOS

Some RAM chips, flash memory chips, and other memory chips use **complementary metal-oxide semiconductor** (**CMOS** pronounced SEE-moss) technology because it provides high speeds and consumes little power. CMOS technology uses battery power to retain information even when the power to the computer is off. Battery-backed CMOS memory chips, for example, can keep the calendar, date, and time current even when the computer is off. The flash memory chips that store a computer’s startup information often use CMOS technology.

Memory Access Times

Access time is the amount of time it takes the processor to read data, instructions, and information from memory. A computer’s access time directly affects how fast the computer processes data. Accessing data in memory can be more than 200,000 times faster than accessing data on a hard disk because of the mechanical motion of the hard disk.

Figure 4-23 This figure shows how a portable media player might store music in flash memory.

Today's manufacturers use a variety of terminology to state access times (Figure 4-24). Some use fractions of a second, which for memory occurs in nanoseconds. A **nanosecond** (abbreviated *ns*) is one billionth of a second. A nanosecond is extremely fast (Figure 4-25). In fact, electricity travels about one foot in a nanosecond.

Other manufacturers state access times in MHz; for example, 800 MHz DDR2 SDRAM. If a manufacturer states access time in megahertz, you can convert it to nanoseconds by dividing 1 billion ns by the megahertz number. For example, 800 MHz equals approximately 1.25 ns (1,000,000,000/800,000,000).

The access time (speed) of memory contributes to the overall performance of the computer. Standard SDRAM chips can have access times up to 133 MHz (about 7.5 ns), and access times of the DDR SDRAM chips reach 266 MHz, DDR2 chips reach 800 MHz, and DDR3 chips reach 1600 MHz. The higher the megahertz, the faster the access time; conversely, the lower the nanoseconds, the faster the access time. The faster RDRAM chips can have access times up to 1600 MHz (about 0.625 ns). ROM access times range from 25 to 250 ns.

While access times of memory greatly affect overall computer performance, manufacturers and retailers usually list a computer's memory in terms of its size, not its access time. Thus, an advertisement might describe a computer as having 2 GB of SDRAM upgradeable to 4 GB.

Access Time Terminology

Term	Abbreviation	Speed
Millisecond	ms	One-thousandth of a second
Microsecond	µs	One-millionth of a second
Nanosecond	ns	One-billionth of a second
Picosecond	ps	One-trillionth of a second

Figure 4-24 Access times are measured in fractions of a second. This table lists the terms used to define access times.

Figure 4-25 It takes about one-tenth of a second to blink your eye, which is the equivalent of 100 million nanoseconds. In the time it takes to blink your eye, a computer can perform some operations 10 million times.

Expansion Slots and Adapter Cards

An **expansion slot** is a socket on the motherboard that can hold an adapter card. An **adapter card**, sometimes called an *expansion card*, is a circuit board that enhances functions of a component of the system unit and/or provides connections to peripherals. A **peripheral** is a device that connects to the system unit and is controlled by the processor in the computer. Examples of peripherals are modems, disk drives, printers, scanners, and keyboards.

Figure 4-26 lists currently used types of adapter cards. Sometimes, all functionality is built in the adapter card. With others, a cable connects the adapter card to a device, such as a digital video camera, outside the system unit. Some are a card that you insert in a slot on the computer. Figure 4-27 shows an adapter card being inserted in an expansion slot on a personal computer motherboard.

Some motherboards include all necessary capabilities and do not require adapter cards. Other motherboards may require adapter cards to provide capabilities such as sound and video. A **sound card** enhances the sound generating capabilities of a personal computer by allowing sound to be input through a microphone and output through external speakers or headphones. A **video card**, also called a *graphics card*, converts computer output into a video signal that travels through a cable to the monitor, which displays an image on the screen.

Types of Adapter Cards

Adapter Card	Purpose
CableCARD	Allows viewing of digital cable television channels
Disk controller	Connects disk drives
FireWire	Connects to FireWire devices
HDTV tuner	Allows viewing of HDTV broadcasts on the monitor
MIDI	Connects musical instruments
Modem	Connects other computers through telephone lines, cable television lines, or other transmission media
Network	Connects other computers and peripherals
PC-to-TV converter	Connects a television
Sound	Connects speakers or a microphone
TV tuner	Allows viewing of television channels on the monitor
USB	Connects to USB devices
Video	Connects a monitor
Video capture	Connects an analog video camera or VCR

Figure 4-26 Currently used adapter cards and their functions.

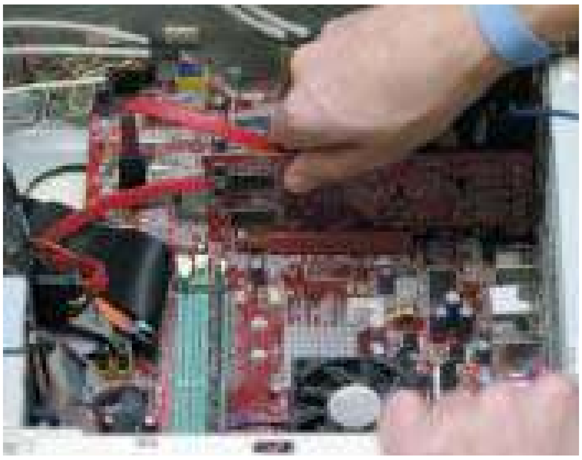


Figure 4-27 An adapter card being inserted in an expansion slot on the motherboard of a personal computer.

Today's computers support **Plug and Play**, which means the computer automatically can configure adapter cards and other peripherals as you install them. Having Plug and Play support means you can plug in a device, turn on the computer, and then immediately begin using the device.

Removable Flash Memory

Unlike adapter cards that require you to open the system unit and install the card on the motherboard, you can change a removable flash memory device without having to open the system unit or restart the computer. This feature, called *hot plugging*, allows you to insert and remove the removable flash memory and other devices while the computer is running. Removable flash memory includes memory cards, USB flash drives, and PC Cards/ ExpressCard modules (Figure 4-28).

- A **memory card** is a removable flash memory device, usually no bigger than 1.5" in height or width, that you insert and remove from a slot in a personal computer, game console, mobile device, or card reader/writer. Many mobile and consumer devices, such as smart phones, digital cameras, and portable media players use memory cards. Some printers and computers have built-in card readers/writers or slots that read memory cards. In addition, you can purchase an external card reader/writer that attaches to any computer.

- A *USB flash drive* is a flash memory storage device that plugs in a USB port on a computer or mobile device. (A later section discusses USB ports.)

- Many desktop computers, traditional notebook computers, and Tablet PCs have a **PC Card slot** or an **ExpressCard slot**, which is a special type of expansion slot that holds a PC Card or an ExpressCard module, respectively. Most netbooks do not have a PC Card slot or ExpressCard slot. A **PC Card** is a thin, credit card-sized removable flash memory device that primarily is used today to enable traditional notebook computers and Tablet PCs to access the Internet wirelessly. ExpressCard modules, about one-half the size of PC Cards, are the next generation of PC Cards. An **ExpressCard module**, which can be used as a removable flash memory device, adds memory, communications, multimedia, and security capabilities to computers.

Figure 4-28 Examples of removable flash memory in use.

Ports and Connectors

A **port** is the point at which a peripheral attaches to or communicates with a system unit so that the peripheral can send data to or receive information from the computer. An external device, such as a keyboard, monitor, printer, mouse, and microphone, often attaches by a cable to a port on the system unit. Instead of port, the term **jack** sometimes is used to identify audio and video ports. The front and back of a system unit on a desktop personal computer contain many ports (Figure 4-29). On notebook computers, including netbooks and Tablet PCs, the ports are on the back, front, and/or sides (Figure 4-30).

A **connector** joins a cable to a port. A connector at one end of a cable attaches to a port on the system unit, and a connector at the other end of the cable attaches to a port on the peripheral. Most connectors and ports are available in one of two genders: male or female. Male connectors and ports have one or more exposed pins, like the end of an electrical cord you plug in the wall. Female connectors and ports have matching holes to accept the pins on a male connector or port, like an electrical wall outlet.

Sometimes, you cannot attach a new peripheral to the computer because the port on the system unit is the same gender as the connector on the cable. In this case, purchasing a gender changer solves this problem. A *gender changer* is a device that enables you to join a port and a connector that are both female or both male.

Figure 4-29 A system unit on a desktop personal computer has many ports on its front and back.

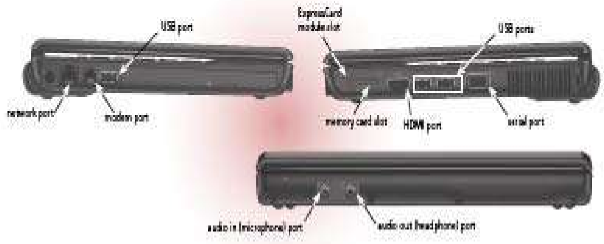


Figure 4-30 Ports on a typical notebook computer.

Manufacturers often identify cables by their connector types to assist you with purchasing a cable to connect a computer to a peripheral port. Figure 4-31 shows the different types of ports you may find on a system unit. Notice that many are color-coded to help you match the connector to the correct port. Some system units include these ports when you buy the computer. You add other ports by inserting adapter cards on the motherboard. Certain adapter cards have ports that allow you to attach a peripheral to the adapter card. The next section discusses the more widely used ports.

Port Types

Type	Picture	Type	Picture	Type	Picture
Audio in		HDMI port		Serial	
Cable TV		Headphones		Side surround sound	
Center surround sound/subwoofer		Keyboard		S/PDIF in	
Composite video in		Microphone		S/PDIF out	
Digital Video Interface (DVI)		Monitor		Speaker	
eSATA port		Mouse		S-video	
FireWire		Network		Telephone line in	
FM reception		Rear surround sound		USB	

Figure 4-31 Examples of different types of ports on a system unit.

USB Ports

A **USB port**, short for *universal serial bus port*, can connect up to 127 different peripherals together with a single connector. Devices that connect to a USB port include the following: mouse, printer, digital camera, scanner, speakers, portable media player, optical disc drive, smart phone, PDA, game console, and removable hard disk. Personal computers typically have six to eight USB ports on the front and/or back of the system unit (Figure 4-29 on page 232). USB ports on mobile devices usually are smaller than those on personal computers. Figure 4-32 shows a variety of USB ports and connectors. *USB 2.0*, also called *Hi-Speed USB*, is a more advanced and faster USB, with speeds 40 times higher than that of its predecessor. *USB 3.0* is approximately 10 times faster than USB 2.0. Both USB 2.0 and USB 3.0 are *backward compatible*, which means they support older USB devices as well as USB 2.0 or USB 3.0 devices. Keep in mind, though, that older USB devices do not run any faster in a newer USB port. To attach multiple peripherals using a single USB port, you can use a USB hub. A **USB hub** is a device that plugs in a USB port on the system unit and contains multiple USB ports in which you plug cables from USB devices. USB hubs are self-powered or bus-powered. A self-powered USB hub draws power from an electrical outlet, whereas a bus-powered USB hub draws power from the USB bus in the computer. (The USB bus is discussed later in the chapter.) Some devices will work only with a self-powered hub.

Some USB hubs are wireless. That is, a receiver plugs into a USB port on the computer and the USB hub communicates wirelessly with the receiver.
USB also supports hot plugging and Plug and Play, which means you can attach peripherals while the computer is running.

FireWire Ports
Previously called an *IEEE 1394 port*, a **FireWire port** is similar to a USB port in that it can connect multiple types of devices that require faster data transmission speeds, such as digital video cameras, digital VCRs, color printers, scanners, digital cameras, and DVD drives, to a single connector. A FireWire port allows you to connect up to 63 devices together. The three latest versions, FireWire 800, FireWire 1600, and FireWire 3200, have speeds faster than the original FireWire 400. You can use a FireWire hub to attach multiple devices to a single FireWire port. A **FireWire hub** is a device that plugs in a FireWire port on the system unit and contains multiple FireWire ports in which you plug cables from FireWire devices. The FireWire port supports Plug and Play.

Other Ports
Some ports not included in typical computers but sometimes used are Bluetooth, SCSI, eSATA, IrDA, serial, and MIDI. For a computer to have these ports, you often must customize the computer purchase order.

Bluetooth Port Bluetooth technology uses radio waves to transmit data between two devices. Bluetooth devices have to be within about 33 feet of each other. Many computers, peripherals, smart phones, PDAs, cars, and other consumer electronics are Bluetooth enabled, which means they contain a small chip that allows them to communicate with other Bluetooth-enabled computers and devices. Bluetooth headsets allow smart phone users to connect their telephone to a headset wirelessly. If you have a computer that is not Bluetooth enabled, you can purchase a *Bluetooth wireless port adapter* that will convert an existing USB port into a Bluetooth port (Figure 4-33). Also available are Bluetooth PC Cards and ExpressCard modules for traditional notebook computers and Tablet PCs, and Bluetooth cards for smart phones and PDAs.

USB Connectors and Ports

	Connector	Port	Where Used
Type A			Desktop computers, traditional notebook computers, netbooks, and Tablet PCs
Type B			Peripherals (printers, scanners, external hard disks, etc.)
Mini-B			Mobile devices (cameras, phones, handheld game consoles)

Figure 4-32 A variety of USB ports and connectors are available.

Figure 4-33 A Bluetooth wireless port adapter, such as the one shown here, converts a USB port into a Bluetooth port.

SCSI Port A special high-speed parallel port, called a **SCSI port**, allows you to attach SCSI (pronounced skuzzy) peripherals such as disk drives and printers. *SAS (serial-attached SCSI)* is a newer type of SCSI that transmits at much faster speeds than parallel SCSI. Depending on the type of *SCSI*, which stands for small computer system interface, you can daisy chain up to either 7 or 15 devices together. Some computers include a SCSI port. Others have a slot that supports a SCSI card.

eSATA Port An **eSATA port**, or *external SATA port*, allows you to connect an external SATA (Serial Advanced Technology Attachment) hard disk to a computer. SATA hard disks are popular because of their fast data transmission speeds. eSATA connections provide up to six times faster data transmission speeds than external hard disks attached to a computer's USB or FireWire port.

IrDA Port Some devices can transmit data via infrared light waves. For these wireless devices to transmit signals to a computer, both the computer and the device must have an **IrDA port** (Figure 4-34). These ports conform to standards developed by the *IrDA* (Infrared Data Association). To ensure nothing obstructs the path of the infrared light wave, you must align the IrDA port on the device with the IrDA port on the computer, similarly to the way you operate a television remote control. Devices that use IrDA ports include a smart phone, PDA, keyboard, mouse, and printer. Several of these devices use a high-speed IrDA port, sometimes called a *fast infrared port*.

Figure 4-34 Many devices communicate wirelessly with desktop or notebook computers through IrDA ports.

Serial Ports A **serial port** is a type of interface that connects a device to the system unit by transmitting data one bit at a time. Some modems that connect the sys tem unit to a telephone line use a serial port because the telephone line expects the data in a specific frequency.

MIDI Port A special type of serial port that connects the system unit to a musical instrument, such as an electronic keyboard, is called a **MIDI port**. Short for *Musical Instrument Digital Interface*, MIDI (pronounced MID-dee) is the electronic music industry's standard that defines how devices, such as sound cards and synthesizers, represent sounds electronically. A *synthesizer*, which can be a peripheral or a chip, creates sound from digital instructions.

A system unit with a MIDI port has the capability of recording sounds that have been created by a synthesizer and then processing the sounds (the data) to create new sounds. Nearly every sound card supports the MIDI standard, so that you can play and manipulate on one computer sounds that originally were created on another computer.

Port Replicators and Docking Stations Instead of connecting peripherals directly to ports on a mobile computer, some mobile users prefer the flexibility of port replicators and docking stations. A *port replicator* is an external device that provides connections to peripherals through ports built into the device. The mobile user accesses peripherals by connecting the port replicator to a USB port or a special port on the mobile computer. Port replicators sometimes disable ports on the mobile computer to prevent conflicts among the devices on the computer and port replicator.

A docking station is similar to a port replicator, but it has more functionality. A *docking station*, which is an external device that attaches to a mobile computer or device, contains a power connection and provides connections to peripherals; it usually also includes slots for memory cards, optical disc drives, and other devices (Figure 4-35).

Figure 4-35 To use a slate Tablet PC while working at a desk, insert the Tablet PC in a docking station. Devices such as a keyboard and an optical disc drive can be plugged in the docking station.

With the mobile computer or device in the docking station, users can work with a full-sized keyboard, a mouse, and other desktop peripherals from their traditional notebook computer, netbook, or Tablet PC.

Buses

As explained earlier in this chapter, a computer processes and stores data as a series of electronic bits. These bits transfer internally within the circuitry of the computer along electrical channels. Each channel, called a **bus**, allows the various devices both inside and attached to the system unit to communicate with each other. Just as vehicles travel on a highway to move from one destination to another, bits travel on a bus (Figure 4-36).

Buses are used to transfer bits from input devices to memory, from memory to the processor, from the processor to memory, and from memory to output or storage devices. Buses consist of two parts: a data bus and an address bus. The *data bus* is used to transfer actual data and the *address bus* is used to transfer information about where the data should reside in memory.

The size of a bus, called the *bus width*, determines the number of bits that the computer can transmit at one time. For example, a 32-bit bus can transmit 32 bits (4 bytes) at a time. On a 64-bit bus, bits transmit from one location to another 64 bits (8 bytes) at a time. The larger the number of bits handled by the bus, the faster the computer transfers data. Using the highway analogy again, assume that one lane on a highway can carry one bit. A 32-bit bus is like a 32-lane highway. A 64-bit bus is like a 64-lane highway.

If a number in memory occupies 8 bytes, or 64 bits, the computer must transmit it in two separate steps when using a 32-bit bus: once for the first 32 bits and once for the second 32 bits. Using a 64-bit bus, the computer can transmit the number in a single step, transferring all 64 bits at once. The wider the bus, the fewer number of transfer steps required and the faster the transfer of data. Most personal computers today use a 64-bit bus.

In conjunction with the bus width, many computer professionals refer to a computer's word size. **Word size** is the number of bits the processor can interpret and execute at a given time. That is, a 64-bit processor can manipulate 64 bits at a time. Computers with a larger word size can process more data in the same amount of time than computers with a smaller word size. In most computers, the word size is the same as the bus width.

Every bus also has a clock speed. Just like the processor, manufacturers state the clock speed for a bus in hertz. Recall that one megahertz (MHz) is equal to one million ticks per second. Today's processors usually have a bus clock speed of 400, 533, 667, 800, 1066, 1333, or 1600 MHz. The higher the bus clock speed, the faster the transmission of data, which results in programs running faster.

A computer has these basic types of buses: a system bus, possibly a backside bus, and an expansion bus. A *system bus*, also called the *front side bus (FSB),* is part of the motherboard and connects the processor to main memory. A *backside bus (BSB)* connects the processor to cache. An *expansion bus* allows the processor to communicate with peripherals. When computer professionals use the term bus by itself, they usually are referring to the system bus.

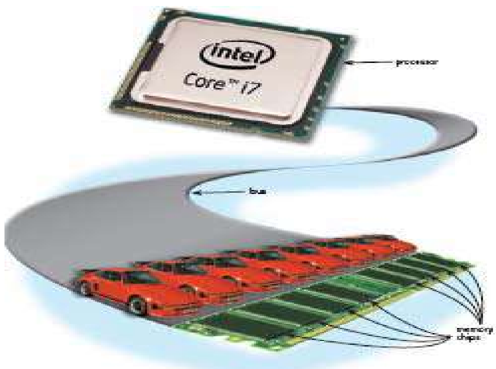


Figure 4-36 Just as vehicles travel on a highway, bits travel on a bus. Buses are used to transfer bits from input devices to memory, from memory to the processor, from the processor to memory, and from memory to output or storage devices.

Expansion Bus
Some peripherals outside the system unit connect to a port on an adapter card, which is inserted in an expansion slot on the motherboard. This expansion slot connects to the expansion bus, which allows the processor to communicate with the peripheral attached to the adapter card. Data transmitted to memory or the processor travels from the expansion slot via the expansion bus and the system bus.
The types of expansion buses on a motherboard determine the types of cards you can add to the computer. Thus, you should understand expansion buses commonly found in today's personal computers: PCI bus, PCI Express bus, AGP bus, USB, FireWire bus, and PC Card bus.

• The *PCI bus* (Peripheral Component Interconnect bus) is a high-speed expansion bus that connects higher speed devices. Types of cards you can insert in a PCI bus expansion slot include video cards, sound cards, SCSI cards, and high-speed network cards.

• The *PCI Express* (*PCIe*) *bus* is an expansion bus that expands on and doubles the speed of the original PCI bus. Nearly all video cards today use the PCI Express bus, as well as many hard disks and network cards. The ExpressCard technology used in traditional notebook computers and Tablet PCs also works with the PCI Express bus. Experts predict the PCI Express bus eventually will replace the PCI bus completely.

• The *Accelerated Graphics Port* (*AGP*) is a bus designed by Intel to improve the speed with which 3-D graphics and video transmit. With an AGP video card in an AGP bus slot, the AGP bus provides a faster, dedicated interface between the video card and memory. Newer processors support AGP technology.

• The USB (universal serial bus) and *FireWire bus* are buses that eliminate the need to install cards in expansion slots. In a computer with a USB, for example, USB devices connect to each other outside the system unit, and then a single cable attaches to the USB port. The USB port then connects to the USB, which connects to the PCI bus on the motherboard. The FireWire bus works in a similar fashion. With these buses, expansion slots are available for devices not compatible with USB or FireWire.

• The expansion bus for a PC Card is the *PC Card bus*. With a PC Card inserted in a PC Card slot, data travels on the PC Card bus to the PCI bus.

Bays
After you purchase a desktop or notebook computer, you may want to install an additional storage device, such as a disk drive, in the system unit. A **bay** is an opening inside the system unit in which you can install additional equipment. A bay is different from a slot on the motherboard, which is used for the installation of adapter cards. A **drive bay** is a rectangular opening that typically holds disk drives. Other bays house card readers and widely used ports such as USB, FireWire, and audio ports. An *external bay* allows a user to access openings in the bay from outside the system unit (Figure 4-37). Optical disc drives are examples of devices installed in external bays. An *internal bay* is concealed entirely within the system unit. Hard disk drives are installed in internal bays.

Figure 4-37 External bays usually are located beside or on top of one another.

Power Supply
Many personal computers plug in standard wall outlets, which supply an alternating current (AC) of 115 to 120 volts. This type of power is unsuitable for use with a computer,

which requires a direct current (DC) ranging from 5 to more than 15 volts. The **power supply** is the component of the system unit that converts the wall outlet AC power into DC power. Different motherboards and computers require different wattages on the power supply. Notebook computers, including netbooks and Tablet PCs, can run using either batteries or a power supply. If a power supply is not providing the necessary power, the computer will not function properly. Built into the power supply is a fan that keeps the power supply cool. Some have variable speed fans that change speed or stop running, depending on temperature in the system unit. Many newer computers have additional fans near certain components in the system unit such as the processor, hard disk, and ports. Some users install more fans to help dissipate heat generated by the components of the system unit. Mobile users may place their notebook computer on a cooling pad to help disperse the computer's heat.

Some external peripherals such as a cable modem, speakers, or a printer have an **AC adapter**, which is an external power supply. One end of the AC adapter plugs in the wall outlet and the other end attaches to the peripheral. The AC adapter converts the AC power into DC power that the peripheral requires.

Putting It All Together

Many components of the system unit influence the speed and power of a computer, including
the type of processor and the amount of RAM. The table in Figure 4-38 lists the suggested minimum processor and RAM requirements based on the needs of various types of computer users.

Suggested Minimum Configurations by User

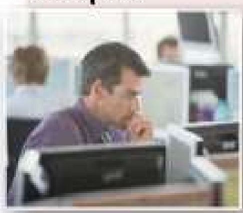
User	Processor and RAM
Home 	Intel Core 2 Quad or Intel Core 2 Duo or AMD Sempron Minimum RAM: 2 GB
Small Office/ Home Office 	Intel Core i7 or Intel Core i7 Extreme or AMD Athlon X2 or AMD Athlon II X2 Dual-Core Minimum RAM: 4 GB
Mobile 	Intel Core i7 Extreme or AMD Turion X2 Minimum RAM: 2 GB
Power 	Intel Itanium 2 or AMD 6-Core Opteron or Intel Quad Core Xeon Minimum RAM: 8 GB
Enterprise 	Intel Core i7 or Intel Core i7 Extreme or AMD Athlon X2 or AMD Athlon II X2 Dual-Core Minimum RAM: 4 GB

Figure 4-38 Suggested processor and RAM configurations by user.

Keeping Your Computer or Mobile Device Clean

Over time, the system unit collects dust — even in a clean environment. Built up dust can block airflow in a computer or mobile device, which can cause it to overheat, corrode, or even stop working. By cleaning your computer or mobile device once or twice a year, you can help extend its life. This preventive maintenance task requires a few basic products (Figure 4-39):

• can of compressed air — removes dust and lint from difficult-to-reach areas; removes sticky liquid spilled on keyboards

• lint-free antistatic wipes and swabs

• screen cleaning solution or 50/50 mix of rubbing alcohol and water (do not use ammonia-based solutions)

• small computer vacuum (or small attachments on your house vacuum)

• antistatic wristband — to avoid damaging internal components with static electricity

• small screwdriver (may be required to open the case or remove adapter cards) Before cleaning the exterior of a computer or mobile device, turn it off, and if necessary, unplug it from the electrical outlet, remove its battery, and disconnect all cables from the ports. Use compressed air to blow away dust from any openings on the computer or device case, such as drives, slots, ports, and fan vents. Then, use an antistatic wipe to clean the exterior of the case and a cleaning solution on a soft cloth to clean the screen.

If you do not feel comfortable cleaning the inside of a desktop or notebook computer case, you can have a local professional or computer company clean it for you. Or, if you are familiar with electronics, you can clean it yourself. While working inside the case, be sure to wear an antistatic wristband. Use the antistatic wipes to clean inside the walls of the case. Vacuum as much dust as possible from the interior of the case, including the wires, chips, adapter cards, and fan blades. Release short blasts of compressed air in areas the vacuum cannot reach. If the motherboard and adapter cards still look dirty, gently clean them with lint-free wipes or swabs lightly dampened with alcohol. When finished, write down the date you cleaned the computer so that you have a record for your next cleaning.

Figure 4-39 With a few products, this computer user keeps his computer clean.

Chapter Exercises

True/False Mark T for True and F for False.

_____ 1. The system unit is a case that contains electronic components of the computer used to process data.

_____ 2. The processor holds data waiting to be processed and instructions waiting to be executed.

_____ 3. The speed of the system clock is just one factor that influences a computer's performance.

_____ 4. Replacing a motherboard is a fairly complicated process, whereas replacing a processor is much simpler.

_____ 5. A byte is the smallest unit of data the computer can process.

_____ 6. When the computer's power is turned off, volatile memory loses its contents.

_____ 7. Current processors include advanced transfer cache (ATC), a type of L2 cache built directly on the processor chip.

_____ 8. Read-only memory refers to memory chips storing permanent data and instructions.

_____ 9. Hi-Speed USB is a more advanced and faster USB, with speeds 100 times higher than that of its predecessor.

_____ 10. USB 3.0 is more than 10 times faster than USB 2.0.

_____ 11. Both USB 2.0 and USB 3.0 are backward compatible, which means they do not support older USB devices.

_____ 12. SAS (serial-attached SCSI) is a newer type of SCSI that transmits more reliably, but at slower speeds, than parallel SCSI.

1. The processor also is called the _____.
a. motherboard b. central processing unit (CPU)
c. adapter card d. chip

2. The _____ is the component of the processor that directs and coordinates most of the operations in the computer.
a. control unit b. arithmetic logic unit c. register d. machine cycle

3. A processor contains small, high-speed storage locations, called _____, that temporarily hold data and instructions.
a. flash drives b. registers c. jacks d. heat sinks

4. Supercomputers use _____ for applications such as artificial intelligence and weather forecasting.
a. system-on-a-chip technology b. massively parallel processing
c. SCSI d. Accelerated Graphics Ports

5. ROM chips, called _____, contain permanently written data, instructions, or information.

a. memory cache b. registers c. firmware d. transistors

6. A(n) _____ is an external device that provides connections to peripherals through ports built into the device.
a. expansion bus b. port replicator c. docking station d. synthesizer

7. A(n) _____, which is an external device that attaches to a mobile computer or device, contains a power connection and provides connections to peripherals; it usually also includes slots for memory cards, optical disc drives, and other devices.
a. docking station b. port replicator c. peripheral d. expansion bus

8. A(n) _____ is part of the motherboard and connects the processor to main memory.
a. expansion bus b. system clock c. memory module d. front side bus

Matching Match the terms with their definitions.

_____ 1. motherboard	a. interprets and carries out the basic instructions that operate a computer
_____ 2. processor	b. small ceramic or metal component with fins on its surface that absorbs and disperses heat produced by electrical components such as a processor
_____ 3. vPro technology	c. amount of time it takes the processor to read data, instructions, and information from memory
_____ 4. heat sink	d. electronic components that store instructions, data, and results of processed data
_____ 5. memory	e. can allocate available space on removable flash memory devices as additional cache
_____ 6. Windows ReadyBoost	f. provides the capability to track computer hardware and software, diagnose and resolve computer problems, and secure computers from outside threats
_____ 7. flash memory	g. nonvolatile memory that can be erased electronically and rewritten
_____ 8. access time	h. main circuit board of the system unit
_____ 9. USB hub	i. device that plugs in a USB port on the system unit and contains multiple USB ports in which you plug cables from USB devices
_____ 10. backside bus	j. connects the processor to cache

Short Answer Write a brief answer to each of the following questions.
1. What are two types of designs of Tablet PCs? ____________ What are the differences in the designs of the two types of Tablet PCs? ____________

2. What is the motherboard? ____________ What is a computer chip? ____________

3. What are the four basic operations in a machine cycle? ____________ What are some functions of registers? ____________

4. What types of devices might be Bluetooth enabled? ____________ Describe three ways in which a computer can become Bluetooth enabled. ____________

5. What is compressed air used for with regards to caring for your computer? ____________ How should you prepare for cleaning your computer? ____________

Chapter Five

Input

What Is Input?

Input is any data and instructions entered into the memory of a computer. As shown in Figure 5-1, people have a variety of options for entering data and instructions into a computer.

As discussed in Chapter 1, *data* is a collection of unprocessed items, including text, numbers, images, audio, and video. Once data is in memory, the computer interprets and executes instructions to process the data into information. Instructions entered into the computer can be in the form of programs, commands, and user responses.

- A program is a series of related instructions that tells a computer what tasks to perform and how to perform them. When a programmer writes a program, he or she enters the program into the computer by using a keyboard, mouse, or other input device. The programmer then stores the program in a file that a user can execute (run). When a user runs a program, the computer loads the program from a storage medium into memory. Thus, a program is entered into a computer's memory.

Figure 5-1 Users can enter data and instructions into a computer in a variety of ways.

- Programs respond to commands that a user issues. A command is an instruction that causes a program to perform a specific action. Users issue commands by pressing keys on the keyboard, clicking a mouse button, speaking into a microphone, or touching an area on a screen.

- A user response is an instruction a user issues by replying to a question displayed by a program. A response to the question instructs the program to perform certain actions. Assume the program asks the question, is the time card correct? If you

you the opportunity to modify the time card entries.

answer Yes, the program processes the time card. If you answer No, the program gives

What Are Input Devices?

An **input device** is any hardware component that allows users to enter data and instructions (programs, commands, and user responses) into a computer. Depending on the application and your particular requirements, the input device selected may vary. The following pages discuss a variety of input devices. Storage devices, such as disk drives, serve as both input and output devices. Chapter 7 discusses storage devices.

The Keyboard

Many people use a keyboard as one of their input devices. A **keyboard** is an input device that contains keys users press to enter data and instructions into a computer (Figure 5-2). Desktop computer keyboards typically have from 101 to 105 keys. All desktop computer keyboards have a typing area that includes the letters of the alphabet, numbers, punctuation marks, and other basic keys. Many desktop computer keyboards also have a numeric keypad on the right side of the keyboard. A keyboard also contains other keys that allow users to enter data and instructions into the computer.

Most of today's desktop computer keyboards are enhanced keyboards. An *enhanced keyboard* has twelve or more function keys along the top; it also has two ctrl keys, two alt keys, and a set of arrow and additional keys between the typing area and the numeric keypad (Figure 5-2). *Function keys*, which are labeled with the letter F followed by a number, are special keys programmed to issue commands to a computer. The command associated with a function key may vary, depending on the program with which you are inter acting. For example, the f3 key may issue one command to an operating system and an entirely different command to a word processing program. To issue commands, users often can press a function key in combination with other special keys (shift, ctrl, alt, and others).

Figure 5-2 On a desktop computer keyboard, you type using keys in the typing area and on the numeric keypad.

Keyboards also often have a windows key(s) and an application key. When pressed, the windows key displays the Windows Start menu, and the application key displays an item's shortcut menu.

Nearly all keyboards have toggle keys. A *toggle key* is a key that switches between two states each time a user presses the key. When you press the num lock key, for example, it locks the numeric keypad so that you can use the keypad to type numbers. When you press the num lock key again, the numeric keypad unlocks so that the same keys can serve to move around a document. Many keyboards have status lights that light up when you activate a toggle key. Users can press the arrow keys and other keys such as page up and page down on the keyboard to move the insertion point left, right, up, or down. The **insertion point**, also known as a *cursor* in some programs, is a symbol on the screen, usually a blinking vertical bar, that indicates where the next character you type will appear (Figure 5-3).

Keyboards with media control buttons allow you to control your media player program, access the computer's optical disc drive, and adjust speaker volume. Internet control buttons allow you to open an e-mail program, start a Web browser, and search the Internet. Some keyboards have USB ports so that you can plug a USB device directly in the keyboard instead of in the system unit. Some keyboards include a fingerprint reader and/or smart card reader, each of which is discussed later in this chapter. A *gaming keyboard* is a keyboard designed specifically for users who enjoy playing games on the computer. Gaming keyboards typically include programmable keys so that gamers can customize the keyboard to the game being played. The keys on gaming keyboards light up so that the keys are visible in all lighting conditions. Some have small displays that show important game statistics, such as time or targets remaining.

Figure 5-3 In most programs, such as Word, the insertion point is a blinking vertical bar. You use the keyboard or other input device to move the insertion point. The pointer, another symbol that is displayed on the screen, is controlled using a pointing device such as a mouse.

Desktop computer keyboards often attach via a cable to a USB port on the system unit. Some keyboards, however, do not have any wires connecting the keyboard to the system unit. A *wireless keyboard*, or *cordless keyboard*, is a battery-powered device that transmits data to the system unit using wireless technology, such as radio waves (Bluetooth) or infrared light waves (IrDA).

Keyboard Ergonomics

Many keyboards have a rectangular shape with the keys aligned in straight, horizontal rows. Users who spend a lot of time typing on these keyboards sometimes experience repetitive strain injuries (RSI) of their wrists and hands. For this reason, some manufacturers offer ergonomic keyboards. An *ergonomic keyboard* has a design that reduces the chance of wrist and hand injuries (Figure 5-4). Even keyboards that are not ergonomically designed attempt to offer a user more comfort by including a wrist rest or palm rest (Figure 5-2 on page 260).

Figure 5-4 An ergonomic keyboard.

The goal of **ergonomics** is to incorporate comfort, efficiency, and safety in the design of the workplace. Employees can be injured or develop disorders of the muscles, nerves, tendons, ligaments, and joints from working in an area that is not designed ergonomically.

Keyboards for Mobile Computers and Mobile Devices

On notebook computers and some handheld computers, smart phones, and other mobile devices the keyboard is built in the top of the system unit. To fit in these mobile computers and devices, the keyboards usually are smaller and have fewer keys than desktop computer keyboards. A typical notebook computer keyboard usually has only about 85 keys. To provide all of the functionality of a desktop computer keyboard, manufacturers design many of the keys to serve two or three purposes. A variety of options are available for typing on a smart phone (Figure 5-5). Many can display an on-screen keyboard, where you press the on-screen keys using a stylus or your finger. Some smart phones have one key for each letter of the alphabet, often called a mini-keyboard. Other phones have keypads that contain fewer keys than there are letters in the alphabet. For these phones, each key on the keypad represents multiple characters, which are identified on the key. That is, the 2 key on the phone’s keypad displays the letters a, b, and c on the key’s face. On many phones, you cycle through the number, letters, and other symbols associated with a particular key by pressing a key on the keypad multiple times. For example, to type the word, hi, on a phone keypad, you would press the 4 key twice to display the letter h, pause momentarily to advance the cursor, and then press the 4 key three times to display the letter i. Some phones use *predictive text input*, where you press one key on the keypad for each letter in a word, and software on the phone predicts the word you want. Predictive text input saves users time when entering text using the phone’s keypad.

Figure 5-5 Users have a variety of options for typing on a phone.

Pointing Devices

A **pointing device** is an input device that allows a user to control a pointer on the screen. In a graphical user interface, a **pointer** is a small symbol on the screen (Figure 5-3 on page 261) whose location and shape change as a user moves a pointing device. A pointing device can be used to move the insertion point; select text, graphics, and other objects; and click buttons, icons, links, and menu commands. The following sections discuss the mouse and other pointing devices.

Mouse

A **mouse** is a pointing device that fits under the palm of your hand comfortably. The mouse is the most widely used pointing device on desktop computers. With a mouse, users control the movement of the pointer, often called a *mouse pointer* in this case. As you move a mouse, the pointer on the screen also moves. Generally, you use the mouse to move the pointer on the screen to an object such as a button, a menu, an icon, a link, or text. Then, you press a mouse button to perform a certain action associated with that object. The top and sides of a mouse have one to four buttons; some also have a small wheel. The bottom of a mouse is flat and contains a mechanism that detects movement of the mouse. Most desktop computer users today have some type of *optical mouse*, which uses devices that emit and sense light to detect the mouse's movement. Some use optical sensors, and others use a laser. The latter, often referred to as a *laser mouse* (Figure 5-6), usually is more expensive than the former. You can place an optical mouse on nearly all types of flat surfaces. Some newer models combine both optical sensors and laser, enabling users to place the mouse on rougher surfaces such as carpeting and park benches. Further, some mouse devices are more sensitive than others for users requiring more precision such as graphic artists, engineers, or game players.

The mobile user who makes presentations may prefer a mouse that has additional buttons for running a slide show and controlling media, similar to a remote control. A newer type of mouse, called an *air mouse*, is a motion-sensing mouse that, in addition to the typical buttons, allows you to control objects, media players, and slide shows by moving the mouse in predetermined directions through the air (Figure 5-7).

Figure 5-6 This mouse uses a laser to detect movement of the mouse. It also includes buttons you push with your thumb that enable forward and backward navigation through Web pages.

For example, raising the mouse up might increase the volume on your media player. A mouse connects to a computer in several ways. Many types connect with a cable that attaches to a USB port or a mouse port on the system unit. A *wireless mouse*, or *cordless mouse*, is a battery-powered device that transmits data using wireless technology, such as radio waves (Bluetooth) or infrared light waves (IrDA). Some users prefer a wireless mouse because it frees up desk space and eliminates the clutter of a cord.

Figure 5-7 This air mouse works on a desk like a laser mouse or in the air by detecting hand motions.

Using a Mouse

Windows users work with a mouse that has at least two buttons. For a right-handed user, the left button usually is the primary mouse button, and the right mouse button is the secondary mouse button. Left-handed people, however, can reverse the function of these buttons. The table in Figure 5-8 explains how to perform a variety of mouse operations. Some programs also use keys in combination with the mouse to perform certain actions. For example, when you hold down the ctrl key while rolling the wheel, text on the screen becomes larger or smaller based on the direction you roll the wheel. The function of the mouse buttons and the wheel varies depending on the program. Some programs support *mouse gestures*, where the user performs certain operations by holding a mouse button while moving the mouse in a particular pattern. For example, moving the mouse down and to the left may close all open windows. Mouse gestures minimize the amount of time users spend navigating through menus or toolbars because users can perform these tasks by simply moving (gesturing) the mouse.

Mouse Operations

Operation	Mouse Action	Example
Point	Move the mouse until the pointer on the desktop is positioned on the item of choice.	Position the pointer on the screen.
Click	Press and release the primary mouse button, which usually is the left mouse button.	Select or deselect items on the screen or start a program or program feature.
Right-click	Press and release the secondary mouse button, which usually is the right mouse button.	Display a shortcut menu.
Double-click	Quickly press and release the left mouse button twice without moving the mouse.	Start a program or program feature.
Triple-click	Quickly press and release the left mouse button three times without moving the mouse.	Select a paragraph.
Drag	Point to an item, hold down the left mouse button, move the item to the desired location on the screen, and then release the left mouse button.	Move an object from one location to another or draw pictures.
Right-drag	Point to an item, hold down the right mouse button, move the item to the desired location on the screen, and then release the right mouse button.	Display a shortcut menu after moving an object from one location to another.
Rotate wheel	Roll the wheel forward or backward.	Scroll vertically (up and down).
Free-spin wheel	Whirl the wheel forward or backward so that it spins freely on its own.	Scroll through hundreds of pages in seconds.
Press wheel	Press the wheel button while moving the mouse.	Scroll continuously.
Tilt wheel	Press the wheel toward the right or left.	Scroll horizontally (left and right).
Press thumb button	Press the button on the side of the mouse with your thumb.	Move forward or backward through Web pages and/or control media, games, etc.

Figure 5-8 Common mouse operations.

Other Pointing Devices

The mouse is the most widely used pointing device today. Some users, however, work with other pointing devices. These include the trackball, touchpad, pointing stick, touch screen, touch-sensitive pads, stylus, pen, signature capture pad, and graphics tablet. The following sections discuss each of these pointing devices.

Trackball

A **trackball** is a stationary pointing device with a ball on its top or side (Figure 5-9). The ball in most trackballs is about the size of a Ping-Pong ball. To move the pointer using a trackball, you rotate the ball with your thumb, fingers, or the palm of your hand. In addition to the ball, a trackball usually has one or more buttons that work just like mouse buttons. A trackball requires frequent cleaning because it picks up oils from fingers and dust from the environment.

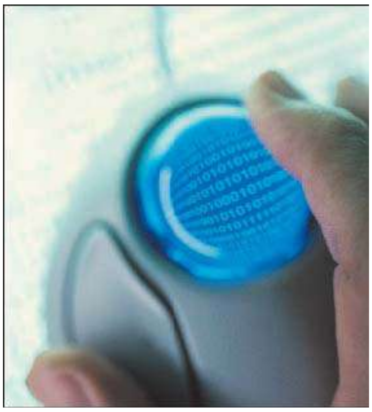


Figure 5-9 A trackball.

For users who have limited desk space, however, a trackball is a good alternative to a mouse because the device is stationary.

Touchpad

A **touchpad** is a small, flat, rectangular pointing device that is sensitive to pressure and motion (Figure 5-10). To move the pointer using a touchpad, slide your fingertip across the surface of the pad. Some touchpads have one or more buttons around the edge of the pad that work like mouse buttons. On most touchpads, you also can tap the pad's surface to imitate mouse operations such as clicking. Touchpads are found most often on notebook computers, including netbooks and many Tablet PCs.

Figure 5-10 Most notebook computers have a touchpad that allows users to control the movement of the pointer.

Pointing Stick

A **pointing stick** is a pressure-sensitive pointing device shaped like a pencil eraser that is positioned between keys on a keyboard (Figure 5-11). To move the pointer using a pointing stick, you push the pointing stick with a finger. The pointer on the screen moves in the direction you push the pointing stick. By pressing buttons below the keyboard, users can click and perform other mouse-type operations with a pointing stick. A pointing stick does not require any additional desk space.

Touch Screens and Touch-Sensitive Pads

A **touch screen** is a touch-sensitive display device. Touch screens that recognize multiple points of contact at the same time are known as *multi-touch*. Users can interact with touch screens by touching areas of the screen. Because touch screens require a lot of arm or hand movements, you do not enter large amounts of data using a touch screen. Instead, you touch words, pictures, numbers, letters, or locations identified on the screen. Some touch screens also respond to finger motions such as sliding your finger to drag an object or pinching your fingers to zoom in or out. The latest version of the Windows operating system provides increased support for computers with touch screens. Support for touch screen makes it easier for users to interact with Some models of desktop computers and notebook computers, including netbooks and Tablet PCs, and many mobile devices have touch screens (Figure 5-12). With some smart phones, portable media players, and other mobile devices, for example, you can touch the screen to perform tasks such as dialing phone numbers, entering text, and making on-screen selections. Some handheld game consoles also have touch screens. A *kiosk*, which is a freestanding computer, usually includes a touch screen (Figure 5-13). For example, travelers use kiosks in airports to print tickets ordered online and in hotels for easy check in and check out. To allow easy access of your bank account from a car, many ATMs have touch screens.

Figure 5-12 Computers and mobile devices have touch screens.

Figure 5-11 Some notebook computers include a pointing stick to allow a user to control the movement of the pointer.

Figure 5-13 This traveler checks in using an airport kiosk.

A recently developed touch screen, called *Microsoft Surface*, is a 30-inch tabletop display that allows one or more people to interact with the screen using their fingers or hands (Figure 5-14). The Microsoft Surface display also allows devices that are not digital, such as an everyday paintbrush, to be used as an input device. Restaurants, hotels, and other public locations provide Microsoft Surface tables to enhance guest services.

Touch-Sensitive Pads

Portable media players that do not have touch screens typically have a *touch-sensitive pad*, which is an input device that enables users to scroll through and play music, view pictures, watch videos or movies, adjust volume, and/or customize settings. Touch sensitive pads typically contain buttons and/ or wheels that are operated with a thumb or finger. For example, users rotate a *Click Wheel* to browse through the portable media player's song, picture, or movie lists and press the Click Wheel's buttons to play or pause media, display a menu, and perform other actions (Figure 5-15).

Figure 5-14 Guests explore photos of hotel amenities by touching and dragging them across the Microsoft Surface display.

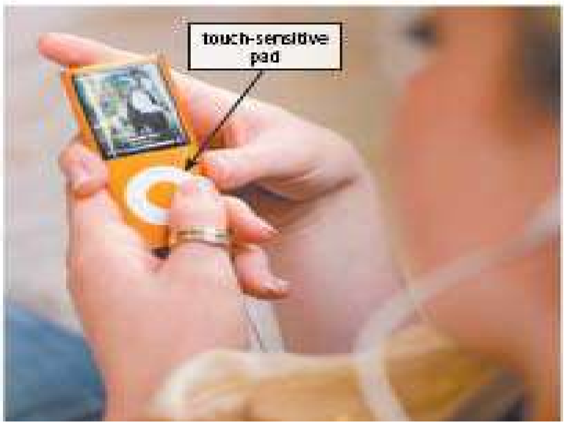


Figure 5-15 You use your thumb to rotate or press buttons on a Click Wheel.

Pen Input

With **pen input**, you touch a stylus or digital pen on a flat surface to write, draw, or make selections. The flat surface may be a screen on a monitor or mobile device, a signature capture pad, or a graphics tablet (Figure 5-16). A **stylus** is a small metal or plastic device that looks like a tiny ink pen but uses pressure instead of ink. A **digital pen**, which is slightly larger than a stylus, typically provides more functionality than a stylus, featuring electronic erasers and programmable buttons. Most digital pens, often simply called pens, are pressure-sensitive. Some desktop and mobile computers and nearly all mobile devices have touch screens that recognize pen input and thus include a pressure sensitive digital pen or stylus. Computers and mobile devices often use *handwriting recognition software*, which is a program that translates the handwritten letters and symbols created on the screen with the stylus or pen into characters that the computer or device can process. To capture a handwritten signature, a user writes his or her name on a **signature capture pad** with a stylus or pen that is attached to the device. Software then transmits the signature via a cable connected to a port on the computer. Signature capture pads often include a magnetic stripe card reader and work with POS terminals, both discussed later in the chapter.

To use pen input on a computer that does not have a touch screen, you can attach a graphics tablet to the computer. A **graphics tablet** is a flat, rectangular, electronic, plastic board. Architects, mapmakers, designers, artists, and home users create drawings by using a pressure sensitive pen on a graphics tablet. Each location on the graphics tablet corresponds to a specific location on the screen. When drawing on the tablet with a pen, the tablet detects and converts the movements into digital signals that are sent in the computer. Large-scale applications sometimes refer to the graphics tablet as a *digitizer*.

Figure 5-16 You use a stylus or a pen to write, draw, or make selections on a screen, signature capture pad, or graphics tablet

Other Input for Smart Phones

Previously discussed input devices such as mini-keyboards, keypads, touch screens, and a stylus are used with smart phones. In addition to these input methods, a variety of alternatives for input is available for smart phones (Figure 5-17).

You can talk directly into the smart phone's microphone or into a Bluetooth headset that wirelessly communicates with the phone. Some smart phones have digital cameras that take pictures and touch-sensitive pads that enable you to interact with media, such as music and photos. Others receive navigation signals to provide users with maps and directions. You can purchase a more elaborate stylus that has a ballpoint pen at one end and a stylus at the other. Instead of typing on a phone’s keyboard or keypad, users can enter text via a *portable keyboard*, which is a full-sized keyboard that communicates with a smart phone or PDA. Some portable keyboards physically attach to and remove from the device; others are wireless. Another option is an optical keyboard that projects an image of a keyboard on a flat surface (Figure 5-18).

You also can transfer, or synchronize, data and information from a computer to a phone. With some phones, you synchronize wirelessly; with others, you attach the phone to the computer via a cable or a cradle that has a cable connected to the computer.

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Figure 5-17 Besides a touch screen and basic stylus, users have a variety of other options for entering data and instructions into a smart phone.

Figure 5-18 The characters you type on this full-sized optical key board appear on your smart phone.

Game Controllers

Video games and computer games use a **game controller** as the input device that directs movements and actions of on-screen objects. Game controllers include gamepads, joysticks and wheels, light guns, dance pads, and a variety of motion-sensing controllers. The following sections discuss a variety of game controllers (Figure 5-19).

Gamepads

A **gamepad**, which is held with both hands, controls the movement and actions of players or objects in video games or computer games. On the gamepad, users press buttons with their thumbs or move sticks in various directions to trigger events. Gamepads communicate with a game console or a personal computer via wired or wireless technology.

Joysticks and Wheels

Users running game software or flight and driving simulation software often use a joystick or wheel to control an airplane, vehicle, or player.

A **joystick** is a handheld vertical lever mounted on a base. You move the lever in different directions to control the actions of the simulated vehicle or player. The lever usually includes buttons, called triggers, that you press to initiate certain events. Some joysticks also have additional buttons you press to perform other actions.

A **wheel** is a steering-wheel-type input device. Users turn the wheel to simulate driving a car, truck, or other vehicle. Most wheels also include foot pedals for acceleration and braking actions. Joysticks and wheels typically attach via a cable to a personal computer or game console.

Light Guns

A **light gun** is used to shoot targets and moving objects after you pull the trigger on the weapon. Instead of emitting light, most light guns work by detecting light. When the user pulls the trigger, the screen uses one of several techniques to send light, which is received by a receptor in the barrel of the gun. Light guns typically attach via a cable to a game console or personal computer.

Dance Pads

A **dance pad** is a flat electronic device divided into panels that users press with their feet in response to instructions from a music video game. These games test the user's ability to step on the correct panel at the correct time, following a pattern that is synchronized with the rhythm or beat of a song. Dance pads communicate with a game console or a personal computer via wired or wireless technology.

Figure 5-19 A variety of game controllers.

Motion-Sensing Game Controllers

Motion-sensing game controllers allow the user to guide on-screen elements by moving a handheld input device in predetermined directions through the air. Some are sold with a particular type of game; others are general purpose. Sports games, for example, use motion-sensing game controllers, such as baseball bats and golf clubs, as their input device. These types of controllers communicate with a game console or a personal computer via wired or wireless technology. A popular general-purpose, motion-sensing game controller is Nintendo's Wii Remote. Shaped like a television remote control and operated with one hand, the *Wii Remote* is a motion-sensing input device that uses Bluetooth wireless technology to communicate with the Wii game console. Users point the Wii Remote in different directions and rotate it to control on-screen players, vehicles, and other objects.

Other Game Controllers

Other popular game controllers include musical instruments and balance boards.

Controllers that resemble musical instruments, such as guitars, drums, and keyboards, work with music video games that enable game players to create sounds and music by playing the instrument. Fitness games often communicate with a balance board, which is shaped like a weight scale and contains sensors that measure a game player's balance and weight. Musical instrument and balance board controllers communicate with game consoles via wired or wireless technology.

Digital Cameras

As discussed in Chapter 1, a **digital camera** is a mobile device that allows users to take pictures and store the photographed images digitally, instead of on traditional film. While many digital cameras look like a traditional camera, many mobile devices such as smart phones, PDAs, and portable media players often have a built-in digital camera. Mobile users such as real estate agents, insurance agents, general contractors, and photojournalists use digital cameras so that they immediately can view photographed images on the camera. Home and business users have digital cameras to save the expense of film developing, duplication, and postage. The three basic types of digital cameras are studio cameras, field cameras, and point-and-shoot cameras. The most expensive and highest quality of the three is a *studio camera*, which is a stationary camera used for professional studio work. Often used by photojournalists, a *field camera* is a portable camera that has many lenses and other attachments. As with the studio camera, a field camera can be quite expensive. A *point-and-shoot camera* is much more affordable and lightweight and provides acceptable quality photographic images for the home or small business user. Figure 5-20 illustrates how one make of a point-and-shoot digital camera works. Often users prefer to *download*, or transfer a copy of, the images from the digital camera to the computer's hard disk. With some digital cameras, images download through a cable that connects the digital camera (or the camera's docking station) to a USB port or a FireWire port on the system unit. For cam eras that store photos on a memory card, simply insert the media in a reading/writing device that communicates wirelessly or attaches to a port on the system unit. When you copy photos to the hard disk in a computer, the photos are available for editing with photo editing software, printing, faxing, sending via e-mail, including in another document, or posting to a Web site or photo community for everyone to see. Many users add photos to greeting cards, a computerized photo album, a family newsletter, certificates, and awards.

Figure 5-20 This figure shows how a digital camera might work.

Digital Camera Photo Quality

One factor that affects the quality of digital camera photos is its resolution. **Resolution** is the number of horizontal and vertical pixels in a display device. A *pixel* (short for picture element) is the smallest element in an electronic image (Figure 5-21). The greater the number of pixels the camera uses to capture a picture, the better the quality of the picture. Thus, the higher the resolution, the better the picture quality, but the more expensive the camera.

Digital camera resolutions range from approximately 4 million to more than 16 million pixels (*MP*). A camera with a 7.1 MP (7,100,000 pixels) resolution will provide a better quality than one with a 4 MP resolution. As a general rule, a 4 MP camera is fine for photos sent via e-mail or posted on the Web. For good quality printed photos, users should have a 5 MP camera for 4 x 6 inch photos, a 6 MP camera for 8 x 10 photos, and 7 MP or greater camera for larger size prints or more professional results.

Manufacturers often use pixels per inch to represent a digital camera's resolution. *Pixels per inch* (*ppi*) is the number of pixels in one inch of screen display. For example, a 2304 x 1728 (pronounced 2304 by 1728) ppi camera has 2,304 pixels per vertical inch and 1,728 pixels per horizontal inch. Multiplying these two numbers together gives an approximate total number of pixels. For example, 2304 times 1728 equals approximately 4 million, or 4 MP. If just one number is stated, such as 1600 ppi, then both the vertical and horizontal numbers are the same.

Many digital cameras provide a means to adjust the ppi to the desired resolution. With a lower ppi, you can capture and store more images in the camera. For example, a camera set at 1280 x 960 ppi might capture and store 61 photos, if it has sufficient storage capacity. The number of photos may reduce to 24 on the same camera set at 2592 x 1944 ppi, because each photo consumes more storage space.

The actual photographed resolution is known as the *optical resolution*. Some manufacturers state *enhanced resolution*, instead of, or in addition to, optical resolution. Optical resolution is different from enhanced resolution. The enhanced resolution usually is higher because it uses a special formula to add pixels between those generated by the optical resolution. Be aware that some manufacturers compute a digital camera's mega pixels from the enhanced resolution, instead of optical resolution. Another measure of a digital camera's photo quality is the number of bits it stores in a pixel. Each pixel consists of one or more bits of data. The more bits used to represent a pixel, the more colors and shades of gray that can be represented. One bit per pixel is enough for simple one-color images. For multiple colors and shades of gray, each pixel requires more than one bit of data. A point-and-shoot camera should be at least 24 bit.

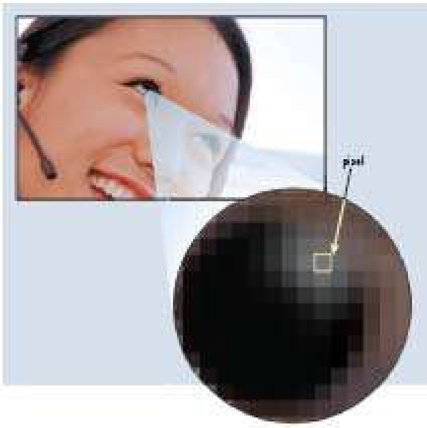


Figure 5-21 A pixel is a single point in an electronic image.

Voice Input

Voice input is the process of entering input by speaking into a microphone. The microphone may be a stand-alone peripheral that sits on top of a desk, or built in the computer or device, or in a headset. Some external microphones have a cable that attaches to a port on the sound card on the computer. Others communicate using wireless technology such as Bluetooth. Uses of voice input include instant messaging that supports voice conversations, chat rooms that support voice chats, VoIP, and voice recognition. Recall that VoIP (Voice over IP) enables users to speak to other users over the Internet.

Voice recognition, also called *speech recognition*, is the computer's capability of distinguishing spoken words. Other popular voice recognition programs for personal computers include IBM ViaVoice and Dragon Naturally Speaking (Figure 5-22). Voice recognition programs recognize a vocabulary of preprogrammed words, which can range from two words to millions of words. The automated telephone system at your bank may ask you to answer questions by speaking the words Yes or No into the telephone. A voice recognition program on your computer, by contrast, may recognize up to two million words. Some current cell phones and other mobile devices allow you to store voice commands such as "Call Tom at home." Operating systems, such as Windows, also include voice recognition capabilities. Keep in mind that the best voice recognition programs are 90 to 95 percent accurate, which means the software may interpret as many as one in ten words incorrectly.

Audio Input

Voice input is part of a larger category of input called audio input. **Audio input** is the process of entering any sound into the computer such as speech, music, and sound effects. To enter highquality sound into a personal computer, the computer must have a sound card. Users enter sound into a computer via devices such as microphones, tape players, CD/DVD/Blu-ray Disc players, or radios, each of which plugs in a port on the sound card.

Some users also record live music and other sound effects into a computer by connecting external music devices such as an electronic keyboard (Figure 5-23), guitar, drums, harmonica, and microphones to a port on the system unit. When purchasing a music device, check its specifications for the type(s) of ports to which it connects. Ports that connect music devices to the system unit include USB, FireWire, MIDI, and S/PDIF, each illustrated in the previous chapter.

Music production software allows users to record, compose, mix, and edit music and sounds. For example, you can change the speed, add notes, or rearrange the score to produce an entirely new arrangement.

Figure 5-22
With voice recognition software, users can dictate text and enter instructions to the computer by speaking into a microphone.

Figure 5-23 An electronic keyboard can be connected to a computer, allowing users to record and store music in the computer.

Video Input

Video input is the process of capturing full-motion images and storing them on a computer's storage medium such as a hard disk or optical disc. Some video devices record video using analog signals. Computers, by contrast, use digital signals. To enter video from an analog device into a personal computer, the analog signal must be converted to a digital signal. To do this, you plug a video camera or other analog video device in a video capture port on the system unit. One type of adapter card that has a video capture port is a *video capture card*, which converts an analog video signal into a digital signal that a computer can process. Most new computers are not equipped with a video capture card because not all users have the need for this type of adapter card.

A **digital video** (**DV**) **camera**, by contrast, records video as digital signals instead of analog signals. Many DV cameras can capture still frames, as well as motion. To transfer recorded images to a hard disk or optical disc, users connect DV cameras directly to a USB port or a FireWire port on the system unit. Thus, the computer does not need a video capture card. Simply connect the video device to the computer and begin transferring images. After saving the video on a storage medium, such as a hard disk or optical disc, you can play it or edit it using video editing software on a computer (Figure 5-24).

Web Cams

A **Web cam**, also called a *PC video camera*, is a type of digital video camera that enables a home or small business user to capture video and still images, send e-mail messages with video attachments, add live images to instant messages, broadcast live images over the Internet, and make video telephone calls. During a *video telephone call*, both parties see each other as they communicate over the Internet. The cost of Web cams usually is less than $100. Attached to the computer's USB port or FireWire port, a Web cam usually sits on top of a desktop computer monitor (shown in Figure 5-1). Many notebook computers have built-in Web cams, such as the one in Figure 5-25.

Figure 5-24 Home users can transfer videos to their computers and then use video editing software to edit the video.

You can configure some Web cams to display their output on a Web page. This use of a Web cam attracts Web site visitors by showing images that change regularly. Home or small business users might use Web cams to show a work in-progress, weather and traffic information, employees at work, or as a security system. Some Web sites have live Web cams that display still pictures and update the displayed image at a specified time or time intervals, such as 15 seconds. A *streaming cam* has the illusion of moving images because it sends a continual stream of still images. To learn more about how to install and use a Web cam, complete the Learn How To 1 activity on page 298.

Video Conferencing

A **video conference** is a meeting between two or more geographically separated people who use a network or the Internet to transmit audio and video data (Figure 5-26). To participate in a video conference using a computer, you need video conferencing software or use a video conferencing Web application, along with a microphone, speakers, and a video camera attached to or built in to a computer. Examples of video conferencing software include CUworld, Live Meeting, and WebEx. As you speak, members of the meeting hear your voice on their speakers. Any image in front of the video camera, such as a person's face, appears in a window on each participant's screen. A *whiteboard* is another window on the screen that displays notes and drawings simultaneously on all participants' screens. This window provides multiple users with an area on which they can write or draw. As the costs of video conferencing hardware and software decrease, increasingly more business meetings, corporate training, and educational classes will be conducted as video conferences.

Figure 5-25 This student uses a notebook computer, which has a built-in Web cam, to watch a video of a lecture for her online class.

Figure 5-26 To save on travel expenses, many large businesses are turning to video conferencing.

Scanners and Reading Devices

Some input devices save users time by eliminating manual data entry. With these devices, users do not type, speak, or write into the computer. Instead, these devices capture data from a *source document*, which is the original form of the data. Examples of source documents include time cards, order forms, invoices, paychecks, advertisements, brochures, photos, inventory tags, or any other document that contains data to be processed. Devices that can capture data directly from a source document include optical scanners, optical readers, bar code readers, RFID readers, magnetic stripe card readers, and magnetic-ink character recognition readers. The following pages discuss each of these devices.

Optical Scanners

An *optical scanner*, usually called a **scanner**, is a light-sensing input device that reads printed text and graphics and then translates the results into a form the computer can process. Four types of scanners are flatbed, pen, sheet-fed, and drum (Figure 5-27).

Types of Scanners

Scanner	**Method of Scanning and Use**	Scannable Items
Flatbed 	▪ Similar to a copy machine ▪ Scanning mechanism passes under the item to be scanned, which is placed on a glass surface	▪ Single-sheet documents ▪ Bound material ▪ Photos ▪ Some models include trays for slides, transparencies, and negatives
Pen or Handheld 	▪ Move pen over text to be scanned, then transfer data to computer ▪ Ideal for mobile users, students, and researchers ▪ Some connect to a smart phone	▪ Any printed text
Sheet-Fed 	▪ Item to be scanned is pulled into a stationary scanning mechanism ▪ Smaller than a flatbed scanner ▪ A model designed specifically for photos is called a photo scanner	▪ Single-sheet documents ▪ Photos ▪ Slides (with an adapter) ▪ Negatives
Drum 	▪ Item to be scanned rotates around stationary scanning mechanism ▪ Very expensive ▪ Used in large businesses	▪ Single-sheet documents ▪ Photos ▪ Slides ▪ Negatives

Figure 5-27 This table describes the various types of scanners.

A **flatbed scanner** works in a manner similar to a copy machine except it creates a file of the document in memory instead of a paper copy (Figure 5-28). Once you scan a document or picture, you can display the scanned object on the screen, modify its appearance, store it on a storage medium, print it, fax it, attach it to an e-mail message, include it in another document, or post it on a Web site or photo community for everyone to see. As with a digital camera, the quality of a scanner is measured by the number of bits it stores in a pixel and the number of pixels per inch, or resolution. The higher each number, the better the quality, but the more expensive the scanner. Most of today's affordable color desktop scanners for the home or small business range from 30 to 48 bits and have an optical resolution ranging from 600 to 9600 ppi. Commercial scanners designed for power users range from 9600 to 14,000 ppi. Many scanners include *OCR (optical character recognition) software*, which can read and convert text documents into electronic files. OCR software is useful if you need to modify a document but do not have the original word processing file. For example, if you scan a business report with a flatbed scanner and do not use OCR software, you cannot edit the report because the scanner saves the report as an image. This is because the scanner does not differentiate between text and graphics. OCR software, however, would convert the scanned image into a text file that you could edit, for example, with a word processing program. Businesses often use scanners for *image processing*, which consists of capturing, storing, analyzing, displaying, printing, and manipulating images. Image processing allows users to convert paper documents such as reports, memos, and procedure manuals into electronic images. Users distribute and publish these electronic documents on networks and the Internet. Business users typically store and index electronic documents with an image processing system.

An *image processing system* is similar to an electronic filing cabinet that provides access to exact reproductions of the original documents. Local governments, for example, use image processing systems to store property deeds and titles to provide the public and professionals, such as lawyers and loan officers, quick access to electronic documents.

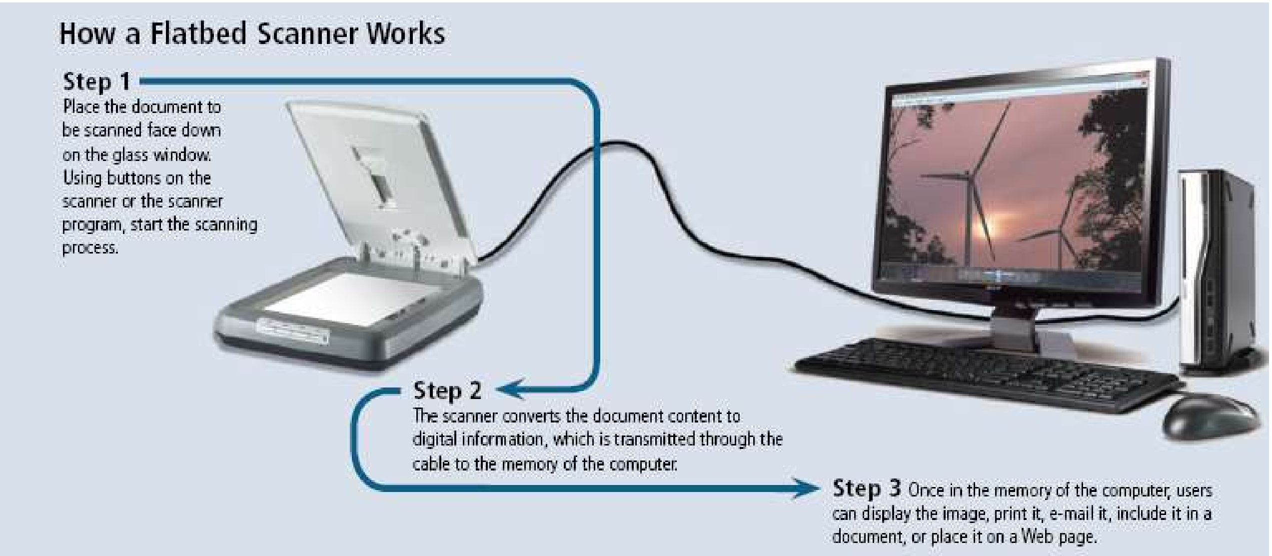


Figure 5-28 This figure shows how a flatbed scanner works.

Optical Readers

An *optical reader* is a device that uses a light source to read characters, marks, and codes and then converts them into digital data that a computer can process. Two technologies used by optical readers are optical character recognition and optical mark recognition.

Optical Character Recognition Optical character recognition (**OCR**) is a technology that involves reading typewritten, computerprinted, or hand-printed characters from ordinary documents and translating the images into a form that the computer can process. Most **OCR devices** include a small optical scanner for reading characters and sophisticated software to analyze what is read. OCR devices range from large machines that can read thousands of documents per minute to handheld wands that read one document at a time. OCR devices read printed characters in an OCR font. A widely used OCR font is called OCR-A (Figure 5-29). During the scan of a document, an OCR device determines the shapes of characters by detecting patterns of light and dark. OCR software then compares these shapes with predefined shapes stored in memory and converts the shapes into characters the computer can process.

Many companies use OCR characters on turnaround documents. A **turnaround document** is a document that you return (turn around) to the company that creates and sends it. For example, when consumers receive a bill, they often tear off a portion of the bill and send it back to the company with their

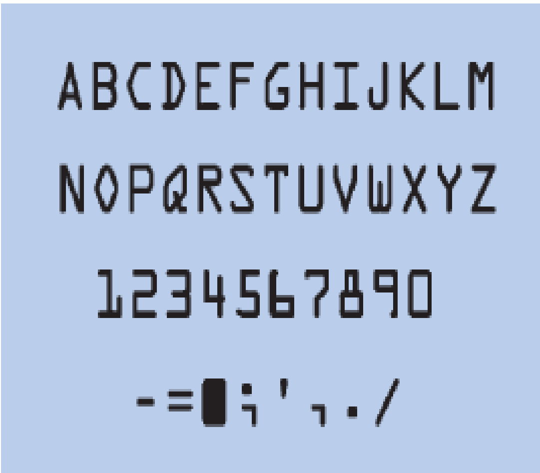


Figure 5-29 A portion of the characters in the OCR-A font. Notice how characters such as the number 0 and the letter O are shaped differently so that the reading device easily can distinguish between them.

payment (Figure 5-30). The portion of the bill they return usually has their payment amount, account number, and other information printed in OCR characters.

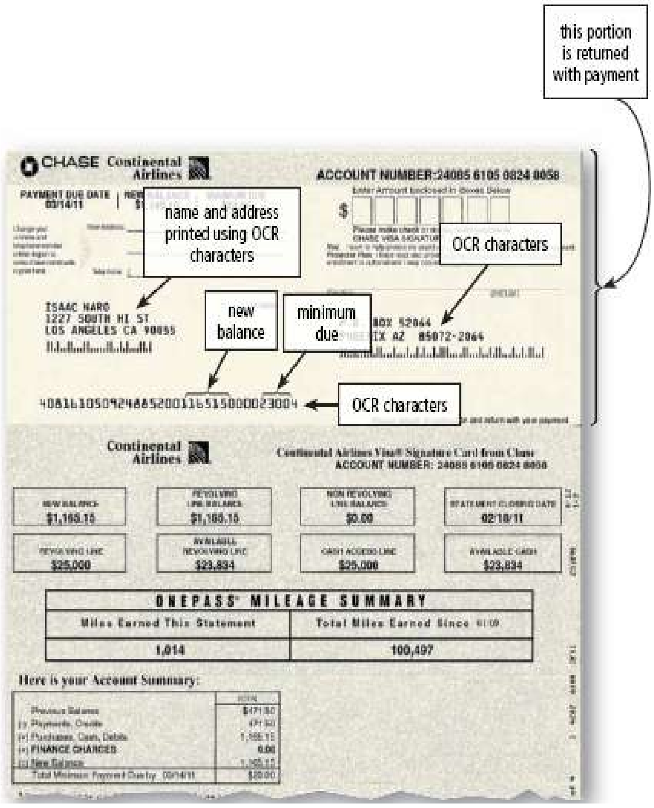


Figure 5-30 OCR characters frequently are used with turnaround documents. With this bill, you tear off the top portion and return it with a payment.

Optical Mark Recognition Optical mark recognition (**OMR**) is a technology that reads hand-drawn marks such as small circles or rectangles (Figure 5-31). A person places these marks on a form, such as a test, survey, or questionnaire answer sheet. With a test, the OMR device first scans the answer key sheet to record correct answers based on patterns of light. The OMR device then scans the remaining documents and matches their patterns of light against the answer key sheet.

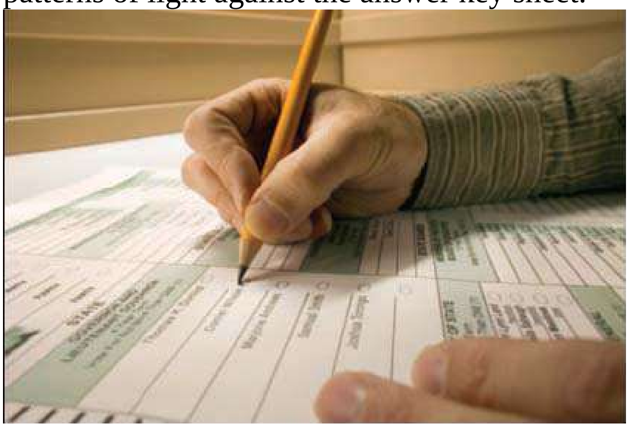


Figure 5-31 This person uses a pencil to darken in boxes on this document that can be read by an OMR device.

Bar Code Readers

A **bar code reader**, also called a **bar code scanner**, is an optical reader that uses laser beams to read bar codes by using light patterns that pass through the bar code lines (Figure 5-32). A **bar code** is an identification code that consists either of a set of vertical lines and spaces of different widths or a two-dimensional pattern of dots, squares, and other images. The bar code represents data that identifies the manufacturer and the item. A newer type of bar code, called a 2-D bar code, can store much more data than the traditional linear bar code.

Manufacturers print a bar code either on a product's package or on a label that is affixed to a product. A variety of products such as groceries, books, clothing, vehicles, mail, and packages have bar codes. Some airports now are accepting electronic boarding passes by using a bar code reader

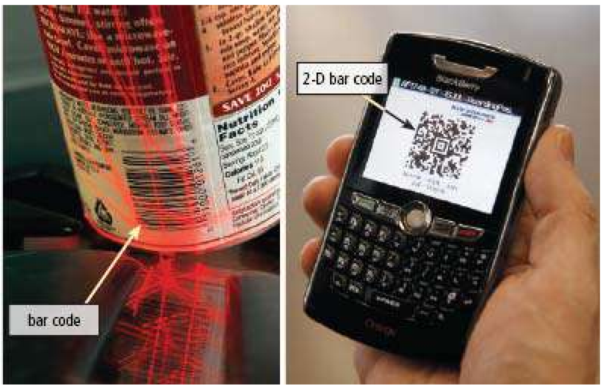


Figure 5-32 A bar code reader uses laser beams to read bar codes on products such as food and boarding passes.

to scan a bar code that is displayed on the screen of a smart phone or PDA. Each industry uses its own type of bar code. The United States Postal Service (USPS) uses a POSTNET bar code. Retail and grocery stores use the *UPC* (*Universal Product Code*) bar code.

RFID Readers

RFID (*radio frequency identification*) is a technology that uses radio signals to communicate with a tag placed in or attached to an object, an animal, or a person. RFID tags, which contain a memory chip and an antenna, are available in many shapes and sizes and sometimes are embedded in glass, labels, or cards. Some RFID tags are as small as a grain of sand; others are the size of a luggage tag. An **RFID reader** reads information on the tag via radio waves. RFID readers can be handheld devices or mounted in a stationary object such as a doorway.

Many retailers see RFID as an alternative to bar code identification because it does not require direct contact or line-of-site transmission. Each product in a store would contain a tag that identifies the product (Figure 5-33). As consumers remove products from the store shelves and walk through a checkout area, an RFID reader reads the tag(s) and communicates with a computer that calculates the amount due, eliminating the need for checking out each item.

Other uses of RFID include tracking times of runners in a marathon; tracking location of soldiers, employee wardrobes, airline baggage, and misplaced or stolen goods; checking lift tickets of skiers; managing inventory; gauging pressure and temperature of tires on a vehicle; checking out library books; and tracking payment as vehicles pass through booths on tollway systems.

Figure 5-33 RFID readers read information stored on an RFID tag and then communicate this information to computers, which instantaneously compute payments and update inventory records. In this example, the RFID tag is embedded in a label attached to the tire.

Magnetic Stripe Card Readers

A **magnetic stripe card reader**, often called a *magstripe reader*, reads the magnetic stripe on the back of credit cards, entertainment cards, bank cards, and other similar cards. The stripe, which is divided in three horizontal tracks, contains information identifying you and the card issuer (Figure 5-34). Some information stored in the stripe includes your name, account number, the card's expiration date, and a country code. Information on magnetic card stripes is used to make payments, authenticate users, record attendance, and provide access to secure areas. When a consumer swipes a credit card through a magstripe reader, for example, it reads the information stored on the magnetic stripe on the card. If the magstripe reader rejects the card, it is possible that the magnetic stripe on the card is scratched, dirty, or erased. Exposure to a magnet or magnetic field can erase the contents of a card's magnetic stripe. In many cases, a magstripe reader is part of a signature capture pad and/or a point-of-sale terminal. Point-of-sale terminals are discussed later in this chapter.

Figure 5-34 A magnetic stripe card reader reads information encoded on the stripe on the back of your credit card.

MICR Readers

MICR (*magnetic-ink character recognition*) devices read text printed with magnetized ink. An **MICR reader** converts MICR characters into a form the computer can process. The banking industry almost exclusively uses MICR for check processing. Each check in your checkbook has precoded MICR characters beginning at the lower-left edge (Figure 5-35). The MICR characters represent the bank routing number, the customer account number, and the check number. These numbers may appear in a different order than the ones shown in the sample in Figure 5-35. When a bank receives a check for payment, it uses an MICR inscriber to print the amount of the check in MICR characters in the lower right corner. The check then is sorted or routed to the customer's bank, along with thousands of others. Each check is inserted in an MICR reader, which sends the check information — including the amount of the check — to a computer for processing. When you balance your checkbook, verify that the amount printed in the lower-right corner is the same as the amount written on the check; otherwise, your statement will not balance. The banking industry has established an international standard not only for bank numbers, but also for the font of the MICR characters. This standardization makes it possible for people to write checks in other countries.

Figure 5-35 The MICR characters preprinted on the check represent the bank routing number, the customer account number, and the check number. The amount of the check in the lower-right corner is added after the check is cashed.

Data Collection Devices

Instead of reading or scanning data from a source document, a *data collection device* obtains data directly at the location where the transaction or event takes place. For example, employees use bar code readers, handheld computers, or other mobile devices to collect data wirelessly (Figure 5-36). These types of data collection devices are used in restaurants, grocery stores, factories, warehouses, the outdoors, or other locations where heat, humidity, and cleanliness are not easy to control. For example, factories and retail stores use data collection devices to take inventory and order products. Data collection devices and many mobile computers and devices have the capability of wirelessly transmitting data over a network or the

Internet. Increasingly more users today send data wirelessly to central office computers using these devices.

Figure 5-36 A warehouse employee uses this rugged handheld computer, which includes a bar code reader, that wirelessly transmits information about the scanned item to the store's inventory system.

Biometric Input

Biometrics is the technology of authenticating a person's identity by verifying a personal characteristic. Biometric devices grant users access to programs, systems, or rooms by analyzing some biometric identifier. A *biometric identifier* is a physiological (related to physical or chemical activities in the body) or behavioral characteristic. Examples include fingerprints, hand geometry, facial features, voice, signatures, and eye patterns.

A *biometric device* translates a personal characteristic (the input) into a digital code that is compared with a digital code stored in the computer. If the digital code in the computer does not match the personal characteristic's code, the computer denies access to the individual. The most widely used biometric device today is a fingerprint reader. A **fingerprint reader**, or scanner, captures curves and indentations of a fingerprint (Figure 5-37). The reader can be set up to perform different functions for different fingers; for example, one finger starts a program and another finger shuts down the computer. With the cost of fingerprint readers often less than $100, home and small business users in stall fingerprint readers to authenticate users be fore they can access a personal computer. External fingerprint readers usually plug into a USB port. To save on desk space, some newer keyboards and notebook computers have a fingerprint reader attached to them, which allows users to log on to programs and Web sites via their fingerprint instead of entering a user name and password.

A *face recognition system* captures a live face image and compares it with a stored image to determine if the person is a legitimate user. Some buildings use face recognition systems to secure access to rooms. Law enforcement, surveillance systems, and airports use face recognition to protect the public. Some notebook computers use this security technique to safeguard a computer. The computer will not start unless the user is legitimate. These programs are becoming more sophisticated and can recognize

Figure 5-37 A fingerprint reader.

people with or without glasses, makeup, or jewelry, and with new hairstyles. Biometric devices measure the shape and size of a person's hand using a *hand geometry system* (Figure 5-38). Because their cost is more than $1,000, larger companies use these systems as time and attendance devices or as security devices. Colleges use hand geometry systems to verify students' identities. Day-care centers and hospital nurseries use them to verify parents who pick up their children. A *voice verification system* compares a person's live speech with their stored voice pattern. Larger

Figure 5-38 A hand geometry system verifies this student's identity before he is allowed access to the school gymnasium.

organizations sometimes use voice verification systems as time and attendance devices. Many companies also use this technology for access to sensitive files and networks. Some financial services use voice verification systems to secure telephone banking transactions.

A *signature verification system* recognizes the shape of your handwritten signature, as well as measures the pressure exerted and the motion used to write the signature. Signature verification systems use a specialized pen and tablet. High security areas use iris recognition systems. The camera in an *iris recognition system* uses iris recognition technology to read patterns in the iris of the eye (Figure 5-39). These patterns are as unique as a fingerprint. Iris recognition systems are quite expensive and are used by government security organizations, the military, and financial institutions that deal with highly sensitive data. Some organizations use *retinal scanners*, which work similarly but instead scan patterns of blood vessels in the back of the retina.

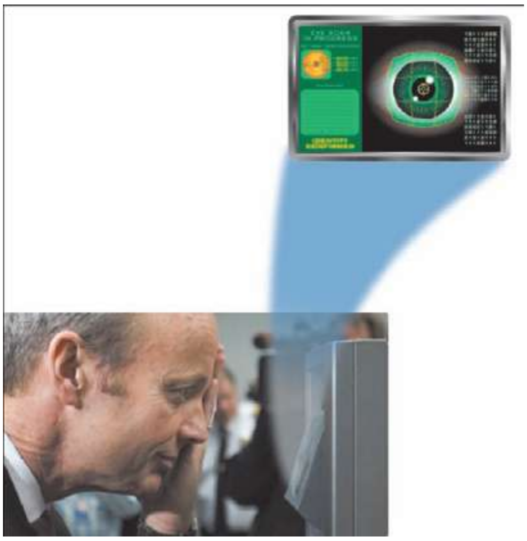


Figure 5-39 An iris recognition system.

Terminals

A *terminal* is a computer, usually with limited processing power, that enables users to send data to and/or receive information from a host computer. The host computer processes the data and then, if necessary, sends information (output) back to the terminal. The host computer usually is a server or mainframe. Special-purpose terminals perform specific tasks and contain features uniquely designed for use in a particular industry. Three widely used special purpose terminals are point-of-sale (POS) terminals, automated teller machines, and DVD kiosks.

Point-of-Sale Terminals

The location in a retail or grocery store where a consumer pays for goods or services is the point of sale (POS). Most retail stores use a **POS terminal** to record purchases, process credit or debit cards, and update inventory. In a grocery store, the POS terminal is a combination of an electronic cash register, bar code reader, and printer (Figure 5-40). When the checkout clerk or customer scans the bar code on the food product, the computer uses the manufacturer and item numbers to look up the price of the item and the complete product name in a database. Then, the price of the item in the database shows on the display device, the name of the item and its price print on a receipt, and the item being sold is recorded so that the inventory can be updated.

Figure 5-40 Many grocery stores offer self-serve checkouts, where the consumers themselves use the POS terminals to scan purchases, scan their store saver card and coupons, and then pay for the goods.

Thus, the output from a POS terminal serves as input to other computers to maintain sales records, update inventory, verify credit, and perform other activities associated with the sales transactions that are critical to running the business. Some POS terminals are Web-enabled, which allows updates to inventory at geographically separate locations. Many POS terminals handle credit card or debit card payments and thus also include a magstripe reader. Some have a fingerprint reader that is linked to a payment method such as a checking account or credit card. After swiping your card through the reader or reading your fingerprint, the POS terminal connects to a system that authenticates the purchase. Once the transaction is approved, the terminal prints a receipt for the customer.

Automated Teller Machines

An **automated teller machine** (**ATM**) is a self-service banking machine that connects to a host computer through a network (Figure 5-41). Banks place ATMs in convenient locations, including grocery stores, convenience stores, retail outlets, shopping malls, sports and concert venues, and gas stations, so that customers conveniently can access their bank accounts. Using an ATM, people withdraw cash, deposit money, transfer funds, or inquire about an account balance. Some ATMs have a touch screen; others have special buttons or keypads for entering input.

To access a bank account, you insert a plastic bankcard in the ATM's magstripe reader. The ATM asks you to enter a password, called a *personal identification number* (*PIN*), which verifies that you are the holder of the bankcard. When your transaction is complete, the ATM prints a receipt for your records.

Figure 5-41 An ATM is a self-service banking terminal that allows customers to access their bank accounts.

DVD Kiosks

A **DVD kiosk** is a self-service DVD rental machine that connects to a host computer through a network (Figure 5-42). The DVD kiosks, some of which can hold more than 600 DVDs, are located nationwide at retail stores, fast-food restaurants, grocery stores, airports, and other convenient public locations. A DVD kiosk is associated with a particular vendor. To rent a movie online, for example, a customer visits the vendor's Web site, establishes an account or connects to an existing account, selects the desired movie, and then chooses a nearby DVD kiosk where the movie will be picked up. Customers also usually can select movies directly on the DVD kiosk via a touch screen or some other input device on the kiosk. After presenting identifying information and swiping a credit card through the reader, the DVD kiosk dispenses the rented movie to the customer. When finished viewing the movie, the customer returns it to any of the vendor's nationwide DVD kiosks, at which time the customer's account is charged a fee based on the time elapsed.

Figure 5-42 A DVD kiosk is a self-service DVD rental machine.

Putting It All Together

When you purchase a computer, you should have an understanding of the input devices included with the computer, as well as those you may need that are not included. Many factors influence the type of input devices you may use: the type of input desired, the hardware and software in use, and the desired cost. The type of input devices you require depends on your intended use. Figure 5-43 outlines several suggested input devices for specific computer users.

Input Devices for Physically Challenged Users

The ever-increasing presence of computers in everyone's lives has generated an awareness of the need to address computing requirements for those who have or may develop physical limi tations. The **Americans with Disabilities Act** (**ADA**) requires any company with 15 or more employees to make reasonable attempts to accommodate the needs of physically challenged workers. Besides voice recognition, which is ideal for blind or visually impaired users, several other input devices are available. A *keyguard* is a metal or plastic plate placed over the keyboard that allows users to rest their hands on the keyboard without accidentally pressing any keys. A keyguard also guides a finger or pointing device so that a user presses only one key at a time. Keyboards with larger keys also are available (Figure 5-44). Still another

Suggested Input Devices by User

User	Input Device
Home 	▪ Enhanced keyboard or ergonomic keyboard ▪ Mouse ▪ Stylus for smart phone or other mobile device ▪ Game controller(s) ▪ 30-bit 600 3 1200 ppi color scanner ▪ 7 MP digital camera ▪ Headphones that include a microphone (headset) ▪ Web cam ▪ Fingerprint reader
Small Offi ce/ Home Offi ce 	▪ Enhanced keyboard or ergonomic keyboard ▪ Mouse ▪ Stylus and portable keyboard for smart phone or other mobile device, or digital pen for Tablet PC ▪ 36-bit 600 3 1200 ppi color scanner ▪ 8 MP digital camera ▪ Headphones that include a microphone (headset) ▪ Web cam
Mobile 	▪ Wireless mouse for notebook computer ▪ Touchpad or pointing stick on notebook computer ▪ Stylus and portable keyboard for smart phone or other mobile device, or digital pen for Tablet PC ▪ 7 or 8 MP digital camera ▪ Headphones that include a microphone (headset) ▪ Fingerprint reader for notebook computer
Power 	▪ Enhanced keyboard or ergonomic keyboard ▪ Mouse ▪ Stylus and portable keyboard for smart phone or other mobile device ▪ Pen for graphics tablet ▪ 48-bit 1200 3 1200 ppi color scanner ▪ 9 to 12 MP digital camera ▪ Headphones that include a microphone (headset) ▪ Web cam
Enterprise 	▪ Enhanced keyboard or ergonomic keyboard ▪ Mouse ▪ Stylus and portable keyboard for smart phone or other mobile device, or digital pen for Tablet PC ▪ Touch screen ▪ 42-bit 1200 3 X 1200 ppi color scanner ▪ 9 to 12 MP digital camera ▪ OCR/OMR readers, bar code readers, MICR reader, or data collection devices ▪ Microphone ▪ Video camera for video conferences ▪ Fingerprint reader or other biometric device ▪

Figure 5-43 This table recommends suggested input devices.

option is the *on-screen keyboard*, in which a graphic of a standard keyboard is displayed on the user's screen. Various pointing devices are available for users with motor disabilities. Small trackballs that the user controls with a thumb or one finger can be attached to a table, mounted to a wheelchair, or held in the user's hand. Another option for people with limited hand movement is a *head-mounted pointer* to control the pointer or insertion point (Figure 5-45). To simulate the functions of a mouse button, a user works with switches that control the pointer. The switch might be a hand pad, a foot pedal, a receptor that detects facial motions, or a pneumatic instrument controlled by puffs of air. Two exciting developments in this area are gesture recognition and computerized implant devices. Both in the prototype stage, they attempt to provide users with a natural computer interface. With *gesture recognition*, the computer will detect human motions. Computers with gesture recognition capability have the potential to recognize sign language, read lips, track facial movements, or follow eye gazes. For paralyzed or speech impaired individuals, a doctor will implant a computerized device into the brain.

Figure 5-44 A keyboard with larger keys.

This device will contain a transmitter. As the user thinks thoughts, the transmitter will send signals to the computer.

Figure 5-45 A camera/receiver mounted on the monitor tracks the position of the head-mounted pointer, which is reflective material that this user is wearing on the brim of her hat. As the user moves her head, the pointer on the screen also moves.

Chapter Exercises

True/False Mark T for True and F for False.

_____ 1. Once data is in memory, the computer interprets and executes instructions to process the data into information.

_____ 2. An input device is any hardware component that allows users to enter data and instructions into a computer.

_____ 3. The command associated with a function key performs the same task within each program with which you are interacting.

_____ 4. A touchpad is a small, flat, rectangular pointing device that is sensitive to pressure and motion.

_____ 5. Touch-sensitive pads typically contain buttons and/or wheels that are operated with a thumb or finger.

_____ 6. To capture a signature, a user speaks his or her name into a signature capture pad.

_____ 7. Resolution is the smallest element in an electronic image.

_____ 8. A whiteboard is a meeting between two or more geographically separated people who use a network or the Internet to transmit audio and video data.

_____ 9. Scanners capture data from a target document, which is the original form of the data.

_____ 10. A flatbed scanner works in a manner similar to a copy machine except it creates a file of the document in memory instead of a paper copy.

_____ 11. A DVD kiosk is a self-service DVD rental machine that connects to a host computer through a network.

_____ 12. A keyguard is a metal or plastic plate placed over the keyboard that allows users to rest their hands on the keyboard without accidentally pressing any keys.

Multiple Choice Select the best answer.

1. A(n) _____ has a design that reduces the chance of wrist and hand injuries.
a. gaming keyboard b. cordless keyboard c. ergonomic keyboard d. function key

2. Some phones use _____, where you press one key on the keypad for each letter in a word and software on the phone predicts the word you want.
a. predictive text input b. text messaging
c. ergonomics d. optical character recognition (OCR)

3. Touch screens that recognize multiple points of contact at the same time are known as _____.

a. touch-sensitive pads b. multi-touch c. graphics tablets d. digitizers

4. Architects, mapmakers, designers, artists, and home users create drawings and sketches on a _____.
a. trackball b. terminal c. graphics tablet d. touchpad

5. _____ is the computer's capability of distinguishing spoken words.
a. Voice input b. VoIP c. MIDI d. Voice recognition

6. _____ allows users to record, compose, mix, and edit music and sounds.
a. Kiosks b. Voice input c. Music production software d. Voice recognition

7. RFID is a technology that uses _____ to communicate with a tag placed in or attached to an object, an animal, or a person.
a. a thin wire b. pixels c. radio signals d. light waves

8. With _____, the computer will detect human motions.
a. a head-mounted pointer b. an on-screen keyboard
c. gesture recognition d. a computerized implant

Matching Match the terms with their definitions.

_____ 1. insertion point	a. freestanding computer that usually includes a touch screen
_____ 2. gaming keyboard	b. symbol on the screen that indicates where the next character typed will appear
_____ 3. ergonomics	c. obtains data directly at the location where the transaction or event takes place
_____ 4. trackball	d. incorporates comfort, efficiency, and safety in the design of the workplace
_____ 5. pointing stick	e. pressure-sensitive pointing device shaped like a pencil eraser that is positioned between keys on a keyboard
_____ 6. kiosk	f. controls the movement and actions of players or objects in video games or computer games
_____ 7. game controller	g. keyboard designed specifically for users who enjoy playing games on the computer
_____ 8. game pad	h. used by video games and computer games as the input device that directs movements and actions of on-screen objects
_____ 9. video capture card	i. converts an analog video signal to a digital signal that a computer can process
_____ 10. data collection device	j. stationary pointing device with a ball on its top or side

Short Answer Write a brief answer to each of the following questions.
1. What are three different types of mouse devices? ____________ What makes them different from each other? ____________.

2. Name at least five mouse operations. ____________ Describe and give examples of each of the mouse operations that you chose. ____________

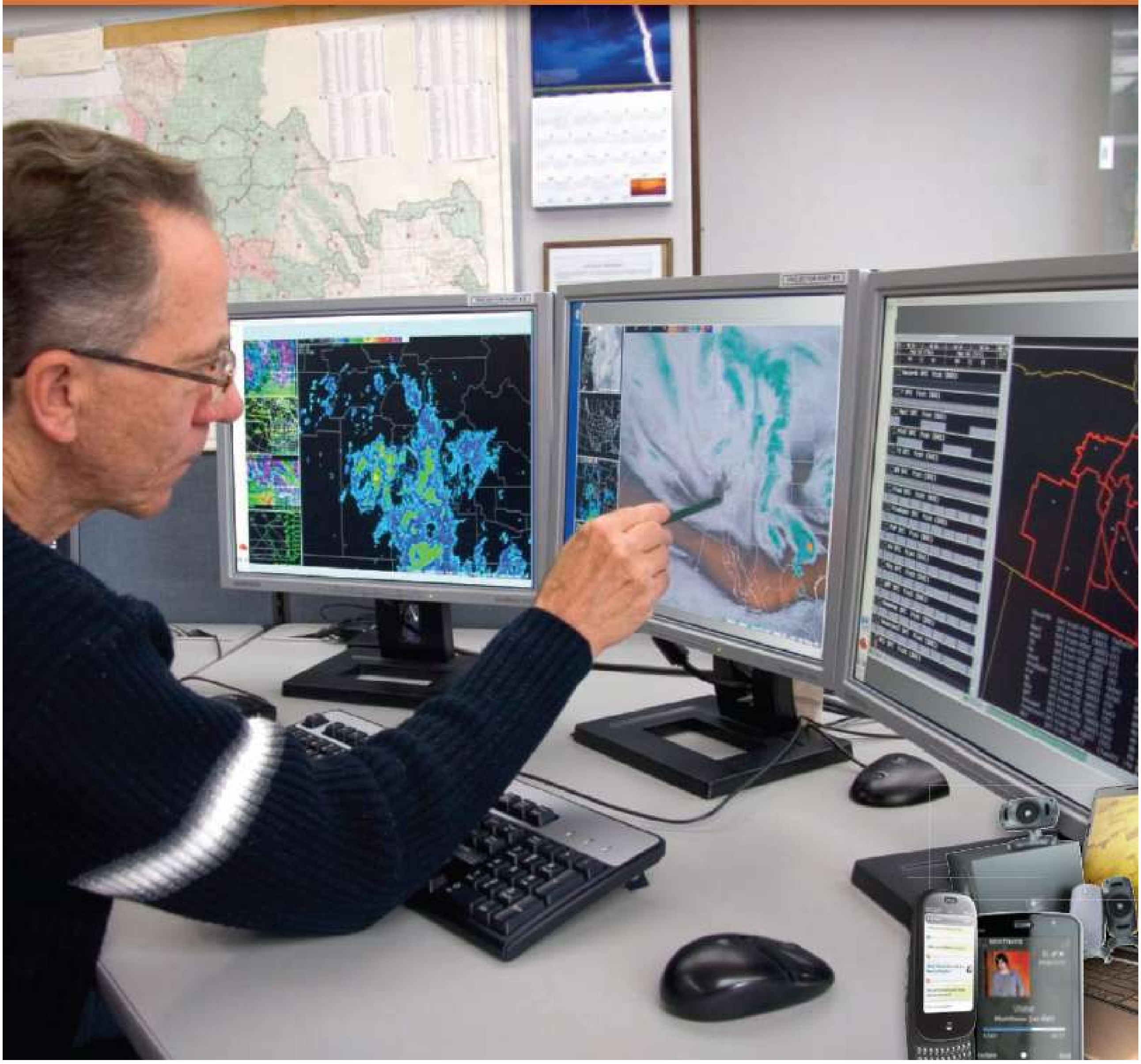
3. What is OCR (optical character recognition)? _____________ What is OMR (optical mark recognition)? _____________

4. What is the most widely used biometric device today? _____________ Describe how the device works. _____________

5. What is the Americans with Disabilities Act (ADA)? _____________ How might gesture recognition and computerized implant devices help physically challenged users in the future? _____________

Chapter Six

Output



What Is Output?

Output is data that has been processed into a useful form. That is, computers process data (input) into information (output). The form of output varies, depending on the hardware and software being used and the requirements of the user. Monitors, traditional notebook computers, netbooks, Tablet PCs, portable media players, smart phones, digital cameras, and other mobile devices have screens that allow users to view documents, Web sites, e-mail messages, photos, videos, and movies. Many printers enable users to print color documents and photos. Through the computer's speakers, headphones, or earbuds, users listen to sounds, music, and voice messages.
While working with a computer, a user encounters four basic types of output: text, graphics, audio, and video (Figure 6-1). Ver often, a single form of output, such as a Web page, includes more than one of these types of output.

- Text — Examples of output that primarily contain text are memos, letters, press releases,reports, classified advertisements, envelopes,mailing labels, and text messages. On the Web, users view and print many other types of textbased output. These include blogs, news and magazine articles, books, television show transcripts, stock quotes, speeches, and lectures.

- Graphics — Many forms of output include graphics to enhance visual appeal and convey information. Business letters have logos. Reports include charts. Newsletters use drawings, clip art, and photos. Users print high- quality photos taken with a digital camera. Many Web sites use animated graphics, such as blinking icons, scrolling messages, or simulations.

Figure 6-1 Four types of output are text, graphics, audio, and video.

Audio — Users download their favorite songs from iTunes and listen to the music while working on the computer. Software such as games, encyclopedias, and simulations often have musical accompaniments for entertainment and audio clips, such as narrations and speeches, to enhance understanding.

A **monitor** is a display device that is packaged as a separate peripheral. Some monitors have a tilt-and swivel base that allows users to adjust the angle of the screen to minimize neck strain and reduce glare from overhead lighting. With some, you can rotate the screen. Adjustable monitor stands allow you to adjust the height of the monitor. Monitor controls permit users to adjust the brightness, contrast, positioning, height, and width of images. Some have integrated speakers and/or a built-in Web cam.

Most mobile computers and devices integrate the display and other components into the same physical case. Some have touch screens. Traditional notebook computers and netbooks have a display that attaches with a hinge to the system unit. Tablet PCs are available with two types of displays: one that attaches with a hinge and one built into the top of the case. Some smart phone and digital camera displays also attach with a hinge to the device. On other smart phones and most PDAs, portable media players, digital cameras, and handheld game consoles, the display is built into the case. Newer vehicles integrate a display in the dashboard, enabling drivers to control audio, video, navigation, temperature, and other settings.

Most display devices show text, graphics, and video information in color. Some, however, are monochrome. *Monochrome* means the information appears in one color (such as white, amber, green, black, blue, or gray) on a different color background (such as black or grayish-white).

Some mobile devices use monochrome displays because they require less battery power.

Two types of display devices are flat-panel displays and CRT monitors. A *flat-panel display* is a lightweight display device with a shallow depth and flat screen that typically uses LCD (liquid crystal display) or gas plasma technology.

Types of flat-panel displays include LCD monitors, LCD screens, and plasma monitors. All flat-panel displays and some CRT monitors have a flat screen. The term, flat screen, means the screen is not curved. The following sections discuss a variety of display devices.

LCD Monitors and LCD Screens

An **LCD monitor** is a desktop monitor that uses a liquid crystal display to produce images.

These monitors produce sharp, flicker-free images. LCD monitors have a small footprint; that is, they do not take up much desk space. For additional space savings, some LCD monitors are wall mountable. LCD monitors are available in a variety of sizes, with the more common being 19, 20, 22, 24, 26, 27, and 30 inches — some are 45 or 65 inches. Most are *widescreen*, which are wider than they are tall (Figure 6-2). You measure a monitor the same way you measure a television, that is, diagonally from one corner to the other.

Netbook screens typically range in size from 7 inches to 12.1 inches, and Tablet PC screens range from 8.4 inches to 14.1 inches. Portable media players usually have screen sizes from 1.5 inches to 3.5 inches.

LCD Technology

A **liquid crystal display** (**LCD**) uses a liquid compound to present information on a display device. Computer LCDs typically contain fluorescent tubes that emit light waves toward the liquid-crystal cells, which are sandwiched between two sheets of material. When an electrical charge passes through the cells, the cells twist.

This twisting causes some light waves to be blocked and allows others to pass through, creating images on the display.

LCD monitors and LCD screens typically produce color using either active-matrix or passive-matrix technology. An *active-matrix display*, also known as a *TFT* (*thin-film transistor*) *display*, uses a separate transistor to apply charges to each liquid crystal cell and thus displays high-quality color that is viewable from all angles. A newer type of TFT technology, called *organic LED* (*OLED*), uses organic molecules that produce an even brighter, easier-to-read display than standard TFT displays. OLEDs are less expensive to produce, consume less power, and can be fabricated on thin, flexible surfaces.

A newer use of OLED technology is in the *headmounted display* (HMD), which is a display in a helmet, goggles, or glasses. HMDs are used by pilots, military and law enforcement personnel, engineers, scientists, travelers, and video game players.

Some newer LCD screens, known as LCD LED screens, use LEDs to light the screen. LCD LED screens offer better picture quality than traditional LCD screens. LCD LED screens also are thinner and consume approximately 40 percent less power than LCD screens.

A *passive-matrix display* uses fewer transistors, requires less power, and is less expensive than an active-matrix display. The color on a passive-matrix display often is not as bright as an active-matrix display.
Users view images on a passive-matrix display best when working directly in front of it.

LCD Quality
The quality of an LCD monitor or LCD screen depends primarily on its resolution, response time, brightness, dot pitch, and contrast ratio distance in millimeters between pixels on a display device.

Text created with a smaller dot pitch is easier to read. Advertisements normally specify a monitor's dot pitch or pixel pitch. Average dot pitch on LCD monitors and screens should be .30 mm or lower. The lower the number, the sharper the image.

• *Contrast ratio* describes the difference in light intensity between the brightest white and arkest black that can be displayed on an LCD monitor. Contrast ratios today range from 500:1 to 2000:1. Higher contrast ratios represent colors better.

On the Web, users tune into radio and television stations and listen to audio clips, podcasts, or live broadcasts of interviews, talk shows, sporting events, news, music, and concerts.
They also use the Internet to conduct realtime conversations with friends, coworkers, or family members, just as if they were speaking on the telephone.

▪ Video — As with audio, software and Web sites often include video clips to enhance understanding. Vodcasts and video blogs, for example, add a video component to the traditional podcast and blog. Users watch a live or prere corded news report, view a replay while attending a live sporting event, observe weather conditions, or enjoy a live performance of their favorite musician or musical group on a computer or mobile device. Instead of renting a movie, users can download movie content from a Web site for a fee and then watch the entire movie on a computer or mobile device.

Attaching a video camera to the computer allows users to watch home movies on the computer. They also can attach a television's antenna or cable to the computer and watch a television program on the computer screen.

An **output device** is any type of hardware component that conveys information to one or more people. Commonly used output devices include display devices; printers; speakers, headphones, and earbuds; data projectors; interactive whiteboards; and force-feedback game controllers and tactile output. This chapter discusses each of these output devices

Display Devices

A **display device**, or simply *display*, is an output device that visually conveys text, graphics, and video information.
Information on a display device, sometimes called *soft copy*, exists electronically and appears for a temporary period.

Display devices consist of a screen and the components that produce the information on the screen. Desktop computers typically use a monitor as their display device.
Determining which size monitor to purchase depends on your intended use. A large monitor allows you to view more information on the screen at once, but usually is more expensive.
You may want to invest in a 30-inch monitor if you use multi ple programs at one time or do a lot of research on the Web. Users working with intense graphics programs, such as desktop publishing and engineering, typically have larger monitors.

Figure 6-2 This widescreen LCD monitor has built-in speakers.

For an even wider screen area, some usersn position two or more monitors side by side or stacked. For example, the left monitor can show the left side of a wide document, such as a spreadsheet, with the right monitor showing the right side. Or, you can run multiple programs simultaneously with some programs showing on one monitor and other program(s) on a second monitor (Figure 6-3).

Figure 6-3 Users sometimes have multiple monitors stacked or side by side to increase their viewing area.

Users of side-byside or stacked monitors include music editors, video editors, network administrators, gamers, researchers, Web developers, graphic designers, and engineers. Mobile computers and mobile devices have built-in LCD screens (Figure 6-4). Many are widescreen; some are touch screen.

Figure 6-4 Many people use their computers and mobile devices to view photos or watch downloaded videos and home movies.

Notebook computer screens are available in a variety of sizes, with the more common being 14.1, 15.4, 17, and 20.1 inches.
On smart phones, screen sizes range from 2.5 inches to 4.1 inches. Digital camera screen sizes usually range from 2.5 inches to 4 inches.

Resolution is the number of horizontal and vertical pixels in a display device. For example, a monitor that has a 1440 3 900 resolution displays up to 1440 pixels per horizontal row and 900 pixels per vertical row, for a total of 1,296,000 pixels to create a screen image. Recall that a *pixel* (short for picture element) is a single point in an electronic image. A higher resolution uses a greater number of pixels and thus provides a smoother, sharper, and clearer image.

As you increase the resolution, however, some items on the screen appear smaller (Figure 6-5).
With LCD monitors and screens, resolution generally is proportional to the size of the device. For example, a widescreen 19-inch LCD monitor typically has a resolu tion of 1440 x 900, while a widescreen 22-inch LCD monitor has a resolution of 1680 x 1050.
LCDs are geared for a specific resolution, called the *native resolution*. Although you can change the resolution to any setting, for optimal results, use the monitor's native resolution setting.

- *Response time* of an LCD monitor or screen is the time in milliseconds (ms) that it takes to turn a pixel on or off. LCD monitors' and screens' response times range from 3 to 16 ms. The lower the number, the faster the response time.

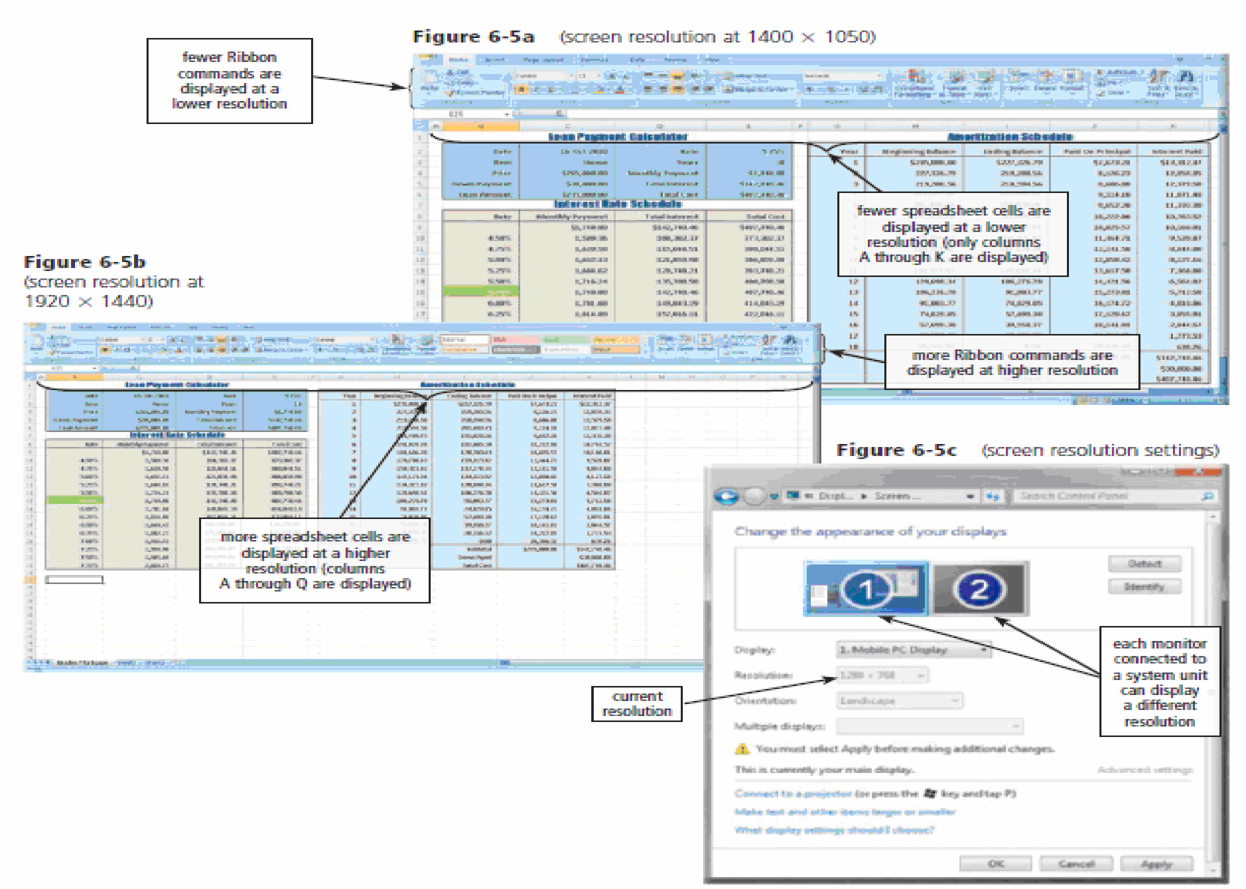


Figure 6-5 Elements on the screen become smaller when the resolution is increased from 1400 x 1050 (a) to 1920 x 1440 (b) but at the higher resolution more content shows on the screen. To change screen resolution, right-click the desktop, click Screen resolution on the shortcut menu, and then make desired changes in the 'Change the appearance of your displays' window (c).

• Brightness of an LCD monitor or LCD screen is measured in nits. A *nit* is a unit of visible light intensity equal to one candela (formerly called candlepower) per square meter. The *candela* is the standard unit of luminous intensity. LCD monitors and screens today range from 250 to 550 nits. The higher the nits, the brighter the images.

• *Dot pitch,* sometimes called *pixel pitch*, is the distance in millimeters between pixels on a display device. Text created with a smaller dot pitch is easier to read. Advertisements normally specify a monitor's dot pitch or pixel pitch. Average dot pitch on LCD monitors and screens should be .30 mm or lower. The lower the number, the sharper the image.

• *Contrast ratio* describes the difference in light intensity between the brightest white and darkest black that can be displayed on an LCD monitor. Contrast ratios today range from 500:1 to 2000:1. Higher contrast ratios represent colors better.

Graphics Chips, Ports, and LCD Monitors
A cable on a monitor plugs in a port on the system unit, which enables communications from a graphics chip. This chip, called the *graphics processing unit (GPU)*, controls the anipulation and display of graphics on a display device. The graphics processing unit either is integrated on the motherboard or resides on a video card (graphics card) in a slot in the motherboard.
Video cards usually contain a fan or heat sink to keep this and other chips from overheating. LCD monitors use a digital signal to pro duce a picture. To display the highest quality images, an LCD monitor should plug in a DVI port, an HDMI port, or a DisplayPort. A *DVI* (*Digital Video Interface*) *port* enables digital signals to transmit directly to the LCD monitor.
An *HDMI (High-Definition Media Interface) port* combines DVI with high-definition (HD) television and video. The *DisplayPort* is an alternative to DVI that also supports HDMI. Current models of system units either have an integrated DVI chip or contain a video card that has one or more DVI ports, HDMI ports, and/or DisplayPorts. They also may have a standard monitor port and an *S-video port*, allowing users to connect external analog devices such as a television, DVD/Blu-ray Disc player, or video recorder, to the computer (Figure 6-6).
Over the years, several video standards have been developed to define the resolution, number of colors, and other display properties.

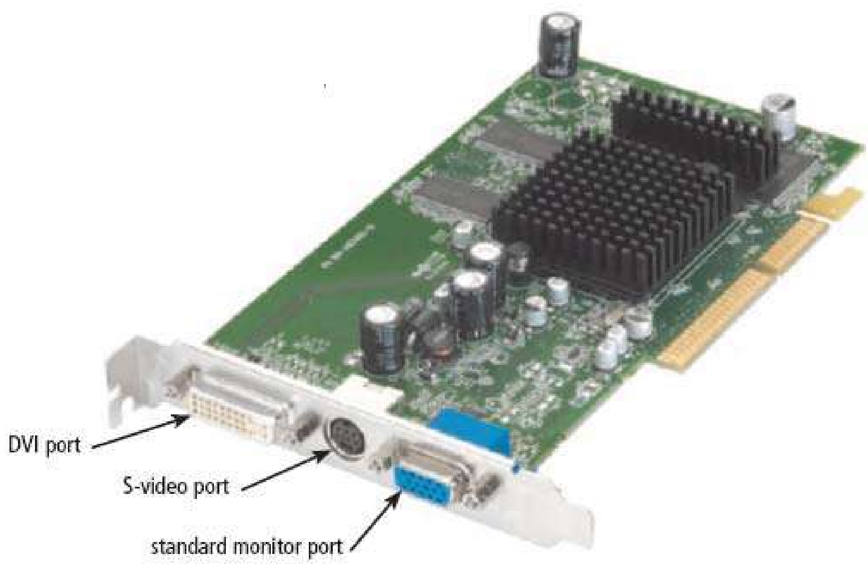


Figure 6-6 Ports on a current video card

The table in Figure 6-7 identifies some video standards available today, along with their typical resolution and aspect ratio. The *aspect ratio* defines a display's width relative to its height. A 2:1 aspect ratio, for example, means the display is twice as wide as it is tall. The aspect ratio for widescreen monitors is 16:10. Some display devices support multiple video standards. For a display device to show images as defined by a video standard, both the display device and graphics processing unit must support the same video standard. The number of colors a graphics processing unit displays is determined by bit depth. The *bit depth*, also called *color depth*, is the number of bits used to store information about each pixel.

Popular Video Standards

Video Standard		Typical Resolution	Aspect Ratio
SVGA	Super Video Graphics Array	800 × 600	4:3
XGA	Extended Graphics Array	1024 × 768	4:3
SXGA	Super XGA	1280 × 1024	5:4
WXGA	Wide XGA	1280 × 1024 or 1366 × 768	16:10 or 16:9
UXGA	Ultra XGA	1600 × 1200	4:3
WSXGA	Wide Super XGA	1680 × 1050	16:10
WUXGA	Wide Ultra XGA	1920 × 1200	16:10
WQXGA	Wide Quad XGA	2560 × 1600	16:10

Figure 6-7 Wide (widescreen) video standard formats are preferable for users who watch movies and play video games on the computer.

For example, a video card with a 24-bit depth uses 24 bits to store information about each pixel. Thus, this video card can display 224 or 16.7million colors.

The greater the number of bits, the better the resulting image. Today's video cards use a pipelining technique that enables them to display in excess of one billion colors.A video card or motherboard, in the case of integrated video, must have enough video memory to generate the resolution and number of colors you want to display. This memory, which often is between 128 MB and 512 MB on typical video cards, stores information about each pixel. Users with intense graphics or gaming requirements may opt for more video memory, such as 1 GB. For a more technical discussion about the manipulation and display of graphics on a display device.

Plasma Monitors

A **plasma monitor** is a display device that uses gas plasma technology, which sandwiches a layer of gas between two glass plates (Figure 6-8). When voltage is applied, the gas releases ultraviolet (UV) light. This UV light causes the pixels on the screen to glow and form an image.

Plasma monitors offer screen sizes up to 150 inches wide and richer colors than LCD monitors but are more expensive.

Like LCD monitors, plasma monitors can hang directly on a wall.

Televisions

Home users sometimes use their television as a display device. Connecting a computer to an analog television requires a converter that translates the digital signal from the computer into an analog signal that the television can display.

The best analog televisions have a resolution of only 520 3 400 pixels. Thus, users are turning to *digital television* (*DTV*) for crisper, higher-quality output on their LCD or plasma televisions.

Digital television signals provide two major advantages over analog signals. First, digital signals produce a higher-quality picture.

Second,many programs can be broadcast on a single digital channel, whereas only one program can be broadcast on an analog channel.
Today, all broadcast stations must transmit digital signals,as mandated by the FCC.

Figure 6-8 Large plasma monitors can measure up to 150 inches wide.

HDTV (*high-definition television*) is the most advanced form of digital television, working with digital broadcast signals, transmitting digital sound, supporting wide screens, and providing resolutions up to 1920 3 1080 pixels. With HDTV, the broadcast signals are digitized when they are sent via over-the-air (OTA) broadcasts from local television networks, satellite, or cable. To receive the HDTV signals via OTA broadcasts, you need a VHF/UHF antenna; via satellite, you need an HDTV-compatible satellite receiver/tuner; and via cable, you need an HDTV-compatible cable box.

Figure 6-9 Video game players often use a television as their game console's output device.

With game consoles, such as Microsoft's Xbox 360, Nintendo's Wii, and Sony's PlayStation 3, the output device often is a television (Figure 6-9). Users plug one end of a cable in the game console and the other end in the video port on the television. Home users often prefer the larger television displays for game playing, watching movies, and browsing the Internet on a television connected to a game console.

CRT Monitors

A **CRT monitor** is a desktop monitor that contains a cathode-ray tube (Figure 6-10).
A *cathode-ray tube* (*CRT*) is a large, sealed glass tube. The front of the tube is the screen. Tiny dots of phosphor material coat the screen on a CRT. Inside the CRT, an electron beam moves back and forth across the back of the screen. This causes the dots on the front of the screen to glow, which produces an image on the screen.
CRT monitors have a much larger footprint than do LCD monitors; that is, they take up more desk space and thus are not used much today. A CRT monitor's *viewable size* is the diagonal measurement of the actual viewing area provided by the screen in the CRT monitor. A 21-inch monitor, for example, may have a viewable size of 20 inches.

Figure 6-10 The popularity of CRT monitors is declining.

Printers

A **printer** is an output device that produces text and graphics on a physical medium such as paper. Printed information, called *hard copy*, exists physically and is a more permanent form of output than that presented on a display device (soft copy).

A hard copy, also called a *printout*, is either in portrait or landscape orientation (Figure 6-11).

A printout in *portrait orientation* is taller than it is wide, with information printed across the shorter width of the paper. A printout in *landscape orientation* is wider than it is tall, with information printed across the widest part of the paper. Letters, reports, and books typically use portrait orientation. Spreadsheets, slide shows, and graphics often use landscape orientation.

Figure 6-11a (portrait orientation)

Figure 6-11b (landscape orientation)

Figure 6-11 Portrait orientation is taller than it is wide. Landscape orientation is wider than it is tall.

Home computer users might print fewer than a hundred pages a week. Small business computer users might print several hundred pages a day. Users of mainframe computers, such as large utility companies that send printed statements to hundreds of thousands of customers each month, require printers that are capable of printing thousands of pages per hour.

To meet this range of printing needs, many different types and styles of printers exist with varying speeds, capabilities, and printing methods.

Producing Printed Output

Until a few years ago, printing a document required connecting a computer to a printer with a cable. Although many users today continue to print using this method, a variety of printing options are available, as shown in Figure 6-13.

Today, wireless printing technology makes the task of printing from a notebook computer, smart phone, or digital camera much easier.

As discussed in Chapter 4, two wireless technologies for printing are Bluetooth and infrared. With *Bluetooth printing*, a computer or other device transmits output to a printer via radio waves.

The computer or other device and the printer do not have to be aligned with each other; rather, they need to be within an approx i mate 30-foot range. With *infrared printing*, a printer communicates with a computer or other device using infrared light waves. To print from a smart phone, for example, a user lines up the IrDA port on the smart phone with the IrDA port on the printer.

Instead of downloading photos from a digital camera to a computer, users can print these digital photos using a variety of techniques. Some cameras connect directly to a printer via a cable.

Others store photos on memory cards that can be removed and inserted in the printer. Some printers have a docking station, into which the user inserts the camera to print photos stored in the camera.

Finally, many home and business users print to a central printer on a network. Their computer may communicate with the network printer via cables or wirelessly.

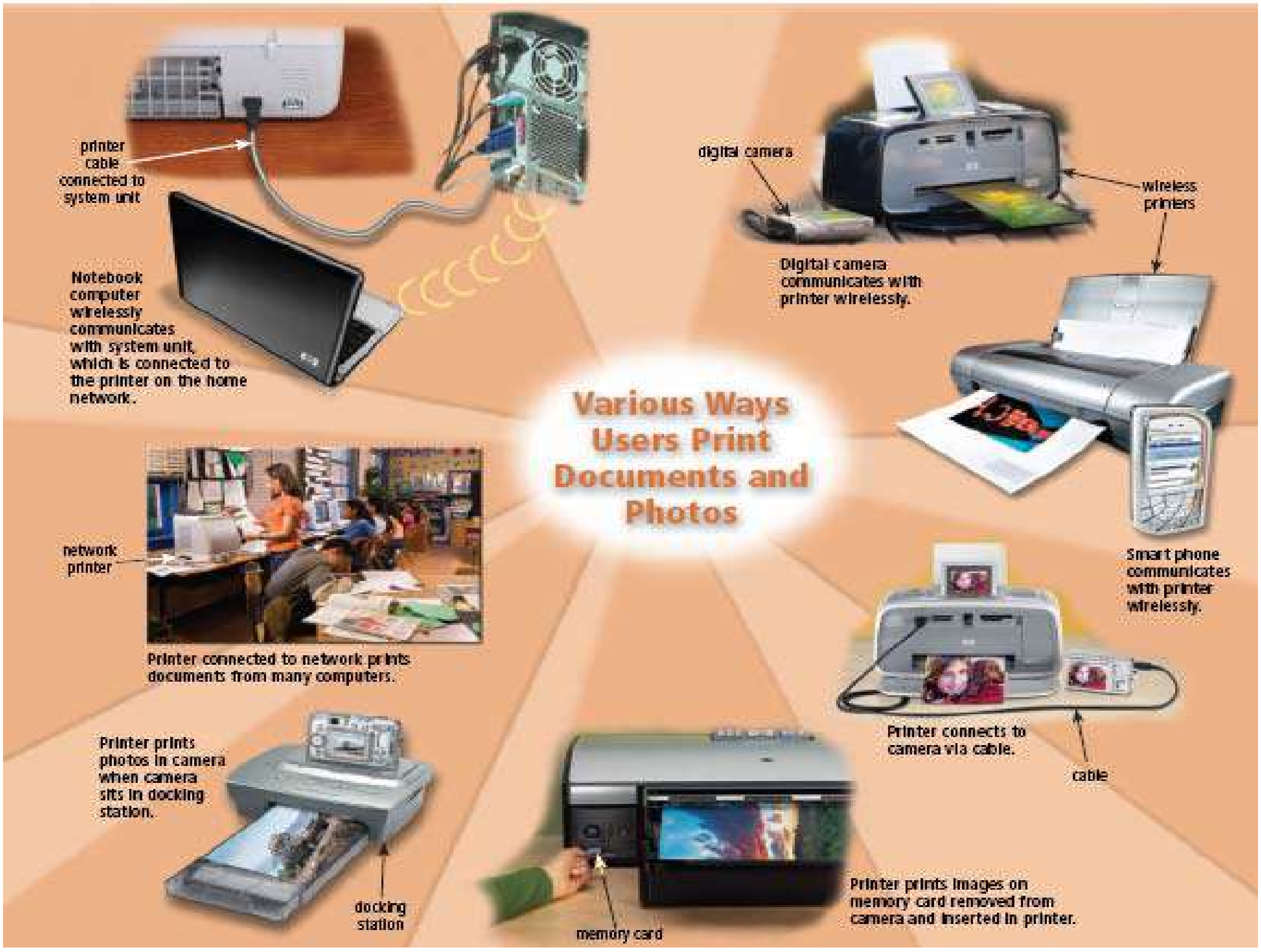


Figure 6-13 Users print documents and photos using a variety of printing methods.

Nonimpact Printers

A **nonimpact printer** forms characters and graphics on a piece of paper without actually striking the paper. Some spray ink, while others use heat or pressure to create images. Commonly used nonimpact printers are ink-jet printers, photo printers, laser printers, thermal printers, mobile printers, label andpostage printers, plotters, and large-format printers. The following pages discuss each of these printer types.

Ink-Jet Printers

An **ink-jet printer** is a type of nonimpact printer that forms characters and graphics by spraying tiny drops of liquid ink onto a piece of paper. Ink-jet printers have become a popular type of color printer for use in the home. A reasonable quality ink-jet printer costs less than $100.

Ink-jet printers produce text and graphics in both black-and-white and color on a variety of paper types (Figure 6-14). These printers normally use individual sheets of paper stored in one or two removable or stationary trays. Ink-jet printers accept papers in many sizes, ranging from 3 x 5 inches to 8½ x 14 inches. Available paper types include plain paper, ink-jet paper, photo paper, glossy paper, and banner paper. Most ink-jet printers can print photographic-quality images on any of these types of paper.

Figure 6-14 Ink-jet printers are a popular type of color printer used in the home.

Ink-jet printers also print on other materials such as envelopes, labels, index cards, greeting card paper (card stock), transparencies, and iron-on T-shirt transfers. Many ink-jet printers include software for creating greeting cards, banners, business cards, and letterhead.

As with many other input and output devices, one factor that determines the quality of an ink-jet printer is its resolution. Printer resolution is measured by the number of *dots per inch* (*dpi*) a printer can print. With an ink-jet printer, a dot is a drop of ink. A higher dpi means the drops of ink are smaller. Most ink-jet printers can print from 1200 to 4800 dpi. As shown in Figure 6-15, the higher the dpi, the better the print quality. The difference in quality becomes noticeable when the size of the printed image increases. That is, a wallet-sized image printed at 1200 dpi may look similar in quality to one printed at 2400 dpi. When you increase the size of the image, to 8 x 10 for example, the printout of the 1200 dpi resolution may look grainier than the one printed using a 2400 dpi resolution.

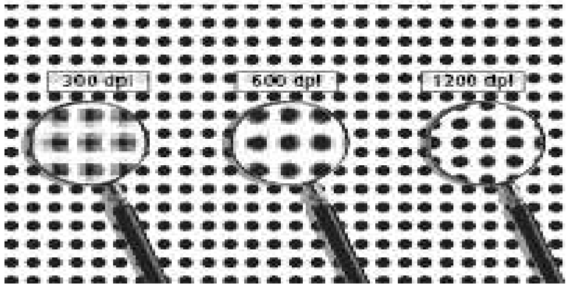


Figure 6-15 You will notice a higher quality output with printers that can print at a higher dpi.

The speed of an ink-jet printer is measured by the number of pages per minute (ppm) it can print. Most ink-jet printers print from 12 to 36 ppm. Graphics and colors print at a slower rate. For example, an ink-jet printer may print 36 ppm for black text and only 27 ppm for color and/or graphics. The print head mechanism in an ink-jet printer contains ink-filled cartridges. Each cartridge has fifty to several hundred small ink holes, or nozzles. The steps in Figure 6-16 illustrate how a drop of ink appears on a page. The ink propels through any combination of the nozzles to form a character or image on the paper.

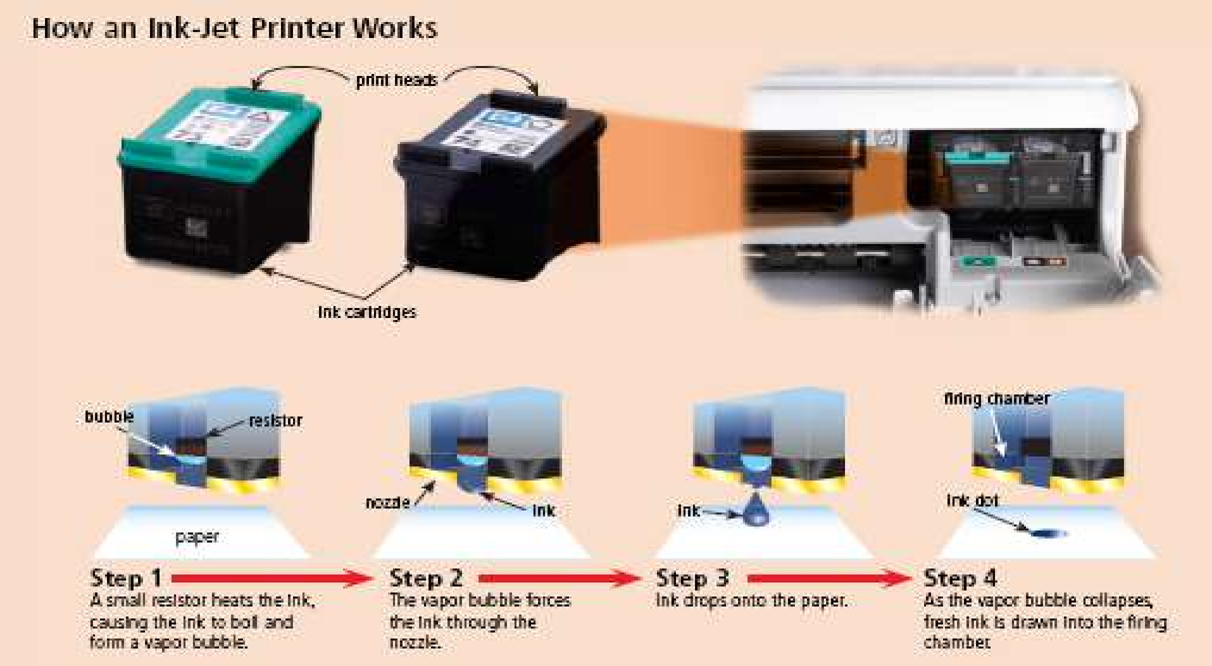


Figure 6-16 This figure shows how an ink-jet printer works.

When the cartridge runs out of ink, you simply replace the cartridge. Most ink-jet printers use two or more ink cartridges: one containing black ink and the other(s) containing colors. Some color cartridges contain a variety of ink colors; others contain only a single color.
Consider the number of ink cartridges a printer requires, along with the cost of the cartridges, when purchasing a printer. Cartridges with black ink cost $10 to $40 each. Color ink cartridge prices range from $15 to $45 each. The number of pages a single cartridge can print varies by manufacturer and the type of documents you print. For example, black ink cartridges typically print from 200 to 800 pages, and color ink cartridges from 125 to 450 pages. To reduce the expense of purchasing cartridges, some users opt to purchase refilled cartridges or have empty cartridges refilled by a third party vendor

Photo Printers

A **photo printer** is a color printer that produces photo-lab-quality pictures (Figure 6-17). Some photo printers print just one or two sizes of photos, for example, 3 3 5 inches and 4 3 6 inches. Others print up to letter size, legal size, or even larger. Some even print pano ramic photos. Generally, the more sizes the printer prints, the more expensive the printer

Figure 6-17 Photo printers print in a range of sizes.

Many photo printers use ink-jet technology.With models that can print letter-sized documents, users connect the photo printer to their computer and use it for all their printing needs. For a few hundred dollars, this type of photo printer is ideal for the home or small business user. Other photo printer technologies are discussed later in the chapter.

Most photo printers are PictBridge enabled, so that you can print photos without a computer. *PictBridge* is a standard tech nology that allows you to print photos directly from a digital camera by connecting a cable from the digital camera to a USB port on the printer.

Photo printers also usually have a built-in card slot(s) so that the printer can print digital photos directly from a memory card. Simply remove the memory card from the digital camera and insert it in the printer's card slot. Then, push buttons on the printer to select the desired photo, specify the number of copies, and indicate the size of the printed photo.

Some photo printers have built-in LCD color screens, allowing users to view and enhance the photos before printing them.

Laser Printers

A **laser printer** is a high-speed, high-quality nonimpact printer (Figure 6-18). Laser printers are available in both black-and-white and color models. A laser printer for personal computers ordinarily uses individual 81/2 3 11-inch sheets of paper stored in one or more removable trays that slide in the printer case. Some laser printers have built-in trays that accom modate dif ferent sizes of paper, while others require separate trays for letter- and legal-sized paper. Most laser printers have a manual feed slot where you can insert individual sheets and envelopes.

Figure 6-18 Laser printers are available in both black-and-white and color models.

Laser printers print text and graphics in high-quality resolutions, usually 1200 dpi for black-and-white printers and up to 2400 dpi for color printers. While laser printers usually cost more than ink-jet printers, many models are available at affordable prices for the home user.

Laser printers usually print at faster speeds than ink-jet printers. Printer manufacturers state that a laser printer for the home and small office user typically prints black-and-white text at speeds of 15 to 62 ppm. Color laser printers print 8 to 40 ppm. Laser printers for large business users print more than 150 ppm.Depending on the quality, speed, and type of laser printer, the cost ranges from a few hundred to a few thousand dollars for the home and small office user, and several hundred thousand dollars for the large business user.

Color laser printers are slightly higher priced than otherwise equivalent black-and-white laser printers.

When printing a document, laser printers pro cess and store the entire page before they actually print it. For this reason, laser printers sometimes are called page printers. Storing a page before printing requires that the laser printer has a certain amount of memory in the device. The more memory in the printer, the faster it usually can print.Depending on the amount of graphics you intend to print, a laser printer for the small business user can have up to 1 GB of memory and an 80 GB hard disk. To print a full-page 1200-dpi photo, for instance, you might need 64 MB of memory in the printer. If the printer does not have enough memory to print the photo, either it will print as much of the photo as its memory will allow, or it will display an error message and not print any of the photo.

Laser printers use software that enables them to interpret a *page description language* (*PDL*), which tells the printer how to arrange the con tents of a printed page. When you purchase a laser printer, it comes with at least one of two common page description languages: PCL or PostScript. Developed by HP, a leading printer manufacturer, *PCL* (*Printer Con trol Language*) is a standard printer language that supports the fonts and layout used in standard office documents. Professionals in the desktop publishing and graphic art fields commonly use *PostScript* because it is designed for complex documents with intense graphics and colors.

Operating in a manner similar to a copy machine, a laser printer creates images using a laser beam and powdered ink, called *toner*. The laser beam produces an image on a special drum inside the printer. The light of the laser alters the electrical charge on the drum wherever it hits. When this occurs, the toner sticks to the drum and then transfers to the paper through a combination of pressure and heat (Figure 6-19).When the toner runs out, you replace the toner cartridge. Toner cartridge prices range from $40 to more than $200 for about 5,000 printed pages.

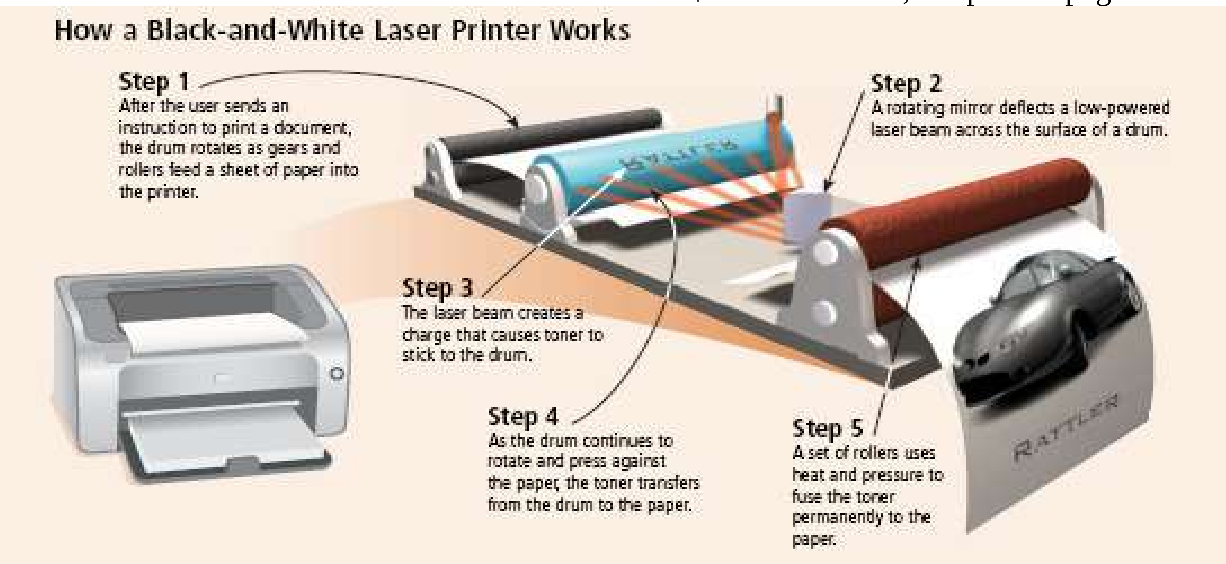


Figure 6-19 This figure shows how a black-and-white laser printer works.

Multifunction Peripherals

A **multifunction peripheral** (MFP), also called an *all-in-one device*, is a single device that looks like a printer or a copy machine but provides the functionality of a printer, scanner, copy machine, and perhaps a fax machine (Figure 6-20)..

Figure 6-20 This multifunction peripheral is a color printer, scanner, copy machine, and fax machine.

A fax machine is a device that codes and encodes documents so that they can be transmitted over telephone lines. The documents can contain text, drawings or photos, or can be handwritten.

The features of these devices vary. For example,some use color ink-jet printer technology, while others include a black-and-white or color laser printer.Small offices and home office (SOHO) users have multifunction peripherals because these devices require less space than having a separate printer, scanner, copy machine, and fax machine. Another advantage of these devices is they are significantly less expensive than if you purchase each device separately. If the device breaks down, however, you lose all four functions, which is the primary disadvantage.

Thermal Printers

A **thermal printer** generates images by pushing electrically heated pins against heatsensitive paper. Basic thermal printers are inexpensive, but the print quality is low and the images tend to fade over time. Self-service gas pumps often print gas receipts using a built-in lower-quality thermal printer. Many point-of-sale terminals in retail and grocery stores also print purchase receipts on thermal paper. Two special types of thermal printers have high print quality and can print at much faster rates than ink-jet and laser printers. A *thermal wax-transfer printer* generates rich, nonsmearing images by using heat to melt colored wax onto heat-sensitive paper. Thermal wax-transfer printers are more expensive than ink-jet printers, but less expensive than many color laser printers. A *dye-sublimation printer*, sometimes called a *digital photo printer*, uses heat to transfer colored dye to specially coated paper. Most dyesublimation printers create images that are of photographic quality (Figure 6-21). Professional applications requiring high image quality, such as photography studios, medical labs, and security identification systems, use dye-sublimation printers. These high-end printers cost thousands of dollars and print images in a wide range of sizes. Most dye-sublimation printers for the home or small business user, by contrast, typically print images in only one or two sizes and are much slower than their professional counterparts. These lower-end dye-sublimation printers are comparable in cost to a photo printer based on ink-jet technology. Some are small enough for the mobile user to carry the printer in a briefcase.

Figure 6-21 The printers shown in this figure use dye-sublimation technology to create photographic-quality output.

Mobile Printers

A **mobile printer** is a small, lightweight, battery-powered printer that allows a mobile user to print from a notebook computer, smart phone, or other mobile device while traveling (Figure 6-22). Barely wider than the paper on which they print, mobile printers fit easily in a briefcase alongside a notebook computer. Mobile printers mainly use ink-jet, thermal, thermal wax-transfer, or dye-sublimation technology. Many of these printers connect to a USB port. Others have a built-in wireless port through which they communicate with the computer wirelessly.

Figure 6-22 A mobile printer is a compact printer that allows the mobile user to print from a mobile computer or device.

Label and Postage Printers

A **label printer** is a small printer that prints on an adhesive-type material (Figure 6-23) that can be placed on a variety of items such as envelopes, packages, optical discs, photos, file folders, and toys. Most label printers also print bar codes. Label printers typically use thermal technology.

Figure 6-23 A label printer.

A *postage printer* is a special type of label printer that prints postage stamps. Some have built-in digital scales for weighing letters and packages. Postage printers allow users to buy and print digital postage, often called *Internet postage*, which means you purchase an amount of postage from an authorized postal service Web site. Each time a postage stamp prints, your postage account is updated. Although you can print Internet postage on an ink-jet or photo printer, postage printers can be more economical because they use thermal technology instead of ink cartridges.

Plotters and Large-Format Printers

Plotters are sophisticated printers used to produce high-quality drawings such as blueprints, maps, and circuit diagrams. These printers are used in specialized fields such as engineering and drafting and usually are very costly. Current plotters use a row of charged wires (called styli) to draw an electrostatic pattern on specially coated paper and then fuse toner to the pattern. The printed image consists of a series of very small dots, which provides high-quality output.

Using ink-jet printer technology, but on a much larger scale, a **large-format printer** creates photo-realistic-quality color prints. Graphic artists use these high-cost, highperformance printers for signs, posters, and other professional quality displays (Figure 6-24).

Plotters and large-format printers can accommodate paper with widths up to 98 inches because blueprints, maps, signs, posters and other such drawings and displays can be quite large. Some plotters and large-format printers use individual sheets of paper, while others take large rolls.

Figure 6-24 Graphic artists use large-format printers to print signs, posters, and other professional quality displays

Impact Printers

An **impact printer** forms characters and graphics on a piece of paper by striking a mechanism against an inked ribbon that physically contacts the paper. Impact printers characteristically are noisy because of this striking activity. These printers commonly produce *near letter quality* (*NLQ*) output, which is print quality slightly less clear than what is acceptable for business letters. Companies may use impact printers for routine jobs such as printing labels. Impact printers are ideal for printing multipart forms because they easily print through many layers of paper. Factories, warehouses, and retail counters may use impact printers because these printers withstand dusty environments, vibrations, and extreme temperatures. Two commonly used types of impact printers are dot-matrix printers and line printers.

A **dot-matrix printer** produces printed images when tiny wire pins on a print head mechanism strike an inked ribbon (Figure 6-25). When the ribbon presses against the paper, it creates dots that form characters and graphics. Most dot-matrix printers use *continuous-form paper*, in which thousands of sheets of paper are connected together end to end. The pages have holes along the sides to help feed the paper through the printer.

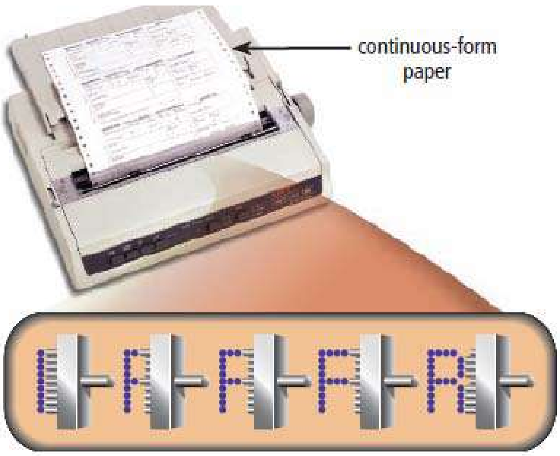


Figure 6-25 A dot-matrix printer produces printed images when tiny pins strike an inked ribbon.

The speed of a dot-matrix printer is measured by the number of characters per second (cps) it can print. The speed of most dot-matrix printers ranges from 375 to 1100 characters per second (cps), depending on the desired print quality.

A **line printer** is a high-speed impact printer that prints an entire line at a time. The speed of a line printer is measured by the number of lines per minute (lpm) it can print. Some line printers print as many as 3,000 lpm. Mainframes, servers, or networked applications, such as manu facturing, distribution, or shipping, often use line printers. These printers typically use 11 x 17-inch continuous-form paper.

Speakers, Headphones, and Earbuds

An **audio output device** is a component of a computer that produces music, speech, or other sounds, such as beeps. Three commonly used audio output devices are speakers, headphones, and earbuds.Most personal computers and mobile devices have a small internal speaker that usually emits only low-quality sound. Thus, many users attach surround sound **speakers** or speaker systems to their com puters, including game consoles and mobile devices, to generate higher-quality sounds for playing games, interacting with multimedia presentations, listening to music, and viewing movies (Figure 6-26).

Most surround sound computer speaker systems include one or two center speakers and two or more *satellite speakers* that are positioned so that sound emits from all directions. Speakers typically have tone and volume controls, allowing users to adjust settings. To boost the low bass sounds, surround sound speaker systems also include a *subwoofer*.

Figure 6-26 Most personal computer users attach high-quality surround sound speaker systems to their computers.

Surround sound systems are available in a variety of configurations. For example, a 2.1 speaker system contains two speakers and a subwoofer. A 5.1 speaker system has four sat ellite speakers, a center speaker, and a subwoofer. A 6.1 speaker system has four satellite speakers, a front center speaker, a rear center speaker, and a subwoofer. A 7.1 speaker system has four satellite speakers, two side speakers, a center speaker, and a subwoofer. In many cases, a cable connects the speakers or the subwoofer to a port on the sound card. With wireless speakers, however, a transmitter connects to the sound card, which wirelessly communicates with the speakers. To take full advantage of highend surround sound speaker systems, be sure the sound card in the computer is compatible with the speaker system.

Audio resolution, which is the number of bytes that represent sound in a given time, is stated as a bit rate such as 8-bit, 16-bit, or 24-bit. A sound card using 8-bit resolution, for example, represents a sound with any 1 of 256 values (2^8), and a 16-bit sound card uses any 1 of 65,536 values (2^{16}).

Higher resolutions result in better sound quality. With 8-bit resolution, the sound quality is similar to an AM radio; 16-bit resolution yields optical disc-quality sound; and 24-bit resolution is used for high-quality digital audio editing. Many users opt for a wireless music system, which includes a USB transmitter that plugs in a computer, a receiver that connects to a television or stereo system, and a remote control. With this system, you can play any optical disc or media file on your computer and transmit the audio to a home or office stereo or television at a distance of up to about 330 feet.

You also can plug a portable media player, such as an iPod, into the computer to hear its songs on the stereo or television speakers. When using speakers, anyone in listening distance can hear the output. In a computer lab oratory or other crowded environment, speakers might not be practical. Instead, users can listen through wireless headphones or earbuds or plug the device in a port on the sound card, in a speaker, or on the front of the system unit. With headphones or earbuds, only the individual wearing the headphones or earbuds hears the sound from the computer.

The difference is that **headphones** cover or are placed outside of the ear (Figure 6-27), whereas **earbuds**, or *earphones* rest inside the ear canal. Both headphones and earbuds usually include noise-cancelling technology to reduce the interference of sounds from the surrounding environment.

A *headset* is a device that functions as both headphones and a microphone. Computer and smart phone users wear a headset to free their hands for typing and other activities while talking or listening to audio output. Portable media players usually include a set of earbuds. As an alternative, you can listen to audio from the portable media player through speakers in a vehicle or on a stereo system at home or work. Or, you can purchase speakers specifically designed to play audio from a portable media player (Figure 6-28).

Figure 6-27 In a crowded environment where speakers are not practical, users can wear headphones to hear audio output.

Figure 6-28 Instead of listening to your portable media player through earbuds, you can purchase separate speakers for the device, such as the wireless speakers shown here.

Electronically produced voice output is growing in popularity. **Voice output** occurs when you hear a person's voice or when the computer talks to you through the speakers on the computer. In some programs, the computer can speak the contents of a document through voice output.On the Web, you can listen to (or download and then listen to) interviews, talk shows, sporting events, news, recorded music, and live concerts from many radio and television stations. Some Web sites and programs, such as media players, dedicate themselves to providing voice output, such as those that allow you to listen to and then purchase and download songs. Very often, voice output works with voice input. For example, when you call an airline to check the status of gates, terminals, and arrival times, your voice interacts with a computergenerated voice output. Another example is *VoIP*, which allows users to speak and listen to others over the Internet using their desktop computer, mobile computer, or mobile device. Sophisticated programs enable the computer to converse with you. Talk into the microphone and say, "I'd like today's weather report." The computer replies, "For which city?" You reply, "Chicago." The computer says, "Sunny and 80 degrees." mobile user, are small portable devices that can be transported easily. Two types of smaller, lower-cost units are LCD projectors and DLP projectors. An *LCD projector*, which uses liquid crystal display technology, attaches directly to a computer, and uses its own light source to display the information shown on the computer screen.

Other Output Devices

In addition to display devices, printers, and speakers, other output devices are available for specific uses and applications such as data projectors, interactive whiteboards, and force-feedback game controllers and tactile output.

Data Projectors

A **data projector** is a device that takes the text and images displaying on a computer screen and projects them on a larger screen so that an audience can see the image clearly (Figure 6-29). For example, many classrooms use data projectors so that all students easily can see an instructor's presentation on the screen. Some data projectors are large devices that attach to a ceiling or wall in an auditorium.

Some operating systems allow projectors to be part of the network, which enables a presenter to operate the projector remotely via a network connection. Others, designed for the Because LCD projectors tend to produce lower-quality images, users often prefer DLP projectors for their sharper, brighter images.A *digital light processing* (*DLP*) *projector* uses tiny mirrors to reflect light, which produces crisp, bright, colorful images that remain in focus and can be seen clearly even in a welllit room. Some newer televisions use DLP

Figure 6-29 A data projector projects an image from a computer screen on a larger screen so that an audience easily can see the image.

instead of LCD or plasma technology.As an alternative to data projectors, some users work with an LCD or plasma display.

Interactive Whiteboards

An **interactive whiteboard** is a touch-sensitive device, resembling a dry-erase board that displays the image on a connected computer screen. A presenter controls the computer program by clicking a remote control, touching the whiteboard, drawing on or erasing the whiteboard with a special digital pen and eraser, or writing on a special tablet. Notes written on the interactive whiteboard can be saved directly on the computer. Interactive whiteboards are used frequently in classrooms as a teaching tool (Figure 6-30), during meetings as a colla boration tool, and to enhance delivery of presentations.

Figure 6-30 Teachers and students can write directly on an interactive whiteboard, or they can write on a wireless slate that communicates with the whiteboard.

Three basic technologies exist for displaying computer images on an interactive whiteboard:
(1) Front projection: separate projector displays an image from the computer screen on the interactive whiteboard;

(2) Rear projection: a pro jector built into the back of the interactive whiteboard displays an image from the computer screen on the whiteboard; and

(3) An interactive whiteboard fits over an LCD screen or a plasma display. Front projection and rear projection interactive whiteboards, which are hung on the wall or mounted on a stand, range in size from 48 to 94 inches. A widely used interactive whiteboard is the SMART Board.

Force-Feedback Game Controllers and Tactile Output

As discussed in Chapter 5, joysticks, wheels, gamepads, and motion-sensing game controllers are input devices used to control movement and actions of a player or object in computer games, simulations, and video games. Today's joysticks, wheels, game pads, and motion-sensing game controllers also include *force feedback*, which is a technology that sends resistance to the device in response to actions of the user (Figure 6-31)

Figure 6-31 Gaming devices often provide force feedback, giving the user a realistic experience.

For example, as you use the simulation software to drive from a smooth road onto a gravel alley, the steering wheel trembles or vibrates, making the driving experi ence as realistic as possible.

These devices also are used in practical training applications such as in the military and aviation. Some input devices, such as a mouse, and mobile devices, such as a smart phone, include *tactile output* that provides the user with a physical response from the device. For example, users may sense a bumping feeling on their hand while scrolling through a smart phone's contact list.

Putting It All Together

Many factors influence the type of output devices you should use: the type of output desired, the hardware and software in use, and the anticipated cost. Figure 6-32 outlines several suggested monitors, printers, and other output devices for various types of computer users.

Output Devices for Physically Challenged Users

As Chapter 5 discussed, the growing presence of computers has generated an awareness of the need to address computing requirements for those with physical limitations. Read Ethics & Issues 6-4 for a related discussion. For users with mobility, hearing, or vision disabilities, many different types of output devices are available. Hearing-impaired users, for example, can instruct programs to display words instead of sounds. With the latest Windows operating systems, users also can set options to make programs easier to use. The Magnifier, for example, enlarges text and other items in a window on the screen (Figure 6-33).

Visually impaired users can change Windows settings, such as increasing the size or changing the color of the text to make the words easier to read. Instead of using a monitor, blind users can work with voice output via Windows Narrator. That is, the computer reads the information that is displayed on the screen. Another alternative is a *Braille printer*, which prints information on paper in Braille (Figure 6-34).

Suggested Output Devices by User

User	Monitor	Printer	Other
Home 	• 19- or 20-inch LCD monitor, or 17-inch LCD screen on notebook computer	• Ink-jet color printer; or • Photo printer	• Speakers • Headphones or earbuds or headset • Force-feedback game controller or tactile output
Small Office/Home Office 	• 20- or 22-inch LCD monitor • LCD screen smart phone or other mobile device	• Multifunction peripheral; or • Ink-jet color printer; or • Laser printer (black-and-white or color) • Label printer • Postage printer	• Speakers
Mobile 	• 17-inch LCD screen on notebook computer • 8.9-inch screen on a netbook • LCD screen on smart phone or other mobile device	• Mobile color printer • Ink-jet color printer; or • Laser printer for in-office use (black-and-white or color) • Photo printer	• Headphones or earbuds or headset • DLP data projector
Power 	• 30-inch LCD monitor	• Laser printer (black-and-white or color) • Plotter or large-format printer; or • Photo printer; or • Dye-sublimation printer	• Speakers • Headphones or earbuds or headset
Enterprise 	• 20- or 22-inch LCD monitor • LCD screen on smart phone or other mobile device	• High-speed laser printer • Laser printer, color • Line printer (for large reports from a mainframe) • Label printer	• Speakers • Headphones or earbuds or headset • Networked DLP data projector • Interactive whiteboard

Figure 6-32 This table recommends suggested output devices for various types of users.

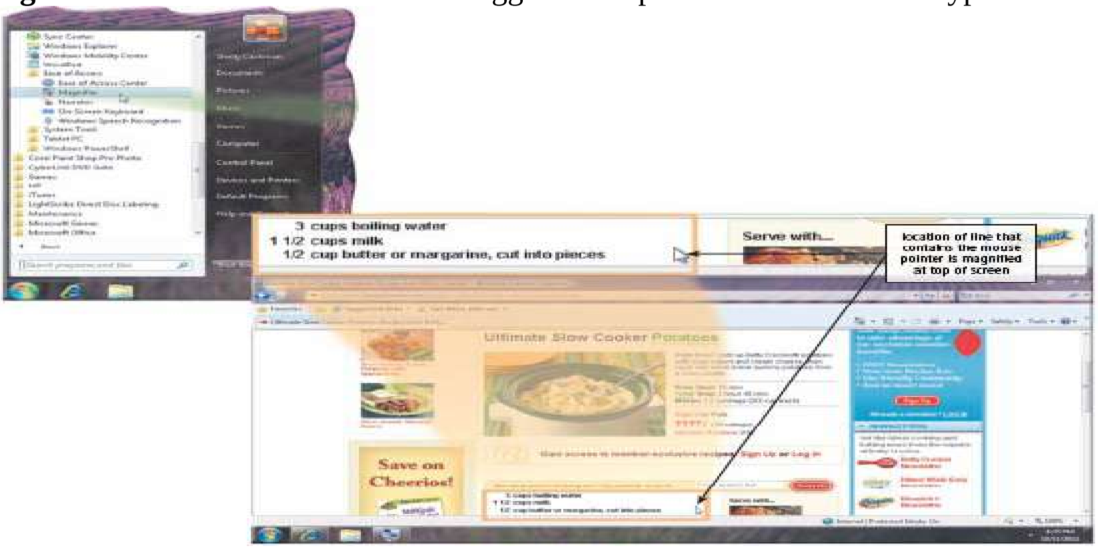


Figure 6-33 The Magnifier in Windows enlarges text and other on-screen items for visually impaired users.

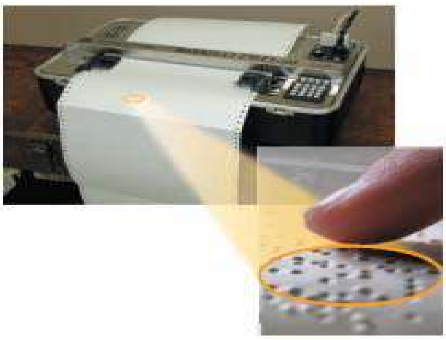


Figure 6-34 A Braille printer.

Chapter Exercises

True/False Mark T for True and F for False.

_____ 1. The form of output generated by a computer varies depending on the hardware and software being used and the requirements of the user.

_____ 2. Information on a display device sometimes is called soft copy.

_____ 3. Most mobile computers and devices do not integrate the display and other components into the same physical case.

_____ 4. Widescreen LCD monitors are wider than they are tall.

_____ 5. Brightness describes the difference in light intensity between the brightest white and darkest black that can be displayed on an LCD monitor.

_____ 6. An HDMI (High-Definition Media Interface) port combines S-video with high-definition (HD) television and video.

_____ 7. With game consoles, the output device often is a television.

_____ 8. A printout in landscape orientation is taller than it is wide)

_____ 9. With Bluetooth printing, a computer or other device transmits output to a printer via infrared light waves.

_____ 10. An all-in-one device is a single device that looks like a printer or a copy machine but provides the functionality of a printer, scanner, copy machine, and perhaps a fax machine.

_____ 11. An impact printer forms characters and graphics on a piece of paper without actually striking the paper.

_____ 12. A headset is a device that functions as both headphones and a Web cam.

_____ 13. An LCD projector uses tiny mirrors to reflect light, which produces crisp, bright, colorful images that remain in focus and can be seen clearly even in a well lit room.

Multiple Choice Select the best answer.

1. Examples of output that primarily contain text-based documents are _____.
a. drawings, clip art, and photos
b. music, narrations, and speeches
c. home movies and live performances
d. letters, reports, and e-mail messages

2. _____ uses organic molecules that produce an even brighter, easier-to-read display than standard TFT displays.
a. HDTV
b. OLED
c. LCD
d. LED

3. The _____ is an alternative to DVI that also supports HDMI.
a. DisplayPort
b. Digital Video Interface
c. S-video port
d. standard monitor port

4. A CRT monitor's viewable size is the _____ measurement of the actual viewing area provided by the screen in the monitor.
a. horizontal b. vertical c. three-dimensional d. diagonal

5. Ink-jet printer resolution is measured by the number of _____ a printer can print.
a. pages per minute (ppm) b. pixels per inch (ppi)
c. lines per minute (lpm) d. dots per inch (dpi)

6. The primary disadvantage of multifunction peripherals is that _____.
a. they require more space than having separate devices
b. if the multifunction peripheral breaks down, all functions are lost
c. they are significantly more expensive than purchasing each device separately
d. all of the above

7. A(n) _____ is a touch-sensitive device, resembling a dry-erase board, that displays the image on a connected computer screen.
a. flatbed scanner b. data projector
c. interactive whiteboard d. video conference

8. _____ is a technology that sends resistance to a device in response to actions of the user.
a. An interactive whiteboard b. A CRT
c. A dance pad d. Force feedback

Matching Match the terms with their definitions.

_____ 1. display device	a. printed information that exists physically and is a more permanent form of output
_____ 2. LCD monitor	b. component of a computer that produces music, speech, or other sounds, such as beeps
_____ 3. head-mounted display	c. defines a display's width relative to its height
_____ 4. nit	d. an output device that visually conveys text, graphics, and video information
_____ 5. candela	e. forms characters and graphics on a piece of paper without actually striking the paper
_____ 6. aspect ratio	f. standard unit of luminous intensity
_____ 7. hard copy	g. a display in a helmet, goggles, or glasses
_____ 8. nonimpact printer	h. unit of visible light intensity equal to one candela per square meter
_____ 9. audio output device	i. provides the user with a physical response from a device
_____ 10. tactile output	j. a desktop monitor that uses a liquid crystal display to produce images

Short Answer Write a brief answer to each of the following questions.

1. How does resolution affect images displayed on a monitor? ____________ How does resolution relate to the size of an LCD monitor or screen? ____________

2. Describe some of the features of HDTV. __________ How do game console users set up the output for the consoles? __________

3. What are two types of wireless printing technology? ____________ How do they differ in how they communicate with a computer or other device? ____________

4. How does an ink-jet printer work? ____________ What are the differences between dye-sublimation printers used by professionals as compared to home or small business users? ____________

5. What might be included with a surround sound system for a computer? ____________ What is audio resolution, and what are three examples of audio resolutions? ____________

Chapter Seven

Storage

Storage

Storage holds data, instructions, and information for future use. Every computer stores system software and application software. To start up,a computer locates an operating system (system software) in storage, usually a hard disk, and loads it into memory (RAM). When a user issues a command to start application software, such as a word processing program or a Web browser, the operating system locates the program in storage, such as on a hard disk or optical disc, and loads it into memory (RAM).

In addition to programs, users store a variety of data and information on mainframe computers, servers, desktop computers, notebook computers (including netbooks and Tablet PCs), smart phones, portable media players, and other mobile devices. For example, all types of users store digital photos; appointments, schedules, and contact/address information; correspondence, such as letters and e-mail messages; tax records; and Web pages.

A home user also might store budgets, bank statements, a household inventory, records of stock purchases, tax information, homework assignments, recipes, music, and videos. In addition or instead, a business user stores reports, financial records, travel records, customer orders and invoices, vendor payments, payroll records, inventory records, presentations, quotations, and contracts. Other users store diagrams, drawings, blueprints, designs, marketing literature, corporate newsletters, and product catalogs.
Storage requirements among users vary greatly. Home users, small office/home office users, and mobile users typically have much smaller storage requirements than enterprise users. For example, a home user may need 320 GB (billion bytes) of storage, while enterprises may require 50 PB (quadrillion bytes).

Figure 7-1 A variety of storage options.

A **storage medium** (media is the plural), also called *secondary storage*, is the physical material on which a computer keeps data, instructions, and information. Examples of storage media are hard disks, solid state drives, memory cards, USB flash drives, ExpressCard modules, optical discs, smart cards, magnetic stripe cards, and microfilm. Cloud storage is another storage option, in which the actual storage media used is transparent to the user. Figure 7-1 shows a variety of storage options. Memory (RAM), by contrast, typically consists of one or more chips on the motherboard or some other circuit board in the computer.

Capacity is the number of bytes (characters) a storage medium can hold.
Figure 7-2 identifies the terms manufacturers use to define the capacity of storage media. For example, a reasonably priced USB flash drive can store up to 4 GB of data (approximately four billion bytes) and a typical hard disk has 320 GB (approximately 320 billion bytes) of storage capacity. Items on a storage medium remain intact even when power is removed from the computer.

Storage Terms

Storage Term	Approximate Number of Bytes	Exact Number of Bytes
Kilobyte (KB)	1 thousand	2^{10} or 1,024
Megabyte (MB)	1 million	2^{20} or 1,048,576
Gigabyte (GB)	1 billion	2^{30} or 1,073,741,824
Terabyte (TB)	1 trillion	2^{40} or 1,099,511,627,776
Petabyte (PB)	1 quadrillion	2^{50} or 1,125,899,906,842,624
Exabyte (EB)	1 quintillion	2^{60} or 1,152,921,504,606,846,976
Zettabyte (ZB)	1 sextillion	2^{70} or 1,180,591,620,717,411,303,424
Yottabyte (YB)	1 septillion	2^{80} or 1,208,925,819,614,629,174,706,176

Figure 7-2 The capacity of a storage medium is measured by the number of bytes it can hold.

Thus, a storage medium is nonvolatile. Most memory (i.e., RAM), by contrast, holds data and instructions temporarily and thus is volatile.
Figure 7-3 illustrates the concept of volatility.For an analogy, think of a filing cabinet that holds file folders as a storage medium, and the top of your desk as memory. When you want to work with a file, you remove it from the filing cabinet (storage medium) and place it on your desk (memory).

When you are finished with the file, you remove it from your desk (memory) and return it to the filing cabinet (storage medium).

A **storage device** is the computer hardware that records and/or retrieves items to and from storage media. **Writing** is the process of transferring data, instructions, and information from memory to a storage medium. **Reading** is the process of transferring these items from a storage medium into memory. When storage devices write data on storage media, they are creating output. Similarly, when storage devices read from storage media, they function as a source of input.
Nevertheless, they are categorized as storage devices, not as input or output devices.

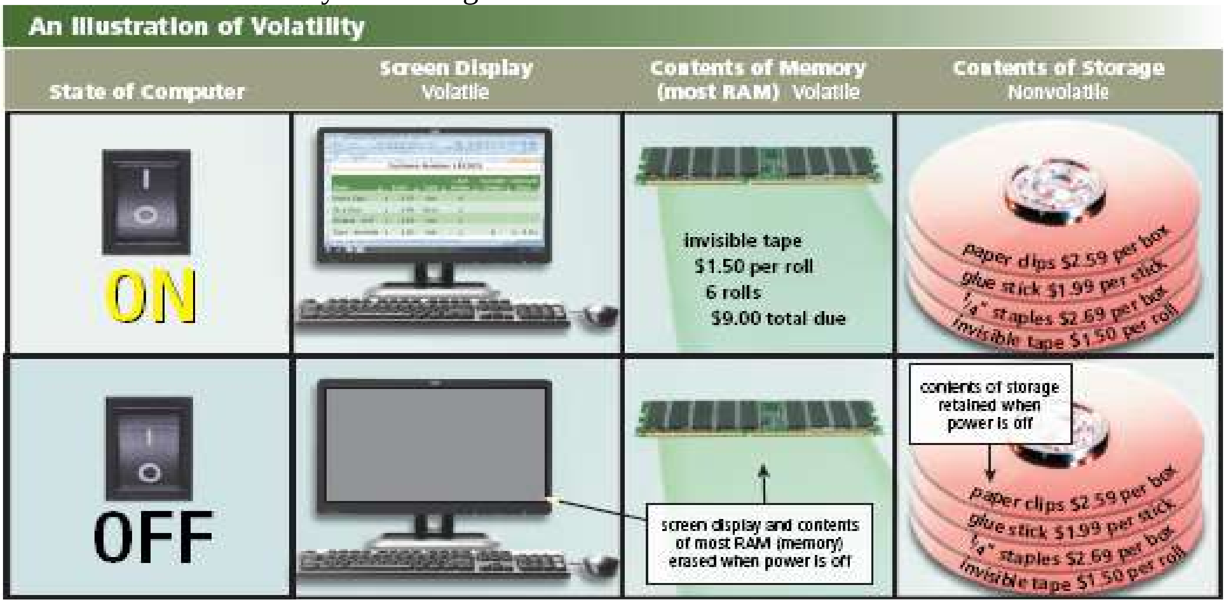


Figure 7-3 A screen display is considered volatile because its contents disappear when power is removed. Likewise, most RAM chips are volatile. That is, their contents are erased when power is removed from the computer. Storage, by contrast, is nonvolatile.Its contents remain when power is off.

The speed of storage devices and memory is defined by access time. **Access time** measures (1) the amount of time it takes a storage device to locate an item on a storage medium or (2) the time required to deliver an item from memory to the processor. The access time of storage devices is slow, compared with the access time of memory.
Memory (chips) accesses items in billionths of a second (nanoseconds). Storage devices, by contrast, access items in thousandths of a second (milliseconds) or millionths of a second (microseconds).

Instead of, or in addition to access time, some manufacturers state a storage device's transfer rate because it affects access time. *Transfer rate* is the speed with which data, instructions, and information transfer to and from a device. Transfer rates for storage are stated in *KBps* (kilobytes per second), *MBps* (megabytes per second), and *GBps* (gigabytes per second).
Numerous types of storage media and storage devices exist to meet a variety of users' needs.

Figure 7-4 shows how different types of storage media and memory compare in terms of transfer rates and uses. This chapter discusses these and other storage media.

Hard Disks

A **hard disk**, also called a *hard disk drive* or hard drive, is a storage device that contains one or more inflexible, circular platters that use magnetic particles to store data, instructions, and information. Depending on how the magnetic particles are aligned, they represent either a 0 bit or a 1 bit. Recall from

Chapter 4 that a bit (binary digit) is the smallest unit of data a computer can process. Thus, the alignment of the magnetic particles represents the data. The system unit on most desktop and notebook computers contains at least one hard disk. The entire device is enclosed in an airtight, sealed case to protect it from contamination. A hard disk that is mounted inside the system unit sometimes is called a *fixed disk* because it is not portable (Figure 7-5). With respect to a storage medium, the term *portable* means you can remove the medium from one computer and carry it to another computer. Portable hard disks are discussed later in this chapter.Current personal computer hard disks have storage capacities from 160 GB to 2 TB and more. Home users store documents, spreadsheets, presentations, databases, e-mail messages, Web pages, digital photos, music, videos, and software on hard disks. Businesses also store correspondence, reports, financial records, customer orders and invoices, payroll records, inventory records, contracts, marketing literature, schedules,and Web sites.

faster transfer rates

		Stores...
Memory	Memory (most RAM)	Items waiting to be interpreted and executed by the processor
Storage	Hard Disk	Operating system; application software; user data and information, including photos, music, and videos; backups
	Memory Cards and USB Flash Drives	Digital photos or files to be transported
	Optical Discs	Software, movies, music
	Tape	Backups

slower transfer rates

Figure 7-4 A comparison of different types of storage media and memory in terms of relative speed and uses.Memory is faster than storage but is expensive and not practical for all storage requirements. Storage is less expensive but is slower than memory

Figure 7-5 The hard disk in a desktop personal computer is enclosed inside an airtight, sealed case inside the system unit. (In this and other hard disk photos in the book, the top plate is removed from the hard disk for illustration purposes.)

Traditionally, hard disks stored data using *longitudinal recording*, which aligned the magnetic particles horizontally around the surface of the disk. With *perpendicular recording*, by contrast, hard disks align the magnetic particles vertically, or perpendicular to the disk's surface, making much greater storage capacities possible.
Figure 7-6 shows the difference between longitudinal and perpendicular recording. Experts estimate that hard disks using perpendicular recording provide storage capacities about 10 times greater than disks that use longitudinal recording.

Hard disks are read/write storage media. That is, you can read from and write on a hard disk any number of times. If the computer contains only one hard disk, the operating system designates it as drive C. Additional hard disks are assigned the next available drive letter. Some people use a second hard disk to duplicate the contents of the first hard disk, in case the first is damaged or destroyed.

Figure 7-6 Magnetic particles are aligned horizontally in longitudinal recording and vertically in perpendicular recording.

Figure 7-7 shows characteristics of a sample 1 TB hard disk that uses perpendicular recording.

Characteristics of a Hard Disk

Characteristics of a hard disk include its capacity, platters, read/write heads, cylinders,sectors and tracks, revolutions per minute, transfer rate, and access time.

Sample Hard Disk Characteristics	
Advertised capacity	1 TB
Platters	4
Read/write heads	8
Cylinders	16,383
Bytes per sector	512
Sectors per track	63
Sectors per drive	1,953,525,168
Revolutions per minute	7,200
Transfer rate	300 MBps
Access time	8.5 ms

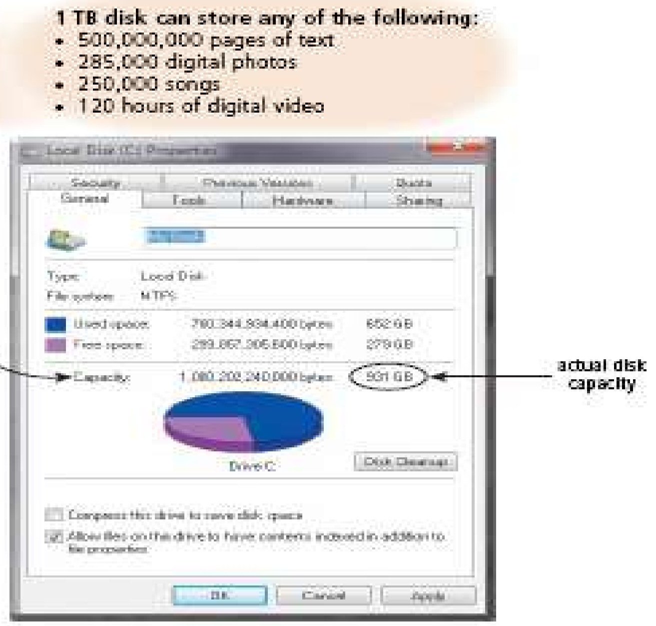


Figure 7-7 Characteristics of a sample 1 TB hard disk. The actual disk's capacity sometimes is different from the advertised capacity because of bad sectors on the disk.

The following paragraphs discuss each of these characteristics.The capacity of a hard disk is determined from whether it uses longitudinal or perpendicular recording, the number of platters it contains, and the composition of the magnetic coating on the platters. A *platter* is made of aluminum, glass, or ceramic and is coated with an alloy material that allows items to be recorded magnetically on its surface. The coating usually is three millionths of an inch thick.

Before any data can be read from or written on a hard disk, the disk must be formatted.

Formatting is the process of dividing the disk into tracks and sectors (Figure 7-8), so that the operating system can store and locate data and information on the disk. A *track* is a narrow recording band that forms a full circle on the surface of the disk. The disk's storage locations consist of pie-shaped sections, which break the tracks into small arcs called *sectors*. On a hard disk, a sector typically stores up to 512 bytes of data. Sometimes, a sector has a flaw and cannot store data. When you format a disk, the operating system marks these bad sectors as unusable.

For reading and writing purposes, sectors are grouped into clusters. A *cluster* is the smallest unit of disk space that stores data and information.

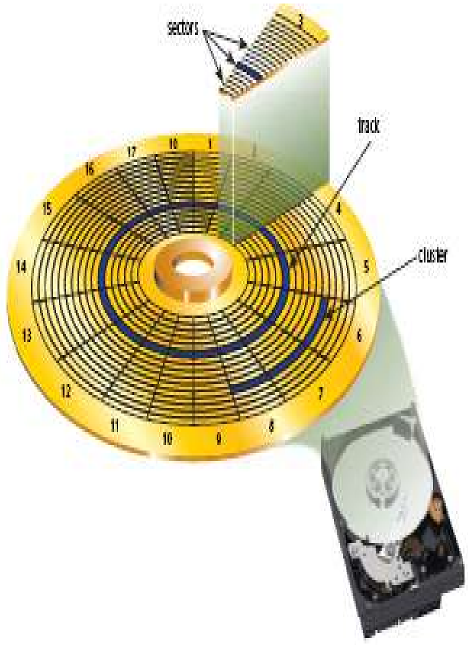


Figure 7-8 Tracks form circles on the surface of a hard disk. The disk's storage locations are divided into pie-shaped sections, which break the tracks into small arcs called sectors.

Each cluster, also called an *allocation unit*, consists of two to eight sectors (the number varies depending on the operating system). Even if a file consists of only a few bytes, it uses an entire cluster. Each cluster holds data from only one file. One file, however, can span many clusters.

On desktop computers, platters most often have a *form factor*, or size, of approximately 3.5 inches in diameter; on notebook computers, mobile devices, and some servers, the form factor is 2.5 inches or less. A typical hard disk has multiple platters stacked on top of one another.

Each platter has two read/write heads, one for each side. The hard disk has arms that move the read/write heads to the proper location on the platter (Figure 7-9). A *read/write head* is the mechanism that reads items and writes items in the drive as it barely touches the disk's recording surface.

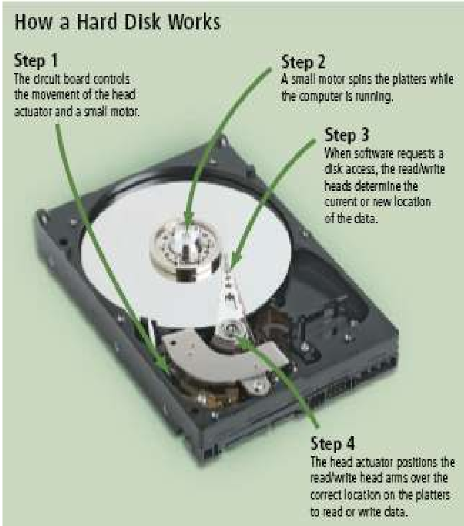


Figure 7-9 This figure shows how a hard disk works.

The location of the read/write heads often is referred to by its cylinder. A *cylinder* is the vertical section of a track that passes through all platters (Figure 7-10). A single movement of the read/write head arms accesses all the platters in a cylinder. If a hard disk has two platters (four sides), each with 1,000 tracks, then it will have 1,000 cylinders with each cylinder consisting of 4 tracks (2 tracks for each platter).

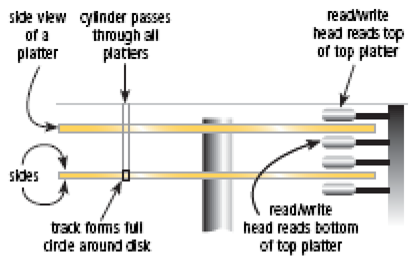


Figure 7-10 A cylinder is the vertical section of track through all platters on a hard disk.

While the computer is running, the platters in the hard disk rotate at a high rate of speed. This spinning, which usually is 5,400 to 15,000 *revolutions per minute* (*rpm*), allows nearly instant access to all tracks and sectors on the platters. The platters may continue to spin until power is removed from the computer, or more commonly today, they stop spinning or slow down after a specified time to save power. The spinning motion creates a cushion of air between the platter and its read/write head. This cushion ensures that the read/write head floats above the platter instead of making direct contact with the platter surface. The distance between the read/write head and the platter is about two millionths of one inch.

As shown in Figure 7-11, this close clearance leaves no room for any type of contamination. Dirt, hair, dust, smoke, and other particles could cause the hard disk to have a head crash. A *head crash* occurs when a read/write head touches the surface of a platter, usually resulting in a loss of data or sometimes loss of the entire disk.

Although current internal hard disks are built to withstand shocks and are sealed tightly to keep out contaminants, head crashes occasionally do still occur. Thus, it is crucial that you back up your hard disk regularly.

A **backup** is a duplicate of a file, program, or disk placed on a separate storage medium that you can use in case the original is lost, damaged, or destroyed. Chapter 8 discusses backup techniques.
Depending on the type of hard disk, transfer rates range from 15 MBps to 320 MBps. Access time for today's hard disks ranges from about 3 to 12 ms (milliseconds).

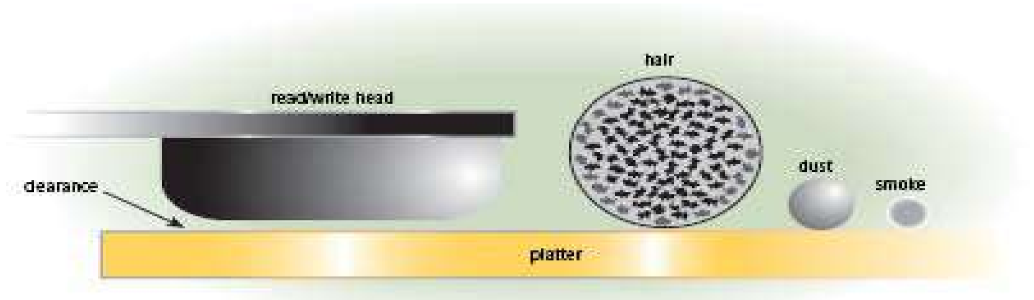


Figure 7-11 The clearance between a disk read/write head and the platter is about two millionths of an inch. A smoke particle, dust particle, human hair, or other contaminant could render the disk unusable.

Hard disks improve their access time by caching, specifically using disk cache. *Disk cache* (pronounced cash), sometimes called a buffer, consists of a memory chip(s) on a hard disk that stores frequently accessed items such as data, instructions, and information (Figure 7-12).

Disk cache and memory cache work in a similar fashion. When a processor requests data, instructions, or information from the hard disk, the hard disk first checks its disk cache — before moving any mechanical parts to access the platters. If the requested item is in disk cache, the hard disk sends it to the processor.

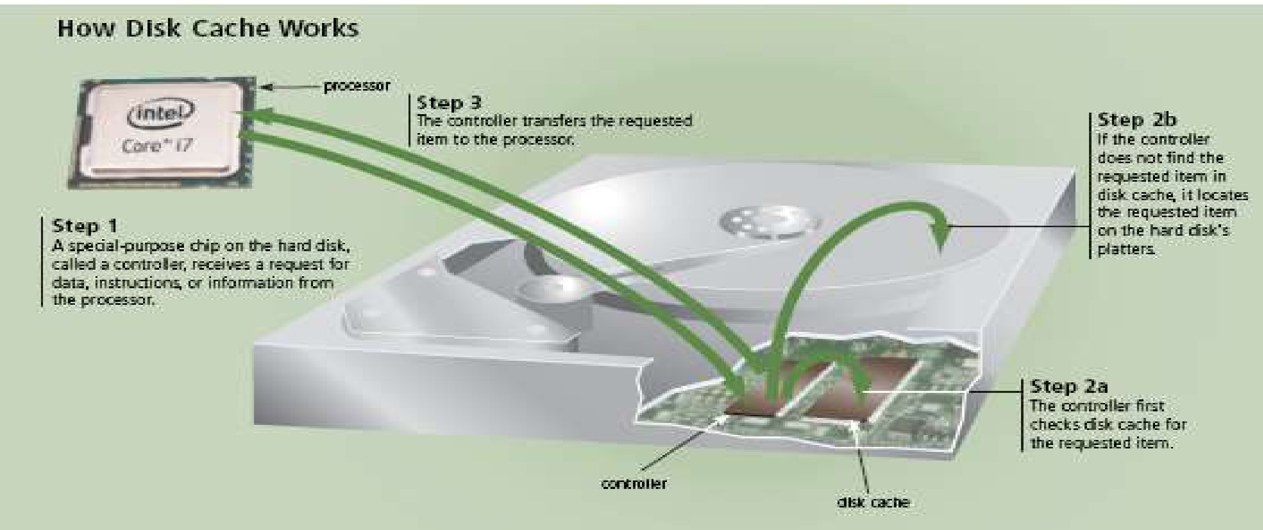


Figure 7-12 This figure shows how disk cache works.

If the hard disk does not find the requested item in the disk cache, then the processor must wait for the hard disk to locate and transfer the item from the disk to the processor. Hard disks today contain between 2 MB and 64 MB of disk cache. The greater the disk cache, the faster the hard disk. *Density* is the number of bits in an area on a storage medium. A higher density means more storage capacity.

RAID

Some personal computer manufacturers provide a hard disk configuration that connects multiple smaller disks into a single unit that acts like a single large hard disk. A group of two or more integrated hard disks is called a **RAID** (redundant array of independent disks). RAID is an ideal storage solution for users who must have the data available when they attempt to access it.

NAS

A **network attached storage** (*NAS*) device is a server connected to a network with the sole purpose of providing storage (Figure 7-13). Any user or device connected to the network can access files on the NAS device. These devices often use a RAID configuration. In the past, enterprises were the primary users of NAS. With the introduction of smaller, less expensive NAS devices, however, some home and small business users opt to add up to 6 TB or more of hard disk storage space to their network with a NAS device

Figure 7-13 A network attached storage device.

External and Removable Hard Disks

An **external hard disk,** shown in the top photo in Figure 7-14, is a separate freestanding hard disk that connects with a cable to a USB port or FireWire port on the system unit or communicates wirelessly. As with the internal hard disk, the entire hard disk is enclosed in an airtight, sealed case. External hard disks have storage capacities of up to 4 TB and more. Some external hard disk units include multiple hard disks that you can use for different purposes, if desired.

A **removable hard disk** is a hard disk that you insert and remove from a drive. Sometimes the drive is built in the system unit. Others are external devices that connect with a cable to a USB port or FireWire port on the system unit. A removable hard disk drive, shown in the bottom photo in Figure 7-14, reads from and writes on the removable hard disk. Removable hard disks have storage capacities up to 1 TB or more.

Figure 7-14 Examples of external and removable hard disks.

Although the transfer rate of external and removable hard disks usually is slower than that of internal hard disks, they do offer many advantages over internal hard disks (fixed disks):

- Transport a large number of files
- Back up important files or an entire internal hard disk (several external hard disk models allow you to back up simply by pushing a button on the disk)
- Easily store large audio and video files
- Secure your data; for example, at the end of a work session, remove the hard disk and lock it up, leaving no data in the computer
- Add storage space to a notebook computer, including netbooks and Tablet PCs
- Add storage space to a desktop computer without having to open the system unit or connect to a network

Miniature Hard Disks

Both internal and external hard disks are available in miniature sizes. These tiny hard disks have form factors of 1.8 inch, 1 inch, and 0.85 inch. Devices such as portable media players, digital cameras, and smart phones often have internal miniature hard disks, which provide greater storage capacities than flash memory (Figure 7-15).

Figure 7-15 This miniature hard disk is used in portable media players and other small devices, enabling users to store music, videos, movies, and any other type of files on the disk.

External hard disks that are smaller in size and capacity, which also contain miniature hard disks, are sometimes called a *pocket hard drive* because they enable mobile users easily to transport photos and other files from one computer to another (Figure 7-16).

Figure 7-16 Users easily can transport data from one computer to another with a pocket hard drive.

When a device containing a miniature hard disk is connected to a computer, the user can read from and write on the device as a separate drive. Miniature hard disks have storage capacities that range from 1 GB to 320 GB. Miniature hard disks with the greater storage capacities typically use perpendicular recording.

Hard Disk Controllers

A *disk controller* consists of a special-purpose chip and electronic circuits that control the transfer of data, instructions, and information from a disk to and from the system bus and other components in the computer. That is, it controls the interface between the hard disk and the system bus. A disk controller for a hard disk, called the hard disk controller, may be part of a hard disk or the motherboard, or it may be a separate adapter card inside the system unit.

In their personal computer advertisements, vendors usually state the type of hard disk interface supported by the hard disk controller. Thus, you should understand the types of available hard disk interfaces. In addition to USB and FireWire, which can function as external hard disk interfaces, four other types of hard disk interfaces for use in personal computers are SATA, EIDE,SCSI, and SAS.

- *SATA* (*Serial Advanced Technology Attachment*) uses serial signals to transfer data, instruc tions, and information. The primary advantage of SATA interfaces is their cables are thinner, longer, more flexible, and less susceptible to interference than cables used by hard disks that use parallel signals. SATA interfaces have data transfer rates of up to 300 MBps and higher. In addition to hard disks, SATA interfaces support connections to optical disc drives. External disks can use the *eSATA* (external SATA) interface, which is much faster than USB and FireWire.

- *EIDE* (*Enhanced Integrated Drive Electronics*) is a hard disk interface that uses parallel signals to transfer data, instructions, and information. EIDE interfaces can support up to four hard disks at 137 GB per disk. These interfaces have data transfer rates up to 133 MBps. EIDE interfaces also provide connec tions for optical disc drives and tape drives. Some manufacturers market their EIDE interfaces as Fast ATA or Ultra ATA.

- *SCSI* interfaces, which also use parallel signals, can support up to eight or fifteen peripheral devices. Supported devices include hard disks, optical disc drives, tape drives, printers, scanners, network cards, and much more. Recall from Chapter 4 that SCSI is an acronym for Small Com puter System Interface. Some computers have a built-in SCSI interface, while others use an adapter card to add a SCSI interface. SCSI interfaces provide up to 640 MBps data transfer rates.

- *SAS* (*serial-attached SCSI*) is a newer type of SCSI that uses serial signals to transfer data, instructions, and information. Advantages of SAS over parallel SCSI include thinner, longer cables; reduced interference; less expensive; support for many more connected devices at once; and faster speeds. SAS interfaces have data transfer rates of 750 MBps and higher. In addition to hard disks, SAS interfaces support connections to optical disc drives, printers, scanners, digital cameras, and other devices. SAS interfaces usually are compatible with devices that have parallel SCSI and SATA interfaces. Experts predict that SAS eventually will replace parallel SCSI.

Maintaining Data Stored on a Hard Disk

Most manufacturers guarantee their hard disks to last approximately three to five years. Many last much longer with proper care. To prevent the loss of items stored on a hard disk, you regularly should perform preventive maintenance such as defragmenting or scanning the disk for errors. To learn more about how to maintain a hard disk, complete the Learn How To 1 activity on pages 392 and 393. Chapter 8 discusses these and other utilities in depth.

Flash Memory Storage

As discussed in Chapter 4, flash memory is a type of nonvolatile memory that can be erased electronically and rewritten. Flash memory chips are a type of *solid state media*, which means they consist entirely of electronic components, such as integrated circuits, and contain no moving parts. The lack of moving parts makes flash memory storage more durable and shock resistant than other types of media such as magnetic hard disks or optical discs. Types of flash memory storage include solid state drives, memory cards, USB flash drives, and ExpressCard modules.

Solid State Drives

A **solid state drive** (**SSD**) is a storage device that typically uses flash memory to store data, instructions, and information (Figure 7-17). With available form factors of 3.5 inches, 2.5 inches, and 1.8 inches, SSDs are used in all types of computers including servers, desktop computers, and mobile computers and devices such as portable media players and digital video cameras.

Figure 7-17 As the price of SSDs drops, experts estimate that increasingly more users will purchase computers and devices that use this media.

Storage capacities of current SSDs range from 16 GB to 256 GB and more. SSDs have several advantages over magnetic hard disks.

- Access times of SSDs are about 0.1 ms, which is more than 80 times faster than a hard disk.
- Transfer rates of SSDs are faster than comparable hard disks. For example, SSD transfer rates range from 80 to 100 MBps, while transfer rates of a typical 2.5-inch hard disk is about 60 MBps.
- SSDs generate less heat and consume less power than hard disks.
- Manufacturers claim that SSDs will last more than 50 years, which is much greater than the 3 to 5 year hard disk stated lifespan. The disadvantages of SSDs are they currently have a higher failure rate than hard disks, and their cost is much higher per gigabyte. As the price of SSDs drops, experts estimate that increasingly more users will purchase computers and devices that use this media.

Memory Cards

Memory cards enable mobile users easily to transport digital photos, music, or files to and from mobile devices and computers or other devices. As mentioned in Chapter 4, a **memory card** is a removable flash memory device, usually no bigger than 1.5 inches in height or width, that you insert and remove from a slot in a computer, mobile device, or card reader/writer (Figure 7-18).

Figure 7-18 Many types of computers and devices have slots for memory cards.

Common types of memory cards include *CompactFlash* (*CF*), *Secure Digital* (*SD*), *Secure Digital High Capacity* (*SDHC*), *microSD,micro SDHC*, *xD Picture Card*, *Memory Stick*, and *Memory Stick Micro* (*M2*). The table in Figure 7-19 compares storage capacities and uses of these media.

Depending on the device, manufacturers claim memory cards can last from 10 to 100 years. Transfer rates range from about 1 MBps to 20 MBps or more, depending on the device. Memory cards are quite expensive compared to other storage media with equivalent capacity. For example, the cost of a 16 GB CompactFlash card can be the same as a 1 TB external hard disk.

Various Memory Cards

Media Type	Storage Capacity	Use
CompactFlash (CF) 	512 MB to 100 GB	Digital cameras, smart phones, PDAs, photo printers, portable media players, notebook computers, desktop computers
Secure Digital (SD) 	512 MB to 8 GB	Digital cameras, digital video cameras, smart phones, PDAs, photo printers, portable media players
SDHC 	4 to 32 GB	Digital cameras
microSD 	1 to 2 GB	Smart phones, portable media players, handheld game consoles, handheld navigation devices
microSDHC 	4 to 16 GB	Smart phones, portable media players, handheld game consoles, handheld navigation devices
xD Picture Card 	256 MB to 2 GB	Digital cameras, photo printers
Memory Stick PRO Duo 	1 to 16 GB	Digital cameras, smart phones, handheld game consoles
Memory Stick Micro (M2) 	1 to 16 GB	Smart phones

Figure 7-19 A variety of memory cards.

To view, edit, or print images and information stored on memory cards, you transfer the contents to your desktop computer or other device. Some printers have slots to read memory cards. If your computer or printer does not have a built-in slot, you can purchase a *card reader/writer*, which is a device that reads and writes data, instructions, and information stored on memory cards. Card reader/writers usually connect to the USB port or FireWire port on the system unit. The type of card you have will determine the type of card reader/writer needed. Figure 7-20 shows how one type of memory card works with a card reader/writer.

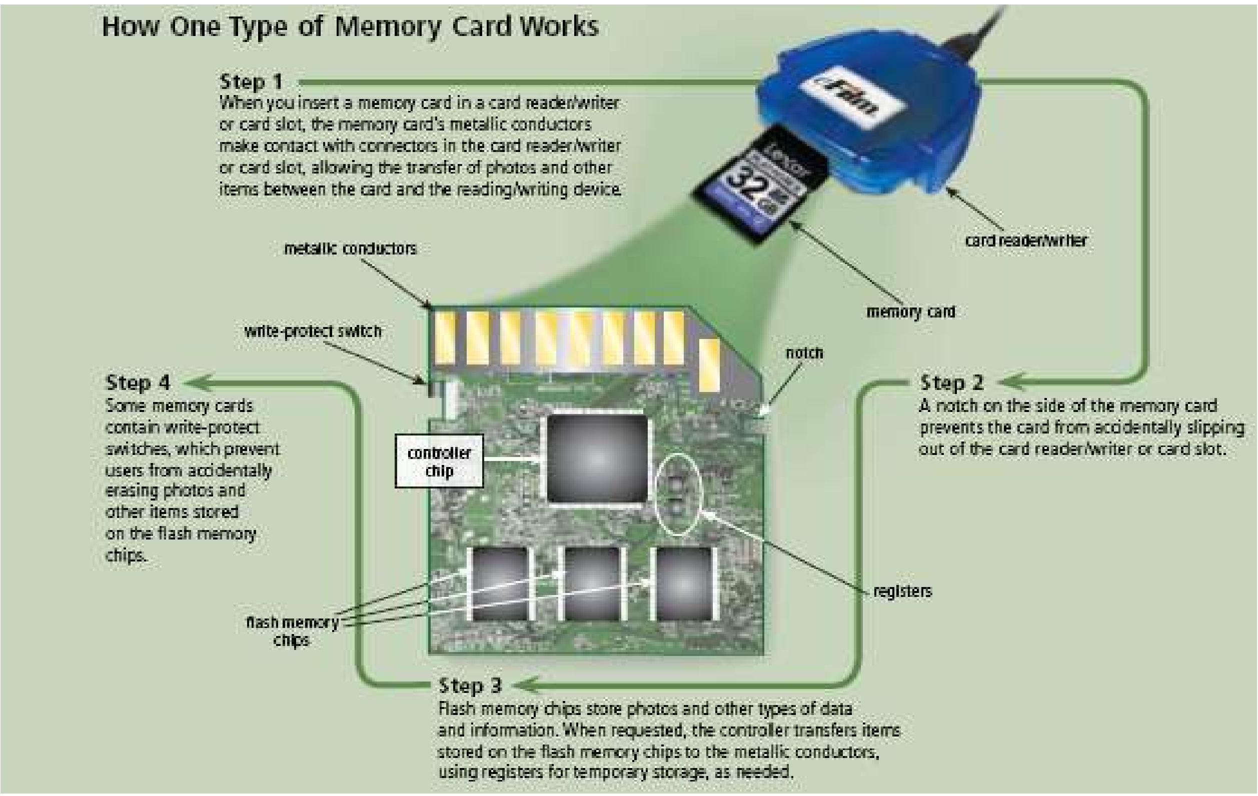


Figure 7-20 This figure shows how one type of memory card works.

USB Flash Drives

As discussed in Chapter 4, a **USB flash drive**, sometimes called a *thumb drive*, is a flash memory storage device that plugs in a USB port on a computer or mobile device (Figure 7-21). USB flash drives are convenient for mobile users because they are small and lightweight enough to be transported on a keychain or in a pocket. With a USB flash drive, users easily transfer documents, photos, music, and videos from one computer to another. Current USB flash drives have data transfer rates of about 12 MBps and storage capacities ranging from 512 MB to 100 GB, with the latter being extremely expensive. A special type of USB flash drive, called a *U3 smart drive*, includes pre-installed software accessed through a Windows-type interface. Some USB flash drives include fingerprint readers, restricting access to authenticated users. The drive designation of a USB flash drive usually follows alphabetically after all other disks. For example, if the computer has one internal hard disk (drive C) and an optical disc drive (drive D) and no other disk drives, then the USB flash drive probably will be drive E.

Figure 7-21 A close-up of the flash memory and circuitry inside a USB flash drive.

ExpressCard Modules

As discussed in Chapter 4, an **ExpressCard module** is a removable device, about 75 mm long and 34 mm wide or L-shaped with a width of 54 mm, that fits in an ExpressCard slot (Figure 7-22). ExpressCard modules can be used to add memory, storage, communications, multimedia, and security capabilities to a computer. Developed by the PCMCIA (Personal Computer Memory Card International Association), ExpressCard modules commonly are used in notebook computers

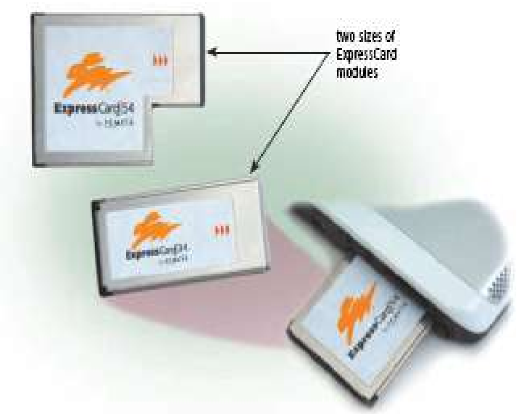


Figure 7-22 ExpressCard modules are available in two sizes.

Cloud Storage

Some users choose cloud storage instead of storing data locally on a hard disk or other media. **Cloud storage** is an Internet service that provides storage to computer users (Figure 7-23).

Figure 7-23 An example of one Web site advertising its storage service.

Types of services offered by cloud storage providers vary. Some provide storage for specific types of files, such as photos or e-mail messages, whereas others store any type of file. Many cloud storage providers offer additional services such as encryption, passwords, Web applications, and Web services. Figure 7-24 identifies a variety of cloud storage providers.

Cloud Storage Providers

Web Site Names	Type of Storage Provided	Other Services
Box.net, IDrive, Windows Live SkyDrive	Backup or additional storage for any type of file	
Flickr, Picasa	Digital photos	Photo editing and photo management
YouTube	Digital videos	
Facebook, MySpace	Digital photos, digital videos, messages, and personal information	Social networking
Google Docs	Documents, spreadsheets, presentations	Productivity suite
Gmail, Windows Live Hotmail, Yahoo! Mail	E-mail messages	
Amazon EC2, Amazon S3, Nirvanix	Enterprise-level storage	Web services, data center services

Figure 7-24 Some of the more widely used cloud storage providers.

Cloud storage is available for all sizes of users, with various degrees of storage services available for home and business users. Cloud storage fee arrangements vary, depending on the user’s storage requirements. For example, one cloud storage service provides 25 GB of storage free to registered users; another charges $5 per month for 150 GB of storage. For enterprises, cloud storage services typically charge for storage on a per gigabyte basis, such as 15 cents per gigabyte. Some also charge an additional per gigabyte fee for data transferred to and from the cloud storage service.

Users subscribe to cloud storage for a variety of reasons:

- To access files on the Internet from any computer or device that has Internet access
- To store large audio, video, and graphics files on the Internet instantaneously, instead of spending time downloading to a local hard disk or other media
- To allow others to access their files on the Internet so that others can listen to an audio file, watch a video clip, or view a photo — instead of e-mailing the file to them
- To view time-critical data and images immediately while away from the main office or location; for example, doctors can view X-ray images from another hospital,home, or office, or while on vacation
- To store offsite backups of data (Chapter 8 presents this and other backup strategies)
- To provide data center functions, relieving enterprises of this task

Optical Discs

An *optical disc* is a type of storage media that consists of a flat, round, portable disc made of metal, plastic, and lacquer that is written and read by a laser. (The spelling, disk, is used for magnetic and flash memory media, and disc is used for optical media.) Optical discs used in personal computers are 4.75 inches in diameter and less than one- twentieth of an inch thick. Smaller computers, game consoles, and mobile devices, however, often use *mini discs* that have a diameter of 3 inches or less.

Optical discs primarily store software, data, digital photos, movies, and music. Some optical disc formats are read only, meaning users cannot write (save) on the media. Others are read/write, which allows users to save on the disc just as they save on a hard disk. Nearly every personal computer today has some type of optical disc drive installed in a drive bay. On some, you push a button to slide out a tray, insert the disc, and then push the same button to close the tray; others are slot loaded, which means you insert the disc in a narrow opening on the drive (Figure 7-25). When you insert the disc, the operating system automatically may start the program, music, or video on the disc.

Figure 7-25 A slot-loaded optical disc drive.

With some discs, you can read and/or write on one side only. Manufacturers usually place a silk-screened label on the top layer of these single-sided discs. You insert a single-sided disc in the drive with the label side up. Other discs are double-sided. Simply remove the disc from the drive, flip it over, and reinsert it in the drive to use the other side of the disc. Double-sided discs often have no label; instead, each side of the disc is identified with small writing around the center of the disc. Some drives use *LightScribe technology,* which works with specially coated optical discs, to etch labels directly on the disc (as opposed to placing an adhesive label on the disc). The drive designation of an optical disc drive usually follows alphabetically after that of all the hard disks. For example, if the computer has one internal hard disk (drive C) and an external hard disk (drive D), then the first optical disc drive is drive E. A second optical disc drive would be drive F.

Optical discs store items by using microscopic pits (indentations) and lands (flat areas) that are in the middle layer of the disc (Figure 7-26).

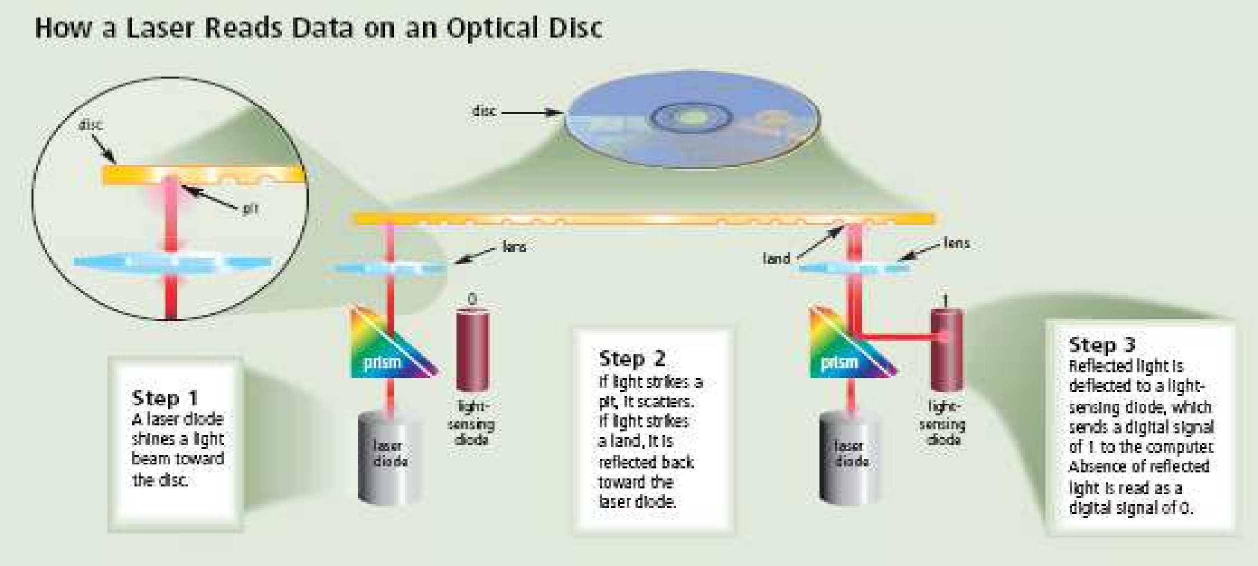


Figure 7-26 This figure shows how a laser reads data on an optical disc.

A high-powered laser light creates the pits.A lower-powered laser light reads items from the disc by reflecting light through the bottom of the disc. The reflected light is converted into a series of bits the computer can process. A land causes light to reflect, which is read as binary digit 1. Pits absorb the light; this absence of light is read as binary digit 0.
Optical discs commonly store items in a single track that spirals from the center of the disc to the edge of the disc. As with a hard disk, this single track is divided into evenly sized sectors on which items are stored (Figure 7-27).

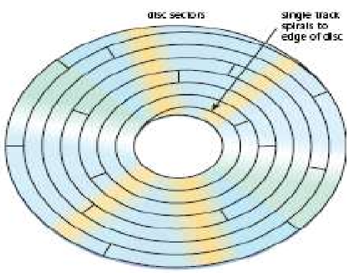


Figure 7-27 An optical disc typically stores data, instructions, and information in a single track that spirals from the center of the disc to the edge of the disc.

Care of Optical Discs

Manufacturers claim that a properly cared for high-quality optical disc will last 5 years but could last up to 100 years. Figure 7-28 offers some guidelines for the proper care of optical discs. Never bend a disc; it may break. Do not expose discs to extreme temperatures or humidity. The ideal temperature range for disc storage is 50 to 70 degrees Fahrenheit. Stacking discs, touching the underside of discs, or exposing them to any type of con taminant may scratch a disc.
Place an optical disc in its protective case, called a *jewel box*, when you are finished using it and store in an upright (vertical) position.

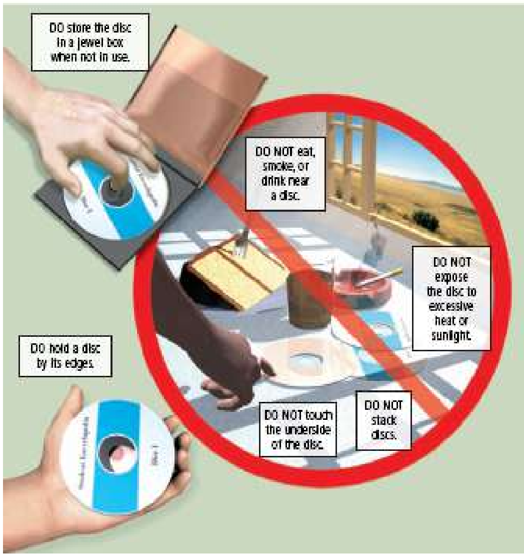


Figure 7-28 Some guidelines for the proper care of optical discs.

Types of Optical Discs

Many different formats of optical discs exist today. Figure 7-29 identifies a variety of optical disc formats and specifies whether a user can read from the disc, write to the disc, and/or erase the disc. The following sections describe characteristics unique to each of these disc formats.

Optical Disc Formats

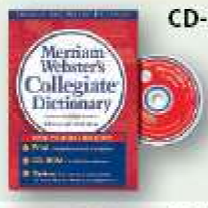
Optical Disc		Read	Write	Erase
	CD-ROM	Y	N	N
	CD-R	Y	Y	N
	CD-RW	Y	Y	Y
	DVD-ROM BD-ROM	Y	N	N
	DVD-R DVD+R BD-R	Y	Y	N
	DVD-RW DVD+RW DVD-RAM BD-RE	Y	Y	Y

Figure 7-29 Manufacturers sell CD-ROM, DVD-ROM, and BD-ROM media prerecorded (written) with audio, video, and software. Users cannot change the contents of these discs. Users, however, can purchase the other formats of optical discs as blank media and record (write) their own data, instructions, and information on these discs.

CDS

A **CD-ROM**, or *compact disc read-only memory*, is a type of optical disc that users can read but not write (record) or erase — hence, the name read-only. Manufacturers write the contents of standard CD-ROMs. A standard CD-ROM is called a *single-session disc* because manufacturers write all items on the disc at one time. Software manufacturers often distribute their programs using CD-ROMs (Figure 7-30). A typical CD-ROM holds from 650 MB to 1 GB of data, instructions, and information. To read a CD-ROM, insert the disc in a **CD-ROM drive** or a CD-ROM player. Because audio CDs and CD-ROMs use the same laser technology, you may be able to use a CD-ROM drive to listen to an audio CD while using the computer.

The speed of a CD-ROM drive determines how fast it installs programs and accesses the disc. Original CD-ROM drives were single-speed drives with transfer rates of 150 KBps. Manufacturers measure all optical disc drives relative to this original CD-ROM drive. They use an X to denote the original transfer rate of 150 KBps. For example, a 48X CD-ROM drive has a data transfer rate of 7,200 (48 × 150) KBps, or 7.2 MBps.

Current CD-ROM drives have transfer rates, or speeds, ranging from 48X to 75X or faster. The higher the number, the faster the CD-ROM drive. Faster CD-ROM drives are more expen sive than slower drives.

CD-RS and CD-RWS A **CD-R** (*compact disc- recordable*) is a multisession optical disc on which users can write, but not erase, their own items such as text, graphics, and audio. *Multisession* means you can write on part of the disc at one time and another part at a later time. Each part of a CD-R, however, can be written on only one time, and the disc's contents cannot be erased.

A **CD-RW** (*compact disc-rewritable*) is an erasable multisession disc you can write on multiple times. CD-RW overcomes the major disadvantage of CD-R because it allows users to write and rewrite data, instructions, and infor mation on the CD-RW disc multiple times — instead of just once. Reliability of the disc tends to drop, however, with each successive rewrite. To write on a CD-RW disc, you must have CD-RW software and

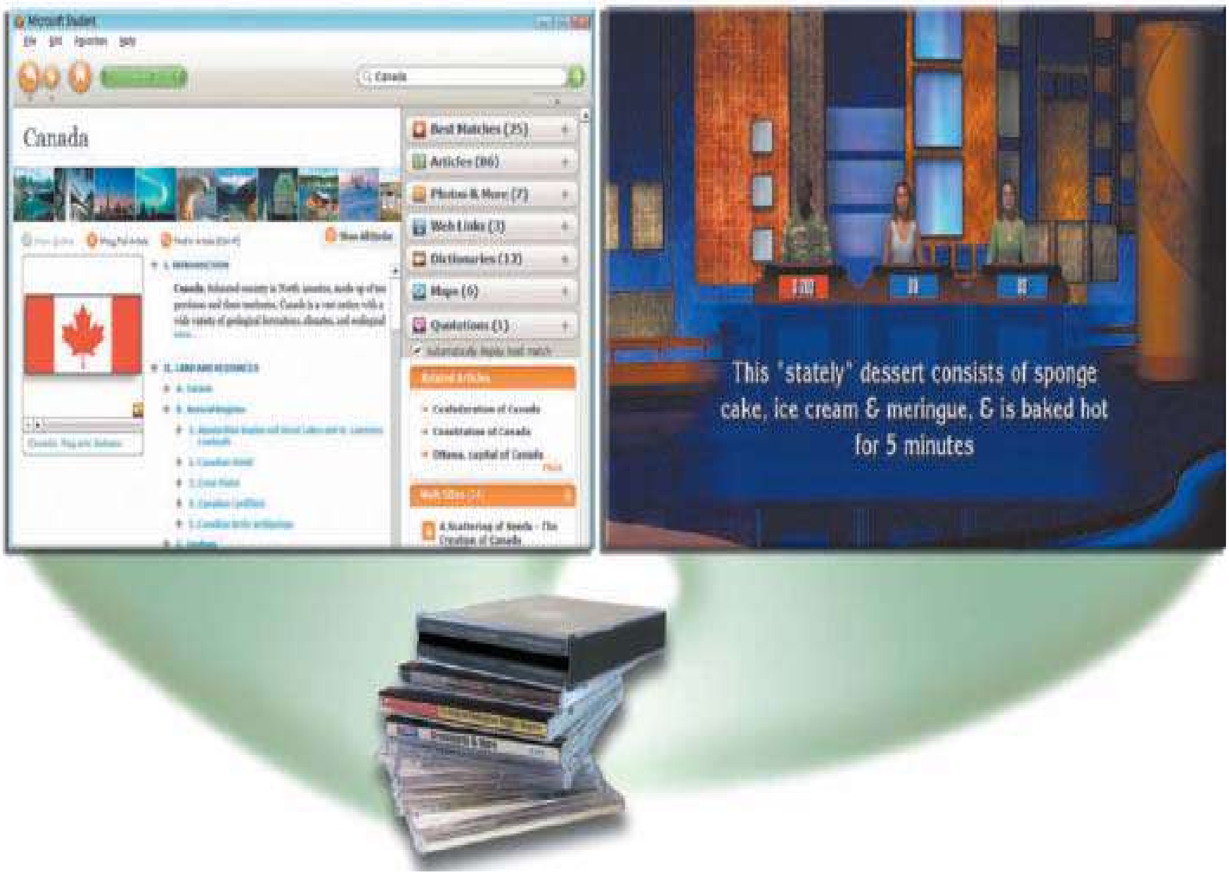


Figure 7-30 Encyclopedias, games, simulations, and many other programs are distributed on CD-ROM.

CD-RW drive. These drives have write speeds of 52X or more, rewrite speeds of 32X or more, and read speeds of 52X or more. Manufacturers state the speeds in this order; that is, write speed, rewrite speed, and read speed is stated as 52/32/52. Most CD-RW drives can read audio CDs, CD-ROMs, CD-Rs, and CD-RWs.

Many personal computers today include either a CD-R or CD-RW drive, or a combination drive that includes CD-R or CD-RW capabilities,as a standard feature so that users can burn their own discs. The process of writing on an optical disc is called *burning*. Some operating systems, such as Windows, include the capability of burning discs. A popular use of CD-RW and CD-R discs is to create audio CDs. For example, users can record their own music and save it on a CD, purchase and download songs from the Web, or re arrange tracks on a purchased music CD. The process of copying audio and/or video data from a purchased disc and saving it on digital media is called *ripping*

Archive Discs and Picture CDs

Many people use archive discs or Picture CDs to preserve their photos. When you post and share photos online on a photo sharing community,you can choose to save your collection of online photos on an archive disc (Figure 7-31). An **archive disc** stores photos from an online photo center in the jpg file format, usually at a maximum resolution of 7200 pixels per photo. The cost of archive discs is determined by the number of photos being stored. One service, for example, charges $9.99 for the first hundred pictures.

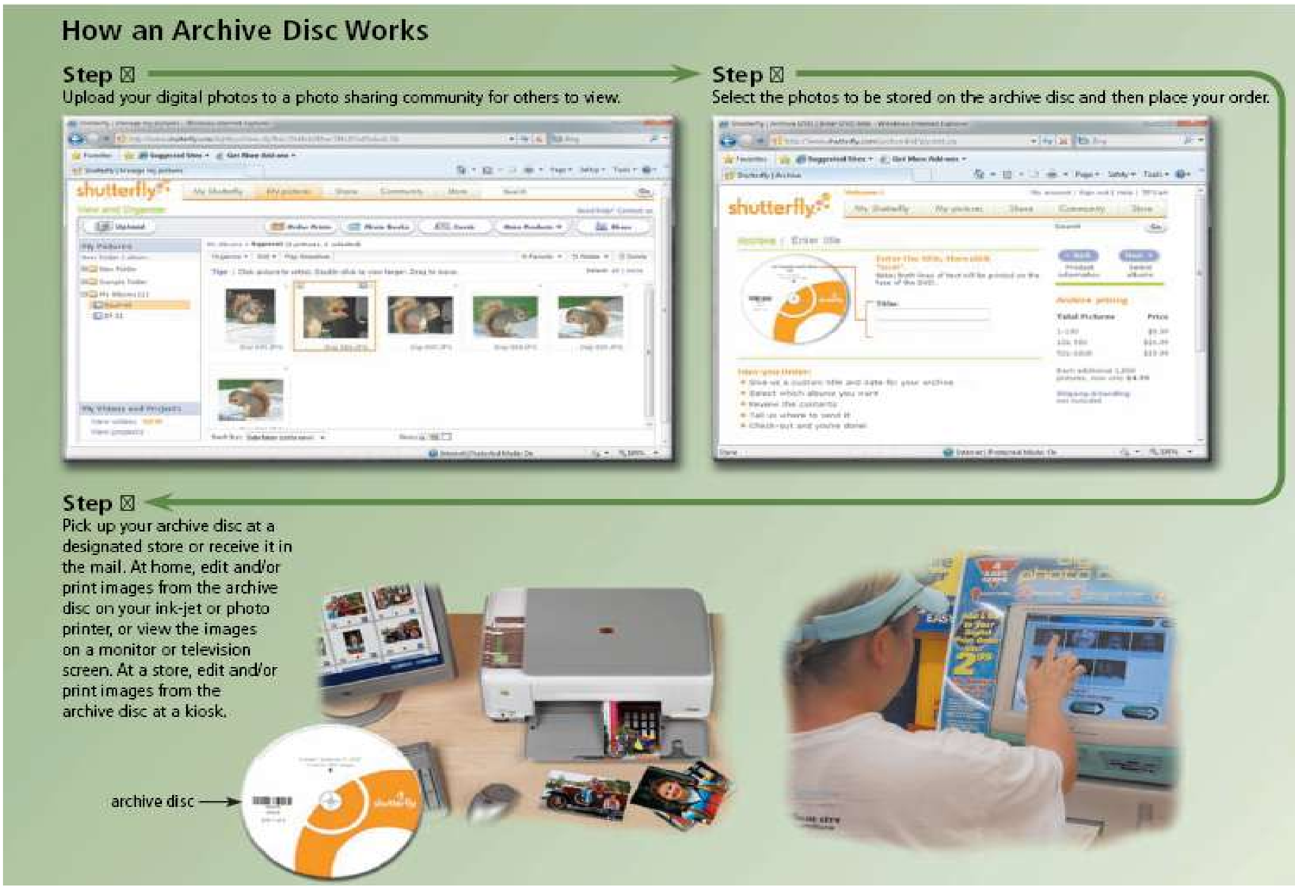


Figure 7-31 This figure shows how an archive disc works.

A Kodak Picture CD is a single-session CD-ROM that stores digital versions of film using a jpg file format at a lower resolution, typically 1024 × 1536 pixels. Many photo centers offer Picture CD service for consumers when they drop off film to be developed. The average cost for a Picture CD is about $3 per roll of film. Most optical disc drives can read an archive disc and a Picture CD. Using photo editing software and photos on these discs, you can remove red eye, crop the photo, enhance colors, trim away edges, adjust the lighting, and edit just about any aspect of a photo. In addition,you can print copies of the photos from the disc on glossy paper with an ink-jet printer. If you do not have a printer to print the images, many stores have kiosks at which you can print pictures from an archive disc, a Picture CD, or other media.

DVDs and Blu-ray Discs

Although the size and shape of a CD and DVD are similar, a DVD stores data, instructions, and information in a slightly different manner and thus achieves a higher storage capacity. DVD quality also far surpasses that of CDs because images are stored at higher resolution. Widely used DVDs are capable of storing 4.7 GB to 17 GB, depending on the storage techniques used. The first storage technique involves making the disc denser by packing the pits closer together. The second involves using two layers of pits. For this technique to work, the lower layer of pits is semitransparent so that the laser can read through it to the upper layer.This technique doubles the capacity of the disc. Finally, some DVDs are double-sided.

A **DVD-ROM** (*digital versatile disc-read-only memory* or *digital video disc-read-only memory*) is a high-capacity optical disc on which users can read but not write or erase. Manufacturers write the contents of DVD-ROMs and distribute them to consumers. DVD-ROMs store movies, music, music videos, huge databases, and complex software (Figure 7-32).

Figure 7-32 A DVD-ROM is a high-capacity optical disc

To read a DVD-ROM, you need a **DVDROM drive** or DVD player. Most DVD-ROM drives also can read audio CDs, CD-ROMs,CD-Rs, and CD-RWs. DVD-ROM drives can read DVDs at speeds of 16X or more and CDs at speeds of 52X or more. Some drives, called DVD/CD-RW drives, are combination drives that read and write DVD and CD media.
Many of today's computers include these combination drives.A newer, more expensive DVD format is Blu-ray, which has a higher capacity and better quality than standard DVDs, especially for high-definition audio and video. A *Blu-ray Disc-ROM (BD-ROM)* has storage capacities of 100 GB, with expectations of exceeding 200 GB in the future. Blu-ray Disc (BD) drives and players are backward compatible with DVD and CD formats. Some game consoles include a Bluray drive. Original Blu-ray Disc drives had read speeds of 4.5 MBps, designated as 1X. Current read/write speeds of Blu-ray Discs range from 9 MBps (2X) to 36 Mbps (8X) in the future. Figure 7-33 compares the current storage capacities of DVD and Blu-ray media.

DVD and Blu-ray Storage Capacities

Sides	Layers	DVD	Blu-ray
1	1	4.7 GB	25 GB
1	2	8.5 GB	50 GB
2	1	9.4 GB	50 GB
2	2	17 GB	100 GB

Figure 7-33 Storage capacities of DVDs and Blu-ray Discs.

Another high density format, called HD VMD,recently emerged as a competitor to Blu-ray. With future technology, an *HD VMD* (*Versatile Multilayer Disc*) potentially will contain up to 20 layers, each with a capacity of 5 GB. Current HD VMDs have capacities of 40 GB and more. A mini-DVD that has grown in popularity is the UMD, which works specifically with the PlayStation Portable (PSP) handheld game console. The *UMD* (Universal Media Disc), which has a diameter of about 2.4 inches, can store up to 1.8 GB of games, movies, or music (Figure 7-34). Similarly, the mini Blu-ray Disc, which is used primarily in digital video recorders, stores approximately 7.5 GB.

Figure 7-34 The PSP handheld game console plays games stored on a UMD.

Recordable and Rewritable DVDs Many types of recordable and rewritable DVD formats are available. *DVD-R* and *DVD+R* are competing DVD-recordable formats, each with up to 4.7 GB storage capacity. Similarly, *BD-R* is a high-capacity DVD-recordable format. Each of these formats allows users to write on the disc once and read (play) it many times. Instead of recordable DVDs, however, most users work with rewritable DVDs because these discs can be written on multiple times and also erased. Three competing rewritable DVD formats, each with storage capacities up to 4.7 GB per side are **DVD-RW, DVD+RW**, and **DVD+RAM**. Likewise, *BD-RE* is a high-capacity rewritable DVD format. To write on these discs, you must have a compatible drive or recorder.

Rewritable drives usually can read a variety of DVD and CD media. Before investing in equipment, check to be sure it is compatible with the media on which you intend to record.

Tape

One of the first storage media used with mainframe computers was tape. **Tape** is a magnetically coated ribbon of plastic capable of storing large amounts of data and information at a low cost. Tape no longer is used as a primary method of storage. Instead, business users utilize tape most often for long-term storage and backup. Comparable to a tape recorder, a **tape drive** reads and writes data and information on a tape. Although older computers used reel-to-reel tape drives, today's tape drives use tape cartridges.

A *tape cartridge* is a small, rectangular, plastic housing for tape (Figure 7-35). Tape cartridges that contain quarter-inch-wide tape are slightly larger than audiocassette tapes. Business suers sometimes back up personal computer hard disks to tape, often using an external tape drive. On larger computers, tape cartridges are mounted in a separate cabinet called a *tape library*. Often, a tape robot automatically retrieves tape cartridges, which are identified by location or bar code. Transfer rates of tape drives range from 1.25 MBps to 6 MBps.

Figure 7-35 A tape drive and a tape cartridge

Tape storage requires *sequential access*, which refers to reading or writing data consecutively.As with a music tape, you must forward or rewind the tape to a specific point to access a specific piece of data. For example, to access item W requires passing through items A through V sequentially.

Hard disks, flash memory storage, and optical discs all use direct access. *Direct access*, also called *random access*, means that the device can locate a particular data item or file immediately, without having to move consecutively through items stored in front of the desired data item or file. When writing or reading specific data, direct access is much faster than sequential access.

Other Types of Storage

In addition to the previously discussed types of storage, other options are available for specific uses and applications. These include tape, magnetic stripe cards and smart cards, microfilm and microfiche, and enterprise storage.

Magnetic Stripe Cards and Smart Cards

A **magnetic stripe card** is a credit card, entertainment card, bank card, or other similar card, with a stripe that contains information identifying you and the card .Information stored in the stripe includes your name, account number,and the card's expiration date. A magnetic stripe card reader reads information stored on the stripe. A **smart card**, which is similar in size to a credit card or ATM card, stores data on a thin microprocessor embedded in the card. Smart cards contain a processor and have input, process, output, and storage capabilities. When you insert the smart card in a specialized card reader,the information on the smart card is read and, if necessary, updated. Some credit cards are smart cards, and some store biometric data such as fingerprints to authenticate a user (Figure 7-36).

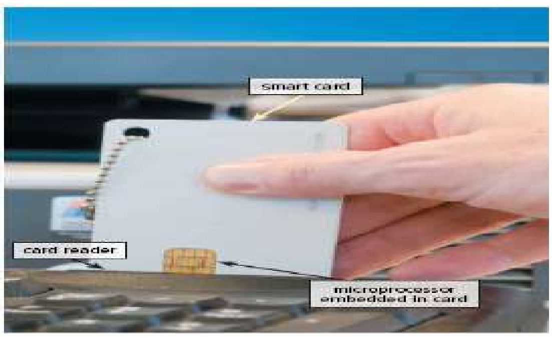


Figure 7-36 This user inserts the smart card to access the computer.

Uses of smart cards include storing medical records, vaccination data, and other health care and identification information; tracking information, such as employee attendance or customer purchases; storing a prepaid amount of money, such as for student purchases on campus; and authenticating users, such as for Internet purchases or building access. In addition, a smart card can double as an ID card.

Microfilm and Microfiche

Microfilm and microfiche store microscopic images of documents on roll or sheet film.

Microfilm is a 100- to 215-foot roll of film. **Microfiche** is a small sheet of film, usually about 4 3 6 inches. A *computer output microfilm recorder* is the device that records the images on the film. The stored images are so small that you can read them only with a microfilm or microfiche reader (Figure 7-37).

Microfilm and microfiche use is widespread, with many companies allowing you to search through and view microfilm images online.

Figure 7-37 Images on microfilm can be read only with a microfilm reader

Libraries use these media to store back issues of newspapers, magazines, and genealogy records. Some large organizations use microfilm and microfiche to archive inactive files. Some banks use them to store transactions and canceled checks. The U.S. Army uses them to store personnel records. The use of microfilm and microfiche provides a number of advantages. They greatly reduce the amount of paper firms must handle. They are inexpensive and have the longest life of any storage media (Figure 7-38).

Media Life Expectancies* (when using high-quality media)

Media Type	Guaranteed Life Expectancy	Potential Life Expectancy
Magnetic disks	3 to 5 years	20 to 30 years
Optical discs	5 to 10 years	50 to 100 years
Solid state drives	50 years	140 years
Microfilm	100 years	500 years

* according to manufacturers of the media

Figure 7-38 Microfilm is the medium with the longest life.

Enterprise Storage

A large business, commonly referred to as an enterprise, has hundreds or thousands of employees in offices across the country or around the world. Enterprises use computers and computer networks to manage and store huge volumes of data and information about customers, suppliers, and employees (Figure 7-39).

Figure 7-39 An enterprise uses high-capacity storage devices.

To meet their large-scale needs, enterprises use special hardware geared for heavy use, maximum availability, and maximum efficiency. One or more servers on the network have the sole purpose of providing storage to connected users.

For high-speed storage access, entire networks are dedicated exclusively to connecting devices that provide storage to other servers. In an enterprise, some storage systems can provide more than 185 TB of storage capacity. Optical disc servers hold hundreds of optical discs.

An enterprise's storage needs usually grow daily. Thus, the storage solutions an enterprise chooses must be able to store its data and information requirements today and tomorrow.

Categories of Users

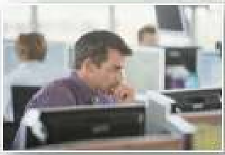
User	Typical Storage Devices
Home 	• 500 GB hard disk • Cloud storage • Optical disc drive • Card reader/writer • USB flash drive
Small Office/Home Office 	• 1 TB hard disk • Cloud storage • Optical disc drive • External hard disk for backup • USB flash drive
Mobile 	• 250 GB hard disk • Cloud storage • Optical disc drive • Card reader/writer • Portable hard disk for backup • USB flash drive
Power 	• 2.5 TB hard disk • Cloud storage • Optical disc drive • Portable hard disk for backup • USB flash drive
Enterprise 	• Desktop Computer - 1 TB hard disk - Optical disc drive - Smart card reader - Tape drive - USB flash drive • Server or Mainframe - Network storage server - 40 TB hard disk system - Optical disc server - Microfilm or microfiche

Figure 7-40 Recommended storage devices for various users .

Chapter Exercises

True/False Mark T for True and F for False.

_____ 1. A storage medium, also called secondary storage, is the physical material on which a computer keeps data, instructions, and information.

_____ 2. Reading is the process of transferring data, instructions, and information from memory to a storage medium

_____ 3. Formatting is the process of dividing the disk into clusters and cylinders.

_____ 4. A cluster can hold data from many files.

_____ 5. A typical hard disk contains only one platter.

_____ 6. A removable hard disk is a separate, freestanding hard disk that connects with a cable to a port on the system unit or communicates wirelessly.

_____ 7. microSD and miniSDHC are common types of removable hard disks.

_____ 8. ExpressCard modules can be used to add memory, storage, communications, multimedia, and security capabilities to a computer.

_____ 9. The process of writing on an optical disc is called ripping.

_____ 10. HD VMDs have a capacity of 40 GB and more.

_____ 11. BD-R is an older low-capacity DVD-recordable format.

_____ 12. Rewritable drives usually can read one type of media.

_____ 13. Direct access means that the device can locate a particular data item or file immediately, without having to move consecutively through items stored in front of the desired data item or file.

Multiple Choice Select the best answer.

1. _____ is the speed with which data, instructions, and information transfer to and from a device.
a. Access time b. Transfer rate c. Formatting d. Reading

2. Traditionally, hard disks stored data using _____, which aligned the magnetic particles horizontally around the surface of the disk.
a. LightScribe technology b. RAID
c. longitudinal recording d. perpendicular recording

3. A group of two or more integrated hard disks is called a _____.
a. backup b. disk cache c. portable hard disk d. RAID

4. Users subscribe to a cloud storage service to _____.
a. save time by storing large files instantaneously
b. allow others to access their files

c. store offsite backups of data
d. all of the above

5. A(n) _____ is a type of storage media that consists of a flat, round, portable disc made of metal, plastic, and lacquer that is written and read by a laser.
a. optical disc b. hard disk c. memory card d. thumb drive

6. _____ technology works with specially coated optical discs to etch labels directly on the disc.
a. SCSI b. SATA c. LightScribe d. LightSaber

7. On larger computers, tape cartridges are mounted in a separate cabinet called a(n) _____.
a. SATA (Serial Advanced Technology Attachment) b. tape library
c. tape cartridge d. HD VMD

8. A _____ card is a credit card, entertainment card, bank card, or other similar card, with a stripe that contains information identifying you and the card.
a. Secure Digital High Capacity b. magnetic stripe
c. Secure Digital d. microSDHC

Matching Match the terms with their definitions.

_____ 1. capacity	a. vertical section of a track that passes through all platters
_____ 2. cluster	b. external disk interface that is much faster than USB and FireWire
_____ 3. cylinder	c. smallest unit of disk space that stores data and information
_____ 4. head crash	d. special-purpose chip and electronic circuits that control the transfer of items to and from the system bus
_____ 5. backup	e. occurs when a read/write head touches the surface of a platter on a hard disk
_____ 6. disk cache	f. duplicate of a file, program, or disk placed on a separate storage medium that you can use in case the original is lost, damaged, or destroyed
_____ 7. disk controller	g. a storage device that typically uses flash memory to store data, instructions,and information
_____ 8. eSATA	h. the number of bytes (characters) a storage medium can hold
_____ 9. solid state media	i. media which consist entirely of electronic components, such as integrated circuits, and contain no moving parts
_____ 10. solid state drive	j. memory chips that the processor uses to store frequently accessed items

Short Answer Write a brief answer to each of the following questions.

1 What is network attached storage? ____________ How much hard disk storage can home and small business users add to their network with a NAS device? ____________

2. What are the advantages of SAS (serial-attached SCSI)? ____________ What types of devices can be connected to SAS interfaces? ____________

3. How is a single-session disc different from a multisession disc? ____________ What is the purpose of archive discs and Picture CDs? ____________

4. Why do users use memory cards? _____________ Name five types of memory cards and describe some of the characteristics of each card. _____________

5. What is one difference between microfilm and microfiche? _____________ What are some uses of microfilm and microfiche? _____________

Chapter Eight

Operating Systems and Utility Programs

System Software

When you purchase a personal computer, it usually has system software installed on its hard disk. **System software** consists of the programs that control or maintain the operations of the computer and its devices. System software serves as the interface between the user, the application software, and the computer's hardware. Two types of system software are operating systems and utility programs. This chapter discusses the operating system and its functions, as well as several types of utility programs for personal computers.

Operating Systems

An **operating system** (**OS**) is a set of programs containing instructions that work together to coordinate all the activities among computer hardware resources. Most operating systems perform similar functions that include starting and shutting down a computer, providing a user interface, managing programs, managing memory, coordinating tasks, configuring devices, establishing an Internet connection, monitoring performance, providing file management and other utilities, and automatically updating itself and certain utility programs. Some operating systems also allow users to control a network and administer security (Figure 8-1).

Although an operating system can run from an optical disc and/or flash memory mobile media, in most cases, the operating system is installed and resides on the computer's hard disk. On handheld computers and many mobile devices such as smart phones, the operating system may reside on a ROM chip.

Different sizes of computers typically use different operating systems because operating systems generally are written to run on a specific type of computer. For example, a mainframe computer does not use the same operating system as a personal computer.

Even the same types of computers, such as desktop computers, may not use the same operating system. Some, however, can run multiple operating systems. When purchasing application software, you must ensure that it works with the operating system installed on your computer or mobile device.

The operating system that a computer uses sometimes is called the *platform*. With purchased application software, the package or specifications identify the required platform (operating system). A *cross-platform* program is one that runs the same on multiple operating systems.

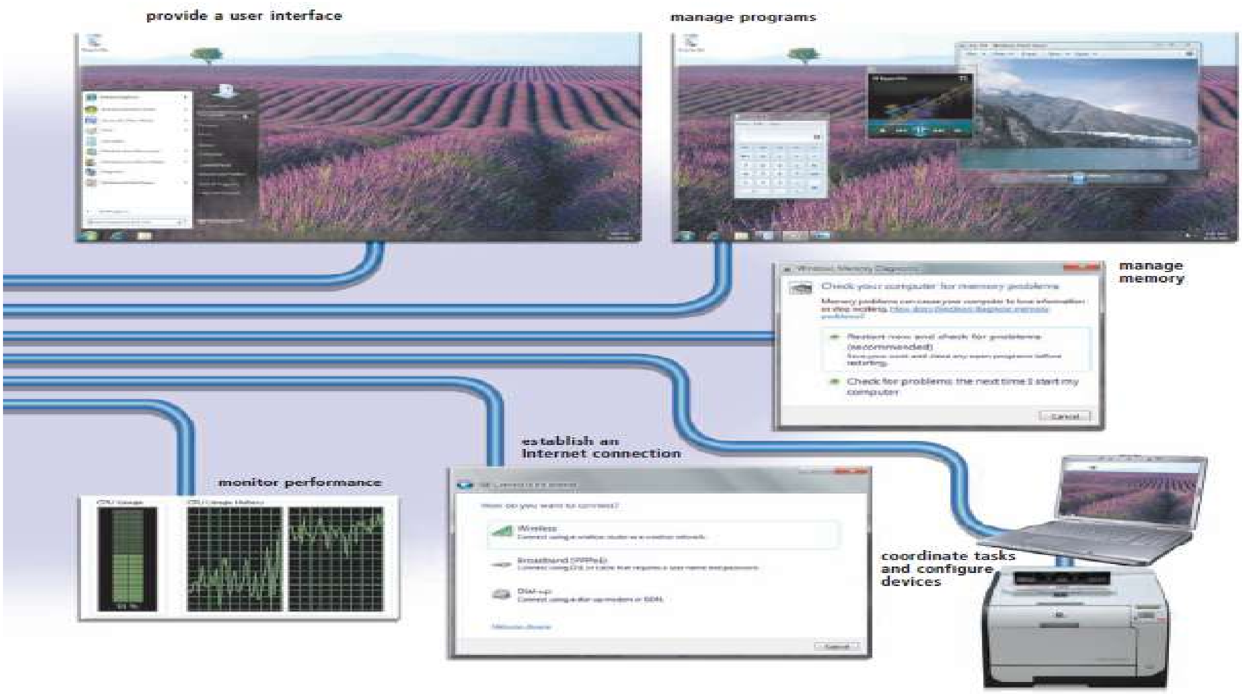


Figure 8-1 Most operating systems perform similar functions, which are illustrated with the latest version of Windows in this figure.

Operating System Functions

Many different operating systems exist, designed for all types of computers. Regardless of the size of the computer, however, most operating systems provide similar functions. The following sections discuss functions common to most operating systems. The operating system handles many of these functions automatically, without requiring any instructions from a user.

Starting and Shutting Down a Computer

The process of starting or restarting a computer is called **booting**. When turning on a computer that has been powered off completely, you are performing a **cold boot**. A **warm boot**, by contrast, is the process of using the operating system to restart a computer. A warm boot properly closes any running processes and programs; however, it does not save any unsaved work. Thus, always remember to save your work before rebooting (restarting) a computer.

With Windows, you can perform a warm boot by clicking the Start button on the taskbar, clicking the arrow next to the Shut down button on the Start menu, and then clicking Restart (Figure 8-2).

When you install new software or update existing software, often an on-screen prompt instructs you to restart the computer. In this case, a warm boot is appropriate. If the computer stops responding, try pressing and holding down the power button to turn off the computer. As a last resort, remove power from the computer and then restart the computer. On newer computers, pressing the power button momentarily is the same as a warm boot, whereas pressing and holding the power button does not properly close running processes and programs.

Each time you boot a computer, the kernel and other frequently used operating system instructions are loaded, or copied, from storage into the computer's memory (RAM). The *kernel* is the core of an operating system that manages memory and devices, maintains the computer's clock, starts programs, and assigns the computer's resources, such as devices, programs, data, and information. The kernel is *memory resident*, which means it remains in memory while the computer is running. Other parts of the operating system are *nonresident*, that is, these instructions remain on a storage medium until they are needed.

When you boot a computer, a series of messages may appear on the screen. The actual information displayed varies depending on the make and type of the computer and the equipment installed. The boot process, however, is similar for large and small computers. The steps in the following paragraphs explain what occurs during a cold boot on a personal computer using the Windows operating system. The steps in Figure 8-3 illustrate and correspond to the steps discussed in the following paragraphs.

Step 1: When you turn on the computer, the power supply sends an electrical signal to the components in the system unit.

Step 2: The charge of electricity causes the processor chip to reset itself and find the ROM chip(s) that contains the BIOS. The **BIOS** (pronounced BYE-ose), which stands for *basic input/output system*, is firmware that contains the computer's startup instructions.

Step 3: The BIOS executes a series of tests to make sure the computer hardware is connected properly and operating correctly. The tests, collectively called the *power-on self test* (*POST*), check the various system components including the buses, system clock, adapter cards, RAM chips, mouse, keyboard, and drives. As the POST executes, LEDs (tiny lights) flicker on devices such as the disk drives and keyboard. Beeps also may sound, and messages may appear on the screen.

Step 4: The POST results are compared with data in a CMOS chip. As discussed in Chapter 4, CMOS is a technology that uses battery power to retain information when the computer is off.

The CMOS chip stores configuration information about the computer, such as the amount of memory; type of disk drives, keyboard, and monitor; the current date and time; and other startup information. It also detects any new devices connected to the computer. If any problems are identified, the computer may beep, display error messages, or cease operating — depending on the severity of the problem.

Figure 8-2 To reboot a running computer, click the Shut down button arrow and then click Restart.

Step 5: If the POST completes successfully, the BIOS searches for specific operating system files called *system files*. The BIOS may look first to see if a USB flash drive plugged in a USB port or a disc in an optical disc drive contains the system files, or it may look directly on drive C (the designation usually given to the first hard disk) for the system files.

Step 6: Once located, the system files load into memory (RAM) from storage (usually the hard disk) and execute. Next, the kernel of the operating system loads into memory. Then, the operating system in memory takes control of the computer.

Step 7: The operating system loads system configuration information. In the latest Windows versions, the *registry* consists of several files that contain the system configuration information. Windows constantly accesses the registry during the computer's operation for information such as installed hardware and software devices and individual user preferences for mouse speed, passwords, and other information. In addition, the Windows registry constantly checks credentials of users to verify they have the necessary privileges to run programs.

Necessary operating system files are loaded into memory. On some computers, the operating system verifies that the person attempting to use the computer is a legitimate user. Finally, the Windows desktop and icons are displayed on the screen. The operating system executes programs in the *Startup folder*, which contains a list of programs that open automatically when you boot the compute.

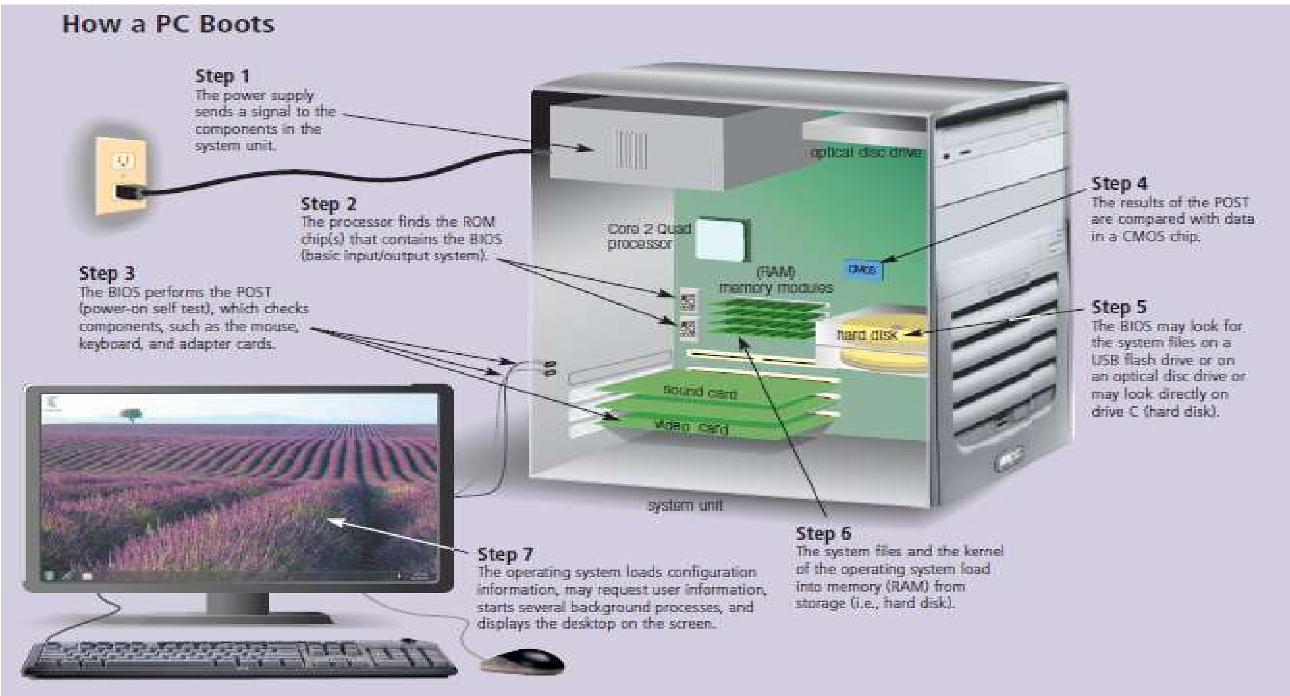


Figure 8-3 This figure shows how a PC boots.

Boot Disk A **boot drive** is the drive from which your personal computer boots (starts). In most cases, drive C (the hard disk) is the boot drive. Sometimes a hard disk becomes damaged and the computer cannot boot from the hard disk, or you may want to preview an operating system without installing it. In these cases, you can boot from a special disk, called a **boot disk** or a **recovery disk**, that contains a few system files that will start the computer. When the word, Live, is used with a type of media, such as Live CD or Live USB, this usually means the media can be used to boot the computer.

When you purchase a computer, it usually includes a boot disk in the form of an optical disc. If you do not have a boot disk, the operating system may provide a means to create one. With the latest versions of Windows, the installation disc is itself a boot disk, which you can use to start Windows in the event you cannot boot from the hard disk.

Shut Down Options Although some users leave their computers running continually and never turn them off, others choose to shut them down. Shut down options including powering off the computer, placing the computer in sleep mode, and hibernating the computer. Both sleep mode and hibernate, which store the current state of all open programs and documents, are designed to save time when you resume working on the computer. *Sleep mode* saves any open documents and programs to RAM, turns off all unneeded functions, and then places the computer in a low-power state. If, for some reason, power is removed from a computer that is in sleep mode, any unsaved work could be lost. *Hibernate*, by contrast, saves any open documents and programs to a hard disk before removing power from the computer.

The function of the Power button on a computer or mobile device varies, and users typically are able to configure its default behavior. When you press the Power button on a desktop computer, for example, it may place the computer in sleep mode or hibernate it. Pressing and holding down the Power button may remove all power from the computer. Closing the lid on a notebook computer may place the computer in a low-power state. The operating system also usually presents shut down options in menus, dialog boxes, or other means.

Providing a User Interface

You interact with software through its user interface. That is, a **user interface** controls how you enter data and instructions and how information is displayed on the screen. Two types of user interfaces are graphical and command-line. Operating systems often use a combination of these interfaces to define how a user interacts with a computer.

Graphical User Interface Most users today work with a graphical user interface. With a *graphical user interface* (*GUI*), you interact with menus and visual images such as buttons and other graphical objects to issue commands. Many current GUI operating systems incorporate features similar to those of a Web browser, such as links and navigation buttons (i.e., Back button and Forward button). Some GUI operating systems provide access to command-line interfaces, which are discussed in the next section.

Windows, for example, offers two different GUIs, depending on your hardware configuration. Computers with less than 1 GB of RAM work with the Windows 7 Basic interface (Figure 8-4a). Computers with more than 1 GB of RAM that have the required hardware may be able to work with the Windows 7 Aero interface, also known as *Windows Aero* (Figure 8-4b), which provides an enhanced visual look, additional navigation options, and animation.

Figure 8-4 Windows 7 offers two different graphical user interfaces, depending on your hardware configuration.

Command-Line Interface

To configure devices, manage system resources, and troubleshoot network connections, network administrators and other advanced users work with a command-line interface. In a *command-line interface,* a user types commands or presses special keys on the keyboard (such as function keys or key combinations) to enter data and instructions (Figure 8-5).

Figure 8-5 A command-line interface requires you enter exact spelling, grammar, and punctuation.

Some people consider command-line interfaces difficult to use because they require exact spelling, grammar, and punctuation. Minor errors, such as a missing period, generate an error message. Command-line interfaces, however, give a user more control to manage detailed settings.

When working with a command line interface, the set of commands entered into the computer is called the *command language*.

Managing Programs

Some operating systems support a single user and only one running program at a time. Others support thousands of users running multi ple programs. How an operating system handles programs directly affects your productivity.

A *single user/single tasking* operating system allows only one user to run one program at a time. For example, if you are working in a graphics program and want to check e-mail messages, you must quit the graphics program before you can run the e-mail program. Early systems were single user/single tasking. Smart phones and other mobile devices, however, often use a single user/single tasking operating system. Most other operating systems today are multitasking.

A *single user/multitasking* operating system allows a single user to work on two or more programs that reside in memory at the same time. Using the example just cited, if you are working with a single user/multitasking operating system, you do not have to quit the graphics program to run the e-mail program. Both programs can run concurrently. Users today typically run multiple programs concurrently. It is common to have an e-mail program and Web browser open at all times, while working with application programs such as word processing or graphics.

When a computer is running multiple programs concurrently, one program is in the foreground and the others are in the background. The one in the *foreground* is the active program, that is, the one you currently are using. The other programs running but not in use are in the *background*. In Figure 8-6, the Windows

Figure 8-6 The foreground program, Windows Live Movie Maker, is displayed on the desktop.

The other programs (Windows Media Player, Microsoft PowerPoint, and Chess Titans) are in the background.

Live Movie Maker program is in the foreground, and three other programs are running in the background (Windows Media Player, Microsoft PowerPoint and Chess Titans). For example, Windows Media Player can play music while you create a movie. The foreground program typically displays on the desktop, and the background programs are hidden partially or completely behind the foreground program. You easily can switch between foreground and background programs. To make a program active (in the foreground) in Windows, click its program button on the taskbar. This causes the operating system to place all other programs in the background.
In addition to application programs, an operating system manages other processes. These processes include utilities or routines that provide support to other programs or hardware. Some are memory resident. Others run as they are required. Figure 8-7 shows a list of some processes running on a Windows computer. The list contains the applications programs running, as well as other programs and processes.
Some operating systems use preemptive multitasking to prevent any one process from monopolizing the computer's resources. With *preemptive multitasking*, the operating system interrupts a program that is executing and passes control to another program waiting to be executed. An advantage of preemptive multitasking is the operating system regains control if one program stops operating properly. A *multiuser* operating system enables two or more users to run programs simultaneously. Networks, servers, mainframes, and super computers allow hundreds to thousands of users to connect at the same time, and thus are multiuser. A *multiprocessing* operating system supports two or more processors running programs at the same time. Multiprocessing involves the coordinated processing of programs by more than one processor. Multiprocessing increases a computer's processing speed. A computer with separate processors also can serve as a fault-tolerant computer. A *fault-tolerant computer* continues to operate when one of its components fails, ensuring that no data is lost. Fault-tolerant computers have duplicate components such as processors, memory, and disk drives. If any one of these components fails, the computer switches to the duplicate component and continues to operate. Airline reservation systems, communications networks, automated teller machines, and other systems that must be operational at all times use fault-tolerant computers.

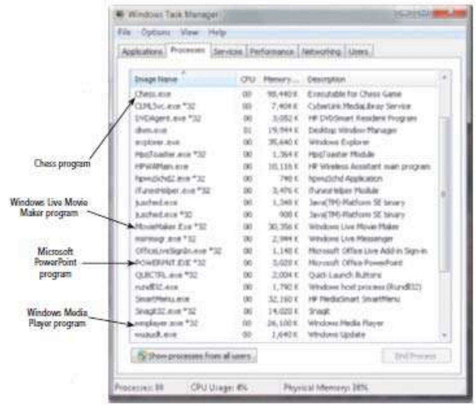


Figure 8-7 An operating system manages multiple programs and processes while you use the computer.

Managing Memory

The purpose of **memory management** is to optimize the use of random access memory (RAM). As Chapter 4 discussed, RAM consists of one or more chips on the motherboard that hold items such as data and instructions while the processor interprets and executes them. The operating system allocates, or assigns, data and instructions to an area of memory while they are being processed.
Then, it carefully monitors the contents of memory. Finally, the operating system releases these items from being monitored in memory when the processor no longer requires them.
If you have multiple programs running simultaneously, it is possible to run out of RAM. For example, assume an operating system requires 512 MB of RAM, an antivirus program — 256 MB of RAM, a Web browser — 128 MB of RAM, a business software suite — 512 MB of RAM, and a photo editing program — 256 MB of RAM. With all these programs running simultaneously, the total

RAM required would be 1664 MB of RAM (512 + 256 + 128 + 512 + 256). If the computer has only 1 GB of RAM, the operating system may have to use virtual memory to solve the problem

With **virtual memory**, the operating system allocates a portion of a storage medium, usually the hard disk, to function as additional RAM (Figure 8-8). As you interact with a program, part of it may be in physical RAM, while the rest of the program is on the hard disk as virtual memory.
Because virtual memory is slower than RAM, users may notice the computer slowing down while it uses virtual memory.
The area of the hard disk used for virtual memory is called a *swap file* because it swaps (exchanges) data, information, and instructions between memory and storage. A *page* is the amount of data and program instructions that can swap at a given time.
The technique of swapping items between memory and storage, called *paging*, is a time-consuming process for the computer.
When an operating system spends much of its time paging, instead of executing application software, it is said to be *thrashing*. If application software, such as a Web browser, has stopped responding and the hard disk's LED blinks repeatedly, the operating system probably is thrashing.
Instead of using a hard disk as virtual memory, Windows users can increase the size of memory through *Windows ReadyBoost,* which can allocate available storage space on removable flash memory devices as additional memory cache. Users notice better performance with Windows ReadyBoost versus hard disk virtual memory because the operating system accesses a flash memory device, such as a USB flash drive or SD memory card, more quickly than it accesses a hard disk. Sometimes, one user may have a higher priority than other users. In this case, the operating system adjusts the schedule of tasks.

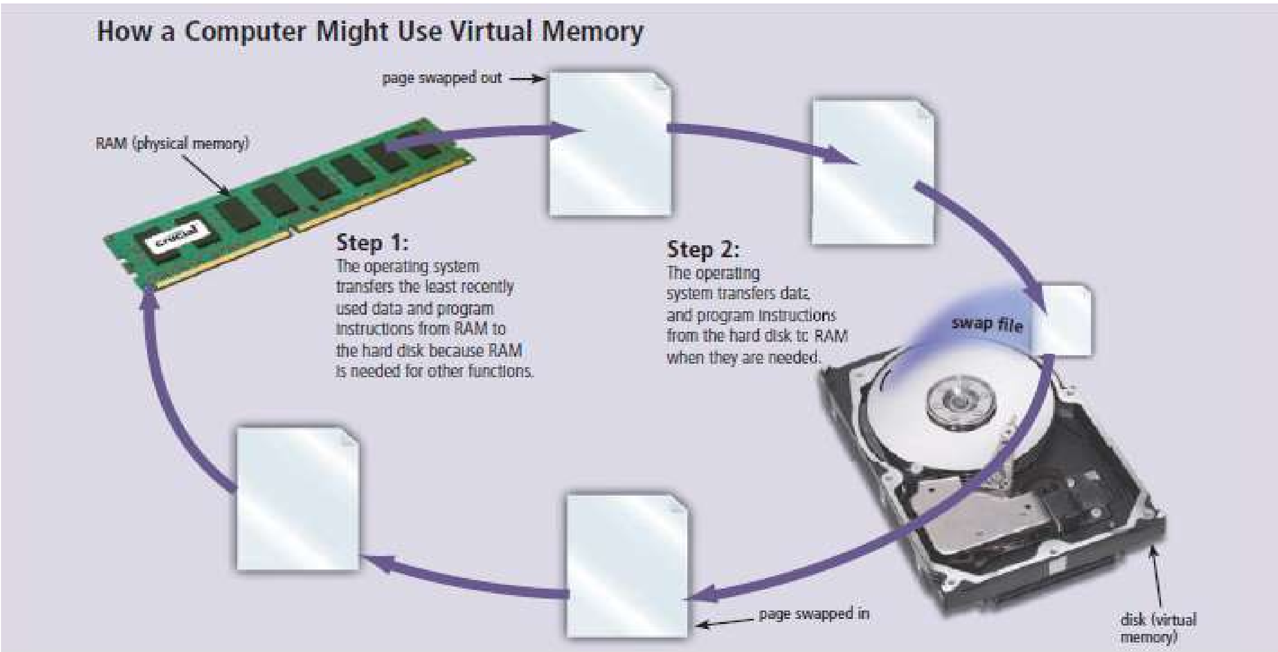


Figure 8-8 This figure shows how a computer might use virtual memory

Coordinating Tasks
The operating system determines the order in which tasks are processed. A task, or job, is an operation the processor manages. Tasks include receiving data from an input device, processing instructions, sending information to an output device, and transferring items from storage to memory and from memory to storage.

A mulituser operating system does not always process tasks on a first-come, first-served basis. Sometimes, a device already may be busy processing one task when it receives a second task. This occurs because the processor operates at a much faster rate of speed than peripheral devices.

For example, if the processor sends five documents to a printer, the printer can print only one document at a time and store as many documents as its memory can handle. While waiting for devices to become idle, the operating system places items in buffers. A **buffer** is a segment of memory or storage in which items are placed while waiting to be transferred from an input device or to an output device. The operating system commonly uses buffers with printed documents. This process, called **spooling**, sends documents to be printed to a buffer instead of sending them immediately to the printer. If a printer does not have its own internal memory or if its memory is full, the operating system's buffer holds the documents waiting to print while the printer prints from the buffer at its own rate of speed. By spooling documents to a buffer, the processor can continue interpreting and executing instructions while the printer prints. This allows users to work on the computer for other activities while a printer is printing. Multiple documents line up in a **queue** (pronounced Q) in the buffer. A program, called a *print spooler*, intercepts documents to be printed from the operating system and places them in the queue (Figure 8-9).

Figure 8-9 Spooling increases both processor and printer efficiency by placing documents to be printed in a buffer on disk before they are printed. This figure illustrates three documents in the queue with one document printing.

Configuring Devices

A **driver**, short for *device driver*, is a small program that tells the operating system how to communicate with a specific device. Each device on a computer, such as the mouse, keyboard, monitor, printer, card reader/writer, and scanner, has its own specialized set of commands and thus requires its own specific driver. When you boot a computer, the operating system loads each device's driver. These devices will not function without their correct drivers.

If you attach a new device to a computer, such as a printer or scanner, its driver must be installed before you can use the device. Today, most devices and operating systems support Plug and Play. As discussed in Chapter 4, **Plug and Play** means the operating system automatically configures new devices as you install them. Specifically, it assists you in the device's installation by loading the necessary drivers automatically and checking for conflicts with other devices. With Plug and Play, a user plugs in a device, turns on the computer, and then uses the device without having to configure the system manually. Devices that connect to a USB port on the system unit typically are Plug and Play.

Manufacturers often update a device's driver. For example, the update may enable the device to work with a new operating system, or it may improve the reliability of the device. You can visit the manufacturer's Web site to determine if a driver has been updated. In some cases, you may be notified that a driver has been updated.
Always be sure to install updated drivers. Internet connections as soon as you connect to the broadband line. Otherwise, Windows includes a Set Up a Connection or Network wizard that guides users through the process of setting up a connection between a computer and an Internet access provider (Figure 8-10).

Some operating systems also include a Web browser and an e-mail program, enabling you to begin using the Web and communicate with others as soon as you set up the Internet connection. Some also include utilities to protect computers from unauthorized intrusions and unwanted software such as viruses and spyware.

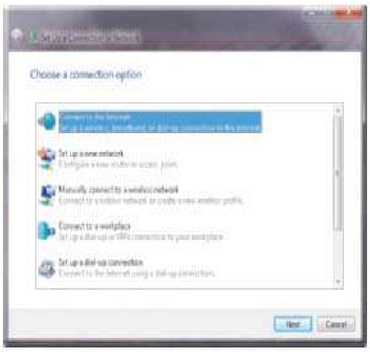


Figure 8-10 To connect to a network using Windows, click the Start button, click Control Panel, click Network and Internet, click Network and Sharing Center, and then click 'Set up a new connection or network' to open the window shown here.

Monitoring Performance
Operating systems typically contain a performance monitor. A **performance monitor** is a program that assesses and reports information about various computer resources and devices (Figure 8-11). For example, users can monitor the processor, disks, network, and memory usage.

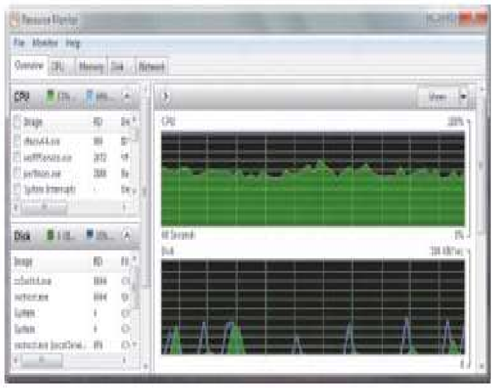


Figure 8-11 The Windows Resource Monitor above is tracking CPU (processor), disk, network, and memory usage.

The information in performance reports helps users and administrators identify a problem with resources so that they can try to resolve any problems. If a computer is running extremely slow, for example, the performance monitor may determine that the computer's memory is being used to its maximum. Thus, you might consider installing additional memory in the computer.

Providing File Management and Other Utilities

Operating systems often provide users with the capability of managing files, searching for files, viewing images, securing a computer from unauthorized access, uninstalling programs, cleaning up disks, defragmenting disks, diagnosing problems, backing up files and disks, and setting up screen savers. A later section in the chapter discusses these and other utilities in depth.

Updating Software Automatically
Many popular programs, including most operating systems, include an **automatic update** feature that automatically provides updates to the program. With an operating system, these updates can include fixes to program *bugs*, or errors, enhancements to security, modifications to device drivers, access to new or expanded components such as desktop themes or games, and even updates to application software on the computer such as a Web browser or an e-mail program (Figure 8-12).

Figure 8-12 With Windows Update, you can download and install important operating system and utility updates.

Many software makers provide free downloadable updates, sometimes called a *service pack*, to users who have registered and/or activated their software. With operating systems, the automatic update feature automatically alerts users when an update is available; further, it can be configured to download and install the update automatically. Users without an Internet connection usually can order the updates on an optical disc for a minimal shipping fee.

Controlling a Network

Some operating systems are designed to work with a server on a network. A **server operating system** is an operating system that organizes and coordinates how multiple users access and share resources on a network. Resources include hardware, software, data, and information. For example, a server operating system allows multiple users to share a printer, Internet access, files, and programs. Some operating systems have network features built into them. In other cases, the server operating system is a set of programs separate from the operating system on the client computers that access the network. When not connected to the network, the client computers use their own operating system. When connected to the network, the server operating system may assume some of the operating system functions. The *network administrator*, the person overseeing network operations, uses the server operating system to add and remove users, computers, and other devices to and from the network. The network administrator also uses the server operating system to install software and administer network security.

Administering Security

Computer and network administrators typically have an *administrator account* that enables them to access all files and programs on the computer or network, install programs, and specify settings that affect all users on a computer or network.
Settings include creating user accounts and establishing permissions. These *permissions* define who can access certain resources and when they can access those resources. For each user, the computer or network administrator establishes a user account, which enables a user to access, or **log on** to, a computer or a network (Figure 8-13).

Figure 8-13 Most multiuser operating systems allow each user to log on, which is the process of entering a user name and a password into the computer.

Each user account typically consists of a user name and password. A **user name**, or **user ID**, is a unique combination of characters, such as letters of the alphabet or numbers, that identifies one specific user. Many users select a combination of their first and last names as their user name. A user named Henry Baker might choose H Baker as his user name.

A **password** is a private combination of characters associated with the user name that allows access to certain computer resources. Some operating systems allow the computer or network administrator to assign passwords to files and commands, restricting access to only authorized users.

To prevent unauthorized users from accessing computer resources, keep your password confidential.
While users type a password, most computers hide the actual password characters by displaying some other characters, such as asterisks (*) or dots. After entering a user name and password, the operating system

compares the user's entry with a list of authorized user names and passwords. If the entry matches the user name and password kept on file, the operating system grants the user access. If the entry does not match, the operating system denies access to the user. The operating system records successful and unsuccessful logon attempts in a file. This allows the computer or network administrator to review who is using or attempting to use the computer. The administrators also use these files to monitor computer usage. To protect sensitive data and information further as it travels over a network, the operating system may encrypt it. *Encryption* is the process of encoding data and information into an unreadable form. Administrators can specify that data be encrypted as it travels over a network to prevent unauthorized users from reading the data. When an authorized user attempts to read the data, it automatically is decrypted, or converted back into a readable form.

Types of Operating Systems

Many of the first operating systems were device dependent and proprietary. A *vicedependent* program is one that runs only on a specific type or make of computer. *Proprietary software* is privately owned and limited to a specific vendor or computer model. Some operating systems still are device dependent. The trend today, however, is toward *device-independent* operating systems that run on computers provided by a variety of manufacturers. The advantage of device independent operating systems is you can retain existing application soft ware and data files even if you change computer models or vendors.

When you purchase a new computer or mobile device, it typically has an operating system preinstalled. As new versions of the operating system are released, users upgrade their existing computers and mobile devices to incorporate features of the new version. Purchasing an operating system upgrade usually costs less than purchasing the entire operating system.
New versions of an operating system usually are backward compatible. that is, they recognize and work with application software written for an earlier version of the operating system (or platform).

The application software, by contrast, may or may not be upward compatible, meaning it may or may not run on new versions of the operating system.
The three basic categories of operating systems that exist today are stand-alone, server, and embedded.

The table in Figure 8-14 lists specific names of operating systems in each category. The following pages discuss a variety of operating systems.

Categories of Operating Systems

Category	Operating System Name
Stand-alone	• DOS • Early Windows versions (Windows 3.x, Windows 95, Windows NT Workstation, Windows 98, Windows 2000 Professional, Windows Millennium Edition, Windows XP, Windows Vista) • Windows 7 • Mac OS X • UNIX • Linux
Server	• Early Windows Server versions (Windows NT Server, Windows 2000 Server, Windows Server 2003) • Windows Server 2008 • UNIX • Linux • Solaris • NetWare
Embedded	• Windows Embedded CE • Windows Mobile • Palm OS • iPhone OS • BlackBerry • Google Android • Embedded Linux • Symbian OS

Figure 8-14 Examples of stand-alone, server, and embedded operating systems. Some stand-alone operating systems include the capability of configuring small home or office networks.

Stand-Alone Operating Systems

A **stand-alone operating system** is a complete operating system that works on a desktop computer, notebook computer, or mobile computing device. Some stand-alone operating systems are called *client operating systems* because they also work in conjunction with a server operating system. Client operating systems can operate with or without a network. Other stand-alone operating systems include networking capabilities, allowing the home and small business user to set up a small network.
Examples of currently used stand-alone operating systems are Windows 7, Mac OS X,

UNIX, and Linux. The following pages briefly discuss these operating systems.

Windows 7

In the mid-1980s, Microsoft developed its first version of Windows, which provided a graphical user interface (GUI). Since then, Microsoft continually has updated its Windows operating system, incorporating innovative features and functions with each subsequent version (Figure8-15).

Highlights of Stand-Alone Windows Versions

Windows Version	Year Released	Highlights
Windows 3.x	1990	• Provided a GUI • An operating environment only — worked in combination with DOS
Windows NT 3.1	1993	• Client OS that connected to a Windows NT Advanced Server • Interface similar to Windows 3.x
Windows 95	1995	• True multitasking operating system • Improved GUI • Included support for networking, Plug and Play technology, longer file names, and e-mail
Windows NT Workstation 4.0	1996	• Client OS that connected to a Windows NT Server • Interface similar to Windows 95 • Network integration
Windows 98	1998	• Upgrade to Windows 95 • More integrated with the Internet; included *Internet Explorer* (a Web browser) • Faster system startup and shut down, better file management, support for multimedia technologies (e.g., DVDs), and USB connectivity
Windows Millennium Edition	2000	• Upgrade to Windows 98 • Designed for the home user who wanted music playing, video editing, and networking capabilities
Windows 2000 Professional	2000	• Upgrade to Windows NT Workstation 4.0 • Complete multitasking client OS designed for business personal computers • Certified device drivers, faster performance, adaptive Start menu, image viewer, enhanced for mobile users
Windows XP	2001	• Upgrade to Windows Millennium Edition called Windows XP Home Edition • Upgrade to Windows 2000 Professional called Windows XP Professional • Windows XP Tablet PC Edition designed for Tablet PC users • Windows XP Media Center Edition designed for PCs used for home entertainment • Windows XP Professional x64 Edition designed for workstations that use 64-bit processors • Improved interface and increased performance in all editions
Service Pack 2	2004	• More built-in security technologies, improved firewall utility, and automatic blocking of Internet pop-up advertisements
Service Pack 3	2008	• Improved security and Network Access Protection restricts computers that do not meet specified requirements
Windows Vista	2006/2007	• Upgrade to Windows XP • Easier to navigate user interface, simplified customization techniques, and improved performance and reliability • Enhanced administration of user accounts and improved firewall • New Instant Search improves searching capabilities • New Documents Explorer, Pictures Explorer, and Music Explorer improve organizing capabilities
Service Pack 1	2008	• Improved Instant Search feature, increased support for devices and drivers, compatibility with more application software, and enhanced security
Service Pack 2	2009	• Support for new hardware, increased performance, and increased security
Windows 7	2009	• Upgrade to Windows Vista • Improved desktop interface and navigation • Simplified home and wireless networking • Enhanced searching capabilities • Improved performance for both desktop and notebook computers • Support for touch screen computers • Access to free, downloadable programs through the Windows Live Web site

Figure 8-15 Microsoft has released many versions of Windows.

Windows 7 is Microsoft's fastest, most efficient operating system to date, offering quicker program start up, built-in diagnostics, automatic recovery, improved security, enhanced searching and organizing capabilities, and an easy-to-use interface (Figure 8-16).

Figure 8-16 Windows 7 has a new interface, easier navigation and searching techniques, and improved security.

Windows 7 includes several programs to enhance user experiences. Home and small office users easily can set up a network and secure it from hackers with *Windows Firewall.* With *Windows DVD Maker*, users easily can create DVDs from digital videos. *Windows Media Player* allows users to listen to Internet radio stations, play MP3 and other music formats, copy music and data to CDs, and watch movies.

Using the *Desktop Gadget Gallery*, users can display a variety of gadgets on the Windows desktop. A *gadget*, also known as a *widget*, is a mini-program with minimal functionality that connects to another program or provides information. Examples of gadgets included with Windows 7 include a calendar, clock, CPU meter, currency converter, news headlines, picture puzzle, picture slide show, weather, and a Windows Media Center gadget. Most users choose one of these Windows 7 editions: Windows 7 Starter, Windows 7 Home Premium, Windows 7 Ultimate, or Windows 7 Professional.

- *Windows 7 Starter*, designed for netbooks and other small notebook computers, uses the Windows 7 Basic interface and allows users easily to search for files, connect to printers and devices, browse the Internet, join home networks, and connect to wireless networks. This edition of Windows typically is preinstalled on new computers and not available for purchase in retail stores.
- *Windows 7 Home Premium* includes all the capabilities of Windows 7 Starter and also includes Windows Aero with its *Aero Flip 3D* feature (Figure 8-17). It also provides tools to create and edit high-definition movies, record and watch television shows, connect to a game console, and read from and write on Blu-ray Discs.

Figure 8-17 With Windows 7 Aero Flip 3D, users flip through windows by rolling the wheel on their Mouse.

- *Windows 7 Ultimate*, which includes all features of Windows 7 Home Premium, provides additional features designed to keep your files secure and support for 35 languages. • With *Windows 7 Professional*, users in all sizes of businesses are provided a secure operating environment that uses Windows Aero where they easily can search for files, protect their computers from unauthorized intruders and unwanted programs, use improved backup technologies, securely connect to Wi-Fi networks, quickly view messages on a powered-off, specially equipped notebook computer, easily share documents and collaborate with other users, and watch and record live television. Additional Windows 7 features are summarized in Figure 8-18. To run Windows 7 Home Premium, your computer must have at least 1 GB of RAM.
- If you are installing Windows on a 64-bit computer, 2 GB of RAM is required. Windows 7 adapts to the hardware configuration on which it is installed. Thus, two users with the same edition of Windows 7 may experience different functionality and interfaces

Additional Windows 7 Features	
Reliability and Performance	• Low-powered Sleep state allows you to resume work quickly when you return to the computer • Programs start faster with Windows SuperFetch technology • Automatically detects and fine-tunes performance problems • Built-in hardware diagnostics detect and repair problems automatically • Automatically recovers from failures, including restoring an unbootable computer to a usable state
Security	• User Account Control allows administrators to restrict permissions • Protects users from dangerous Web sites • Improved firewall and *Windows Defender* protects your computer from external threats • Parental controls allow parents to monitor and control computer usage
Information Management	• Improved and redesigned windows help users locate files by showing thumbnails that preview content • Use Search to locate files based on file name or any other property saved with the file • Coordinate your schedule with others' schedules in *Windows Calendar* • Use the *Snipping Tool* to copy screen elements to a file on your computer • Easily share files with other users
Appearance and Navigation	• Easy-to-navigate user interface with translucent windows • Display a preview of windows open in a particular program when you point to that program button on the taskbar • Windows Snap and Aero Shake make it easier to manage the appearance of open windows • Jump Lists make it easier to open recent files quickly in their respective program • *Windows Touch* supports computers with multi-touch technology
Communications and the Internet	• Enhanced Internet Explorer • Free access to *Windows Live Essentials*, which includes programs such as *Windows Live Messenger* for instant messaging, *Windows Live Photo Gallery* for photo editing and sharing, *Windows Live Mail* for e-mail, *Windows Live Writer* for blogging, and *Windows Live Movie Maker* for video editing and sharing • Consistent and secure wireless network connections • Speech recognition allows you to interact with the computer by voice

Figure 8-18 Some additional features of Windows 7.

Mac OS X

Since it was released in 1984 with Macintosh computers, Apple's **Macintosh operating system** has set the standard for operating system ease of use and has been the model for most of the new GUIs developed for non-Macintosh systems. The latest version, **Mac OS X**, is a multitasking operating system available only for computers manufactured by Apple (Figure 8-19).

Figure 8-19 Mac OS X is the operating system used with Apple Macintosh computers.

Mac OS X includes features from previous versions of the Macintosh operating system such as large photo-quality icons, built-in networking support, e-mail, chat, online shopping, enhanced speech recognition, optical disc burning, and enhanced multimedia capabilities. In addition, Mac OS X includes these features:

- New desktop search technology
- Dashboard, a desktop area for mini-programs called widgets
- Built-in, fast Web browser
- Parental controls
- Improved backup utility, called Time Machine
- Accessibility interface reads e-mail messages
- 3-D personal video and audio conferencing
- Filter to eliminate junk e-mail messages
- Contact lists synchronized with Bluetooth enabled smart phone or other mobile device
- Latest version of QuickTime to listen to music and view videos on the Internet
- Easy networking of computers and devices

▪Windows network connection and shared Windows documents

UNIX

UNIX (pronounced YOU-nix) is a multitasking operating system developed in the early 1970s by scientists at Bell Laboratories. Bell Labs (a subsidiary of AT&T) was prohibited from actively promoting UNIX in the commercial marketplace because of federal regulations. Bell Labs instead licensed UNIX for a low fee to numerous colleges and universities, where UNIX obtained a wide following. UNIX was implemented on many different types of computers. After deregulation of the telephone companies in the 1980s, UNIX was licensed to many hardware and software companies.
Several versions of this operating system exist, each slightly different. When programmers move application software from one UNIX version to another, they sometimes have to rewrite some of the programs. Although some versions of UNIX have a command-line interface, most versions of UNIX offer a graphical user interface (Figure 8-20). Today, a version of UNIX is available for most computers of all sizes. Power users often work with UNIX because of its flexibility and power. Manufacturers such as Sun and IBM sell personal computers and work stations with a UNIX operating system.

Figure 8-20 Many versions of UNIX have a graphical user interface.

Linux is one of the faster growing operating systems. **Linux** (pronounced LINN-uks), introduced in 1991, is a popular, multitasking UNIX type operating system. In addition to the basic operating system, Linux also includes many free programming languages and utility programs.

Linux

Linux is not proprietary software like the operating systems discussed thus far. Instead, Linux is *open source software*, which means its code is provided for use, modification, and redistribution. It has no restrictions from the copyright holder regarding modification of the software's internal instructions and redistribution of the software. Many programmers have donated time to modify and redistribute Linux to make it the best possible version of UNIX. Promoters of open source software state two main advantages: users who modify the software share their improvements with others, and customers can personalize the software to meet their needs. Some distributions of Linux are command-line. Others are GUI (Figure 8-21)

Figure 8-21 This distribution of Linux has a graphical user interface.

The two most popular GUIs available for Linux are GNOME and KDE. Some companies such as Red Hat market software that runs on their own distribution of Linux. Many application programs, utilities, and plug-ins have Linux distributions, including OpenOffice.org, StarOffice, Mozilla, Yahoo! Messenger, RealPlayer, QuickTime, and Acrobat Reader.
Users obtain Linux in a variety of ways. Some download it free from the Web. Others purchase it from vendors such as Red Hat or IBM, who bundle their own software with the operating system. Linux optical discs are included in many Linux books and also are available for purchase from vendors. Some retailers such as Dell will preinstall Linux on a new computer's hard disk on request. If you want to preview the Linux operating system, you can obtain a Live CD or Live USB.

Server Operating Systems

As discussed earlier in this chapter, a server operating system is an operating system that is designed specifically to support a network. A server operating system typically resides on a server. The client computers on the network rely on the server(s) for resources. Many of the stand-alone operating systems discussed in the previous section function as clients and work in conjunction with a server operating system. Some of these stand-alone operating systems do include networking capability; however, server operating systems are designed specifically to support all sizes of networks, including medium- to large-sized businesses and Web servers. Examples of server operating systems include Windows Server 2008, UNIX, Linux, Solaris, and NetWare.

Windows Server 2008

Windows Server 2008 is an upgrade to Windows Server 2003. Windows Server 2008,which includes features of previous Windows Server versions, offers the following capabilities:

- Improved Web server management, enabling users to share data
- Enhanced server security
- Network Access Protection restricts computers that do not meet specified requirements
- Protection against malicious software attacks
- Shares many technologies with Windows
- Client support using Windows, Mac OS,UNIX, and Linux To meet the needs of all sizes of businesses, the **Windows Server 2008 family** includes many editions, with the more common listed below:
- *Windows Server 2008 Standard* for the typical small- to medium-sized business network
- *Windows Server 2008 Enterprise* for mediumto large-sized businesses, including those with e-commerce operations
- *Windows Server 2008 Datacenter* for businesses with huge volumes of transactions and large-scale databases *Windows Web Server 2008* for Web server and Web hosting businesses
- *Windows Server 2008 for Itanium-Based Systems* for computers with 64-bit processors that function as a Web server

Most editions of Windows Server 2008 include Hyper-V, which is a virtualization technology.

Virtualization is the practice of sharing or pooling computing resources, such as servers. Through virtualization, for example, operating systems such as Windows Server 2008 can separate a physical server into several virtual servers. Each virtual server then can perform an independent, separate function, such as running a different operating system.

UNIX

In addition to being a stand-alone operating system, UNIX also is a server operating system.

That is, UNIX is capable of handling a high volume of transactions in a multiuser environment and working with multiple processors using multiprocessing. For this reason, some computer professionals call UNIX a *multipurpose operating system* because it is both a stand-alone and server operating system. Many Web servers use UNIX as their operating system.

Linux

Some network servers use Linux as their operating system. Thus, Linux also is a multipurpose operating system. With Linux, a network administrator can configure the network, administer security, run a Web server, and process e-mail. Clients on the network can run Linux, UNIX, or Windows. Distributions of Linux include the Mozilla Web browser.

Solaris

Solaris, a version of UNIX developed by Sun Microsystems, is a server operating system designed specifically for e-commerce applications. Solaris manages high-traffic accounts and incorporates security necessary for Web transactions. Client computers often use a desktop program, such as GNOME desktop, that communicates with the Solaris operating system.

NetWare

Novell's *NetWare* is a server operating system designed for client/server networks. NetWare

has a server portion that resides on the network server and a client portion that resides on each client computer connected to the network.
NetWare supports open source software and runs on all types of computers from mainframes to personal computers. Client computers also can have their own stand-alone operating system such as a Windows, Mac OS, or Linux.

Embedded Operating Systems

The operating system on mobile devices andmany consumer electronics, called an **embedded operating system**, resides on a ROM chip. Popular embedded operating systems today include Windows Embedded CE, Windows Mobile, Palm OS, iPhone OS, BlackBerry, Google Android, embedded Linux, and Symbian OS. The following sections discuss these operating systems, most of which work on smart phones.

Windows Embedded CE

Windows Embedded CE is a scaled-down Windows operating system designed for use on communications, entertainment, and computing devices with limited functionality. Examples of devices that use Windows Embedded CE include VoIP telephones, industrial control devices, digital cameras, point-of-sale terminals, automated teller machines, digital photo frames, fuel pumps, security robots, handheld navigation devices, portable media players, ticket machines, and computerized sewing machines (Figure 8-22).

Figure 8-22 This sewing machine uses Windows Embedded CE to assist with stitching quilts, garments, crafts, decorations, and embroidery.

Windows Embedded CE is a GUI that supports color, sound, multitasking, multimedia, e-mail, Internet access, and Web browsing. A built-in file viewer allows users to view files created in popular programs such as Word, Excel, and PowerPoint. Devices equipped with Windows Embedded CE can communicate wirelessly with computers and other devices using Bluetooth or other wireless technologies, as long as the device is equipped with the necessary communications hardware.

Windows Mobile

Windows Mobile, an operating system based on Windows Embedded CE, includes functionality, programs, and a user interface designed for specific types of smart phones (Figure 8-23) and PDAs. Devices with a touch screen use Windows Mobile Professional and those without touch screens use Windows Mobile Standard. With the Windows Mobile operating system and a compatible device, users have access to all the basic PIM (personal information manager) functions such as contact lists, schedules, tasks, calendars, and notes. Information on the mobile device easily synchronizes with a personal computer or prints on a printer using a cable or a wireless technology.

Figure 8-23 A smart phone that uses the Windows Mobile operating system.

Windows Mobile also provides numerous additional features that allow users to check e-mail, browse the Web, listen to music, take pictures or record video, watch a video, send and receive text messages and instant messages, record a voice message, manage finances, view a map, read an e-book, or play a game.
Many programs, such as Word, Excel, Outlook, and Internet Explorer, have scaled-down versions that run with Windows Mobile. Some devices with Windows Mobile also support handwriting and voice input.

Palm OS

A competing operating system to Windows Mobile is *Palm OS*, which runs on smart phones (Figure 8-24) and PDAs. With Palm OS devices, users manage schedules and contacts, phone messages, notes, task and address lists, and appointments. Information on the mobile device easily synchronizes with a personal computer or prints on a printer using a cable or a wireless technology.

Figure 8-24 A smart phone that uses the Palm OS operating system.

Many Palm OS devices allow users to connect wirelessly to the Internet; browse the Web; send and receive e-mail messages, text messages, and instant messages; listen to music; record voice messages; and view digital photos. Most have touch screens. The latest version of Palm OS allows for biometric identification and supports the use of smart cards.

iPhone OS

iPhone OS, developed by Apple, is an operating system for the iPhone and iPod touch, Apple's smart phone (Figure 8-25) and touch screen portable media player, respectively. These devices are multi-touch, meaning they recognize multiple points of contact.

Figure 8-25 The iPhone OS runs on Apple's iPhone.

This feature enables users to interact with iPhone OS devices using finger motions such as tapping a button on the screen, sliding your finger to drag an object, and pinching or unpinching your fingers to zoom in or out. With the iPhone OS, users can manage contacts and notes, send and receive e-mail and text messages, take pictures, record videos, record voice messages, view a compass, connect to the Internet wirelessly and browse the Web, check stocks, access maps and obtain directions, listen to music, watch movies and videos, and display photos. It also provides Wi-Fi access to the iTunes Music Store.

BlackBerry

The *BlackBerry* operating system runs on handheld devices supplied by RIM (Research In Motion). BlackBerry devices provide PIM capabilities such as managing schedules, contacts, and appointments, as well as phone capabilities. They also provide wireless functionality that includes sending e-mail messages, text messages, and instant messages; connecting to the Internet and browsing the Web; and accessing Bluetooth devices. Some BlackBerry devices allow users to take pictures, play music, and access maps and directions. Information on the device easily synchronizes wirelessly with a computer or other BlackBerry device. Many BlackBerry devices include a minikeyboard; some have touch screens (Figure 8-26).

Figure 8-26 A smart phone that uses the BlackBerry operating system.

Google Android

Google Android is an operating system designed by Google for mobile devices. Used on more than 20 different types of mobile devices, Google Android allows programmers to design programs specifically for devices supporting this operating system. Google Android contains features such as access to e-mail accounts, an alarm clock, video capture, access to Google Apps, Wi-Fi access, and easy Web browsing.

Embedded Linux

Embedded Linux is a scaled-down Linux operating system designed for smart phones, PDAs, portable media players, Interne telephones, and many other types of devices and computers requiring an embedded operating system. Devices with embedded Linux offer calendar and address book and other PIM functions, touch screens, and handwriting recognition. Many also allow you to connect to the Internet, take pictures, play videos, listen to music, and send e-mail and instant messages.
Devices that use embedded Linux synchronize with desktop computers using a variety of technologies including Bluetooth.

Symbian OS

Symbian OS is an open source multitasking operating system designed for smart phones. In addition to making phone calls, users of Symbian OS can maintain contact lists; save appointments; browse the Web; and send and receive text and picture messages, e-mail messages, and faxes using a smart phone. Users enter data by pressing keys on the keypad or keyboard, touching the screen, writing on the screen with a stylus, or speaking into the smart phone. Symbian OS allows users to communicate wirelessly.

Utility Programs

A **utility program**, also called a **utility**, is a type of system software that allows a user to perform maintenance-type tasks, usually related to managing a computer, its devices, or its programs. Most operating systems include several built-in utility programs (Figure 8-27). Users often buy stand-alone utilities, however, because they offer improvements over those included with the operating system.

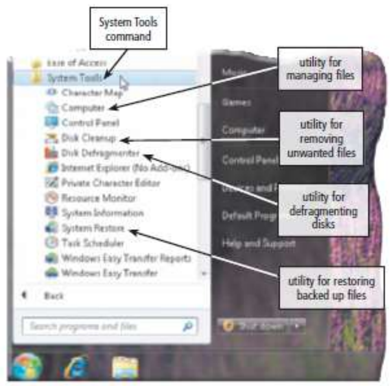


Figure 8-27 To display the utilities available in the Windows System Tools list, click the Start button, click All Programs, click Accessories, and then click System Tools.

Functions provided by utility programs include the following: managing files, searching
for files, viewing images, uninstalling programs, cleaning up disks, defragmenting disks, backing up files and disks, setting up screen savers, securing a computer from unauthorized access, protecting against viruses, removing spyware and adware, filtering Internet content, compressing files, playing media files, burning optical discs, and maintaining a personal computer.

The following sections briefly discuss each of these utilities.

File Manager

A **file manager** is a utility that performs functions related to file management. Some of the file management functions that a file manager performs are displaying a list of files on a storage medium (Figure 8-28); organizing files in folders; copying, renaming, deleting, moving, and sorting files and folders; and creating shortcuts. A **folder** is a specific named location on a storage medium that contains related documents. A **shortcut** is an icon on the desktop or in a folder that provides a user with immediate access to a program or file.

Figure 8-28 Windows includes file managers that allow you to view documents, photos, and music. In this case, thumbnails of photos are displayed.

Operating systems typically include a file manager. Windows, for example, includes Windows Explorer, which displays links to files and folders, as well as previews of folder contents and certain types of files.

Search Utility A **search utility** is a program that attempts to locate a file on your computer based on criteria you specify (Figure 8-29). The criteria could be a word or words contained in a file, date the file was created or modified, size of the file, location of the file, file name, author/ artist, and other similar properties. Search utilities can look through documents, photos, music, and other files on your computer and/ or on the Internet, combining search results in a single location. Search utilities typically use an index to assist with locating files quickly. An *index* stores a variety of information about a file, including its name, date created, date modified, author name, and so on. When you enter search criteria, instead of looking through every file and folder on the storage medium, the search utility looks through the index first to find a match. Each entry in the index contains a link to the actual file on the disk for easy retrieval. Operating systems typically include a built-in search utility. In Windows, all the Explorer windows, as well as the Start menu, contain a Search box where you enter the search criteria

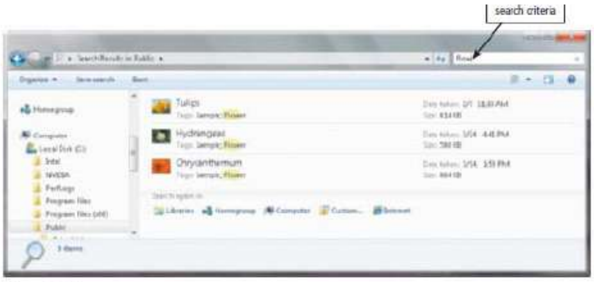


Figure 8-29 This search displays files whose name or contents contain the text, flow.

Image Viewer

An **image viewer** is a utility that allows users to display, copy, and print the contents of a graphics file, such as a photo. With an image viewer, users can see images without having to open them in a paint or image editing program.
Most operating systems include an image viewer. Windows image viewer is called *Windows Photo Viewer*, which also allows you to print and e-mail photos (Figure 8-30).

Figure 8-30 Windows Photo Viewer allows users to see the contents of a photo file.

Uninstaller

An **uninstaller** is a utility that removes a program, as well as any associated entries in the system files. When you install a program, the operating system records the information it uses to run the software in the system files. The uninstaller deletes files and folders from the hard disk, as well as removes program entries from the system files. Operating systems usually provide an uninstaller. In Windows, you are able to access the uninstaller for many installed programs through the ‘Uninstall a program’ command in the Control Panel. You also can access the uninstaller for some programs through that programs folder on the Start menu, or on the program's installation media.

Disk Cleanup

A *disk cleanup* utility searches for and removes unnecessary files. Unnecessary files may include downloaded program files, temporary Internet files, deleted files, and unused program files. Operating systems, such as Windows, include a disk cleanup utility (Figure 8-31).

Figure 8-31 Disk Cleanup searches for and removes unnecessary files.

Disk Defragmenter

A **disk defragmenter** is a utility that reorganizes the files and unused space on a computer's hard disk so that the operating system accesses data more quickly and programs run faster. When an operating system stores data on a disk, it places the data in the first available sector on the disk. It attempts to place data in sectors that are contiguous (next to each other), but this is not always possible. When the contents of a file are scattered across two or more noncontiguous sectors, the file is *fragmented*.

Fragmentation slows down disk access and thus the performance of the entire computer. **Defragmenting** the disk, or reorganizing it so that the files are stored in contiguous sectors, solves this problem (Figure 8-32). Operating systems usually include a disk defragmenter. Windows Disk Defragmenter is available in the System Tools list.

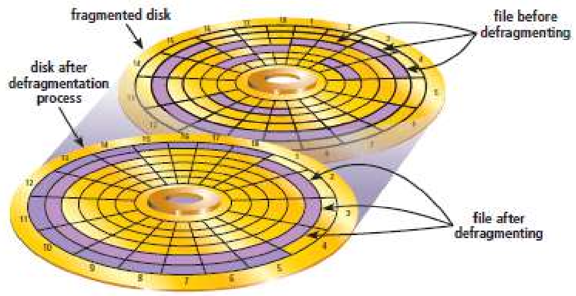


Figure 8-32 A fragmented disk has many files stored in noncontiguous sectors. Defragmenting reorganizes the files so that they are located in contiguous sectors, which speeds access time.

Backup and Restore Utilities

A **backup utility** allows users to copy, or *back up*, selected files or an entire hard disk to another storage medium such as another hard disk, optical disc, USB flash drive, or tape. During the back up process, the utility monitors progress and alerts you if it needs additional media, such as another disc. Many backup programs *compress*, or shrink the size of, files during the backup process. By compressing the files, the backup program requires less storage space for the backup files than for the original files. Because they are compressed, you usually cannot use backup files in their backed up form.

In the event you need to use a backup file, a **restore utility** reverses the process and returns backed up files to their original form. Backup utilities work with a restore utility. You should back up files and disks regularly in the event your originals are lost, damaged, or destroyed. Most backup and restore utilities include a scheduler, which instructs the computer to perform a backup automatically on a regularly scheduled basis. Operating systems, such as Windows, include a backup and restore utility (Figure 8-33). When you purchase an external hard disk, it also usually includes a backup and restore utility. Instead of backing up to a local disk storage device, some users opt to use cloud storage to back up their files. As described in Chapter 7, cloud storage is a service on the Web that provides storage to computer users, usually for free or for a minimal monthly fee.

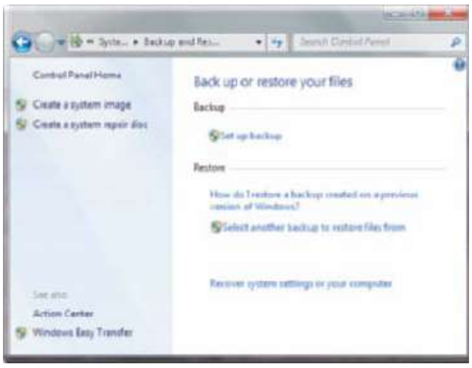


Figure 8-33 A backup utility allows users to copy files or an entire hard disk to another storage medium.

Screen Saver

A **screen saver** is a utility that causes a display device's screen to show a moving image or blank screen if no keyboard or mouse activity occurs for a specified time. When you press a key on the keyboard or move the mouse, the screen saver disappears and the screen returns to the previous state. Screen savers originally were developed to prevent a problem called *ghosting*, in which images could be etched permanently on a monitor's screen. Although ghosting is not as severe of a problem with today's displays, manufacturers continue to recommend that users install screen savers for this reason. Screen savers also are popular for security, business, and entertainment purposes. To secure a computer, users configure their screen saver to require a password to deactivate. In addition to those included with the operating system, many screen savers are available in stores (Figure 8-34) and on the Web for free or a minimal fee.

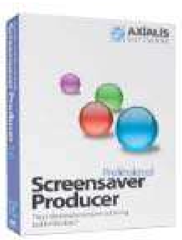


Figure 8-34 With this screen saver software, you can create your own screen savers.

Personal Firewall

A **personal firewall** is a utility that detects and protects a personal computer from unauthorized intrusions. Personal firewalls constantly monitor all transmissions to and from a computer.

When connected to the Internet, your computer is vulnerable to attacks from a hacker. A *hacker* is someone who tries to access a computer or network illegally. Users with broadband Internet connections, such as through DSL and cable Internet service, are even more susceptible than those with dial-up access because the Internet connection always is on. Operating systems often include a personal firewall. Windows automatically enables its built-in personal firewall, called Windows Firewall, upon installation of the operating system. If your operating system does not include a personal firewall or you want additional protection, you can purchase a stand-alone personal firewall utility (Figure 8-35) or a hardware firewall, which is a device such as a router that has a built-in firewall.

Figure 8-35 A stand-alone personal firewall utility.

Antivirus Programs

The term, computer **virus**, describes a potentially damaging computer program that affects, or infects, a computer negatively by altering the way the computer works without the user's knowledge or permission. Once the virus is in a computer, it can spread throughout and may damage your files and operating system.

Computer viruses do not generate by chance. The programmer of a virus, known as a *virus author*, intentionally writes a virus program. Some virus authors find writing viruses a challenge. Others write virus programs to cause destruction. Writing a virus program usually requires significant programming skills.

Some viruses are harmless pranks that simply freeze a computer temporarily or display sounds or messages. The Music Bug virus, for example, instructs the computer to play a few chords of music. Other viruses destroy or corrupt data stored on the hard disk of the infected computer. If you notice any unusual changes in your computer's performance, it may be infected with a virus (Figure 8-36).

Signs of Virus Infection

- An unusual message or image is displayed on the computer screen
- An unusual sound or music plays randomly
- The available memory is less than what should be available
- A program or file suddenly is missing
- An unknown program or file mysteriously appears
- The size of a file changes without explanation
- A file becomes corrupted
- A program or file does not work properly
- System properties change
- The computer operates much slower than usual

Figure 8-36 Viruses attack computers in a variety of ways. This list indicates some of the more common signs of virus infection.

Viruses are just one type of malicious software.
Malware (short for malicious software) is software that acts without a user's knowledge and deliberately alters the computer's operations. In addition to viruses, worms and Trojan horses are malware.
A **worm**, such as Sasser or Klez, copies itself repeatedly, for example, in memory or over a network, using up system resources and possibly shutting down the system. A **Trojan horse** (named after the Greek myth) hides within or looks like a legitimate program such as a screen saver. A certain condition or action usually triggers the Trojan horse. Unlike a virus or worm, a Trojan horse does not replicate itself to other computers.
Currently, more than one million known threats to your computer exist. To protect a computer from virus attacks, users should install an antivirus program and update it frequently. An **antivirus program** protects a computer against viruses by identifying and removing any computer viruses found in memory, on storage media, or on incoming files. Most antivirus programs also protect against worms and Trojan horses. When you purchase a new computer, it often includes antivirus software.
Three more popular antivirus programs are McAfee VirusScan, Norton AntiVirus (Figure 8-37), and Windows Live OneCare, most of which also contains spyware removers, Internet filters, and other utilities. As an alternative to purchasing these products on disc, both McAfee and Norton offer Web-based antivirus programs.

Figure 8-37 An antivirus program scans memory, disks, and incoming e-mail messages and attachments for viruses and attempts to remove any viruses it finds.

Spyware and Adware Removers

Spyware is a program placed on a computer without the user's knowledge that secretly collects information about the user, often related to Web browsing habits. Spyware can enter a computer as a virus or as a result of a user installing a new program. The spyware program communicates information it collects to an outside source while you are online.

Adware is a program that displays an online advertisement in a banner or pop-up window on Web pages, e-mail, or other Internet services. Sometimes, spyware is hidden in adware.

A **spyware remover** is a program that detects and deletes spyware and other similar programs. An *adware remover* is a program that detects and deletes adware. Most spyware and adware removers cost less than $50; some are available on the Web at no cost. Some operating systems and antivirus programs include spyware and adware removers. Popular stand-alone spyware and adware removers include Ad-Aware, Spy Sweeper, Spybot – Search and Destroy, and Windows Defender.

Internet Filters

Filters are programs that remove or block certain items from being displayed. Four widely used Internet filters are Web filters, anti-spam programs, phishing filters, and pop-up blockers.

Web Filters Web filtering software is a program that restricts access to certain material on the Web. Some restrict access to specific Web sites; others filter sites that use certain words or phrases. Many businesses use Web filtering software to limit employee's Web access. Some schools, libraries, and parents use this software to restrict access to minors. Windows 7 contains parental controls, which allow parents to record and control the types of content their children can access on the Internet.

Anti-Spam Programs *Spam* is an unsolicited e-mail message or newsgroup posting sent to many recipients or newsgroups at once. Spam is Internet junk mail. The content of spam ranges from selling a product or service, to promoting a business opportunity, to advertising offensive material. An **anti-spam program** is a filtering program that attempts to remove spam before it reaches your inbox. If your e-mail program does not filter spam, many anti-spam programs are available at no cost on the Web. Internet access providers often filter
spam as a service for their subscribers.

Phishing Filters *Phishing* is a scam in which a perpetrator attempts to obtain your personal and/or financial information. A **phishing filter** is a program that warns or blocks you from potentially fraudulent or suspicious Web sites. Some Web browsers include phishing filters.
Pop-Up Blockers A *pop-up ad* is an Internet advertisement that suddenly appears in a new window in the foreground of a Web page displayed in your browser. A **pop-up blocker** is a filtering program that stops pop-up ads from displaying on Web pages. Many Web browsers include a pop-up blocker. You also can download pop-up blockers from the Web at no cost.

File Compression
A **file compression utility** shrinks the size of a file(s). A compressed file takes up less storage space than the original file. Compressing files frees up room on the storage media and improves system performance. Attaching a compressed file to an e-mail message, for example, reduces the time needed for file transmission. Uploading and downloading compressed files to and from the Internet reduces the file transmission time.
Two types of compression are lossy and lossless. With *lossy* compression, because the quality of a file decreases slightly each time the file is compressed, you will be unable to restore the file to its exact original state. With audio and video files, small degradations in quality usually are not recognizable; thus, lossy compression often is used on these types of files. With *lossless* compression, by contrast, a compressed file can be returned to its
exact original state. Text files typically use lossless compression.
Compressed files, sometimes called **zipped files**, usually have a .zip extension. When you receive or download a compressed file, you must uncompress it. To **uncompress**, or *unzip*, a file, you restore it to its original form. Some operating systems such as Windows include file compression and uncompression capabilities. Two popular stand-alone file compression utilities are PKZIP and WinZip.

Media Player
A **media player** is a program that allows you to view images and animation, listen to audio, and watch video files on your compute (Figure 8-38). Media players may also include the capability to organize media files, convert them to different formats, connect to and purchase media from an online media store, download podcasts and vodcasts, burn audio CDs, and transfer media to portable media players. Windows includes Windows Media Player. Three other popular media players are iTunes, RealPlayer, and Rhapsody.

Figure 8-38 A popular media player.

Disc Burning

Disc burning software writes text, graphics, audio, and video files on a recordable or rewritable CD, DVD, or Blu-ray Disc. This software enables the home user easily to back up contents of their hard disk on an optical disc and make duplicates of uncopyrighted music or movies. Disc burning software usually also includes photo editing, audio editing, and video editing capabilities (Figure 8-39). When you buy a recordable or rewritable disc, it typically includes burning software. You also can buy stand-alone disc burning software for a cost of less than $100.

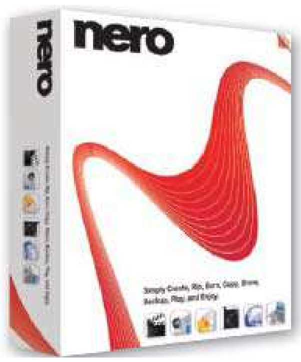


Figure 8-39 You can copy text, graphics, audio, and video files to discs using the digital media suite shown here, provided you have the correct type of drive and media.

Personal Computer Maintenance

Operating systems typically include a diagnostic utility that diagnoses computer problems but does not repair them. A **personal computer maintenance utility** identifies and fixes operating system problems, detects and repairs disk problems, and includes the capability of improving a computer's performance. Additionally, some personal computer maintenance utilities continuously monitor a computer while you use it to identify and repair problems before they occur. Norton System Works is a popular personal computer maintenance utility designed for Windows operating systems (Figure 8-40).

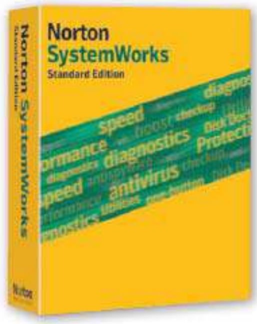


Figure 8-40 A popular maintenance program for Windows users.

Chapter Exercises

Multiple Choice Select the best answer.
1. The _____ chip, which uses battery power, stores configuration information about the computer.
a. BIOS b. CMOS c. POST d. RAM

2. Windows users can increase the size of memory through _____, which can allocate available storage space on removable flash memory devices as additional memory cache.
a. Windows Aero b. Windows ReadyBoost c. Plug and Play d. a disk defragmenter

3. A _____ is a mini-program with minimal functionality that connects to another program or provides information.
a. service pack b. search utility c. gadget d. swap file

4. When you enter search criteria, instead of looking through every file and folder on the storage medium, the search utility looks through the _____ first to find a match.
a. index b. buffer c. file manager d. driver

5. Defragmenting reorganizes the files on a disk so that they are located in _____ access time.
a. noncontiguous sectors, which slows b. contiguous sectors, which slows
c. contiguous sectors, which speeds d. noncontiguous sectors, which speeds

6. _____ is a utility that detects and protects a personal computer from unauthorized intrusions.
a. Automatic updates b. Sleep mode
c. Windows Explorer d. Windows Firewall

7. _____ is a program that displays an online advertisement in a banner or pop-up window on Web pages, e-mail, or other Internet services.
a. Spyware b. A Trojan horse c. Adware d. Spam

8. A(n) _____ is a program that warns or blocks you from potentially fraudulent or suspicious Web sites.
a. phishing filter b. Web filter c. adware remover d. Trojan horse

True/False Mark T for True and F for False.

_____ 1. All sizes of computers typically use the same operating system because operating systems generally are written to run on any type of computer.

_____ 2. Booting is the process of permanently removing a computer from operation.

_____ 3. Permissions define who can access certain resources and when they can access those resources.

_____ 4. A device-independent program is one that runs only on a specific type or make of computer.

_____ 5. Users can control and customize a variety of gadgets on the Windows desktop.

_____ 6. Linux is open source software, which means its code can be modified and redistributed.

_____ 7. BlackBerry devices provide PIM capabilities such as managing schedules, contacts, and appointments, as well as phone capabilities.

_____ 8. Windows allows you to manage your documents, pictures, music, and other files using Windows Explorer.

_____ 9. An adware remover is a program that detects and deletes spam.

_____ 10. Phishing is a scam in which a perpetrator attempts to obtain your personal and/or financial information.

Matching Match the terms with their definitions.

_____ 1. sleep mode	a. the practice of sharing or pooling computing resources, such as servers
_____ 2. hibernate	b. server operating system designed for client/server networks
_____ 3. page	c. saves any open documents and programs to a hard disk before removing power from the computer
_____ 4. user name	d. unique combination of characters that identifies one specific user
_____ 5. Aero Flip 3D	e. works with the mouse to flip through windows by rolling the wheel on the mouse
_____ 6. UNIX	f. saves any open documents and programs to RAM, turns off all unneeded functions, and then places the computer in a low-power state
_____ 7. virtualization	g. with virtual memory, the amount of data and program instructions that can be swapped at a given time
_____ 8. NetWare	h. multitasking operating system developed in the early 1970s by scientists at Bell Laboratories
_____ 9. Google Andriod	i. operating system for mobile devices
_____ 10. shortcut	j. an icon on the desktop or in a folder that provides a user with immediate access to a program or file

Short Answer Write a brief answer to each of the following questions.

1. How is a cold boot different from a warm boot? ____________ How is a memory-resident part of an operating system different from a nonresident part of an operating system? ____________

2. What is a user interface? ____________ How are graphical and command-line user interfaces different? ___________

3. What is the purpose of an automatic update feature? ____________ Why and when might a user receive a service pack? ____________

4. What happens during a backup? ____________ What is the purpose of a restore utility? ____________

5. Describe four embedded operating systems. ____________ What are the uses for each of the four types? ____________

Chapter Nine

Communications and Networks

Communications

Computer **communications** describes a process in which two or more computers or devices transfer data, instructions, and information. Today, even the smallest computers and devices can communicate directly with one another, with hundreds of computers on a company network, or with millions of other computers around the globe — often via the Internet. Figure 9-1 shows a sample communications system. Some communications involve cables and wires; others are sent wirelessly through the air. For successful communications, you need the following:

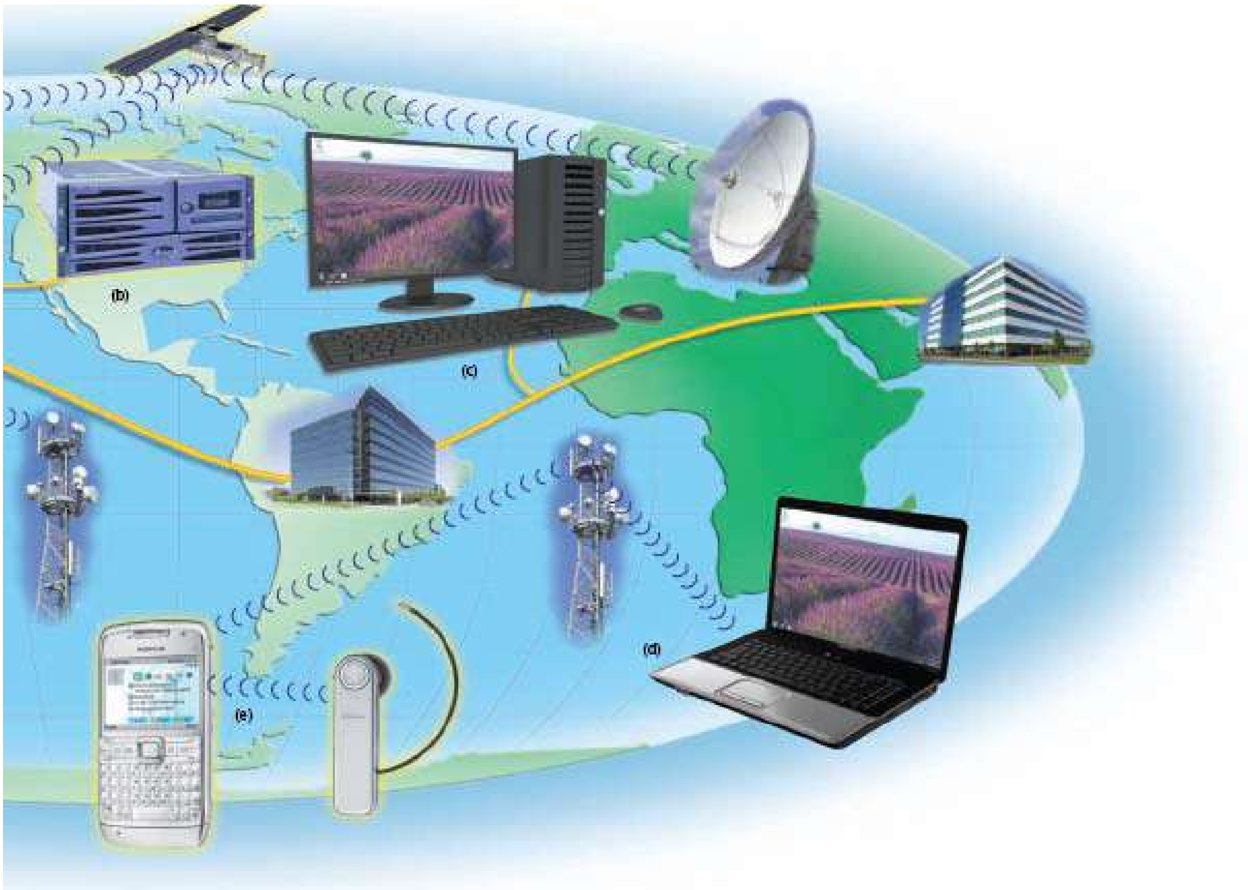
- A **sending device** that initiates an instruction to transmit data, instructions, or information.
- A communications device that connects the sending device to a communications channel.
- A **communications channel**, or transmission media on which the data, instructions, or information travel.
- A communications device that connects the communications channel to a receiving device.
- A **receiving device** that accepts the transmission of data, instructions, or information.

Figure 9-1 An example of a communications system. Some devices that serve as sending devices and receiving devices are (a) mainframe computers, (b) servers, (c) desktop computers, (d) notebook computers, (e) smart phones, (f) Internet-enabled portable media players, (g) handheld game consoles, and (h) GPS receivers. The communications channel consists of telephone and power lines, cable television and other underground lines, microwave stations, and satellites.

As shown in Figure 9-1, all types of computers and mobile devices serve as sending and receiving devices in a communications system. This includes mainframe computers, servers, desktop computers, notebook computers, smart phones, portable media players, handheld game consoles, and GPS receivers. One type of communications device that connects a communications channel to a sending or receiving device such as a computer is a modem. Two examples of communications channels are cable television lines and telephone lines. This chapter presents various uses of communications, discusses different types of networks, and then examines several types of communications devices and communications channels.

Uses of Computer Communications

Computer communications are everywhere. Many require that users subscribe to an Internet access provider. With other computer communications, an organization such as a business or school provides communications services to employees, students, or customers. The following pages discuss a variety of computer communications.



Blogs, Chat Rooms, E-Mail, Fax, FTP, Instant Messaging, Internet, Newsgroups, RSS, Video Conferencing, VoIP, Web, Web 2.0, Web Folders, and Wikis

Previous chapters discussed many uses of computer communications as they related to a particular topic. In the course of a day, it is likely you use, or use information generated by, one or more of these previously discussed communications technologies. The list in Figure 9-2 reviews the features of these modes of communications. The following pages discuss a variety of other uses of communications that have not been discussed in depth previously. These include wireless messaging services, wireless Internet access points, cybercafés, global positioning systems, collaboration, groupware, voice mail, and Web services.

Wireless Messaging Services

Users can send and receive wireless messages to and from smart phones, cell phones, handheld game consoles, and other mobile devices and computers using three techniques: text messaging, picture/video messaging, and wireless instant messaging (Figure 9-3). The type of messaging you use depends primarily on the services offered by the wireless Internet service provider (WISP) that works with the cell phone or other mobile device you select. In most cases, you can receive these messages at no cost but pay a per use or monthly fee to send messages to others.

Summary of Communications Discussed in Previous Chapters	
Communications Type	**Brief Description**
Blogs	Time-stamped articles on a network that reflect the author's interests, opinions, and personality
Chat Rooms	Real-time typed conversation among two or more people that takes place on a computer connected to a network that also may allow the exchange of messages, photos, files, audio, and video
E-Mail	Transmission of messages and files via a computer network
Fax	Transmits and receives documents over telephone lines
FTP	Internet standard that permits users to upload and download files to and from FTP servers on the Internet
Instant Messaging	Real-time one-on-one Internet communications service that notifies you when one or more people are online and then allows you to exchange messages, photos, files, audio, and video
Internet	Worldwide collection of networks that links millions of businesses, government agencies, educational institutions, and individuals
Newsgroups	Online areas in which users have written discussions about a particular subject
RSS	Specification that enables Web content to be distributed to subscribers
Video Conferencing	Real-time meeting between two or more geographically separated people who use a network to transmit audio and video data
VoIP	Conversation that takes place over the Internet using a telephone connected to a computer, mobile device, or telephone adapter
Web	Worldwide collection of electronic documents on the Internet that users access through a Web browser
Web 2.0	Web sites that provide a means for users to share personal information, allow users to modify Web site content, and/or have application software built into the site for visitors to use
Web Folders	Location on a Web server to which users publish documents and other files
Wikis	Collaborative Web sites that allow users to create, add to, modify, or delete Web site

Figure 9-2 Uses of communications discussed in earlier chapters.

Figure 9-3 Users can send and receive text messages, picture/video messages, and wireless instant messages to and from their smart phones and other computers and devices

Text Messaging A mobile device with **text messaging**, also called **SMS** (*short message service*), capability allows users to send and receive short text messages, typically fewer than 300 characters, on a phone or other mobile device or computer. Text messaging services typically provide users with several options for sending and receiving messages:

- Mobile to Mobile: send a message from your mobile device to another mobile device
- Mobile to E-Mail: send a message from your mobile device to an e-mail address anywhere in the world
- Web to Mobile: send a message from a text messaging Web site to a mobile device, or request that a Web site alert a mobile device with messages of breaking news and other updates, such as sports scores, stock prices, and weather forecasts
- Mobile to Provider: send a message by entering a *common short code (CSC)*, which is a four- or five-digit number assigned to a specific content or wireless service provider, followed by the message, such as a vote for a television program contestant or an entry for a sweepstakes

Most services store incoming text messages for a limited amount of time, such as five days.
After the specified time, the WISP deletes any unread messages from its server.

Picture/Video Messaging With **picture messaging**, users can send pictures and sound files, as well as short text messages, to a phone or other mobile device, or a computer. With **video messaging**, users can send short video clips, usually about 30 seconds in length, in addition to all picture messaging services. Smart phones and other mobile devices with picture/ video messaging, also called *MMS* (*multimedia message service*), capability typically have a digital camera built into the device. Users who expect to receive numerous picture/video messages should verify the phone has sufficient memory. Picture/video messaging services typically provide users these options for sending and receiving messages:

• Mobile to Mobile: send the picture/video from your mobile device to another mobile device

• Mobile to E-Mail: send the picture/video from your mobile device to an e-mail address anywhere in the world.

If you send a picture message to a phone that does not have picture/video messaging capability, the phone usually displays a text message directing the user to a Web page that contains the picture/video message. Some online social networks allow you to send a picture/video message to an assigned number to post the message automatically to your online profile.

Wireless Instant Messaging Wireless instant messaging (IM) is a real-time Internet communications service that allows wireless mobile devices to exchange messages with one or more mobile devices or online users. Some WISPs partner with IM services so that you can use your smart phone or other mobile device to send and receive wireless instant messages. AT&T's wireless service, for example, allows communications through various instant messengers such as AIM (AOL Instant Messenger), Windows Live Messenger, and Yahoo! Messenger. With a compatible IM service, users have these IM options:

• Mobile to Mobile: use a wireless instant messenger to communicate between two mobile devices

• Mobile to Personal Computer: use a wireless instant messenger to communicate between a mobile device and a desktop or notebook computer

• Web to Mobile: send or forward messages from a desktop or notebook computer's instant messenger to a mobile device

Wireless Internet Access Points

At home, work, school, and in many public locations, people connect wirelessly to the Internet through a **wireless Internet access point** using notebook computers, smart phones, handheld game consoles, or other devices. Users access wireless Internet access points with computers or devices that have the necessary built-in wireless capability or the appropriate wireless network card, USB network adapter, ExpressCard module, or PC Card (Figure 9-4). Two types of wireless Internet access points are hot spots and mobile wireless networks. A *hot spot* is a wireless network that provides Internet connections to mobile computers and devices. Through the hot spot, mobile users check e-mail, browse the Web, and access any service on the Internet. Three hot spot technologies are Wi-Fi, WiMAX, and Bluetooth. Wi-Fi hot spots provide wireless network connections to users in public locations such as airports and airplanes, train stations, hotels, convention centers, schools, campgrounds, marinas, shopping malls, bookstores, libraries, restaurants, and coffee shops. The coverage range for WiMAX hot spots can be much wider than Wi-Fi; for example, they can cover an entire city. Bluetooth hot spots provide location based services, such as sending coupons or menus, to users whose enabled devices enter the coverage range. Sections later in this chapter discuss Wi-Fi, WiMAX, and Bluetooth in more detail. Some hot spots provide free Internet access, some charge a per-use fee, and others require users to subscribe to a WISP, to which they pay per-access fees, daily fees, or a monthly fee. Per-access fees average $3, daily fees range from $5 to $20, and monthly fees range from $20 to $60 for unlimited access, with the higher monthly fee providing greater coverage areas. Instead of hot spots, some users access the Internet through mobile wireless networks that provide users with high-speed wireless Internet connections, as long as they are in the network's range. A mobile wireless network usually covers most major cities and airports. Subscription fees for unlimited monthly Internet access to a mobile wireless network through a cell phone usually range from $30 to $50. Fees for notebook computer access are higher, usually ranging from $60 to $80 per month. Two types of mobile wireless networks are 3G and 4G, which are discussed later in this chapter.

Figure 9-4 Mobile users in this hot spot access the Internet through their notebook computers. One computer uses a wireless USB network adapter; another uses a wireless PC Card. Others have Intel's built-in wireless Centrino 2 mobile technology.

Cybercafés

When mobile users travel without their notebook computer or Internet-enabled mobile device, they can visit a cybercafé to access e-mail, the Web, and other Internet services.

A **cybercafé**, or Internet cafe, is a coffeehouse, restaurant, or other location that provides personal computers with Internet access to its customers (Figure 9-5). Cybercafés exist in cities around the world. Although some provide free Internet access, most charge a per-hour or per minute fee. Some cybercafés also are hot spots, providing wireless Internet connections to users with mobile computers and devices.

Figure 9-5 People using Internet-connected computers in a cybercafé.

Global Positioning Systems

A **global positioning system** (**GPS**) is a navigation system that consists of one or more earth-based receivers that accept and analyze signals sent by satellites in order to determine the receiver's geographic location (Figure 9-6). A *GPS receiver* is a handheld, mountable, or embedded device that contains an antenna, a radio receiver, and a processor. Many include a screen display that shows an individual's location on a map. Some also function as a portable media player allowing you, for example, to play music and view pictures on the device. Many mobile devices such as smart phones have GPS capability built into the device or as an add-on feature. Some users carry a handheld GPS receiver; others mount a receiver to an object such as an automobile, boat, airplane, farm and construction equipment, or computer. The first and most used application of GPS technology is to assist people with determining where they are located. The data obtained from a GPS, however, can be applied to a variety of other uses: creating a map, ascertaining the best route between two points, locating a lost person or stolen object, monitoring the movement of a person or object, determining altitude, and calculating speed.

Many vehicles use GPSs to provide drivers with directions or other information, such as alternate traffic routes, automatically call for help if the airbag is deployed, dispatch roadside assistance, unlock the driver's side door if keys are locked in the car, and track the vehicle if it is stolen. Newer GPS receivers also give drivers information about nearby points of interest, such as gas stations, restaurants, and hotels. Hikers and remote campers may carry GPS receivers in case they need emergency help or directions. Some GPS receivers work in conjunction with a cellular wireless network. Parents, for example, can locate a child's whereabouts through a cell phone equipped with a GPS receiver.

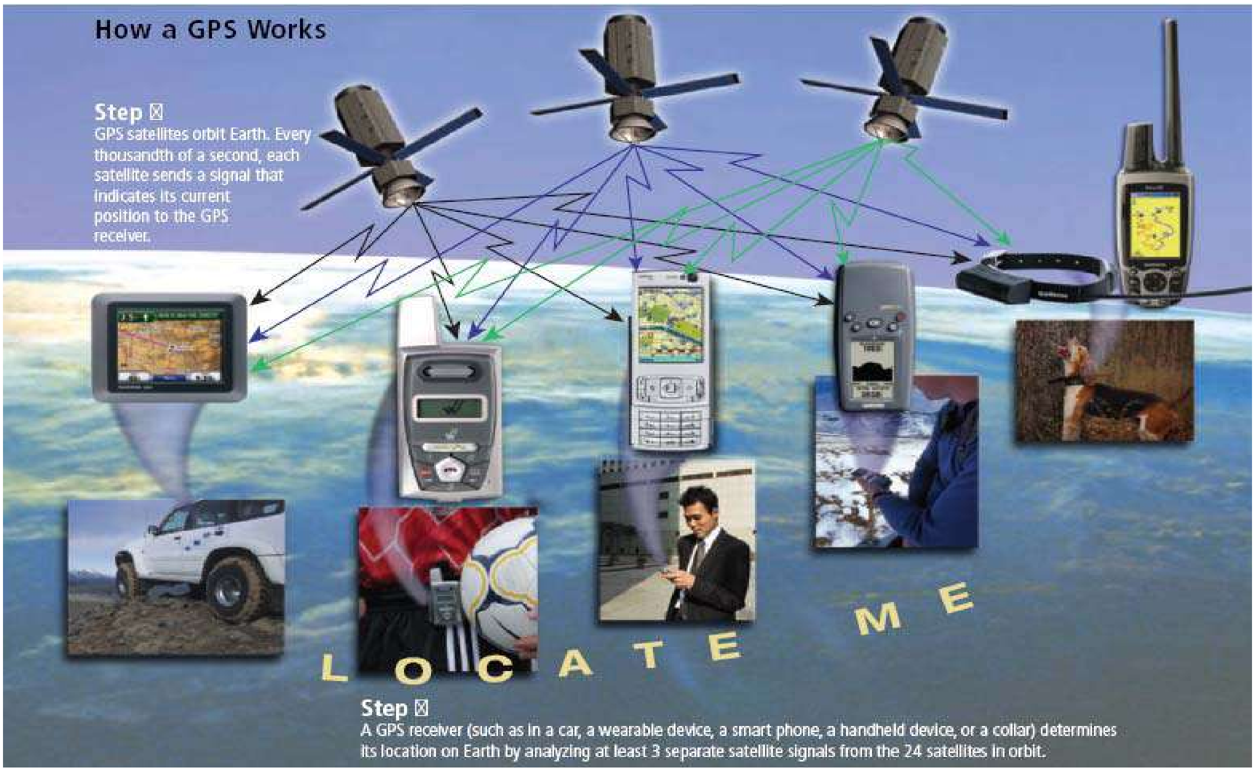


Figure 9-6 This figure shows how a GPS works.

Groupware

Groupware is software that helps groups of people work together on projects and share information over a network. Groupware is a component of a broad concept called *workgroup computing*, which includes network hardware and software that enables group members to communicate, manage projects, schedule meetings, and make group decisions. To assist with these activities, most groupware provides personal information manager (PIM) functions, such as an electronic appointment calendar, an address book, and a notepad. A major feature of groupware is group scheduling, in which a group calendar can track the schedules of multiple users and help coordinate appointments and meeting times.

Voice Mail

Voice mail, which functions much like an answering machine, allows someone to leave a voice message for one or more people. Unlike answering machines, however, a computer in the voice mail system converts an analog voice message into digital form. Once digitized, the message is stored in a voice mailbox. A *voice mailbox* is a storage location on a hard disk in the voice mail system. To help users manage voice mail messages, some systems offer visual voice mail. With *visual voice mail*, users can view message details such as the length of calls and, in some cases, read message contents instead of listening to them. Some voice mail systems can send audio voice mail files to e-mail addresses. Others can convert a voice mail message to a text message for display on a computer or mobile device such as a smart phone, which you then can manage like any other text message.

Collaboration

Many programs provide a means to **collaborate**, or work online, with other users connected to a server. Three methods of collaboration include collaborative software, reviewing via e-mail, and document management systems. *Collaborative software* includes tools that enable users to share documents via online meetings and communicate with other connected users. An *online meeting* allows users to share documents with others in real time (Figure 9-7). When the online meeting takes place on the Web, it is called a **Web conference**. In an online meeting, all participants see a document(s) at the same time. As someone changes the document, everyone in the meeting sees the changes being made. During the online meeting, participants have the ability to open a chat window and type messages to one another. Collaborative software often has whiteboard and video/audio conferencing capabilities. Examples of collaborative software include Acrobat Connect, GoToMeeting, Microsoft Groove, Micro soft Office Live Meeting, Google Wave, and WebEx. Microsoft Office SharePoint Server contains a suite of programs, one of which is collaborative software. Instead of interacting in a live meeting, users often collaborate via e-mail. For example, if users want others to review a document, they can e-mail the document for review. When the recipients (reviewers) receive the document, they may add comments to the document. As the reviewers make changes to the document, both the original text and the changes are displayed. When the originator receives the document back from all reviewers, he or she can merge all comments and changes into a single document. Some organizations use document management systems to make collaboration possible among employees. A *document management system* provides for storage and management of a company's documents, such as word processing documents, presentations, and spreadsheets. Users then access these documents, depending on their needs. A document management system can track all changes made to a document. It also can store additional information such as the document's creation date, the user who created the document, a summary of the document, and any keywords associated with the document. Google Docs is a Web-based document management system with basic services available to subscribers at no cost and premium services available for a fee. With Google Docs, multiple users can work on the same document at the same time, viewing each other's edits as they are entered.

Figure 9-7 Through an online meeting, all participants see a document at the same time.

Web Services

Web services describe standardized software that enables programmers to create applications that communicate with other remote computers over the Internet or on an internal business network (Figure 9-8).

Businesses use Web services because this technology provides a means for departments to communicate with each other, suppliers, vendors, and with clients. For example, third-party vendors can use Web services to communicate with their online retailer's Web site to manage their inventory levels.
Web services often provide content for mashups. A *mashup* is a Web application that combines services from two or more sources, creating a new application. An e-commerce business, for example, might determine the address of its closest retail store from its Web site and combine (mash) the location with a map from a travel and mapping Web site to provide a Web site visitor with driving directions.

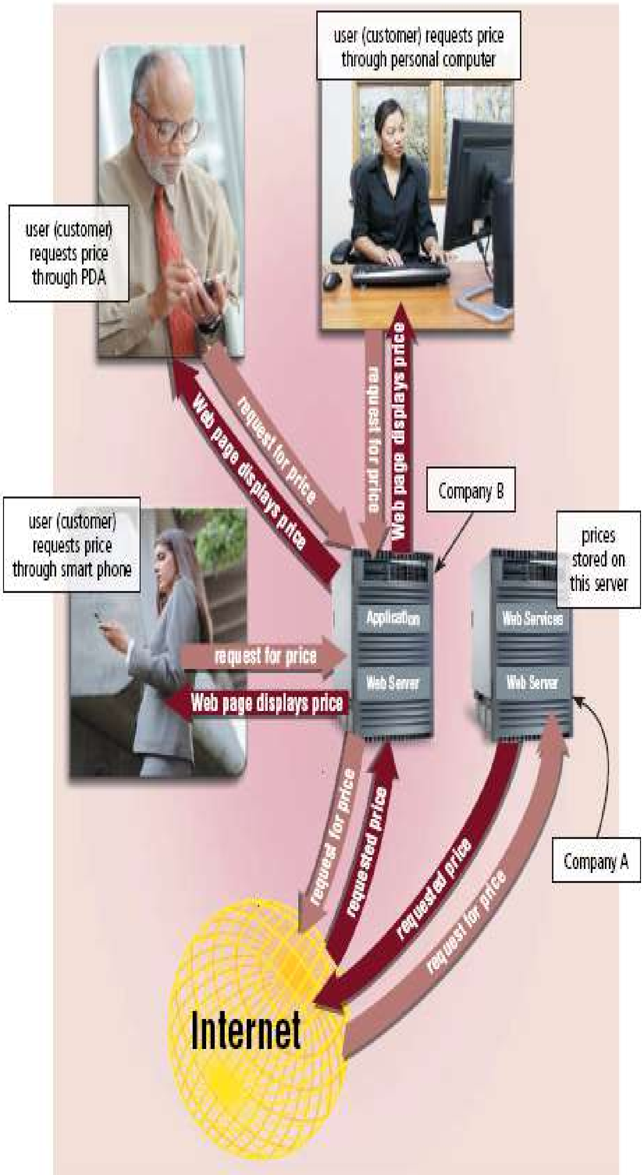


Figure 9-8 An example of Web services.

Web services do not require a specific programming language, operating system, or Web browser. Different applications from different platforms can communicate with each other by sending properly formatted *XML* (Extensible Markup Language) files to the Web services. A Windows application, for example, can communicate with a UNIX application. Web services do not have a user interface because the application's user interface interacts with the Web service.

Networks

As discussed in Chapter 1, a **network** is a collection of computers and devices connected together via communications devices and transmission media. Many businesses network their computers together to facilitate communications, share hardware, share data and information, share software, and transfer funds (Figure 9-9). A network can be internal to an organization or span the world by connecting to the Internet. The following paragraphs explain the advantages of using a network.

- Facilitating communications — Using a network, people communicate efficiently and easily via e-mail, instant messaging, chat rooms, blogs, wikis, online social networks, video telephone calls, online meetings, video conferencing, VoIP, wireless messaging services, and groupware. Some of these communications, such as e-mail, occur within a business's internal network. Other times, they occur globally over the Internet.

- Sharing hardware — In a networked environment, each computer on the network can have access to hardware on the network. Business and home users network their hardware to save money. That is, it may be too costly to provide each user with the same piece of hardware such as a printer. If the computers and a laser printer are connected to a network, the computer users each access the laser printer on the network, as they need it.

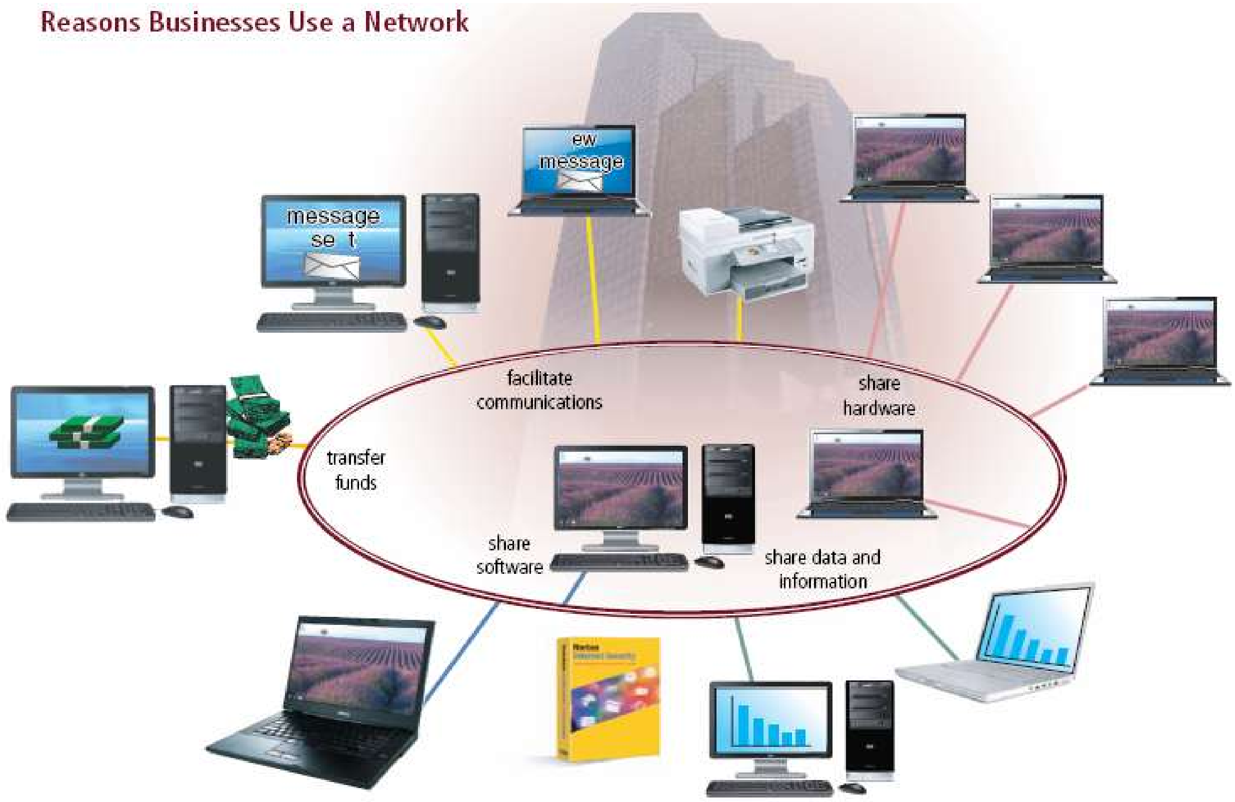


Figure 9-9 Businesses use networks to facilitate communications, share hardware, share data and information, share software, and transfer funds.

- Sharing data and information — In a networked environment, any authorized computer user can access data and information stored on other computers on the network. A large company, for example, might have a database of customer information. Any authorized person, including a mobile user with a smart phone or other device connected to the network, has access to the database. Most businesses use a standard, such as *EDI* (*electronic data interchange*), that defines how data transmits across telephone lines or other means. For example, companies use EDI to handle product catalog distribution, bids, requests for quotations, proposals, order placement, shipping notifications, invoicing, and payment processing. EDI enables businesses to operate with a minimum amount of paperwork. Another popular data sharing standard is XML, briefly described earlier in this chapter. Using XML, Web programmers can create one version of a Web page that then can be displayed in a form appropriate for a variety of display devices. XML also is used in RSS, which is used to distribute content, such as news, to subscribers.

- Sharing software — Users connected to a network have access to software on the network. To support multiple users' access of software, most vendors sell network versions or site licenses of their software, which usually cost less than buying individual copies of the software for each computer. A *network license* is a legal agreement that allows multiple users to access the software on a server simultaneously. The network license fee usually is based on the number of users or the number of computers attached to the network. A *site license* is a legal agreement that permits users to install the software on multiple computers — usually at a volume discount.

• Transferring funds — Called *electronic funds transfer* (*EFT*), it allows users connected to a network to transfer money from one bank account to another via transmission media. Both businesses and consumers use EFT. Consumers use an ATM to access their bank account. Businesses deposit payroll checks directly in employees' bank accounts. Consumers use credit cards to make purchases from a retail Web site.

Businesses use EFT to purchase and pay for goods purchased from vendors. Both businesses and consumers pay bills online, with which they instruct a bank to use EFT to pay creditors.

Instead of using the Internet or investing in and administering an internal network, some companies hire a value-added network provider for network functions. A *value-added network* (*VAN*) is a third-party business that provides networking services such as secure data and information transfer, storage, e-mail, and management reports. Some VANs charge an annual or monthly fee; others charge by service used.

LANs, MANs, and WANs
Networks usually are classified as a local area network, metropolitan area network, or wide area network. The main differentiation among these classifications is their area of coverage, as described in the following pages.

LAN A **local area network** (**LAN**) is a network that connects computers and devices in a limited geographical area such as a home, school computer laboratory, office building (Figure 9-10), or closely positioned group of buildings. Each computer or device on the network, called a *node*, often shares resources such as printers, large hard disks, and programs.

Often, the nodes are connected via cables.

A **wireless LAN** (**WLAN**) is a LAN that uses no physical wires. Computers and devices that access a wireless LAN must have built-in wireless capability or the appropriate wireless network card, USB network adapter, ExpressCard module, PC Card, or flash card. Very often, a WLAN communicates with a wired LAN for access to its resources, such as software, hardware, and the Internet (Figure 9-11).

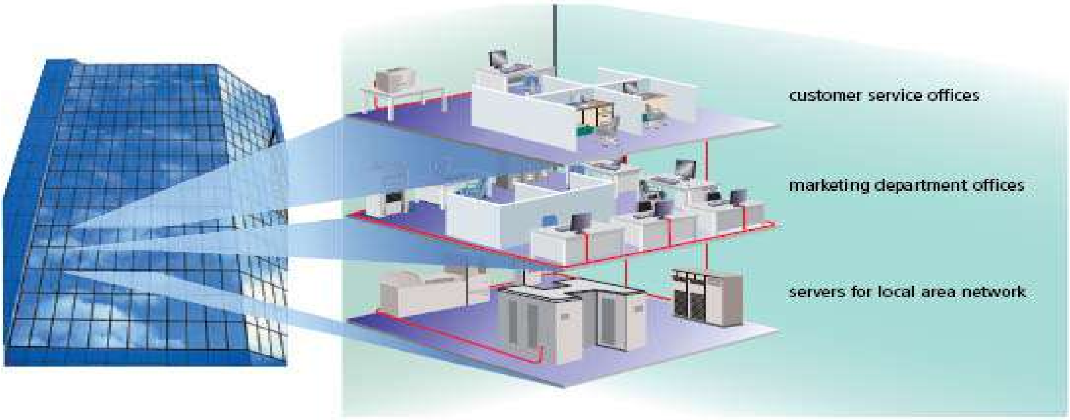


Figure 9-10 Computers on different floors access the same local area network (LAN) in an office building.

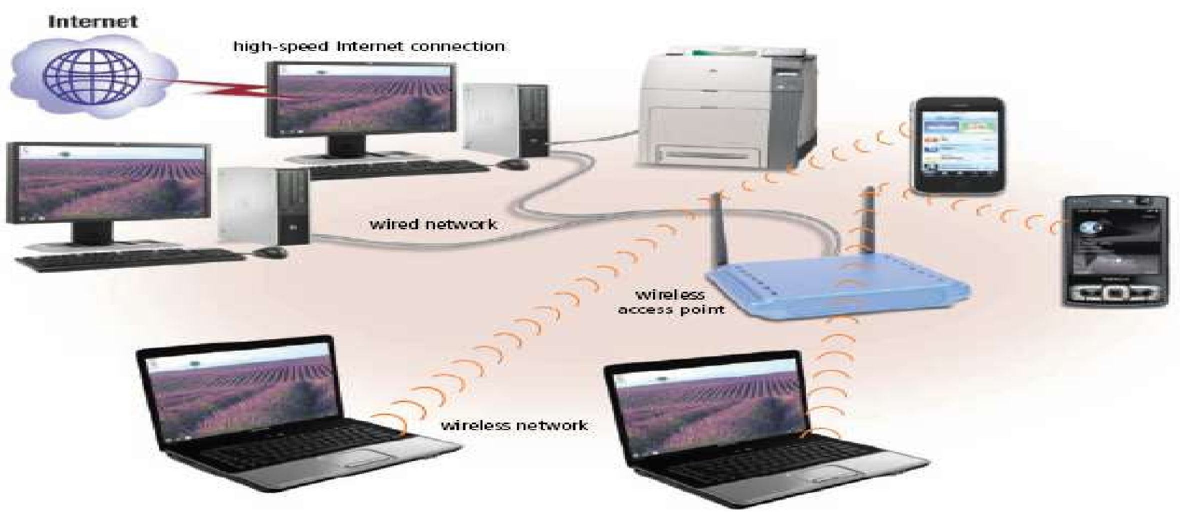


Figure 9-11 Computers and mobile devices on a wireless LAN often communicate via an access point with a wired LAN to access its software, printer, the Internet, and other resources.

MAN A *metropolitan area network* (*MAN*) is a high-speed network that connects local area networks in a metropolitan area such as a city or town and handles the bulk of communications activity across that region. A MAN typically includes one or more LANs, but covers a smaller geographic area than a WAN. A MAN usually is managed by a consortium of users or by a single network provider that sells the service to the users. Local and state governments, for example, regulate some MANs. Telephone companies, cable television operators, and other organizations provide users with connections to the MAN.

WAN A **wide area network** (**WAN**) is a network that covers a large geographic area (such as a city, country, or the world) using a communications channel that combines many types of media such as telephone lines, cables, and radio waves (Figure 9-12). A WAN can be one large network or can consist of two or more LANs connected together. The Internet is the world's largest WAN.

Network Architectures

The design of computers, devices, and media in a network, sometimes called the *network architecture*, is categorized as either client/server or peer-to-peer. The following sections discuss these network architectures.

Client/Server On a **client/server network**, one or more computers act as a server, and the other computers on the network request ser vices from the server (Figure 9-13). A **server**, sometimes called a *host computer,* controls access to the hardware, software, and other resources on the network and provides a centralized storage area for programs, data, and information. The **clients** are other computers and mobile devices on the network that rely on the server for its resources. For example, a server might store a database of customers. Clients on the network (company employees) access the customer database on the server. Some servers, called *dedicated servers,* perform a specific task and can be placed with other dedicated servers to perform multiple tasks. For example, a *file server* stores and manages files. A *print server* manages printers and documents being printed. A *database server* stores and provides access to a database. A *network server* manages network traffic (activity). A *Web server* is a computer that delivers requested Web pages to your computer. Although it can connect a smaller number of computers, a client/server network typically provides an efficient means to connect 10 or more computers. Most client/server networks require a person to serve as a network administrator because of the large size of the network.

Figure 9-12 An example of a WAN.

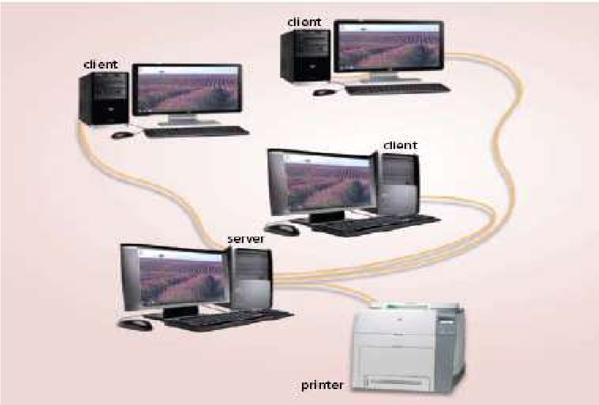


Figure 9-13 On a client/server network, one or more computers act as a server, and the clients access the server(s).

Peer-to-Peer One type of *peer-to-peer network* is a simple, inexpensive network that typically connects fewer than 10 computers. Each computer, called a *peer*, has equal responsibilities and capabilities, sharing hardware (such as a printer), data, or information with other computers on the peer-to-peer network (Figure 9-14). Each computer stores files on its own storage devices. Thus, each computer on the network contains both the server operating system and application software. All computers on the network share any peripheral device(s) attached to any computer. For example, one computer may have a laser printer and a scanner, while another has an ink-jet printer and an external hard disk. Peer-to-peer networks are ideal for very small businesses and home users. Some operating systems, such as Windows, include a peer-to-peer networking utility that allows users to set up a peer-to-peer network.

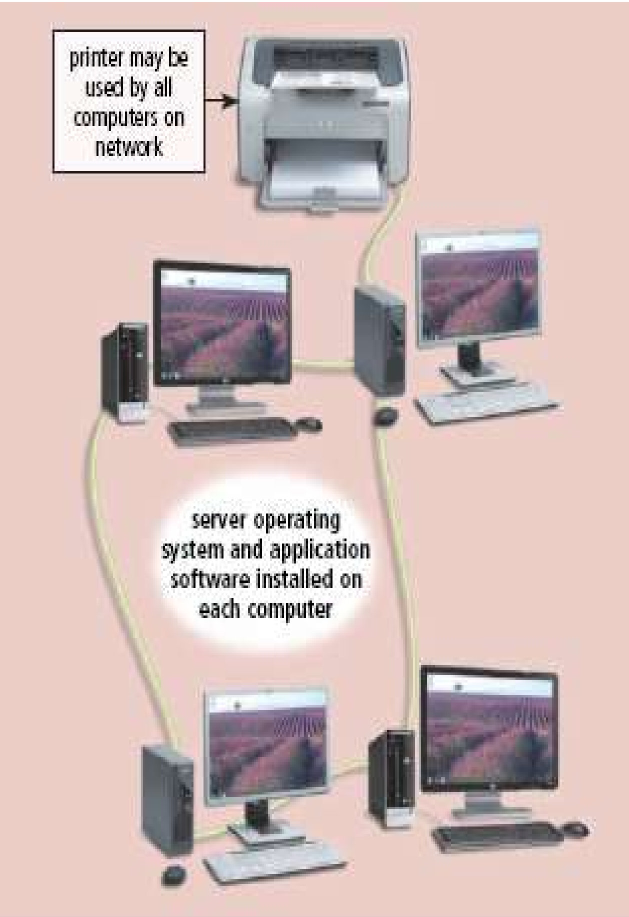


Figure 9-14 Each computer on a peer-to-peer network shares its hardware and software with other computers on the network.

Internet Peer-to-Peer Another type of peer-to-peer, called *P2P*, describes an Internet network on which users access each other's hard disks and exchange files directly over the Internet (Figure 9-15). This type of peer-to-peer network sometimes is called a *file sharing network* because users with compatible software and an Internet connection copy files from someone else's hard disk to their hard disks. As more users connect to the network, each user has access to shared files on other users' hard disks. When users log off the network, others no longer have access to their hard disks. To maintain an acceptable speed for communications, some implementations of P2P limit the number of users.

Examples of networking software that support P2P are BitTorrent, Gnutella, Kazaa, and LimeWire, which allow users to swap music and other files via the Web. For example, when one user requests a song, the program searches through lists of shared files — which are stored on one or more connected computers, called supernodes. If a match is found, the music file is copied from the computer on which it resides to the requesting computer. These programs initially stirred much controversy with respect to copyright infringement of music because they allowed users easily to copy music and movie files free from one computer to another. To help reduce copyright infringement, today's music and movie sharing services typically are fee based, and music and movie files often are encrypted as they travel across the Internet. Many businesses also see an advantage to using P2P. That is, companies and employees can exchange files using P2P, freeing the company from maintaining a network server for this purpose. Business-to-business e-commerce Web sites find that P2P easily allows buyers and sellers to share company information such as product databases.

Network Topologies

A **network topology** refers to the layout of the computers and devices in a communications network. Three commonly used network topologies are star, bus, and ring. Most networks, including the Internet, use combinations of these topologies.

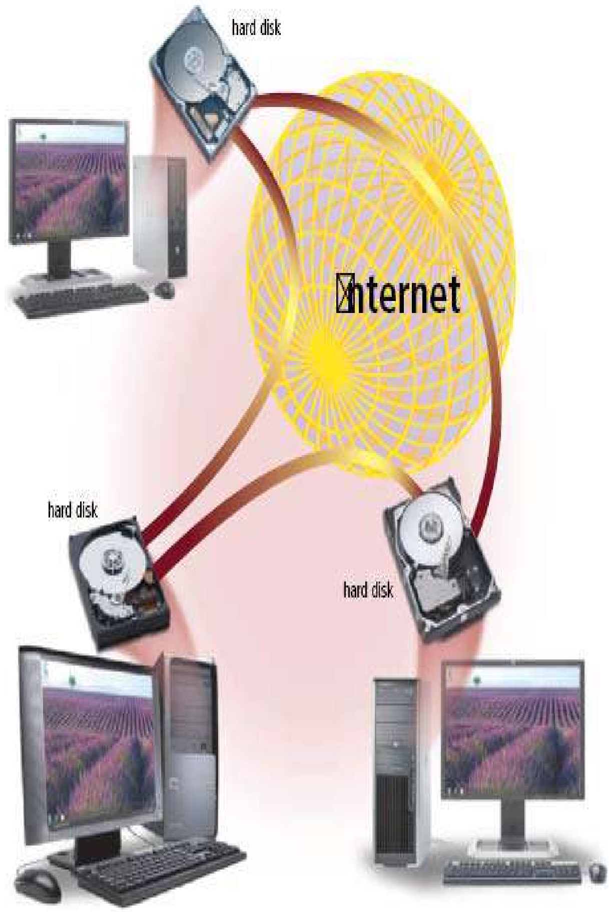


Figure 9-15 P2P describes an Internet network on which users connect to each other's hard disks and exchange files directly.

Star Network On a *star network*, all of the computers and devices (nodes) on the network connect to a central device, thus forming a star (Figure 9-16). Two types of devices that provide a common central connection point for nodes on the network are a *hub* and a *switch*. All data that transfers from one node to another passes through the hub or switch. Star networks are fairly easy to install and maintain. Nodes can be added to and removed from the network with little or no disruption to the network. On a star network, if one node fails, only that node is affected. The other nodes continue to operate normally. If the hub or switch fails, however, the entire network is inoperable until the device is repaired. Most large star networks, therefore, keep backup hubs or switches available in case the primary one fails.

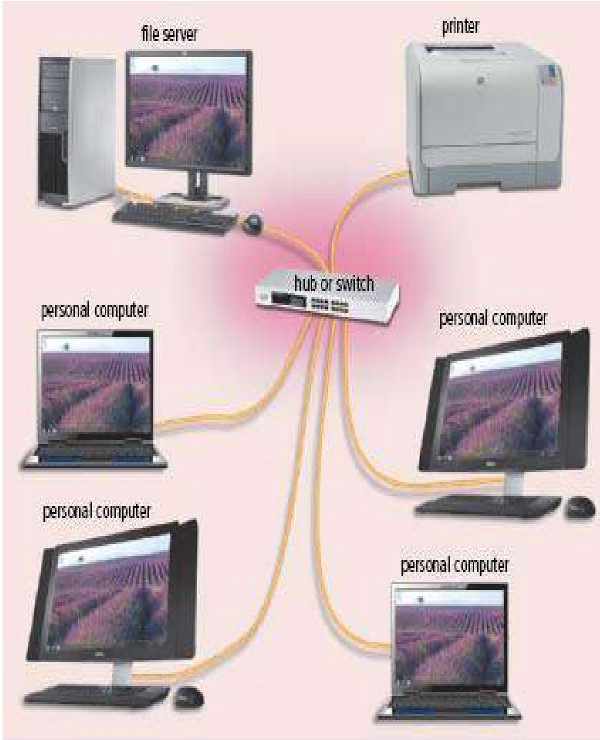


Figure 9-16 A star network contains a single, centralized hub or switch through which all the devices in the network communicate.

Bus Network A *bus network* consists of a single central cable, to which all computers and other devices connect (Figure 9-17). The *bus* is the physical cable that connects the computers and other devices. The bus in a bus network transmits data, instructions, and information in both directions. When a sending device transmits data, the address of the receiving device is included with the transmission so that the data is routed to the appropriate receiving device.
Bus networks are popular on LANs because they are inexpensive and easy to install. One advantage of the bus network is that computers and other devices can be attached and detached at any point on the bus without disturbing the rest of the network. Another advantage is that failure of one device usually does not affect the rest of the bus network. The greatest risk to a bus network is that the bus itself might become inoperable. If that happens, the network remains inoperative until the bus is back in working order.

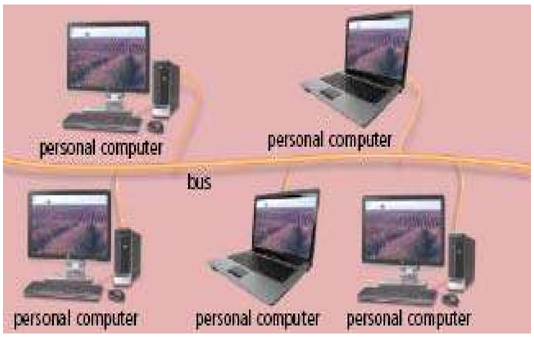


Figure 9-17 Devices in a bus network share a single data path.

Ring Network On a *ring network*, a cable forms a closed loop (ring) with all computers and devices arranged along the ring (Figure 9-18). Data transmitted on a ring network travels from device to device around the entire ring, in one direction. When a computer or device sends data, the data travels to each computer on the ring until it reaches its destination. If a computer or device on a ring network fails, the entire network potentially could stop functioning. A ring network can span a larger distance than a bus network, but it is more difficult to install. The ring topology primarily is used for LANs, but also is used in WANs.

Intranets

Recognizing the efficiency and power of the Internet, many organizations apply Internet and Web technologies to their internal networks. An *intranet* (intra means within) is an internal network that uses Internet technologies. Intranets generally make

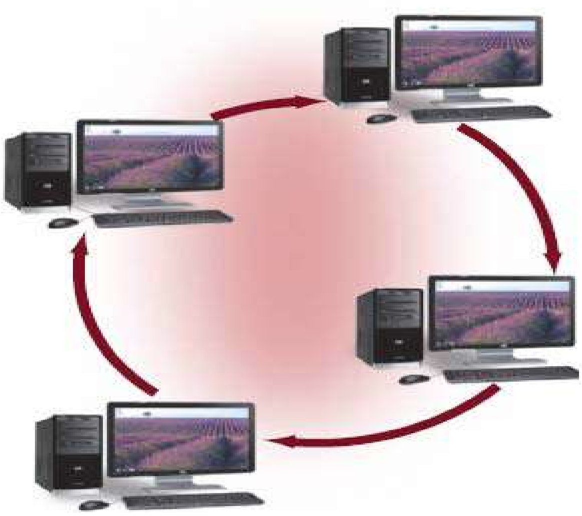


Figure 9-18 On a ring network, all connected devices form a continuous loop.

company information accessible to employees and facilitate working in groups. Simple intranet applications include electronic publishing of organizational materials such as telephone directories, event calendars, procedure manuals, employee benefits information, and job postings. Additionally, an intranet typically includes a connection to the Internet. More sophisticated uses of intranets include groupware applications such as project management, chat rooms, group scheduling, and video conferencing. An intranet essentially is a small version of the Internet that exists within an organization. It has a Web server, supports Web pages containing multimedia, and is accessible via a Web browser such as Internet Explorer, Firefox, Opera, Safari, and Google Chrome. Users update information on the intranet by creating and posting a Web page, using a method similar to that used on the Internet. Sometimes a company uses an *extranet*, which allows customers or suppliers to access part of its intranet. Package shipping companies, for example, allow customers to access their intranet to print air bills, schedule pickups, and even track shipped packages as the packages travel to their destinations.

Network Communications Standards

Today's networks connect terminals, devices, and computers from many different manufacturers across many types of networks, such as wide area, local area, and wireless. For the different devices on various types of networks to be able to communicate, the network must use similar techniques of moving data through the network from one application to another. For example, an IBM mainframe computer cannot communicate directly with an Apple Macintosh network — some form of translation must occur for devices on these two types of networks to communicate. To alleviate the problems of incompatibility and ensure that hardware and software components can be integrated into any network, various organizations such as ANSI and IEEE (pronounced I triple E) propose, develop, and approve network standards. A *network standard* defines guidelines that specify the way computers access the medium to which they are attached, the type(s) of medium used, the speeds used on different types of networks, and the type(s) of physical cable and/or the wireless technology used. A standard that outlines characteristics of how two network devices communicate is called a *protocol*. Specifically, a protocol may define data format, coding schemes, error handling, and sequencing techniques. Hardware and software manufacturers design their products to meet the guidelines specified in a particular standard, so that their devices can communicate with the network. The following pages discuss some of the more widely used network communications standards and protocols for both wired and wireless networks including Ethernet, token ring, TCP/IP, Wi-Fi, Bluetooth, UWB, IrDA, RFID, WiMAX, and WAP. Oftentimes, these network standards and protocols work together to move data through a network. Some of these standards define how a network is arranged physically; others specify how messages travel along a network, and so on. Thus, as data moves through a network from one program to another, it may use one or more of these standards.

Ethernet

Ethernet is a network standard that specifies no central computer or device on the network (nodes) should control when data can be transmitted; that is, each node attempts to transmit data when it determines the network is available to receive communications. If two computers on an Ethernet network attempt to send data at the same time, a collision will occur, and the computers must attempt to send their messages again. Ethernet is based on a bus topology, but Ethernet networks can be wired in a star pattern. The Ethernet standard defines guidelines for the physical configuration of a network, e.g., cabling, network cards, and nodes. Today, Ethernet is the most popular network standard for LANs because it is relatively inexpensive and easy to install and maintain.
Ethernet networks often use cables to transmit data. At a 10 Mbps (million bits per second) data transfer rate, the original Ethernet standard is not very fast by today's standards. A more recent Ethernet standard, called *Fast Ethernet*, has a data transfer rate of 100 Mbps, ten times faster than the original standard. *Gigabit Ethernet* provides an even higher speed of transmission, with transfer rates of 1 Gbps (1 billion bits per second). The *10-Gigabit Ethernet* standard supports transfer rates up to 10 Gbps, *40-Gigabit Ethernet* up to 40 Gbps, and *100-Gigabit Ethernet* up to 100 Gbps.

Token Ring

The **token ring** standard specifies that computers and devices on the network share or pass a special signal, called a token, in a unidirectional manner and in a preset order. A *token* is a special series of bits that function like a ticket. The device with the token can transmit data over the network. Only one token exists per network. This ensures that only one computer transmits data at a time. Token ring is based on a ring topology (although it can use a star topology). The token ring standard defines guidelines for the physical configuration of a network, e.g., cabling, network cards, and devices. Some token ring networks connect up to 72 devices. Others use a special type of wiring that allows up to 260 connections. The data transfer rate on a token ring network can be 4 Mbps, 16 Mbps, 100 Mbps, or 1 Gbps.

TCP/IP

Short for Transmission Control Protocol/ Internet Protocol, **TCP/IP** is a network standard, specifically a protocol, that defines how messages (data) are routed from one end of a network to the other, ensuring the data arrives correctly. TCP/IP describes rules for dividing messages into small pieces, called *packets*; providing addresses for each packet; checking for and detecting errors; sequencing packets; and regulating the flow of messages along the network.

TCP / IP has been adopted as a network standard for Internet communications. Thus, all hosts on the Internet follow the rules defined in this standard. As shown in Figure 9-19, Internet communications also use other standards, such as the Ethernet standard, as data is routed to its destination. When a computer sends data over the Internet, the data is divided into packets. Each packet contains the data, as well as the recipient (destination), the origin (sender), and the sequence information used to reassemble the data at the destination. Each packet travels along the fastest individual available path to the recipient's computer via communications devices called routers. This technique of breaking a message into individual packets, sending the packets along the best route available, and then reassembling the data is called *packet switching*.

Figure 9-19 Network communications use a variety of standards to ensure that data travels correctly to its destination. Some standards used in Internet communications include the TCP/IP and Ethernet standards, as shown in this figure.

Wi-Fi

Computers and devices that have the appropriate wireless capability can communicate via radio waves with other computers or devices using **Wi-Fi** (wireless fidelity), which identifies any network based on the 802.11 standards. Developed by IEEE, **802.11** is a series of network standards that specifies how two wireless devices communicate over the air with each other. The table in Figure 9-20 outlines various 802.11 standards and their data transfer rates. A designation of 802.11 a/b/g on a computer or device indicates it supports those three standards (a, b, and g). The newest standard, 802.11n, uses multiple transmitters and receivers, known as *MIMO* (multiple-input multiple-output), to reach speeds from 2 to 10 times faster than 802.11g. Wi-Fi sometimes is referred to as wireless Ethernet because it uses techniques similar to the Ethernet standard to specify how physically to configure a wireless network. Thus, Wi-Fi networks easily can be integrated with wired Ethernet networks. When a Wi-Fi network accesses the Internet, it works in conjunction with the TCP/IP network standard. Wi-Fi Certified products are guaranteed to be able to communicate with each other. Most of today's computers and many mobile devices, such as smart phones and handheld game consoles, are Wi-Fi enabled. One popular use of the Wi-Fi network standard is in hot spots (discussed earlier in this chapter) that offer mobile users the ability to connect to the Internet with their Wi-Fi enabled wireless computers and devices. Many homes and small businesses also use Wi-Fi to network computers and devices wirelessly. In open or outdoor areas free from interference, the computers or devices should be within 300 feet of each other.

802.11 Series of Standards	
Standard	**Transfer Rates**
802.11	1 or 2 Mbps
802.11a	Up to 54 Mbps
802.11b	Up to 11 Mbps
802.11g	54 Mbps and higher
802.11n	108 Mbps and higher

Figure 9-20 A comparison of standards in the 802.11 series.

In closed areas, the wireless network range is about 100 feet. To obtain communications at the maximum distances, you may need to install extra hardware. Some large areas, such as college or business campuses, are set up as a *Wi-Fi mesh network*, in which each mesh node routes its data to the next available node until the data reaches its destination — usually an Internet connection. A Wi-Fi mesh network is more flexible than a hot spot because each node in a mesh network does not have to be directly connected to the Internet.

Bluetooth

Bluetooth is a network standard, specifically a protocol, that defines how two Bluetooth devices use short-range radio waves to transmit data. The data transfers between devices at a rate of up to 3 Mbps. To communicate with each other, Bluetooth devices often must be within about 10 meters (about 33 feet) but can be extended to 100 meters with additional equipment.

A Bluetooth device contains a small chip that allows it to communicate with other Bluetooth devices. Examples of Bluetooth-enabled devices can include desktop computers, notebook computers, handheld computers, smart phones, headsets, keyboards, mouse devices, microphones, digital cameras, GPS receivers, and printers. For computers and devices not Bluetooth-enabled, you can purchase a Bluetooth wireless port adapter that will convert an existing USB port into a Bluetooth port. Most current operating systems have built-in Bluetooth support.

UWB

UWB, which stands for **ultra-wideband**, is a network standard that specifies how two UWB devices use short-range radio waves to communicate at high speeds with each other. At distances of 10 meters (about 33 feet), the data transfer rate is 110 Mbps. At closer distances, such as 2 meters (about 6.5 feet), the transfer rate is at least 480 Mbps. UWB can transmit signals through doors and other obstacles. Because of its high transfer rates, UWB is best suited for transmission of large files such as video, graphics, and audio. Examples of UWB uses include wirelessly transferring video from a digital video camera, printing pictures from a digital camera, downloading media to a portable media player, or displaying a slide show on a projector.

IrDA

As discussed in Chapter 4, some computers and devices use the **IrDA** standard to transmit data wirelessly to each other via infrared (IR) light waves. The devices transfer data at rates from 115 Kbps (thousand bits per second) to 4 Mbps between their IrDA ports. Infrared requires a *line-of-sight transmission*; that is, the sending device and the receiving device must be in line with each other so that nothing obstructs the path of the infrared light wave. Because Bluetooth and UWB do not require line-of-sight transmission, some industry experts predict that these technologies will replace infrared.

RFID

RFID (*radio frequency identification*) is a standard, specifically a protocol, that defines how a network uses radio signals to communicate with a tag placed in or attached to an object, an animal, or a person. The tag, called a transponder, consists of an antenna and a memory chip that contains the information to be transmitted via radio waves. Through an antenna, an RFID reader, also called a transceiver, reads the radio signals and transfers the information to a computer or computing device.

RFID tags are passive or active. An active RFID tag contains a battery that runs the chip's circuitry and broadcasts a signal to the RFID reader. A passive RFID tag does not contain a battery and thus cannot send a signal until the reader activates the tag's antenna by sending out electromagnetic waves. Because passive RFID tags contain no battery, these can be small enough to be embedded in skin. Depending on the type of RFID reader, the distance between the tag and the reader ranges from 5 inches to 15 feet. Readers can be handheld or embedded in an object such as a doorway or the tollbooth shown in Figure 9-21.

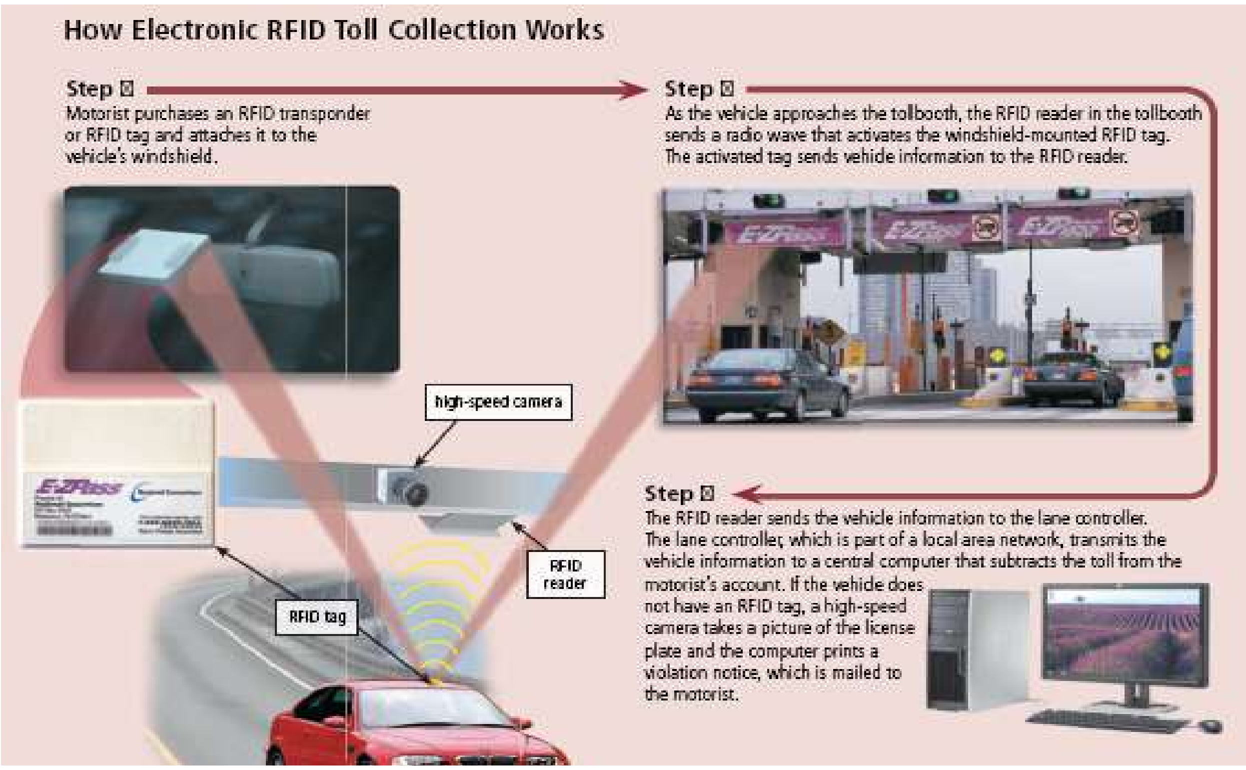


Figure 9-21 This figure shows how electronic RFID toll collection works.

WiMAX

WiMAX (Worldwide Interoperability for Microwave Access), also known as **802.16**, is a network standard developed by IEEE that specifies how wireless devices communicate over the air in a wide area. Using the WiMAX standard, computers or devices with the appropriate WiMAX wireless capability communicate via radio waves with other computers or devices via a WiMAX tower. The WiMAX tower, which can cover up to a 30-mile radius, connects to the Internet or to another WiMAX tower.

Two types of WiMAX specifications are fixed wireless and mobile wireless. With fixed wireless WiMAX, a customer accesses the Internet from a desktop computer at home or other permanent location. Mobile wireless WiMAX, by contrast, enables users to access the WiMAX network with mobile computers and mobile devices such as smart phones. Fixed wireless WiMAX has data transfer rates up to 40 Mbps, while mobile wireless WiMAX has data transfer rates up to 15 Mbps. The WiMAX standard provides wireless broadband Internet access at a reasonable cost over long distances to business and home users, including rural and remote areas. WiMAX, similar to Wi-Fi, connects mobile users to the Internet via hot spots. Many computers and mobile devices such as smart phones have built-in WiMAX capability. Some game consoles also support the WiMAX standard.

WAP

The **Wireless Application Protocol** (**WAP**) is a standard, specifically a protocol, that specifies how some mobile devices such as smart phones can display the content of Internet services such as the Web, e-mail, and chat rooms (Figure 9-22). To display a Web page on a smart phone, the phone should contain a microbrowser. WAP works in conjunction with the TCP/IP network standard. WAP uses a client/server network. The wireless device contains the client software, which connects to the Internet access provider's server.

Communications Software

Communications software consists of programs that (1) help users establish a connection to another computer or network; (2) manage the transmission of data, instructions, and information; and (3) provide an interface for users to communicate with one another. The first two are system software and the third is application software. Chapter 3 presented a variety of examples of application software for communications: e-mail, FTP, Web browser, newsgroup/message boards, chat rooms, instant messaging, video conferencing, and VoIP. Sometimes, communications devices are preprogrammed to accomplish communications tasks. Other communications devices require separate communications software to ensure proper transmission of data. Communications software works with the network standards and protocols just discussed to ensure data moves through the network or the Internet correctly. Communications software usually is bundled with the operating system or purchased network devices.

Often, a computer has various types of communications software, each serving a different purpose. One type of communications software, for example, helps users establish an Internet connection using wizards, dialog boxes, and other on-screen messages. Another allows home and small office users to configure wired and wireless networks and connect devices to an existing network.

Communications over the Telephone Network

The *public switched telephone network* (*PSTN*) is the worldwide telephone system that handles voice-oriented telephone calls (Figure 9-23). Nearly the entire telephone network today uses digital technology, with the exception of the final link from the local telephone company to a home, which often is analog. The telephone network is an integral part of computer communications. Data, instructions, and information are transmitted over the telephone network using dial-up lines or dedicated lines. The following sections discuss various types of lines that use the telephone network for data communications.

Figure 9-22 A WAP-enabled smart phone.

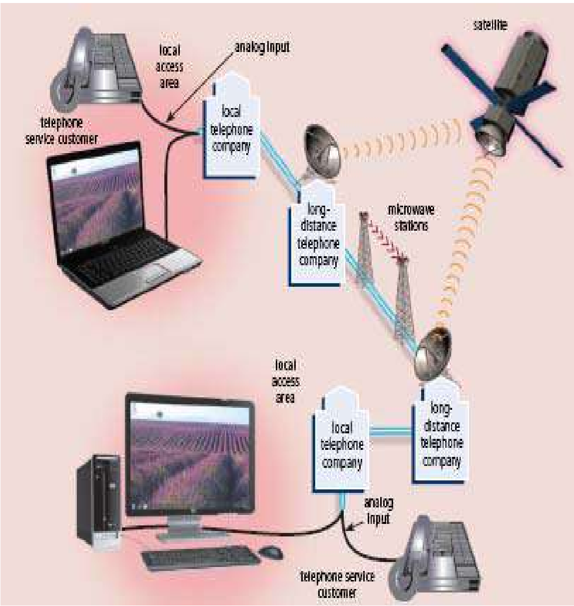


Figure 9-23 A sample telephone network configurations.

Dial-Up Lines

A **dial-up line** is a temporary connection that uses one or more analog telephone lines for communications. A dial-up connection is not permanent. Using a dial-up line to connect computers costs no more than making a regular telephone call.

Dedicated Lines

A **dedicated line** is a type of always-on connection that is established between two communications devices (unlike a dial-up line where the connection is reestablished each time it is used). The quality and consistency of the connection on a dedicated line are better than a dial-up line because dedicated lines provide a constant connection. Businesses often use dedicated lines to connect geographically distant offices. Dedicated lines can be either analog or digital. Digital lines increasingly are connecting home and business users to networks around the globe because they transmit data and information at faster rates than analog lines.

Five types of digital dedicated lines are ISDN lines, DSL, FTTP, T-carrier lines, and ATM. Although cable television (CATV) lines and fixed wireless are not a type of telephone line, they are very popular ways for the home user to connect to the Internet. Fixed wireless Internet connections use an antenna on your house or business to communicate with a tower location via radio signals. Later sections in this chapter discuss the use of CATV lines and radio signals to connect to the Internet. The table in Figure 9-24 lists the approximate monthly costs of various types of Internet connections and transfer rates (speeds), as compared with dial-up lines. The following sections discuss ISDN lines, DSL, FTTP, T-carrier lines, and ATM.

ISDN Lines

For the small business and home user, an ISDN line provides faster transfer rates than dial-up telephone lines. Not as widely used today as in the past, *ISDN* (Integrated Services Digital Network) is a set of standards for digital transmission of data over standard copper telephone lines. With ISDN, the same telephone line that could carry only one computer signal now can carry three or more signals at once through the same line, using a technique called *multiplexing*.

Speeds of Various Internet Connections

Type of Line	Approximate Monthly Cost	Transfer Rates
Dial-up	Local or long-distance rates	Up to 56 Kbps
ISDN	\$10 to \$40	Up to 1.54 Mbps
DSL	\$13 to \$70	128 Kbps to 8.45 Mbps
Cable TV (CATV)	\$20 to \$50	128 Kbps to 52 Mbps
FTTP	\$35 to \$180	5 Mbps to 100 Mbps
Fixed wireless	\$35 to \$80	256 Kbps to 10 Mbps
Fractional T1	\$200 to \$700	128 Kbps to 768 Kbps
T1	\$400 to \$1,600	1.544 Mbps
T3	\$5,000 to \$15,000	44.736 Mbps
ATM	\$3,000 or more	155 Mbps to 622 Mbps, can reach 10 Gbps

Figure 9-24 The speeds of various lines that can be used to connect to the Internet.

DSL

DSL is a popular digital line alternative for the small business or home user. **DSL** (*Digital Subscriber Line*) transmits at fast speeds on existing standard copper telephone wiring. Some DSL installations include a dial tone, providing users with both voice and data communications. These DSL installations often require that filters be installed to reduce noise interference when voice communications share the same line. ADSL is one of the more popular types of DSLs. As shown in Figure 9-25, *ADSL* (*asymmetric digital subscriber line*) is a type of DSL that supports faster transfer rates when receiving data (the *downstream rate*) than when sending data (the *upstream rate*). ADSL is ideal for Internet access because most users download more information from the Internet than they upload.

FTTP

FTTP, which stands for **Fiber to the Premises**, uses fiber-optic cable to provide extremely high-speed Internet access to a user's physical permanent location. Two specific types of FTTP are FTTH and FTTB. *FTTH* (*Fiber to the Home*) provides home users with Internet access via fiber-optic cable. Similarly, *FTTB* (*Fiber to the Building*) refers to small businesses that use fiber-optic cables to access the Internet. With FTTP service, an optical terminal at your location receives the signals and transfers them to a router connected to your computer. As the cost of install ing fiber decreases, more homes and businesses will opt for this high-speed Internet access.

T-Carrier Lines

A **T-carrier line** is any of several types of long-distance digital telephone lines that carry multiple signals over a single communications line. Whereas a standard dial-up telephone line carries only one signal, digital T-carrier lines use multiplexing so that multiple signals share the line. T-carrier lines provide very fast data transfer rates. Only medium to large companies usually can afford the investment in T-carrier lines because these lines are so expensive. The most popular T-carrier line is the *T1 line*. Businesses often use T1 lines to connect to the Internet. Many Internet access providers use T1 lines to connect to the Internet backbone. Home and small business users purchase *fractional T1*, in which they share a connection to the T1 line with other users. Fractional T1 is slower than a dedicated T1 line, but it also is less expensive. Users who do not have other high-speed Internet access in their areas can opt for fractional T1. With fractional T1 lines, the data transfer rates become slower as additional users are added.

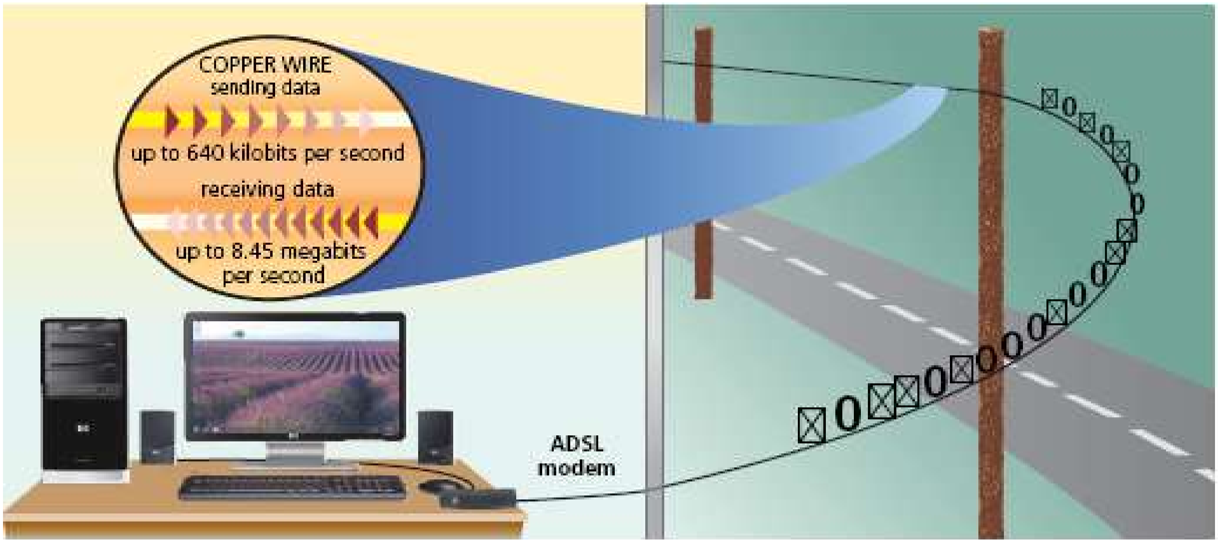


Figure 9-25 ADSL connections transmit data downstream (receiving) at a much faster rate than upstream (sending).

A *T3 line* is equal in speed to 28 T1 lines. T3 lines are quite expensive. Main users of T3 lines include large corporations, telephone companies, and Internet access providers connecting to the Internet backbone. The Internet backbone itself also uses T3 lines.

ATM

ATM (Asynchronous Transfer Mode) is a service that carries voice, data, video, and multimedia at very high speeds. Telephone networks, the Internet, and other networks with large amounts of traffic use ATM. Some experts predict that ATM eventually will become the Internet standard for data transmission, replacing T3 lines.

Communications Devices

A **communications device** is any type of hardware capable of transmitting data, instructions, and information between a sending device and a receiving device. At the sending end, a communications device sends the data, instructions, or information from the sending device to a communications channel. At the receiving end, a communications device receives the signals from the communications channel.
One type of communications device that connects a communications channel to a sending or receiving device such as a computer is a modem. Computers process data as digital signals. Data, instructions, and

information travel along a communications channel in either analog or digital form, depending on the communications channel. The following pages describe these types of communications devices: dial-up modems, digital modems, wireless modems, network cards, wireless access points, routers, and hubs and switches.

Dial-Up Modems

A *dial-up modem* is a communications device that can convert digital signals to analog signals and analog signals to digital signals, so that data can travel along an analog telephone line. Recall that an analog signal consists of a continuous electrical wave, and a digital signal consists of individual electrical pulses that represent bits grouped together into bytes. For example, a dial-up modem connected to a sending computer converts the computer's digital signals into analog signals. The analog signals then can travel over a standard telephone line. At the receiving end, if necessary, another dial-up modem converts the analog signals back into digital signals that a receiving computer can process. A dial-up modem usually is in the form of an adapter card that you insert in an expansion slot on a computer's motherboard. One end of a standard telephone cord attaches to a port on the modem card and the other end plugs into a telephone outlet. Devices other than computers also use modems. A stand-alone fax machine, for example, has a modem that converts a scanned digitized image into an analog signal that is sent to a recipient's fax machine.

Digital Modems: ISDN, DSL, and Cable

A *digital modem* is a communications device that sends and receives data and information to and from a digital line. Three types of digital modems are ISDN modems, DSL modems, and cable modems. These modems typically include built-in Wi-Fi connectivity. An *ISDN modem* sends digital data and information from a computer to an ISDN line and receives digital data and information from an ISDN line. A **DSL modem** sends digital data and information from a computer to a DSL line and receives digital data and information from a DSL line. ISDN and DSL modems usually are external devices, in which one end connects to the telephone line and the other end connects to a port on the system unit.

A **cable modem**, sometimes called a *broadband modem*, is a digital modem that sends and receives digital data over the cable television (CATV) network (Figure 9-26). With more than 110 million homes wired for cable television, cable modems provide a faster Internet access alternative to dial-up for the home user and can have speeds similar to DSL. Some users install an amplifier to improve the signal strength, which can fluctuate depending on many factors such as tasks you are performing and number of other connected users. As shown in Figure 9-27, CATV service enters your home through a single line. To access the Internet using the CATV service, the CATV company installs a splitter inside your house. From the splitter, one part of the cable runs to your televisions and the other part connects to the cable modem. Many CATV operators provide a cable modem as part of the installation; some offer a rental plan, and others require that you purchase one separately. A cable modem usually is an external (separate) device, in which one end of a cable connects to a CATV wall outlet and the other end plugs in a port, such as on an Ethernet card, in the system unit. An Ethernet card is a type of network card. A later section discusses network cards.

Figure 9-26 A cable modem.

Figure 9-27 A typical cable modem installation.

Wireless Modems
Some mobile users have a **wireless modem** that uses the cell phone network to connect to the Internet wirelessly from a notebook computer, a smart phone, or other mobile device (Figure 9-28). Wireless modems, which have an external or built-in antenna, are available as USB flash drives, ExpressCard modules, PC Cards, and memory cards. Some smart phones also can function as a wireless modem when connected with a special cable to a personal computer.

Figure 9-28 Wireless modems allow users to access the Internet wirelessly using the cell phone network.

Network Cards
A **network card**, sometimes called a *network interface card* (*NIC* pronounced nick), is a communications device that enables a computer or device that does not have built-in networking capability to access a network. The network card coordinates the transmission and receipt of data, instructions, and information to and from the computer or device containing the network card. Network cards are available in a variety of styles (Figure 9-29). A network card for a desktop computer is an adapter card that has a port to which a cable connects. A network card for mobile computers and devices is in the form of a USB network adapter, ExpressCard module, PC Card, or a memory card.

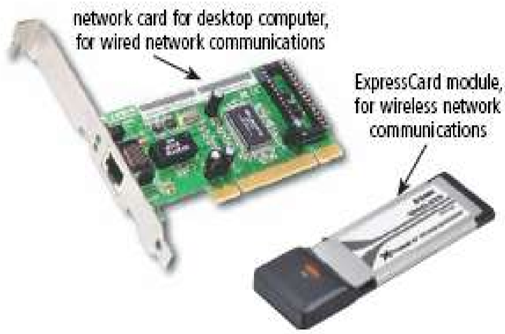


Figure 9-29
Network cards are available for both desktop and notebook computers.

Network cards that provide wireless data transmission also are available. This type of card, called a *wireless network card*, often has an antenna. Sometimes the antenna is detachable, allowing the user to position it in a location with the best signal strength. Users also can install an amplifier to increase and/or stabilize the signal strength. Some network cards include support for both wired and wireless networks.

A network card follows the guidelines of a particular network communications standard, such as Ethernet or token ring. An Ethernet card is the most common type of network card. Ethernet cards may support multiple speeds.

Wireless Access Points
A *wireless access point* is a central communications device that allows computers and devices to transfer data wirelessly among themselves or to transfer data wirelessly to a wired network (Figure 9-30). Wireless access points have high-quality antennas for optimal signals. For the best signal, some manufacturers suggest positioning the wireless access point at the highest possible location and the use of an amplifier.

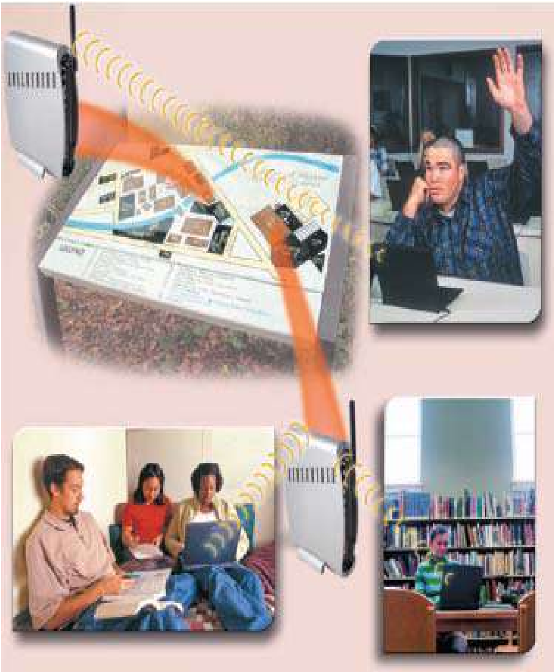


Figure 9-30 Wireless access points around campus allow students to access the school network wirelessly from their classrooms, the library, dorms, and other campus locations. To access the network, the notebook computer or mobile device must have built-in wireless capability or a wireless network card.

Routers

A *router* is a communications device that connects multiple computers or other routers together and transmits data to its correct destination on a network. A router can be used on any size of network. On the largest scale, routers along the Internet backbone forward data packets to their destination using the fastest available path. For smaller business and home networks, a router allows multiple computers to share a single high-speed Internet connection such as through a cable modem or DSL modem (Figure 9-31). These routers connect from 2 to 250 computers. To prevent unauthorized users from accessing files and computers, many routers are protected by a built-in firewall, called a *hardware firewall*. Some also have built-in antivirus protection. Routers also support wireless communications, eliminating the need for a separate wireless access point in a wireless network. If the network has a separate wireless access point, it connects to the router via a cable. Some routers also include additional functionality such as including a built-in print server. Today's routers or combination wireless access point/routers are easy to configure and secure against unauthorized access.

Figure 9-31 Through a router, home and small business networks can share access to a high-speed Internet connection such as through a cable or DSL modem.

Hubs and Switches

Today, thousands of computer networks exist, ranging from small networks operated by home users to global networks operated by numerous telecommunications firms. Inter connecting these many types of networks requires various types of communications devices. A hub or switch is a device that provides a central point for cables in a network (Figure 9-32). Larger networks typically use a hub, while smaller networks use a switch. Some hubs and/or switches include routers. That is, the hub or switch receives data from many directions and then forwards it to one or more destinations.

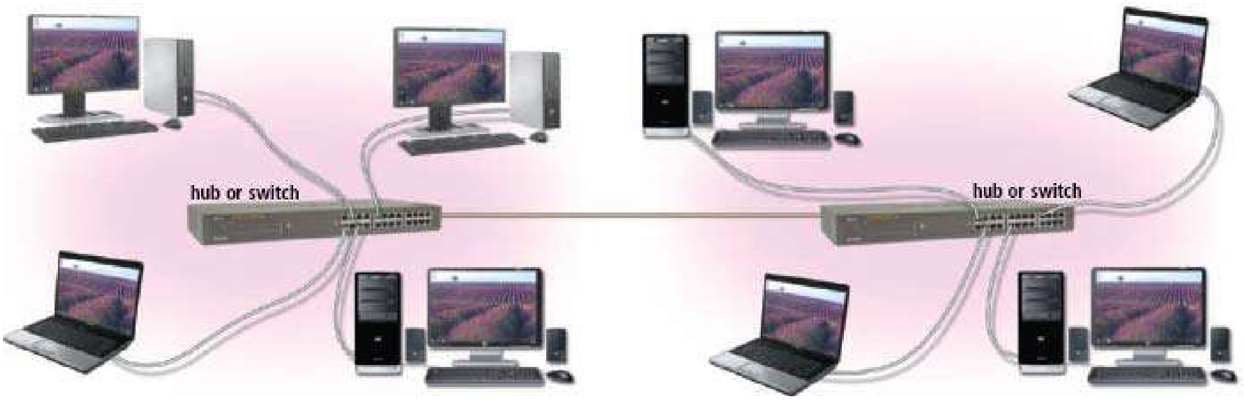


Figure 9-32 A hub or switch is a central point that connects several devices in a network together.

Home Networks

Many home users are connecting multiple computers and devices together in a **home network**. Home networking saves the home user money and provides many conveniences. Each networked computer in the house has the following capabilities:

• Connect to the Internet at the same time
• Share a single high-speed Internet connection
• Access files and programs on the other computers in the house
• Share peripherals such as a printer, scanner, external hard disk, or optical disc drive
• Play multiplayer games with players on other computers in the house
• Connect game consoles to the Internet
• Subscribe to and use VoIP

Many vendors offer home networking packages that include all the necessary hardware and software to network your home using wired or wireless techniques. Some of these packages also offer intelligent networking capabilities. An *intelligent home network* extends the basic home network to include features such as lighting control, thermostat adjustment, and a security system. You no longer need extensive knowledge of networks to set up a home network. For example, the latest version of Windows allows you to connect all computers in your house to a home network easily.

Wired Home Networks

As with other networks, a home network can use wires, be wireless, or use a combination of wired and wireless. Three types of wired home networks are Ethernet, powerline cable, and phoneline.

Ethernet Network As discussed earlier in this chapter, traditional Ethernet networks require that each computer have built-in network capabilities or contain a network card, which connects to a central network hub or similar device with a physical cable. This may involve running cable through walls, ceilings, and floors in the house. For the average home user, the hardware and software of an Ethernet network can be difficult to configure.

Powerline Cable Network A home *powerline cable network* is a network that uses the same lines that bring electricity into the house. This network requires no additional wiring. One end of a cable plugs in the computer's USB port and the other end of the cable plugs in a wall outlet. The data transmits through the existing power lines in the house.

Phoneline Network A *phoneline network* is an easy-to-install and inexpensive network that uses existing telephone lines in the home. With this network, one end of a cable connects to an adapter card or PC Card in the computer and the other end plugs in a wall telephone jack. The phoneline network does not interfere with voice and data transmissions on the telephone lines. That is, you can talk on the telephone and use the same line to connect to the Internet.

Wireless Home Networks

To network computers and devices that span multiple rooms or floors in a home, it may be more convenient to use a wireless strategy. One advantage of wireless networks is that you can take a mobile computer outside, for example in the backyard, and connect to the Internet through the home network, as long as you are in the network's range. Most home networks use a Wi-Fi network, which sends signals through the air at distances of up to 1,500 feet in some configurations. Wi-Fi networks are fairly easy to configure. Each computer accessing the network must have the appropriate built-in wireless networking capabilities (such as Intel's Centrino technology) or a wireless network card, which communicates either with a wireless access point or a combination router/wireless access point (Figure 9-33). Even in a wireless home network, one desktop computer usually connects to the router/wireless access point using a cable. Wireless networks do have the disadvantage of interference. Walls, ceilings, and electrical devices such as cordless telephones and microwave ovens can disrupt wireless network communications.

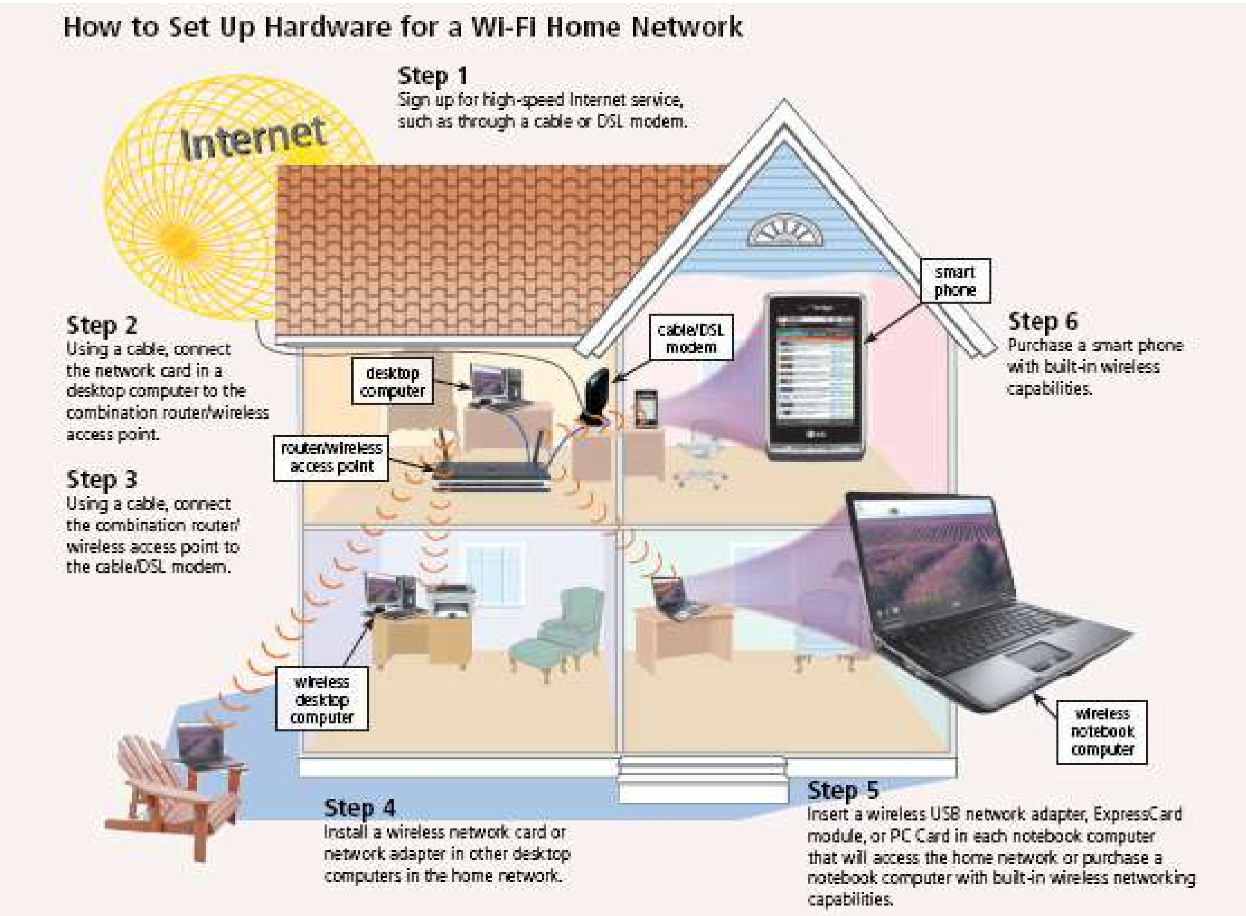


Figure 9-33 This figure shows how to set up hardware for a Wi-Fi home network.

Communications Channel

As described at the beginning of the chapter, a communications channel is the transmission media on which data, instructions, or information travel in a communications system. The amount of data, instructions, and information that can travel over a communications channel sometimes is called the **bandwidth**. The higher the bandwidth, the more the channel transmits. For example, a cable modem has more bandwidth than a dial-up modem.

For transmission of text only, a lower bandwidth is acceptable. For transmission of music, graphics, photos, virtual reality images, or 3-D games, however, you need a higher bandwidth.
When the bandwidth is too low for the application, you will notice a considerable slowdown in system performance.

Latency is the time it takes a signal to travel from one location to another on a network. Several factors that negatively can affect latency include the distance between the two points, the type of transmission media, and the number of nodes through which the data must travel over the communications channel. For best performance, bandwidth should be high and latency low.

A communications channel consists of one or more transmission media. **Transmission media** consist of materials or substances capable of carrying one or more signals. When you send data from a computer, the signal that carries the data may travel over various transmission media. This is especially true when the transmission spans a long distance. Figure 9-34 illustrates a typical communications channel and shows the variety of transmission media used to complete the connection. Although many media and devices are involved, the entire communications process could take less than one second.

Broadband media transmit multiple signals simultaneously. In many cases, download transfer rates of broadband are faster than its upload transfer rates. Home and business users today opt for broadband Internet access because of the fast transfer rates. Two previously discussed services that offer broadband transmission are DSL and the cable television Internet service. Satellites also offer broadband transmission.
Transmission media are one of two types: physical or wireless. *Physical transmission media* use wire, cable, and other tangible materials to send communications signals. *Wireless transmission media* send communications signals through the air or space using radio, micro wave, and infrared signals. The following sections discuss these types of media.

Physical Transmission Media

Physical transmission media used in communications include twisted-pair cable, coaxial cable, and fiber-optic cable. These cables typically are used within or underground between buildings. Ethernet and token ring LANs often use physical transmission media. The table in Figure 9-35 lists the transfer rates of LANs using various physical transmission media. The following sections discuss each of these types of cables.

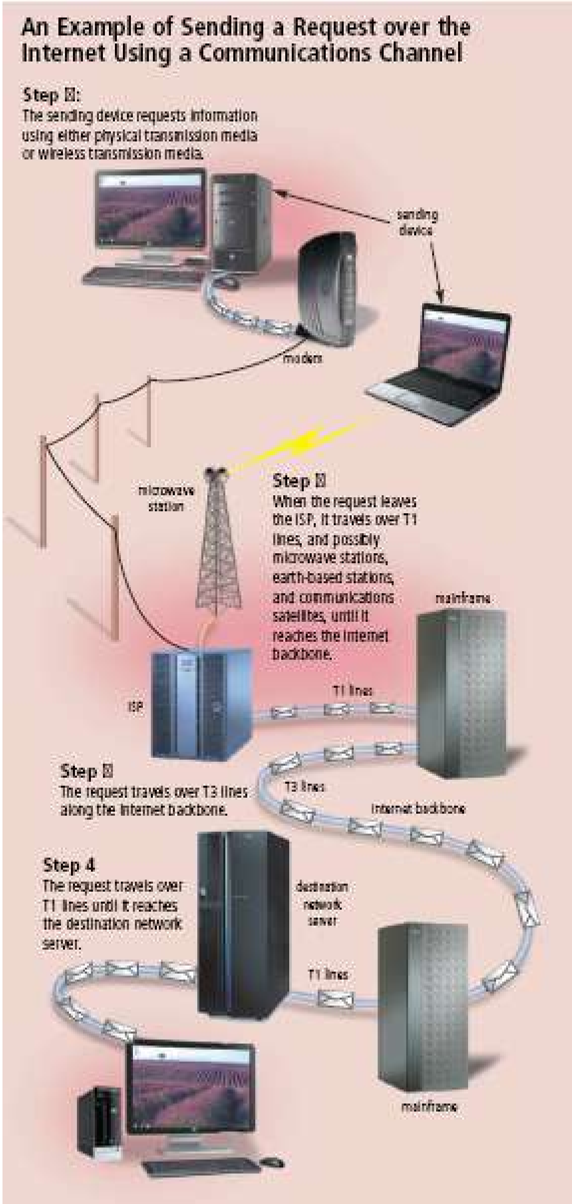


Figure 9-34 This figure shows an example of sending a request over the Internet using a communications channel.

Twisted-Pair Cable

One of the more widely used transmission media for network cabling and telephone systems is twisted-pair cable. **Twisted-pair cable** consists of one or more twisted-pair wires bundled together (Figure 9-36). Each *twisted-pair wire* consists of two separate insulated copper wires that are twisted together. The wires are twisted together to reduce noise. **Noise** is an electrical disturbance that can degrade communications.

Transfer Rates for Various Types of LANs Using Physical Transmission Media	
Type of Cable and LAN	**Maximum Transfer Rate**
Twisted-Pair Cable	
• 10Base-T (Ethernet)	10 Mbps
• 100Base-T (Fast Ethernet)	100 Mbps
• 1000Base-T (Gigabit Ethernet)	1 Gbps
• Token ring	4 Mbps to 16 Mbps
Coaxial Cable	
• 10Base2 (ThinWire Ethernet)	10 Mbps
• 10Base5 (ThickWire Ethernet)	10 Mbps
Fiber-Optic Cable	
• 10Base-F (Ethernet)	10 Mbps
• 100Base-FX (Fast Ethernet)	100 Mbps
• FDDI (Fiber Distributed Data Interface) token ring	100 Mbps
• Gigabit Ethernet	1 Gbps
• 10-Gigabit Ethernet	10 Gbps
• 40-Gigabit Ethernet	40 Gbps
• 100-Gigabit Ethernet	100 Gbps

Figure 9-35 The speeds of various physical communications media when they are used in LANs.

Coaxial Cable

Coaxial cable, often referred to as *coax* (pronounced KO-ax), consists of a single copper wire surrounded by at least three layers: (1) an insulating material, (2) a woven or braided metal, and (3) a plastic outer coating (Figure 9-37). Cable television (CATV) network wiring often uses coaxial cable because it can be cabled over longer distances than twisted-pair cable. Most of today's computer networks, however, do not use coaxial cable because other transmission media such as fiber-optic cable transmit signals at faster rates.

Fiber-Optic Cable

The core of a **fiber-optic cable** consists of dozens or hundreds of thin strands of glass or plastic that use light to transmit signals. Each strand, called an *optical fiber,* is as thin as a human hair. Inside the fiber-optic cable, an insulating glass cladding and a protective coating surround each optical fiber (Figure 9-38). Fiber-optic cables have the following advantages over cables that use wire, such as twisted-pair and coaxial cables:

• Capability of carrying significantly more signals than wire cables
• Faster data transmission
• Less susceptible to noise (interference) from other devices such as a copy machine
• Better security for signals during transmission because they are less susceptible to noise
• Smaller size (much thinner and lighter weight)

Disadvantages of fiber-optic cable are it costs more than twisted-pair or coaxial cable and can be difficult to install and modify. Despite these limitations, many local and long-distance telephone companies are replacing existing telephone lines with fiber-optic cables, enabling them to offer fiber Internet access to home and business users. Businesses also are using fiber-optic cables in high-traffic networks or as the backbone in a network.

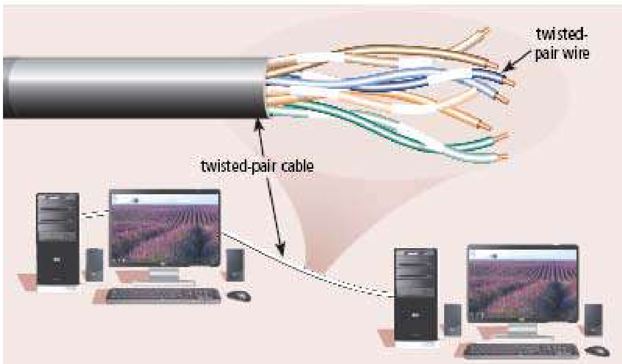


Figure 9-36 A twisted-pair cable consists of one or more twisted pair wires. Each twisted-pair wire usually is color coded for identification. Telephone networks and LANs often use twisted-pair cable.

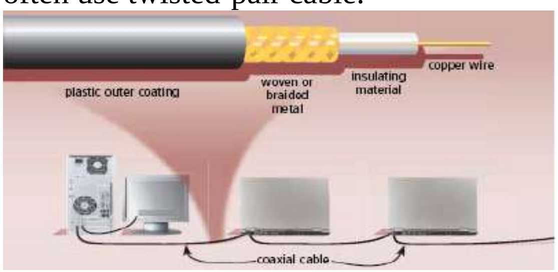


Figure 9-37 On a coaxial cable, data travels through a copper wire. This illustration shows computers networked together with coaxial cable.

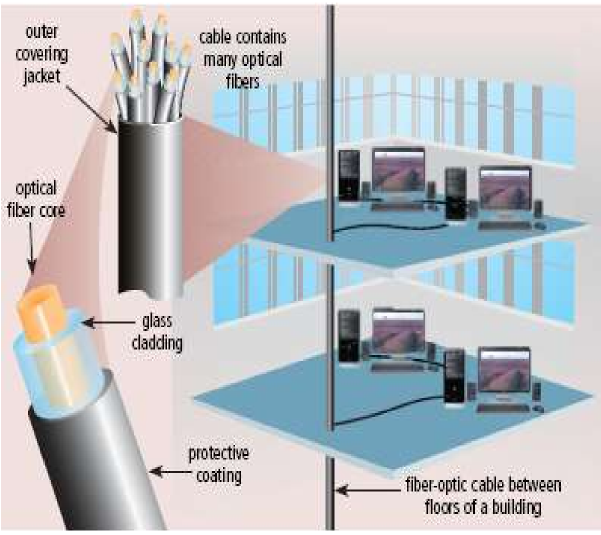


Figure 9-38 A fiber-optic cable consists of hair-thin strands of glass or plastic that carry data as pulses of light.

Wireless Transmission Media

Many users opt for wireless transmission media because it is more convenient than installing cables. In addition to convenience, businesses use wireless transmission media in locations where it is impossible to install cables. Types of wireless transmission media used in communications include infrared, broadcast radio, cellular radio, microwaves, and communications satellites. The table in Figure 9-39 lists transfer rates of various wireless transmission media. The following sections discuss these types of wireless transmission media.

Transfer Rates for Various Types of Wireless Transmission Media

Medium		Maximum Transfer Transmission Rate
Infrared		115 Kbps to 4 Mbps
Broadcast radio	• Bluetooth	1 Mbps to 2 Mbps
	• HomeRF	1.6 Mbps to 10 Mbps
	• 802.11b	11 Mbps
	• 802.11a	54 Mbps
	• 802.11g	54 Mbps
	• 802.11n	108 Mbps
	• UWB	110 Mbps to 480 Mbps
Cellular radio	• 2G	9.6 Kbps to 19.2 Kbps
	• 3G	144 Kbps to 2.4 Mbps
	• 4G	Up to 15 Mbps
Microwave radio		150 Mbps
Communications satellite		1 Gbps

Figure 9-39 The transfer rates of various wireless transmission media.

Infrared

As discussed earlier in the chapter, infrared (IR) is a wireless transmission medium that sends signals using infrared light waves. Mobile computers and devices, such as a mouse, printer, and smart phone, often have an IrDA port that enables the transfer of data from one device to another using infrared light waves.

Broadcast Radio

Broadcast radio is a wireless transmission medium that distributes radio signals through the air over long distances such as between cities, regions, and countries and short distances such as within an office or home. For radio transmissions, you need a transmitter to send the broadcast radio signal and a receiver to accept it. To receive the broadcast radio signal, the receiver has an antenna that is located in the range of the signal. Some networks use a transceiver, which both sends and receives signals from wireless devices. Broadcast radio is slower and more susceptible to noise than physical transmission media but it provides flexibility and portability.

Bluetooth, UWB, Wi-Fi, and WiMAX communications technologies discussed earlier in this chapter use broadcast radio signals. Bluetooth and UWB are alternatives to infrared communications, with the latter designed for high bandwidth transmissions. Hot spots use Wi-fi, WiMAX, and Bluetooth networks.

Cellular Radio

Cellular radio is a form of broadcast radio that is used widely for mobile communications, specifically wireless modems and cell phones (Figure 9-40). A cell phone is a telephone device that uses high-frequency radio waves to transmit voice and digital data messages. Because only a limited number of radio frequencies exist, cellular network providers reuse frequencies so that they can accommodate the large number of users. Some users install an amplifier or booster to improve the signal strength.

Some mobile users connect their notebook computer or other mobile computer to a cell phone to access the Web, send and receive e-mail messages, enter a chat room, or connect to an office or school network while away from a standard telephone line. Others watch *mobile TV*, which is a service that provides television programs over the cellular network. Several categories of cellular transmissions exist, defining the development of cellular networks. Although the definitions of these categories may vary by cellular providers, below are some general guides.

- *1G* (first generation) transmitted analog data
- *2G* (second generation) transmit digital data at speeds from 9.6 Kbps to 19.2 Kbps
- *3G* (third generation) transmit digital data at speeds from 144 Kbps to 2.4 Mbps
- *4G* (fourth generation) transmit digital data at speeds up to 15 Mbps

Examples of 3G standards include *GSM* (Global System for Mobile Communications), *UMTS* (Universal Mobile Telecommunications System), *GPRS* (General Packet Radio Service), *CDMA* (Code Division Multiple Access), *EDGE* (Enhanced Data GSM Environment), and *EVDO* (Evolution Data Optimized). These 3G standards allow users quickly to display multi media and graphics, browse the Web, watch television or a video, have a video conference, and transfer data on a cellular device. Providers that offer 3G service include Sprint, Verizon, and AT&T.

The most recent cellular network category, the 4G network, uses the mobile wireless WiMAX communication standard. Several major communications companies have worked together to develop a nationwide 4G network.

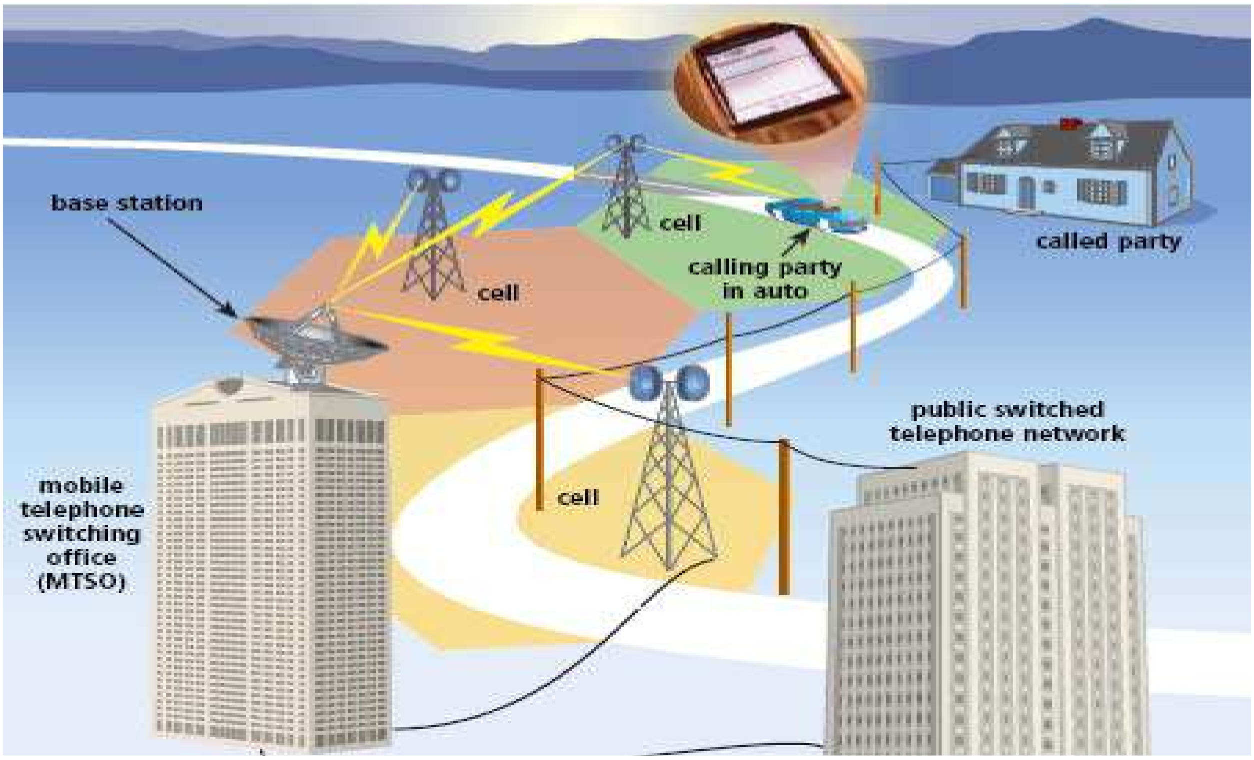


Figure 9-40 As a person with a cell phone drives from one cell to another, the radio signals transfer from the base station (microwave station) in one cell to a base station in another cell.

Personal Communications Services (*PCS*) is the term used by the U.S. Federal Communications Commission (FCC) to identify all wireless digital communications. Devices that use PCS include cell phones, PDAs, pagers, and fax machines. These devices have voice mail, call forwarding, fax capability, caller ID, and wireless modems for Internet and e-mail access.

Microwaves

Microwaves are radio waves that provide a high-speed signal transmission. Microwave transmission, often called *fixed wireless*, involves sending signals from one microwave station to another (Figure 9-41). Microwaves can transmit data at rates up to 4,500 times faster than a dial-up modem.

A *microwave station* is an earth-based reflective dish that contains the antenna, transceivers, and other equipment necessary for microwave communications. As with infrared, microwaves use line-of-sight transmission. To avoid possible obstructions, such as buildings or mountains, microwave stations often sit on the tops of buildings, towers, or mountains. Microwave transmission typically is used in environments where installing physical transmission media is difficult or impossible and where line-of-sight transmission is available. For example, microwave transmission is used in wide-open areas such as deserts or lakes, between buildings in a close geographic area, or to communicate with a satellite. Current users of microwave transmission include universities, hospitals, city governments, cable television providers, and telephone companies. Homes and small businesses that do not have other high-speed Internet connections available in their area also opt for lower-cost fixed wireless plans.

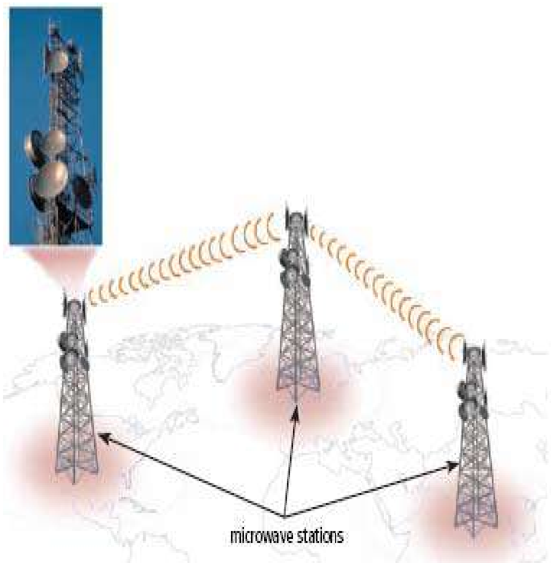


Figure 9-41 A microwave station is a ground-based reflective dish that contains the antenna, transceivers, and other equipment necessary for microwave communications.

Figure 9-42 Communications satellites are placed about 22,300 miles above the Earth's equator.

Communications Satellite

A **communications satellite** is a space station that receives microwave signals from an earth-based station, amplifies (strengthens) the signals, and broadcasts the signals back over a wide area to any number of earth-based stations (Figure 9-42). These earth-based stations often are micro wave stations. Other devices, such as smart phones and GPS receivers, also can function as earth-based stations. Transmission from an earth-based station to a satellite is an *uplink*. Transmission from a satellite to an earth-based station is a *downlink*. Applications such as air navigation, television and radio broadcasts, weather forecasting, video conferencing, paging, global positioning systems, and Internet connections use communications satellites. With the proper satellite dish and a satellite modem card, consumers can access the Internet using satellite technology. With satellite Internet connections, however, uplink transmissions usually are slower than downlink transmissions. This difference in speeds usually is acceptable to most Internet satellite users because they download much more data than they upload. Although a satellite Internet connection is more expensive than cable Internet or DSL connections, sometimes it is the only high-speed Internet option in remote areas.

Chapter Exercises

True/False Mark T for True and F for False.

_____ 1. A communications channel is the media on which data, instructions, or information travel.

_____ 2. With video messaging, users can send short video clips, usually about 15 minutes, in addition to all picture messaging services.

_____ 3. A network is a collection of computers and devices connected together via communications devices and transmission media.

_____ 4. A local area network (LAN) is a network that covers a large geographic area using a communications channel that combines many types of media such as telephone lines, cables, and radio waves.

_____ 5. A Web server is a computer that delivers requested Web pages to your computer.

_____ 6. An intranet is an internal network that uses Internet technologies.

_____ 7. The 40-Gigabit Ethernet standard is the fastest of the Ethernet standards.

_____ 8. Bluetooth does not require line-of-sight transmission.

_____ 9. At distances of 10 meters (about 33 feet), the data transfer rate for UWB devices is 480 Mbps.

_____ 10. Fiber to the Premises (FTTP) uses fiber-optic cable to provide extremely high-speed Internet access to a user's physical permanent location.

_____ 11. Latency is the time it takes a signal to travel from one location to another on a network.

Multiple Choice Select the best answer.

1. With _____, users can view message details such as the length of calls and, in some cases, read message contents instead of listening to them.
a. Web services b. Internet telephony c. visual voice mail d. video messaging

2. When an online meeting takes place on the Web, it is called _____.
a. video messaging b. a peer-to-peer network
c. a Web conference d. a Web meeting

3. A document management system _____.
a. allows users to share documents with other users in real time
b. provides personal information manager functions
c. provides for storage and management of a company's documents
d. prints to a Web address associated with a particular printer

4. A _____ is a Web application that combines services from two or more sources, creating a new application.
a. document management system b. peer-to-peer network
c. Web service d. mashup

5. _____ are devices that provide a common central connection point for nodes on the network.
a. Packets and tokens b. Hubs and switches

c. T1 and T3 lines d. Routers and digital modems

6. _____ is a standard, specifically a protocol, that defines how a network uses radio signals to communicate with a tag placed in or attached to an object, an animal, or a person.
a. RFID b. WiMAX c. Bluetooth d. UWB

7. _____ consists of a single copper wire surrounded by at least three layers.
a. Fiber-optic cable b. Infrared c. Twisted-pair cable d. Coaxial cable

8. _____ is a service that provides television programs over the cellular network.
a. Cellular radio b. Mobile TV c. Video messaging d. UWB

Matching Match the terms with their definitions.

_____ 1. picture messaging	a. communications device that can convert digital signals to analog signals and analog signals to digital signals, so that data can travel along an analog telephone line
_____ 2. groupware	b. amount of data, instructions, and information that can travel over a
_____ 3. extranet	communications channel
_____ 4. IrDA	c. materials or substances capable of carrying one or more signals
_____ 5. ATM	d. specification to transmit data wirelessly among computers and devices via infrared light waves
_____ 6. dial-up modem	e. allows users to send pictures and sound files, as well as short text messages, to a phone or other mobile device, or a computer
_____ 7. digital modem	f. service that carries voice, data, video, and multimedia at very high speeds
_____ 8. bandwidth	g. communications device that sends and receives data and information to and from a digital line
_____ 9. transmission media	h. allows customers or suppliers to access part of a company's intranet
_____ 10. noise	i. electrical disturbance that can degrade communications
	j. software that helps groups of people share information over a network

Short Answer Write a brief answer to each of the following questions.
1. What is text messaging? ____________ What are some options for sending and receiving text messages? ___________

2. Describe how the global positioning system (GPS) works. ____________ How do individuals use GPS technology? ____________

3. How are a local area network (LAN), a metropolitan area network (MAN), and a wide area network (WAN) different? ____________ What is a wireless LAN? ____________

4. What is a network topology? ________ What are the five types of digital dedicated lines? ______

5. What are three different types of digital modems? ______ How does each one function? _______

Chapter Ten

Programming Languages and Program Development

Computer Programs and Programming Languages

Although you may never write a computer program, information you request may require a programmer to create or modify a program. Thus, you should understand how programmers develop programs to meet information requirements. A **computer program** is a series of instructions that directs a computer to perform tasks. A computer **programmer**, often called a *developer*, creates and modifies computer programs. To create a program, programmers sometimes write, or *code*, a program's instructions using a programming language. A **programming language** is a set of words, abbreviations, and symbols that enables a programmer to communicate instructions to a computer. Other times, programmers use a program development tool to create a program. A program that provides a user-friendly environment for building programs often is called a *program development tool*. Just as humans speak a variety of languages (English, Spanish, French, and so on), programmers use a variety of programming languages and tools to create programs (Figure 10-1). Several hundred programming languages exist today. Each language has its own rules for writing the instructions. Languages often are designed for specific purposes, such as scientific applications, business solutions, or Web page development.

Figure 10-1 Programmers must decide which programming languages and program development tools to use when they create programs.

When solving a problem or building a solution, programmers often use more than one language; that is, they integrate the languages.

Two types of languages are low-level and high-level. A *low-level language* is a programming language that is machine dependent. A *machine dependent language* runs on only one particular type of computer. These programs are not easily portable to other types of computers. Each language instruction in a low-level language usually equates to a single machine instruction, discussed further in the next section. With a *high-level language*, by contrast, each language instruction typically equates to multiple machine instructions. High-level languages often are machine independent. A *machine-independent language* can run on many different types of computers and operating systems. The following pages discuss low-level languages, as well as several types of high-level languages.

Low-Level Languages

Two types of low-level languages are machine languages and assembly languages. **Machine language**, known as the first generation of programming languages, is the only language the computer directly recognizes (Figure 10-2).

Machine language instructions use a series of binary digits (1s and 0s) or a combination of numbers and letters that represents binary digits. The binary digits correspond to the on and off electrical states. As you might imagine, coding in machine language is tedious and time-consuming. With an **assembly language**, the second generation of programming languages, a programmer writes instructions using symbolic instruction codes (Figure 10-3).

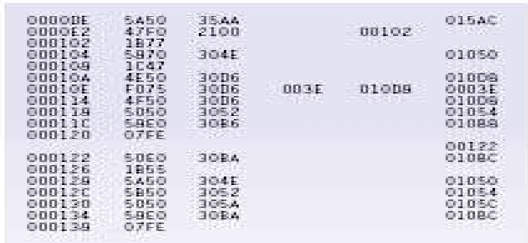


Figure 10-2 A sample machine language program, coded using the hexadecimal number system. For information about hexadecimal, see Appendix C at the back of this book.

Symbolic instruction codes are meaningful abbreviations. With an assembly language, a programmer writes abbreviations such as A for addition, C for compare, L for load, and M for multiply. Assembly languages also use symbolic addresses. A *symbolic address* is a meaningful name that identifies a storage location. For example, a programmer can use the name RATE to refer to the storage location that contains a pay rate. Despite these advantages, assembly languages can be difficult to learn. In addition, programmers must convert an assembly language program into machine language before the computer can *execute*, or run, the program. That is, the computer cannot execute the assembly source program.

A **source program** is the program that contains the language instructions, or code, to be converted to machine language. To convert the assembly language source program into machine language, programmers use a program called an *assembler*. One assembly language instruction usually equates to one machine language instruction. In some cases, however, the assembly language includes macros. An assembly language *macro* generates many machine language instructions for a single assembly language instruction. Macros save the programmer time during program development. Today, assembly languages primarily are used to increase the performance of critical tasks or to control hardware.

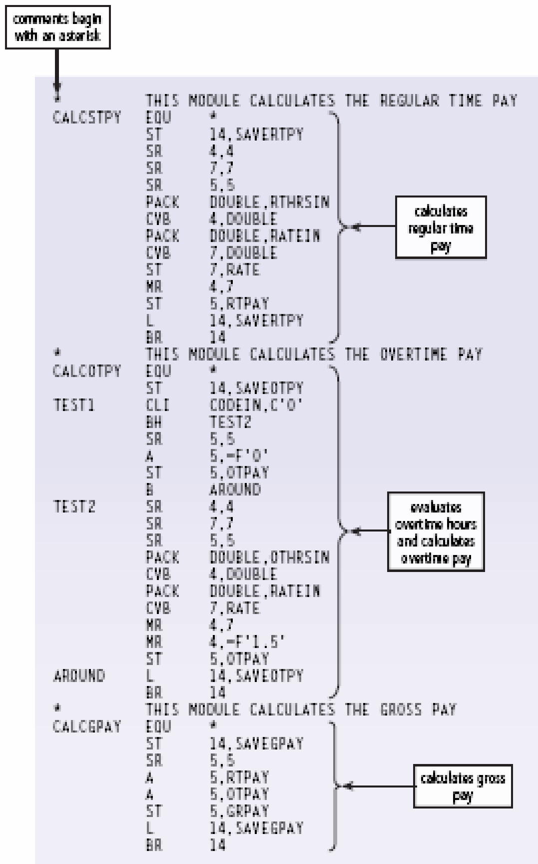


Figure 10-3 An excerpt from an assembly language payroll program. The code shows the computations for regular time pay, overtime pay, and gross pay and the decision to evaluate the overtime hours.

Procedural Languages

The disadvantages of machine and assembly (low-level) languages led to the development of procedural languages in the late 1950s and 1960s. In a **procedural language**, the programmer writes instructions that tell the computer what to accomplish and how to do it. With a procedural language, often called a **third-generation language** (**3GL**), a programmer uses a series of English-like words to write instructions. For example, ADD stands for addition or PRINT means to print. Many 3GLs also use arithmetic operators such as * for multiplication and 1 for addition. These English-like words and arithmetic symbols simplify the program development process for the programmer.

As with an assembly language program, the 3GL code (instructions) is called the source program. Programmers must convert this source program into machine language before the computer can execute the program. This translation process often is very complex, because one 3GL source program instruction translates into many machine language instructions. For 3GLs, programmers typically use either a compiler or an interpreter to perform the translation. A *compiler* is a separate program that converts the entire source program into machine language before executing it. The machine language version that results from compiling the 3GL is called the *object code* or *object program*. The compiler stores the object code on storage media for execution later.

While it is compiling the source program into object code, the compiler checks the source program for errors. The compiler then produces a program listing that contains the source code and a list of any errors. This listing helps the programmer make necessary changes to the source code and correct errors in the program. Figure 10-4 shows the process of compiling a source program. A compiler translates an entire program before executing it. An interpreter, by contrast, translates and executes one statement at a time. An *interpreter* reads a code statement, converts it to one or more machine language instructions, and then executes those machine language instructions. It does this all before moving to the next code statement in the program. Each time the source program runs, the interpreter translates and executes it, statement by statement. An interpreter does not produce an object program. Figure 10-5 shows the process of interpreting a program.

One advantage of an interpreter is that when it finds errors, it displays feedback immediately. The programmer can correct any errors before the interpreter translates the next line of code. The disadvantage is that interpreted programs do not run as fast as compiled programs. This is because an interpreter must translate the source program to machine language each time the program executes. Once a program is compiled, by contrast, users simply execute the object code to run the program.

Many programming languages include both an interpreter and a compiler. In this case, the programmer can use the interpreter during program development. When the program is complete and error free, the programmer can compile the program so that it runs faster when it is placed into production for users to execute.

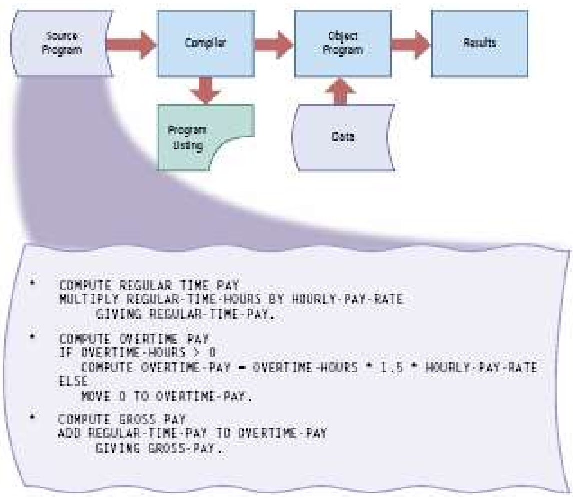


Figure 10-4 A compiler converts the source program into a machine language object program. If the compiler encounters any errors, it records them in the program-listing file, which the programmer may print when the entire compilation is complete. When a user wants to run the program, the object program is loaded into the memory of the computer and the program instructions begin executing.

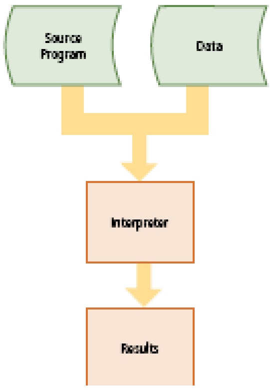


Figure 10-5 With an interpreter, one line of the source program at a time is converted into machine language and then immediately executed by the computer. If the interpreter encounters an error while converting a line of code, an error message immediately is displayed on the screen and the program stops.

Hundreds of procedural languages exist. Only a few, however, are used widely enough for the industry to recognize them as standards. These include C and COBOL. To illustrate the similarities and differences among these programming languages, the following figures show program code in these languages. The code solves a simple payroll problem — computing the gross pay for an employee.

The process used to compute gross pay can vary from one system to another. The examples on the following pages use a simple *algorithm*, or set of steps, to help you easily compare one programming language with another.

C

The **C** programming language, developed in the early 1970s by Dennis Ritchie at Bell Laboratories, originally was designed for writing system software. Today, many programs are written in C (Figure 10-6). This includes operating systems and application software such as word processing and spreadsheet programs.

C is a powerful language that requires professional programming skills. Many programmers use C for business and scientific problems. C runs on almost any type of computer with any operating system, but it is used most often with the UNIX and Linux operating systems.

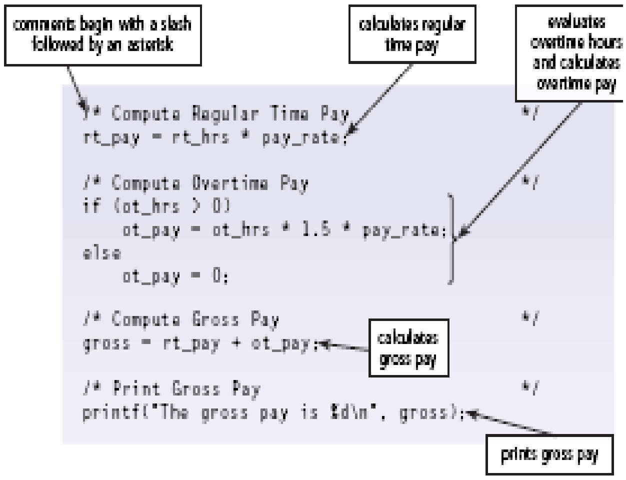


Figure 10-6 An excerpt from a C payroll program. The code shows the computations for regular time pay, overtime pay, and gross pay; the decision to evaluate the overtime hours; and the output of the gross pay.

COBOL

COBOL (*COmmon Business-Oriented Language*) evolved out of a joint effort between the United States government, businesses, and major universities in the early 1960s (Figure 10-7). Naval officer Grace Hopper, a pioneer in computer programming, was a prime developer of COBOL.

COBOL is a programming language designed for business applications. Although COBOL programs often are lengthy, their English-like statements make the code easy to read, write, and maintain. COBOL especially is useful for processing transactions, such as payroll and billing, on mainframe computers. COBOL programs also run on other types of computers.

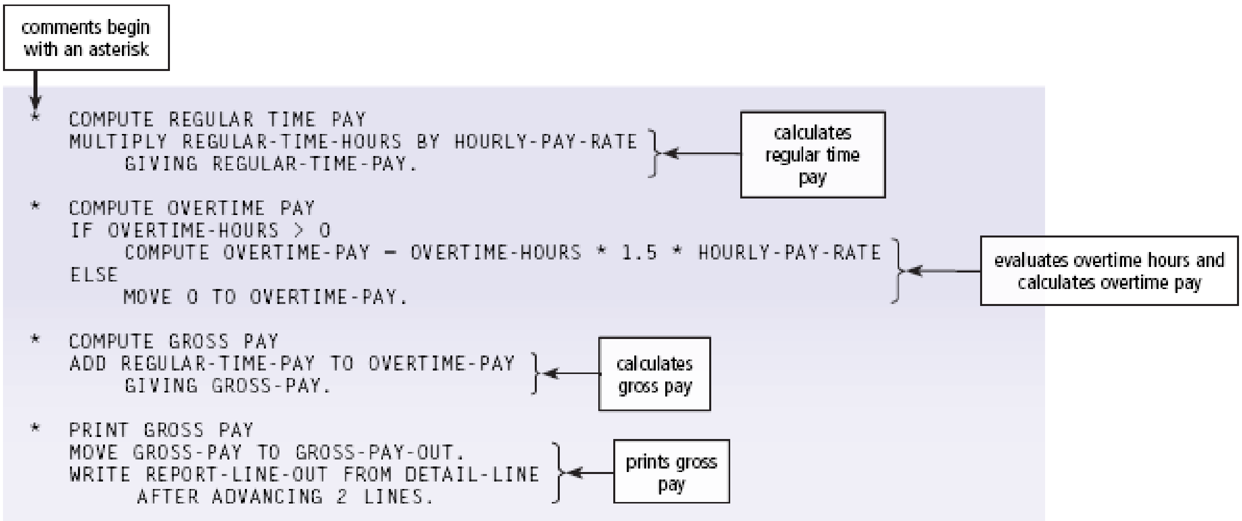


Figure 10-7 An excerpt from a COBOL payroll program. The code shows the computations for regular time pay, overtime pay, and gross pay; the decision to evaluate the overtime hours; and the output of the gross pay.

Object-Oriented Programming Languages and Program Development Tools

Computer programmers use an **object-oriented programming** (**OOP**) **language** or objectoriented program development tool to implement an object-oriented design. Recall from Chapter 12 that an *object* is an item that can contain both data and the procedures that read or manipulate that data. An object represents a real person, place, event, or transaction. A major benefit of OOP is the ability to reuse and modify existing objects. For example, once a programmer creates an Employee object, it is available for use by any other existing or future program. Thus, programmers repeatedly reuse existing objects. For example, the payroll program and health benefits program both use the Employee object. That is, the payroll program would use it to process employee paychecks and the health benefits program would use it to process health insurance payments. Programs developed using the object-oriented approach have several advantages. The objects can be reused in many systems, are designed for repeated use, and become stable over time. In addition, programmers create applications faster because they design programs using existing objects.

In addition to being able to work with objects, an OOP language is event driven. An *event* is an action to which the program responds. Examples of events include pressing a key on the keyboard, typing a value in a text box, moving the mouse, clicking a button, or speaking an instruction. An *event-driven program* checks for and responds to events. Some programming languages are event driven but are not complete OOP languages. Other programming languages, such as Java, C#, F#, C++, and the latest versions of Visual Basic, are complete object-oriented languages. Object-oriented programming languages and program development tools work well in a RAD environment. **RAD** (*rapid application development*) is a method of developing software, in which a programmer writes and implements a program in segments instead of waiting until the entire program is completed. Users begin working with sections of the program as they are completed. An important concept in RAD is the use of prebuilt components. For example, programmers do not have to write code for buttons and text boxes on Windows forms because they already exist in the programming language or tools provided with the language. Most object-oriented program development tools are IDEs. An **IDE** (**integrated development environment**) includes tools for building graphical user interfaces, an editor for entering program code, a compiler and/or interpreter, and a debugger (to remove errors, which is discussed later in the chapter). Some IDEs work with a single programming language; others, such as Eclipse support multiple languages. *Eclipse* is an open source, advanced development environment that works with a variety of programs including Java and C++, which are discussed next. The following sections discuss a variety of object-oriented programming languages and program development tools.

Java

Java is an object-oriented programming language developed by Sun Microsystems. Figure 10-8 shows a portion of a Java program and the window that the program displays. When programmers compile a Java program, the resulting object code typically is called *bytecode*, which is machine independent. Java then uses a *just-in-time* (*JIT*) *compiler* to convert the bytecode into machine-dependent code that is executed immediately. Programmers use J*ava Platform, Standard Edition* (*Java SE*), developed by Sun Microsystems, to create stand-alone programs for desktop computers and servers. Similarly, programmers use J*ava Platform, Micro Edition* (*Java ME*) to create programs for smart phones and other mobile devices. *Java EE* (*Java Platform, Enterprise Edition*) is a set of technologies built on Sun's Java SE that allows programmers to develop and deploy large applications for organizations, often used in Web 2.0 environments for Web applications. The goal of Java EE is to simplify and reduce program development time by developing standard, reusable objects.

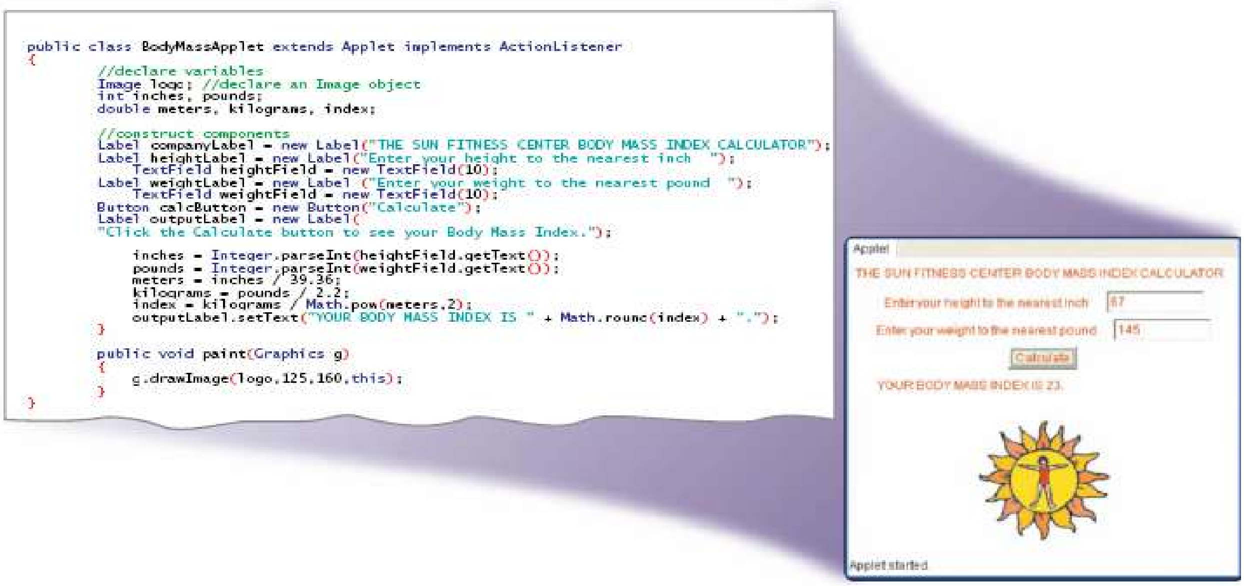


Figure 10-8
A portion of a Java program and the window the program displays.

.NET

The Microsoft .NET Framework, or **.NET** (pronounced dot net), is a set of technologies that allows almost any type of program to run on the Internet or an internal business network, as well as stand-alone computers and mobile devices. Similarly, *ASP.NET* is a Web application framework that provides the tools necessary for the creation of dynamic Web sites. Features of .NET include the CLR and classes. The *CLR* (Common Language Runtime) is an environment that enables programmers to develop .NET programs using a variety of languages. A .NET-compatible language compiles the program source code into *Microsoft Intermediate Language* (*MSIL*). The CLR then converts the MSIL into object code using a justin- time compiler. The CLR supports classes so that .NET programmers can access a variety of common functions in their programs, which saves development time.

Using .NET and/or ASP.NET, programmers easily can develop Web applications, Web services, and Windows programs. Examples of languages that support .NET include C++, C#, F#, Visual Basic, Delphi, and PowerBuilder. The following sections discuss each of these languages.

C++

Developed in the 1980s by Bjarne Sroustrup at Bell Laboratories, **C++** (pronounced SEE-plus-plus) is an objectoriented programming language that is an extension of the C programming language. C++ includes all the elements of the C language, plus it has additional features for working with objects, classes, events, and other object-oriented concepts (Figure 10-9). Programmers commonly use C++ to develop database and Web applications. Much application software, such as word processing and spreadsheet programs, also is written in C++. A programmer does not need C programming experience to be a successful C++ programmer.

C#

C# (pronounced SEE-sharp) is an object-oriented programming language based on C++ that was developed primarily by Anders Hejlsberg, Microsoft chief architect and distinguished engineer. C# has been accepted as a standard for Web applications and XML-based Web services. Recall from Chapter 9 that Web services describe standardized software that enables programmers to create applications that communicate with other remote computers over the Internet or on an internal business network. Like Java, C# uses a JIT compiler but its resulting code is MSIL. C# applications can be built on existing C or C++ applications, saving development time for companies migrating from C or C++.

F#

F# (pronounced EFF-sharp), which is included with the latest version of Visual Studio (discussed in the next section), is a programming language that combines the benefits of an object-oriented language with the benefits of a functional language. A *functional language* is a programming language whose natural programming structure is useful in mathematical programs. Benefits of programs written in F# include easy access to .NET libraries and performance similar to that of C# programs.

```
// portion of a C++ program that allows users to create
// a new zip code from a string or a number and expand
// zip codes, as appropriate, to a 10-digit number

ZipC::ZipC( const unsigned long zipnum )
{
  ostringstream strInt;
  strInt << zipnum;
  code = strInt.str();
}

const string ZipC::getCode()
{
  return code;
}

void ZipC::setCode(const string newCode)
{
  code = newCode;
}

void ZipC::expand( const string suffix )
{

  if(code.length() == 5 &&      // small size?
     suffix.length() == 4)      // length ok?
  {
     code += "-";
     code.append(suffix);
  }
}
```

Figure 10-9 Sample C++ program.

Visual Studio

Visual Studio is Microsoft's suite of program development tools that assists programmers in building programs for Windows, Windows Mobile, or operating systems that support .NET. Visual Studio includes enhanced support for building security and reliability into applications through its programming languages, RAD tools, IDE, a specialized query language called LINQ (Language Integrated Query), and other resources that reduce development time. For example, Visual Studio includes *code snippets*, which are prewritten code and templates associated with common programming tasks. *Visual Studio Tools for Office* (*VSTO*) is a set of tools integrated in Visual Studio that enables developers to create programs that work with Microsoft's Office suite, including Word, Excel, PowerPoint, Outlook, and Project. The next sections discuss the programming languages in the Visual Studio suite.

- **Visual Basic** is a programming language that allows programmers easily to build complex task-oriented object-based pro grams. Visual Basic is based on the BASIC programming language, which was developed by Micro soft Corporation in the early 1990s. This language is easy to learn and use. Thus, Visual Basic is ideal for beginning programmers. The first step in building a Visual Basic program often is to design the graphical user interface using Visual Basic objects (Steps 1 and 2 in Figure 10-10). Visual Basic objects include items such as buttons, text boxes, and labels. Next, the programmer writes instructions to define any actions that should occur in response to specific events (Step 3 in Figure 10-10). Finally, the programmer generates and tests the final program (Step 4 in Figure 10-10). To learn more about how to design a user interface, complete the Learn How To 1 activity on pages 708 and 709. An event in Visual Basic might be the result of an action that a user initiates. For example, when a user clicks a button in a Visual Basic program, the program executes the Click event. Programmers create events in Visual Basic by writing instructions (code) with its built-in programming language.

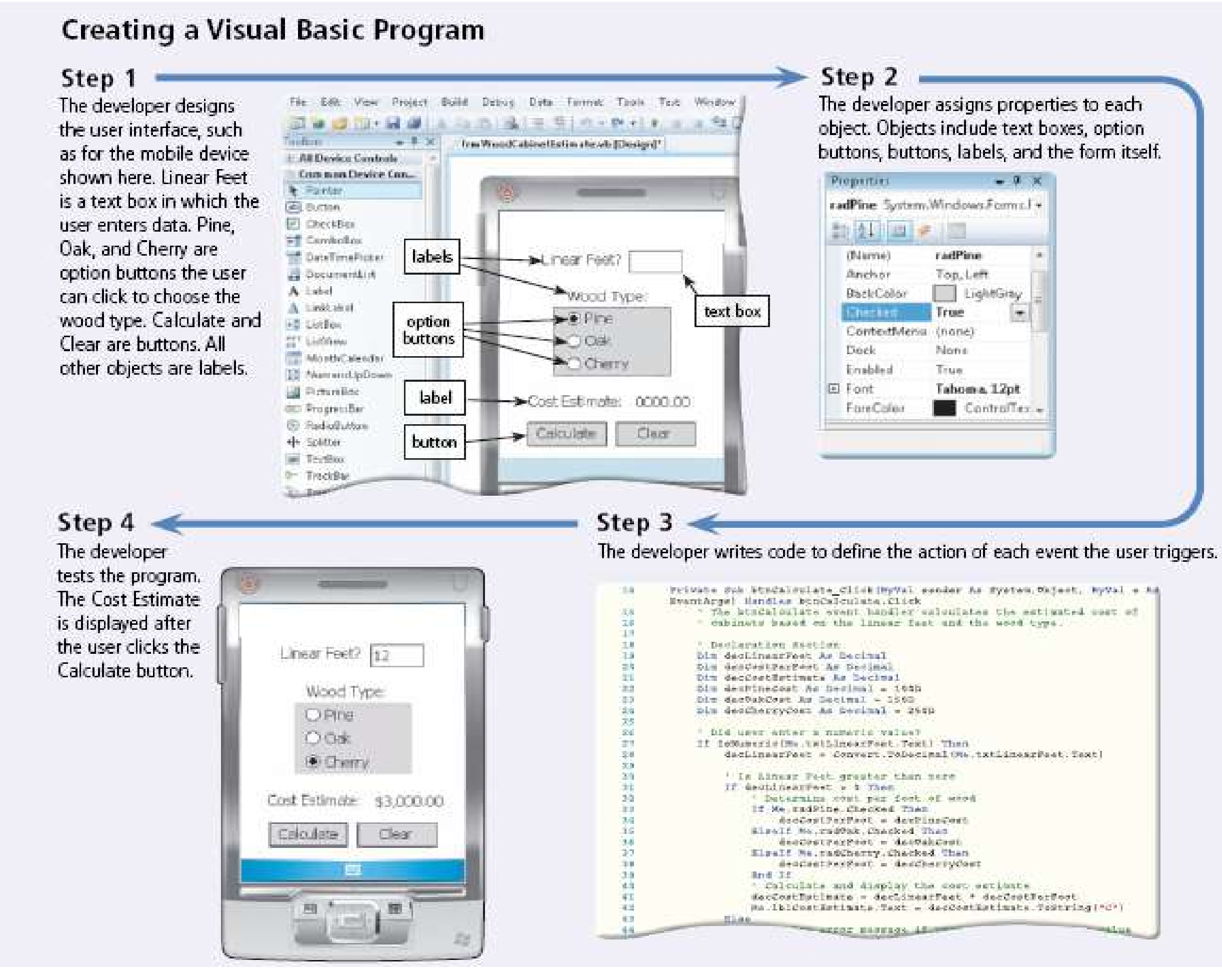


Figure 10-10 This figure shows how to create a Visual Basic program.

- **Visual C++** is a programming language based on C++. Not only is Visual C++ a powerful object-oriented programming language, it enables programmers to write Windows, Windows Mobile, and .NET applications quickly and efficiently. Features that make Visual C++ so powerful include reusable templates, direct access to machine level memory locations, an optimizing compiler, and advanced error reporting.

- **Visual C#** is a programming language that combines programming elements of C++ with an easier, rapid development environment. The purpose of Visual C# is to take the complexity out of Visual C++ and still provide an object-oriented programming language. Programmers familiar with the C/C++ programming language family often migrate to the easier-to-use Visual C#.

Visual Programming Languages

A **visual programming language** is a language that uses a visual or graphical interface for creating all source code. The graphical interface, called a *visual programming environment* (*VPE*), allows programmers to drag and drop objects to develop programs. Examples of visual programming languages include Alice, Mindscript, and Prograph.

Delphi

Borland's **Delphi** is a powerful program development tool that is ideal for building large-scale enterprise and Web applications in a RAD environment (Figure 10-11). Programmers use Delphi to develop programs quickly for Windows, Linux, and .NET platforms. Delphi also provides visual modeling tools based on the UML. Recall from Chapter 12 that the UML (Unified Modeling Language) has been adopted as a standard notation for object modeling and development. With Delphi, programmers easily link the UML designs to the working solutions.

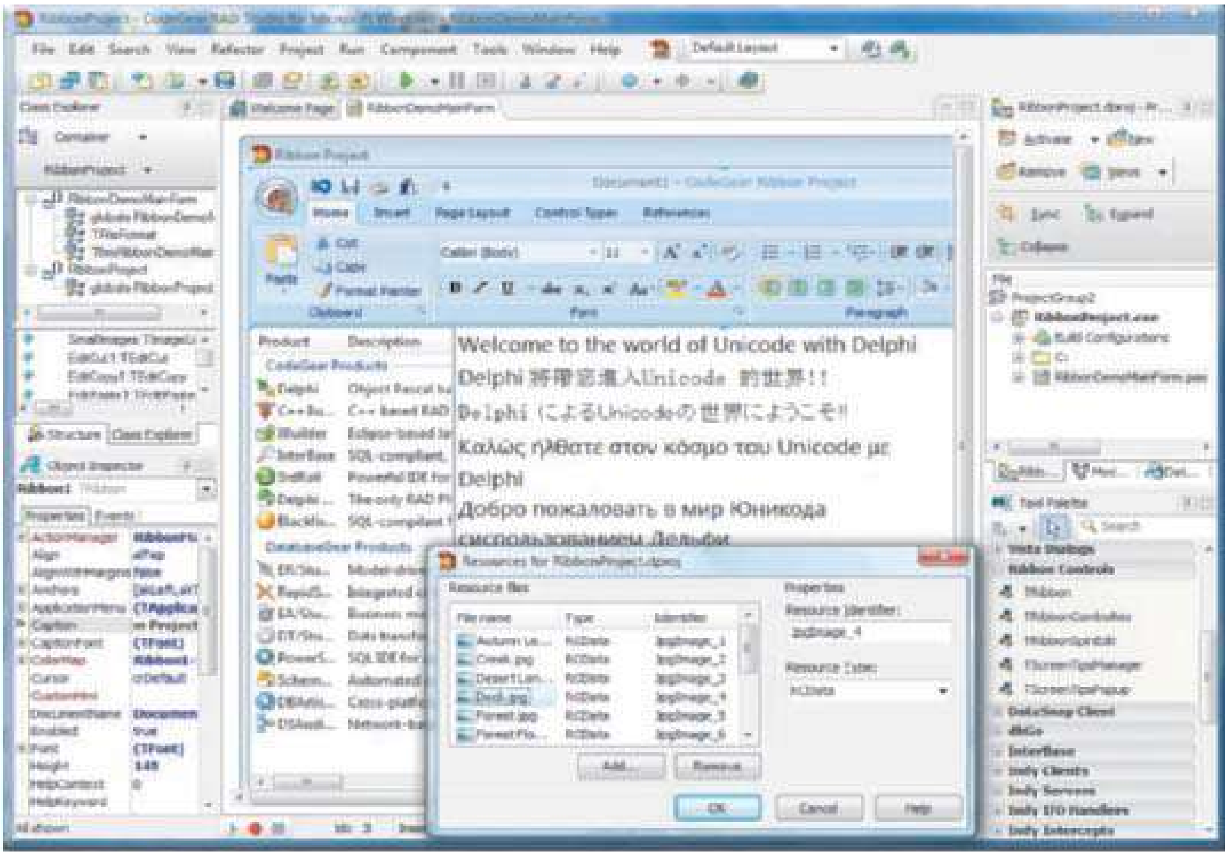


Figure 10-11 The latest version of Delphi, shown in this figure, makes Windows development tasks faster, better, and easier by supporting Microsoft's .NET Framework with both Delphi and C# languages, as well as Delphi for Windows applications in a RAD environment.

PowerBuilder

PowerBuilder, developed by Sybase, is another powerful program development RAD tool that is best suited for Web-based, .NET, and large scale enterprise object-oriented applications. Programmers also use PowerBuilder to develop small- and medium-scale client/server applications. PowerBuilder includes a consistent interface, wizards, and many other features that enable programmers to develop applications quickly (Figure 10-12). In terms of complexity, PowerBuilder is comparable to Delphi.

Figure 10-12 PowerBuilder is a program development RAD tool ideal for building large-scale and Web-based applications.

Other Programming Languages and Development Tools

The following sections discuss a variety of other programming languages and program development tools.

4GLs

A **4GL** (*fourth-generation language*) is a nonprocedural language that enables users and programmers to access data in a database. With a **nonprocedural language**, the programmer writes English-like instructions or interacts with a graphical environment to retrieve data from files or a database. Nonprocedural languages typically are easier to use than procedural languages. Many object-oriented program development tools use 4GLs. One popular 4GL is SQL. As discussed in Chapter 10, **SQL** is a query language that allows users to manage, update, and retrieve data in a relational DBMS (Figure 10-13). These powerful languages allow database administrators to define a database and its structure. They also enable users to maintain and access the data in the database.

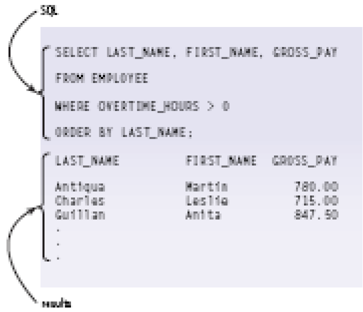


Figure 10-13 SQL is a 4GL that can be used to query database tables. This query produces an alphabetical list of those employees who receive overtime pay; that is, their overtime hours are greater than 0.

Classic Programming Languages

In addition to the programming languages discussed on the previous pages, programmers sometimes use the languages listed in Figure 10-14, which were more popular in the past than today.

Application Generators

An **application generator** is a program that creates source code or machine code from a specification of the required functionality. When using an application generator, a programmer or user works with menu-driven tools and graphical user interfaces to define the desired specifications. Application generators most often are bundled with or are included as part of a DBMS.

An application generator typically consists of a report writer, form, and menu generator. As discussed in Chapter 10, a *report writer* allows you to design a report on the screen, retrieve data into the report design, and then display or print the report. A *form* is a window on the screen that provides areas for entering or changing data in a database. Figure 10-15 shows a sample form design and the resulting form it generates showing sample data a user may enter in the form. A *menu generator* enables you to create a menu for the application options. If you create three reports and two forms for an application, for example, the menu would contain at least six options: one for each report, one for each form, and one to exit, or quit, the application.

Classic Programming Languages	
Ada	Derived from Pascal, developed by the U.S. Department of Defense, named after Augusta Ada Lovelace Byron, who is thought to be the first female computer programmer
ALGOL	ALGOrithmic Language, the first structured procedural language
APL	A Programming Language, a scientific language designed to manipulate tables of numbers
BASIC	Beginners All-purpose Symbolic Instruction Code, developed by John Kemeny and Thomas Kurtz as a simple, interactive problem-solving language
Forth	Similar to C, used for small computerized devices
FORTRAN	FORmula TRANslator, one of the first high-level programming languages used for scientific applications
HyperTalk	An object-oriented programming language developed by Apple to manipulate cards that can contain text, graphics, and sound
LISP	LISt Processing, a language used for artificial intelligence applications
Logo	An educational tool used to teach programming and problem solving to children
Modula-2	A successor to Pascal used for developing system software
Pascal	Developed to teach students structured programming concepts, named in honor of Blaise Pascal, a French mathematician who developed one of the earliest calculating machines
PILOT	Programmed Inquiry Learning Or Teaching, used to write computer-aided instruction programs
PL/1	Programming Language One, a business and scientific language that combines many features of FORTRAN and COBOL
Prolog	PROgramming LOGic, used for development of artificial intelligence applications
RPG	Report Program Generator, used to assist businesses with generating reports and to access/update data in databases
Smalltalk	Object-oriented programming language

Figure 10-14 Classic programming languages.

Macros

A **macro** is a series of statements that instructs an application how to complete a task. Macros allow users to automate routine, repetitive, or difficult tasks in application software such as word processing, spreadsheet, or database programs. That is, users can create simple programs within the software by writing macros. You usually create a macro in one of two ways: (1) record the macro or (2) write the macro.

If you want to automate a routine or repetitive task such as formatting or editing, you would record a macro. A *macro recorder* is similar to a movie camera because both record all actions until turned off. To record a macro, start the macro recorder in the software. Then, perform the steps to be part of the macro, such as clicks of the mouse or keystrokes. Once the macro is recorded, you can run it anytime you want to perform that same sequence of actions. For example, if you always print three copies of certain documents, you could record the actions required to print three copies. To print three copies, you would run the macro called PrintThreeCopies.

When you become familiar with programming techniques, you can write your own macros instead of recording them. Many programs use *Visual Basic for Applications* (*VBA*), which can work with Visual Studio Tools for Office, or a similar language as their macro programming language.

The macro in Figure 10-16a shows an Excel VBA macro that automates the data entry process to determine the monthly payment, total interest, and total cost of an auto loan. Figure 10-16b shows the dialog box generated from the macro that prompts the user to enter the car model.

Web Page Development

The designers of Web pages, known as *Web developers*, use a variety of techniques to create Web pages. These include some of the languages previously discussed and the languages discussed in the following sections.

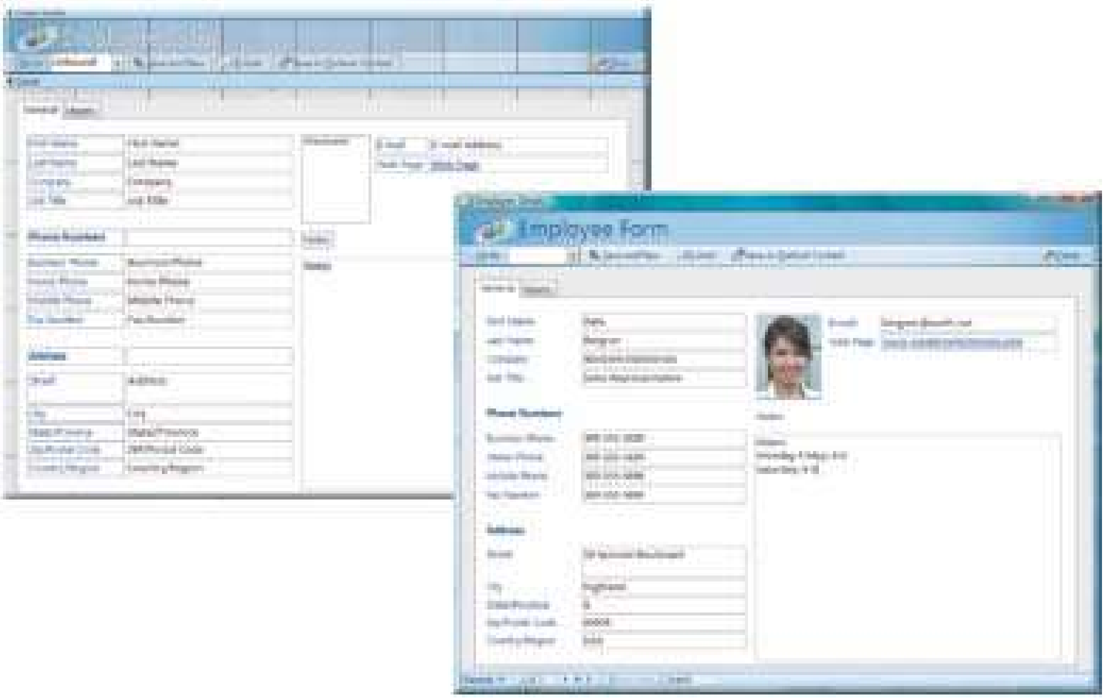


Figure 10-15 A form design and the resulting filled-in form created with Microsoft Access.

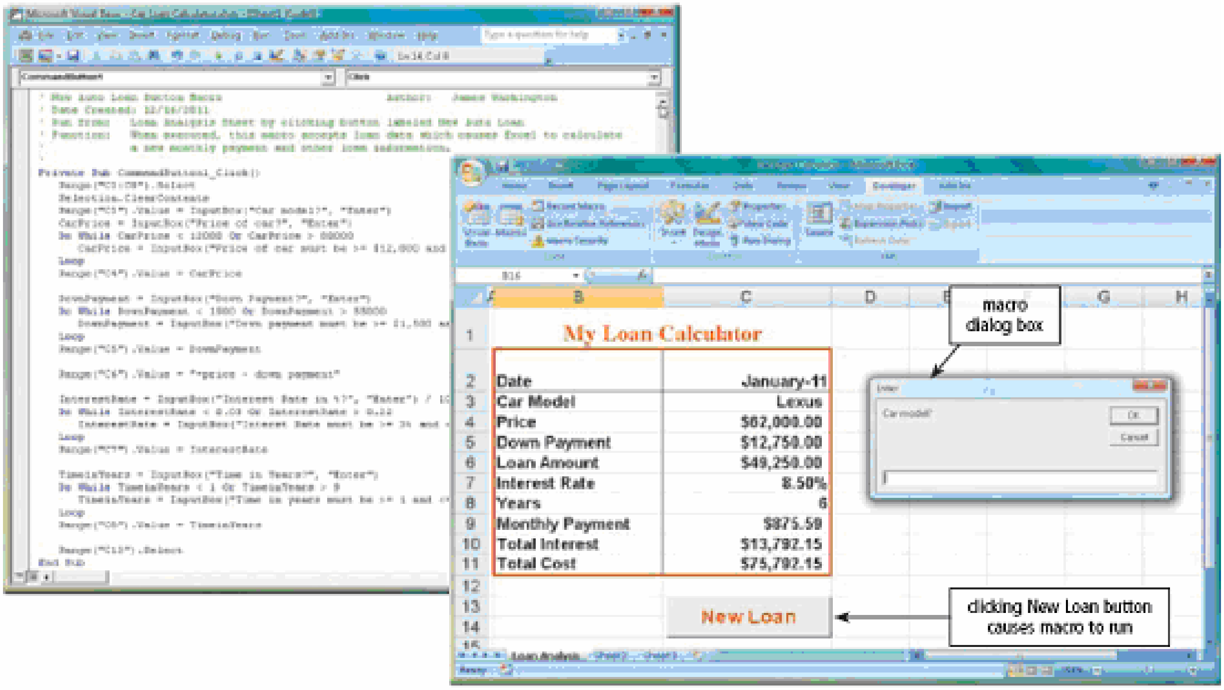


Figure 10-16 The left screen shows a VBA macro used to automate an auto loan. After a macro is written, the user clicks the New Loan button to run the macro. The right screen shows the macro guiding the user through part of the data entry process.

HTML and XHTML

HTML (*Hypertext Markup Language*) is a special formatting language that programmers use to format documents for display on the Web. You view a Web page written with HTML in a Web browser such as Internet Explorer, Safari, Firefox, Opera, or Google Chrome. Similarly, **XHTML** (extensible HTML) is a markup language that enables Web sites to be displayed more easily on microbrowsers in smart phones and other mobile devices, as well as on desktop and notebook computers. Figure 10-17a shows part of the XHTML code used to create the Web page shown in Figure 10-17b. XHTML includes features of HTML and XML, which is discussed in the next section. HTML and XHTML are not actually programming languages. They are, however, languages that have specific rules for defining the placement and format of text, graphics, video, and audio on a Web page. HTML and XHTML use *tags* or *elements*, which are words, abbreviations, and symbols that specify links to other documents and indicate how a Web page is displayed when viewed on the Web. A Web page, thus, is a file that contains both text and HTML and/or XHTML tags. Examples of tags are <p> to indicate a new paragraph, <tr> to create a new row in a table, and <title> to define a document title. You can write HTML code using any text editor such as Notepad. Many programmers however, never write HTML and XHTML code because several programming languages and program development tools generate it automatically.

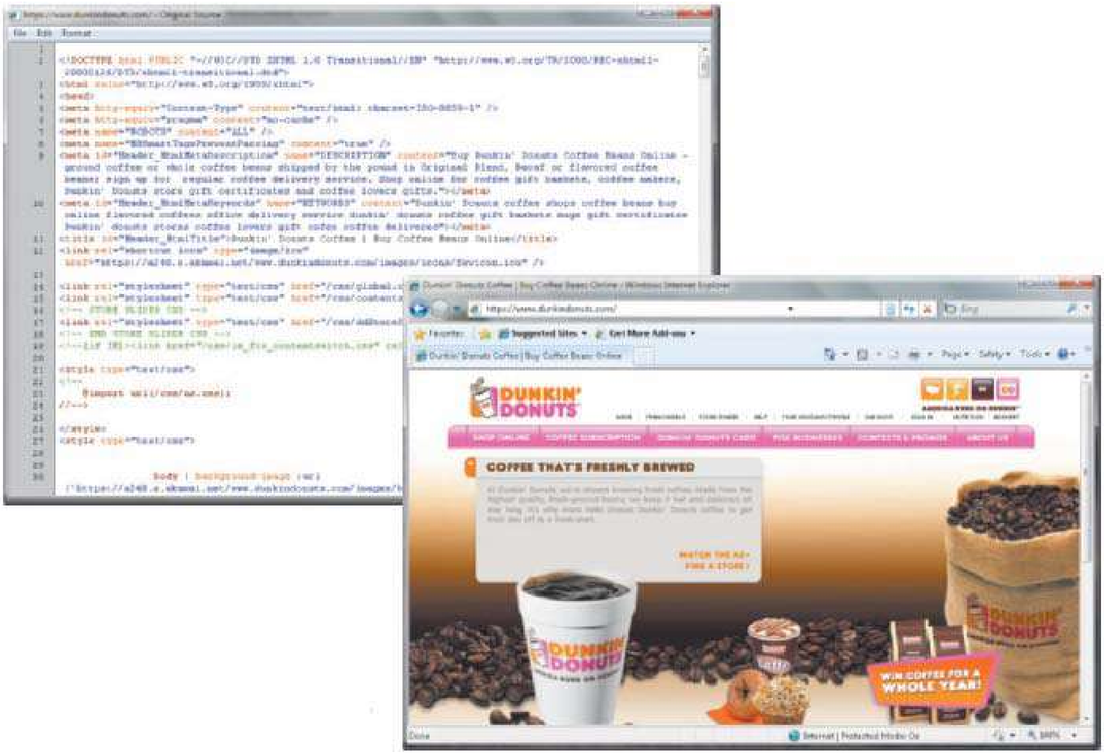


Figure 10-17 The portion of the XHTML code in the top figure generates a portion of a Web page shown in the bottom figure.

XML and WML

XML (Extensible Markup Language) is an increasingly popular format for sharing data that allows Web developers to create customized tags, as well as use predefined tags, used for developing a single Web site whose content can be formatted to display appropriately on various devices. XML separates the Web page content from its format, allowing the Web browser to display the contents of a Web page in a form appropriate for the display device. For example, a smart phone, a PDA, and a notebook computer all could display the same XML page or use different formats or sections of the XML page.

Wireless devices use a subset of XML called WML. **WML** (wireless markup language) allows Web developers to design pages specifically for microbrowsers. Many smart phones and other mobile devices use WML as their markup language.

A *style sheet* contains descriptions of a document's characteristics. (Many word processing documents use style sheets to define formats of characters and paragraphs.) XML works with *XSL* (Extensible Stylesheet

Language), which is a language for creating a style sheet that describes how to present the data described in an XML document on a Web page. XML, for example, can instruct a Web browser to display data bold and centered. An extension of XSL, called *XSLT* (Extensible Stylesheet Language Transformations), creates style sheets that describe how to transform XML documents into other types of documents.
When a user requests a Web page, for example, the server uses the format described in the XSLT file to transform the XML into the appropriate format, such as WML for a smart phone microbrowser, a Web page for a notebook computer, or a label format for a mailing label program (Figure 10-18). Two applications of XML are **RSS 2.0**, which stands for Really Simple Syndication, and **ATOM**, which are specifications that content aggregators use to distribute content to subscribers. The online publisher creates an RSS or ATOM document, called a Web feed, that is made available to Web sites for publication. News Web sites, blogs, and podcasts often use Web feeds to publish headlines and stories. Most Web browsers can read Web feeds, meaning they automatically download updated content from Web pages identified in the feed.

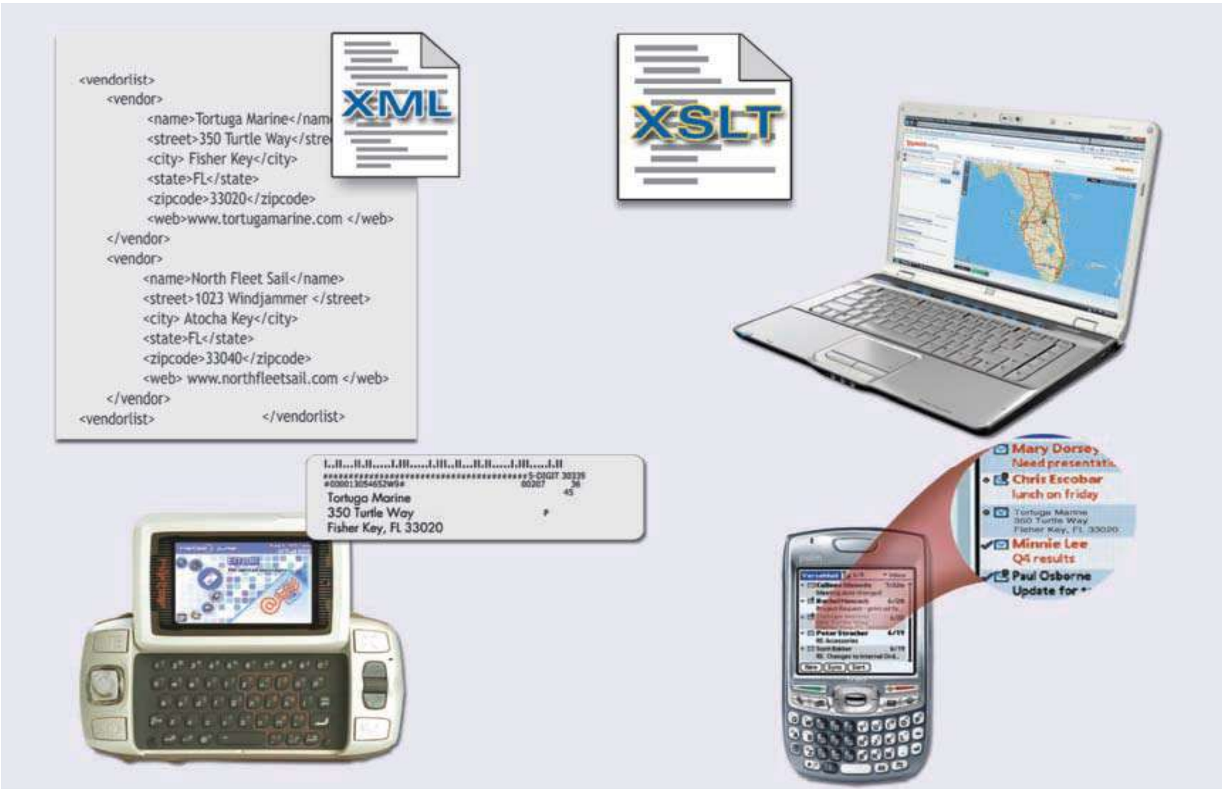


Figure 10-18 A sample XML document converted by an XSLT document for display on various devices.

Scripts, Applets, Servlets, and ActiveX Controls

Markup languages tell a browser how to display text and images, set up lists and option buttons, and establish links on a Web page. By adding dynamic content and interactive elements such as scrolling messages, animated graphics, forms, pop-up windows, and interaction, Web pages become much more interesting. To add these elements, Web developers write small programs called scripts, applets, servlets, and ActiveX controls. These programs run inside of another program. This is different from programs discussed thus far, which are executed by the operating system. In this case, the Web browser executes these short programs.

As discussed in Chapter 9, your computer is the client computer when it is connected to the Web.

- A **script** is an interpreted program that runs on the client. That is, a script runs on your computer, instead of running on a Web server.
- An **applet** also usually runs on the client inside of an interpreted program, but the applet itself is compiled. Thus, an applet usually runs faster than a script.
- Scripts and applets shift the computational work from the Web server to the client. A **servlet**, by contrast, is an applet that runs on the server.

Similar to an applet, an **ActiveX control** is a small program that runs on the client computer, instead of the server. ActiveX controls use ActiveX technology. **ActiveX** is a set of object oriented technologies from Microsoft that allows components on a network to communicate with one another. To run an ActiveX control, the Web browser must support ActiveX technology. If it does not, you will need a plug-in program to run ActiveX controls. One reason Web developers use scripts, applets, servlets, and ActiveX controls is to add special multi media effects to Web pages. Examples include animated graphics, scrolling messages, calendars, and advertisements. Another reason to use these programs is to include interactive capabilities on Web pages. Cookies, shopping carts, games, counters, image maps, and processing forms are types of scripts, applets, servlets, and ActiveX controls that allow you to transfer information to and from a Web server.

A **counter** tracks the number of visitors to a Web site. An **image map** is a graphical image that points to one or more Web addresses. Web pages use image maps in place of, or in addition to, text links. When you click a certain part of the graphical image, the Web browser sends the coordinates of the clicked location to the Web server, which in turn locates the corresponding Web address and sends the Web page to your computer.

A **processing form**, often simply called a form, collects data from visitors to a Web site, who fill in blank fields and then click a button that sends the information. When a user clicks that button on the form, that action executes the script or applet. It transmits the data to the server, processes it, and then, if appropriate, sends information back to your Web browser via the server.

CGI Scripts
To send and receive information between your computer and a Web server, the script, applet, or servlet uses the CGI. The *CGI* (*common gateway interface*) is the communications standard that defines how a Web server communicates with outside sources. Many times, the outside source is a database. The program that manages the sending and receiving across the CGI is a *CGI script*. The steps in Figure 10-19 show how a CGI script works.

A CGI script can be in the form of a script, applet, servlet, or ActiveX control. You can download CGI scripts from the Web and purchase them. If one does not exist that meets your needs, you can write your own CGI script using a scripting language. The next section discusses scripting languages.

Scripting Languages
Programmers write scripts, applets, servlets, or ActiveX controls using a variety of languages. These include some of the languages previously discussed, such as Java, C++, C#, F#, and Visual Basic. Some programmers use scripting languages. A *scripting language* is an interpreted language that typically is easy to learn and use. Popular scripting languages include JavaScript, Perl, PHP, Rexx, Tcl, and VBScript.

- **JavaScript** is an interpreted language that allows a programmer to add dynamic content and interactive elements to a Web page (Figure 10-20). These elements include alert messages, scrolling text, animations, drop-down menus, data input forms, pop-up windows, interactive quizzes, and mouse rollovers. A *mouse rollover* or *mouseover* occurs when text, a graphic, or other object changes as the user moves the mouse pointer over the object on the screen. Web developers insert JavaScript code directly in an HTML or XHTML document.

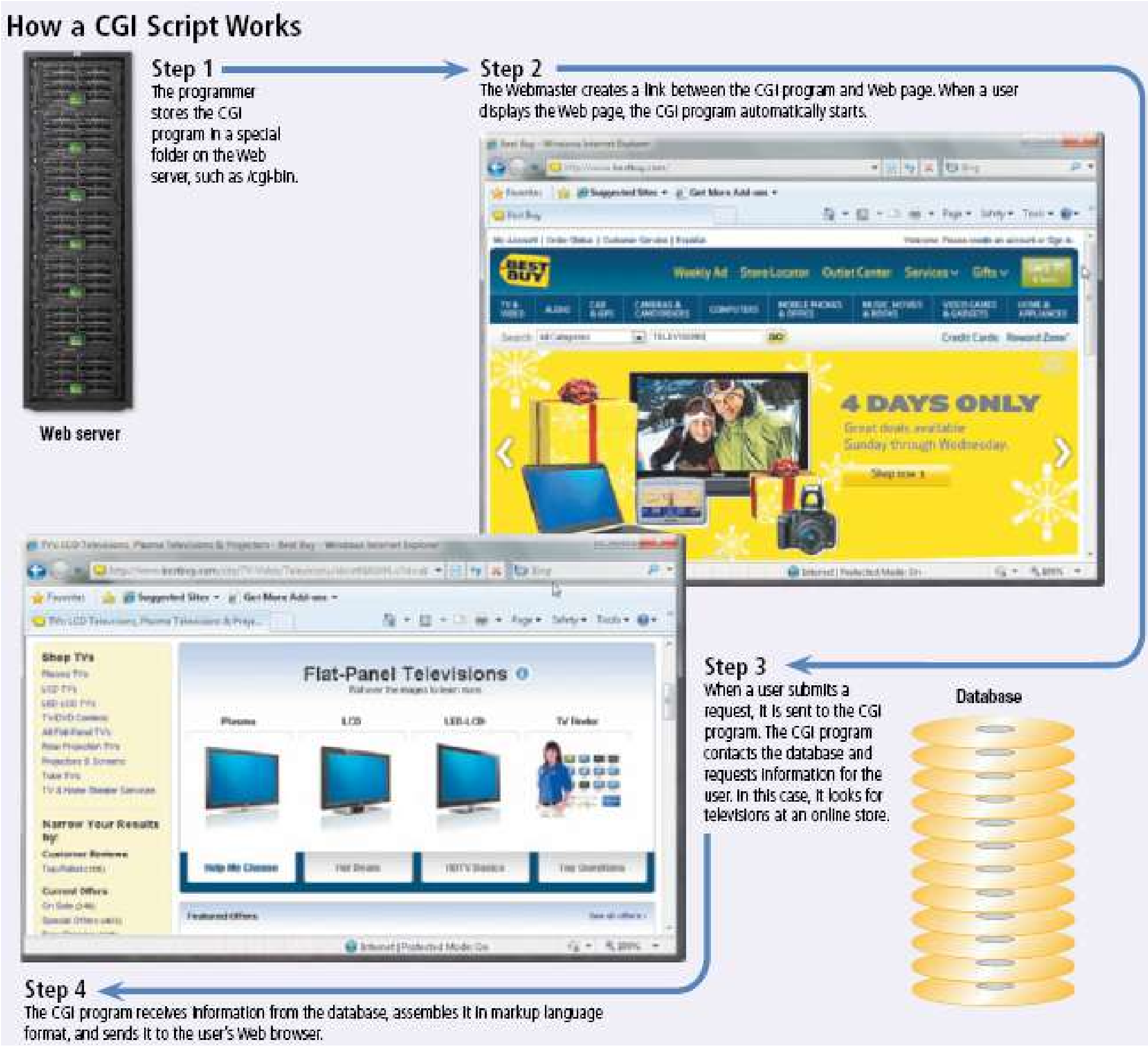


Figure 10-19 This figure shows how a CGI script works.

Although it shares many of the features of the full Java language, JavaScript is a much simpler language. JavaScript is an *open language*, which means anyone can use it without purchasing a license. JavaScript thus allows the programmer to improve the appearance of Web pages without spending a large amount of money.

- **Perl** (*Practical Extraction and Report Language*) originally was developed by Larry Wall at NASA's Jet Propulsion Laboratory as a procedural language similar to C and C++. The latest release of Perl, however, is an interpreted scripting language. Because Perl has powerful text processing capabilities, it has become a popular language for writing scripts.

- **PHP**, which stands for PHP: Hypertext Preprocessor, is a free, open source scripting language. PHP, which is a language similar to C, Java, and Perl, is used primarily on Linux Web servers. Web developers create dynamic Web pages by inserting PHP scripts along with HTML or XHTML in a Web page.

- **Rexx** (*REstructured eXtended eXecutor*) was developed by Mike Cowlishaw at IBM as a procedural interpreted scripting language for both the professional programmer and the nontechnical user. In addition to all IBM operating systems, Rexx works with Windows, Mac OS, and most UNIX operating systems.

- **Tcl** (*Tool Command Language*) is an interpreted scripting language created by Dr. John Ousterhout and maintained by Sun

Microsystems Laboratories. Tcl has a companion program, called Tool Kit (Tk), that allows Web developers to build graphical user interfaces.

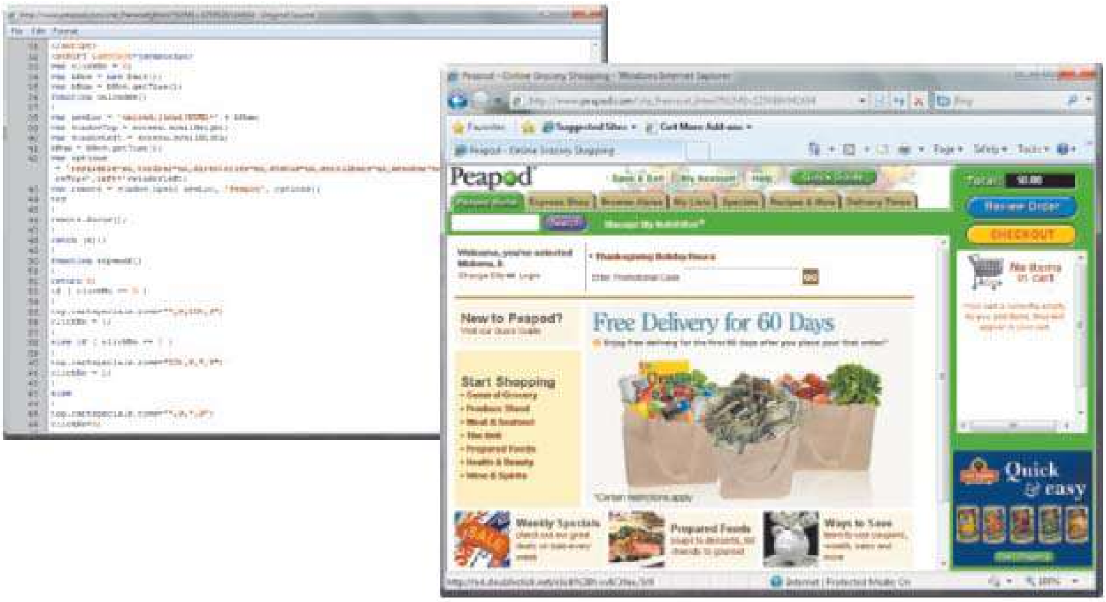


Figure 10-20 Shown here is a portion of JavaScript code and its associated Web page.

- **VBScript** (*Visual Basic, Scripting Edition*) is a subset of the Visual Basic language that allows pro grammers to add intelligence and interactivity to Web pages. As with JavaScript, Web developers embed VBScript code directly into an HTML or XHTML document. Programmers already familiar with Visual Basic choose VBScript as their scripting language, so that they do not have to learn a new scripting language. The latest version of Internet Explorer includes VBScript.

Dynamic HTML Dynamic HTML (**DHTML**) is a type of HTML that allows Web developers to include more graphical interest and interactivity in a Web page, without the Web page accessing the Web server. That is, the client's computer automatically updates and changes its own content. These Web pages display much faster than Web pages created with HTML. Typically, Web pages created with DHTML are more animated and responsive to user interaction. Colors change, font sizes grow, objects appear and disappear as a user moves the mouse, and animations dance around the screen. Dynamic HTML works by using the document object model, cascading style sheets, and scripting languages. The *document object model* (*DOM*) defines every item on a Web page as an object. Fonts, graphics, headlines, tables, and every other page element are objects. With DOM, Web developers can change properties, such as color or size, of any or all of these objects on the Web page. A *cascading style sheet* (*CSS*) contains the formats for how a particular object should be displayed in a Web browser. For example, CSS specifies items such as background colors, image and link colors, fonts, and font sizes. A single DHTML document can contain multiple cascading style sheets, thus, the name cascading. As a user moves the mouse or clicks an item, a new style sheet can be applied to change the appearance of the screen.

After a Web developer has defined and formatted objects on a Web page, a scripting language such as JavaScript manipulates them. A script can move, display, hide, or change the appearance of an object as the user performs actions such as a mouse rollover.

Ruby on Rails

Ruby on Rails (*RoR*), also called *Rails*, is an open source framework that provides technologies for developing object-oriented, database-driven Web sites. Rails uses a free, object-oriented scripting language called *Ruby*, which is derived from a variety of languages including Ada, LISP, Perl, and Smalltalk. Rails is designed to make Web developers more productive by providing them an easy-to-use environment and eliminating time-consuming steps in the Web development process.

Web 2.0 Program Development

As previously discussed, Web 2.0 refers to Web sites that provide a means for users to share personal information, allow users to modify Web site content, and have application software built into the site for visitors to use. Web 2.0 sites include social networking sites, wikis, blogs, online auctions, and Web applications such as Google Docs. Web 2.0 sites often use RSS, previously discussed, and Ajax. **Ajax**, which stands for Asynchronous JavaScript and XML, is a method of creating interactive Web applications designed to provide immediate response to user requests. Instead of refreshing entire Web pages, Ajax works with the Web browser to update only changes to the Web page. This technique saves time because the Web application does not spend time repeatedly sending unchanged information across the network. Ajax combines several programming tools: JavaScript or other scripting language, HTML or XHTML, XML, XSLT, and CSS. Some companies, such as Microsoft, Google, and Yahoo!, provide their Ajax toolkits at no cost. Web browsers that support Ajax include Internet Explorer, Safari, Firefox, and Opera. Examples of Web sites that use Ajax are Google Maps and Flickr. Most Web 2.0 sites also use APIs so that Web developers can create their own Web applications. An *API* (application programming interface) is a collection of tools that programmers use to interact with an environment such as a Web site or operating system. Mapping Web sites, for example, include APIs that enable programmers to integrate maps into their Web sites (Figure 10-21). Another use of APIs is in mashups. Recall that a mashup is a Web application that combines services from two or more sources, creating a new application.

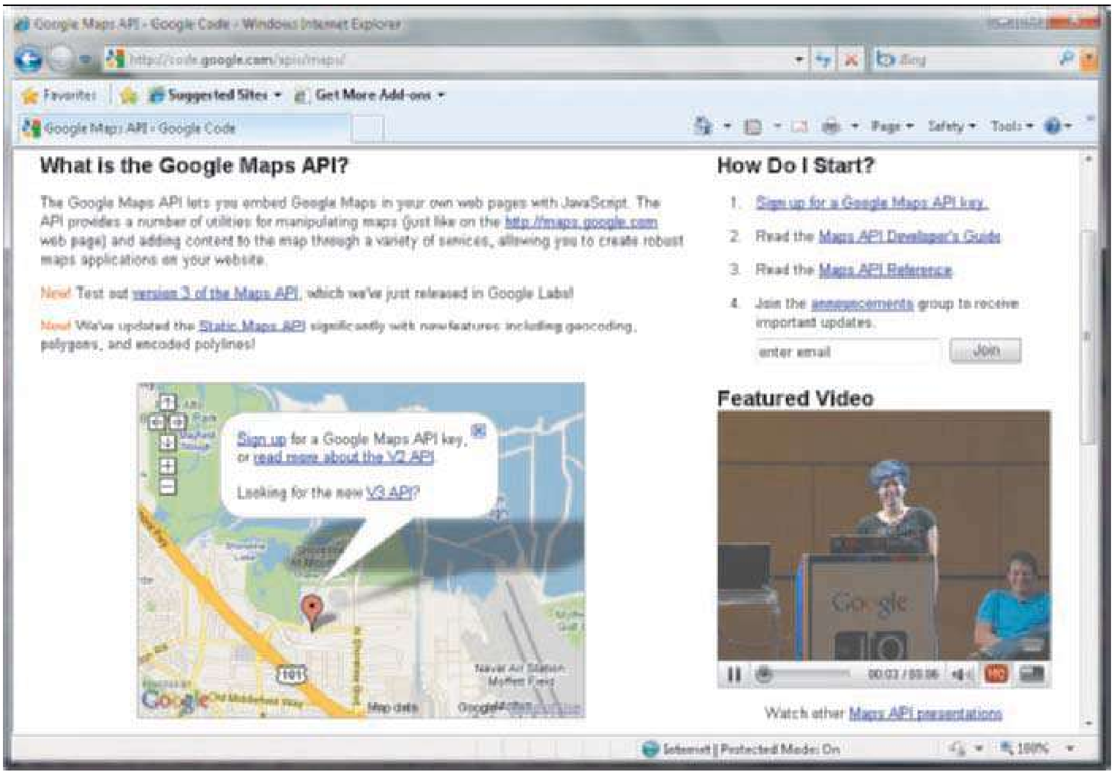


Figure 10-21 Google Maps provides tools for programmers to integrate APIs into their Web sites.

Web Page Authoring Software
As Chapter 3 discussed, you do not need to learn HTML to develop a Web page. You can use **Web page authoring software** to create sophisticated Web pages that include images, video, audio, animation, and other effects. Web page authoring software generates HTML and XHTML tags from your Web page design. With Web page authoring software, you can view or modify the HTML or XHTML associated with a Web page. Sometimes, you may add an HTML or XHTML tag that the Web page authoring software does not provide. Learning HTML and XHTML basics will enable you to fine-tune Web page formats created with authoring software. Four popular Web page authoring programs are Dreamweaver, Expression Web, Flash, and SharePoint Designer.

- **Dreamweaver**, by Adobe Systems, is a Web page authoring program that allows Web developers to create, maintain, and manage professional Web sites. Some features of Dream weaver include its visual environment, use of cascading style sheets, capability of manipulating code, built-in graphics editor (called Fireworks), and XML support.

- **Expression Web** is Microsoft's Web page authoring program that enables Web developers to create professional, dynamic, interactive Web sites. Expression Web requires the .NET and supports HTML, DHTML, XHTML, XML, JavaScript, and cascading style sheets. It also integrates with Visual Studio.

- **Flash**, by Adobe Systems, is a Web page authoring program that enables Web developers to combine interactive content with text, graphics, audio, and video. Features of Flash include its animation and interactive tools, professional video capabilities, easy deployment to mobile devices such as smart phones, and XML support.

- **SharePoint Designer** is a Web page authoring program that is part of the Microsoft Office and SharePoint families of products. SharePoint Designer supports ASP.NET, cascading style sheets, XHTML, and XSLT.

Multimedia Program Development

Multimedia authoring software allows programmers to combine text, graphics, animation, audio, and video in an interactive presentation. Many programmers use multimedia authoring software for computerbased training (CBT) and Web-based training (WBT). Popular Web page authoring programs typically share similar features and are capable of creating similar applications. Popular programs include ToolBook and Director.

- **ToolBook**, from SumTotal Systems, has a graphical user interface and uses an objectoriented approach, so that programmers can design multimedia applications using basic objects. These objects include buttons, fields, graphics, backgrounds, and pages. In ToolBook, programmers can convert a multimedia application into HTML or XHTML, so that it can be distributed over the Internet. Many businesses and colleges use ToolBook to create content for distance learning courses (Figure 10-22).

- **Director**, from Adobe Systems, is a popular multimedia authoring program with powerful features that allow programmers to create highly interactive multimedia applications. Director's powerful features make it well suited for developing electronic presentations, optical discs for education and entertainment, simulations, programs for kiosks, and Web applications. Web applications can include streaming audio and video, interactivity, and multiuser functionality. Users view Web applications developed in Director on the Web using the Shockwave plug-in.

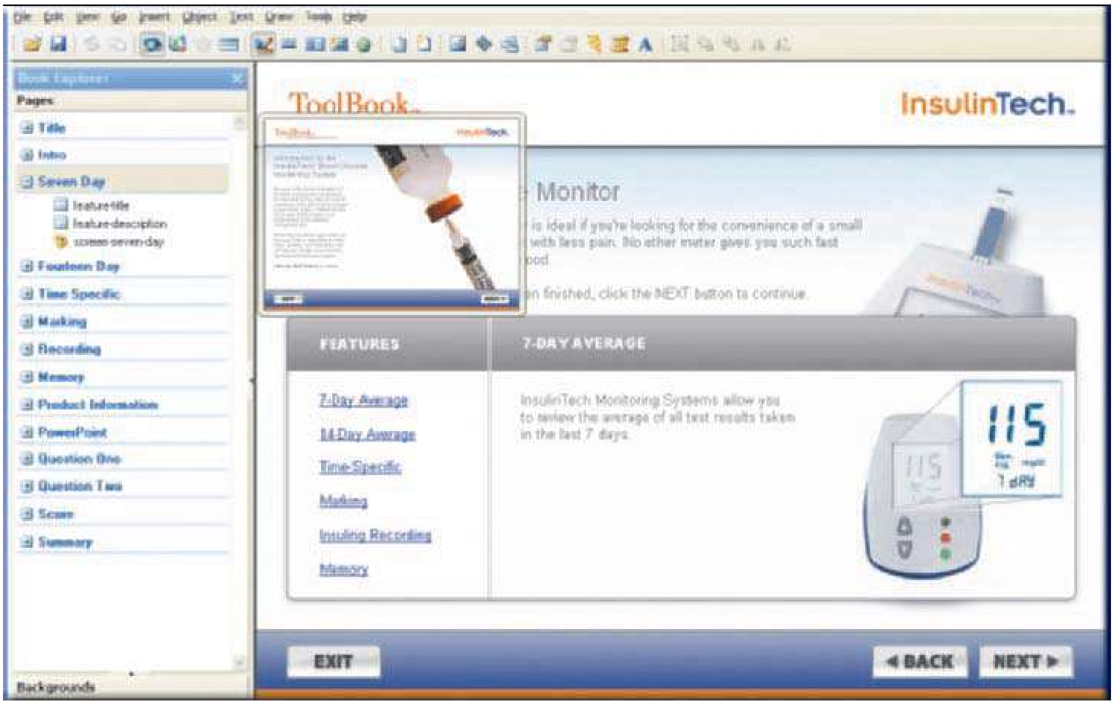


Figure 10-22 A sample ToolBook application.

Program Development

Program development consists of a series of steps programmers use to build computer programs. As Chapter 12 discussed, the system development life cycle guides information technology (IT) professionals through the development of an information system. Likewise, the **program development life cycle** (**PDLC**) guides computer programmers through the development of a program. The program development life cycle consists of six steps (Figure 10-23):

1. Analyze Requirements
2. Design Solution
3. Validate Design
4. Implement Design
5. Test Solution
6. Document Solution

As shown in Figure 10-23, the steps in the program development life cycle form a loop. Program development is an ongoing process within system development. Each time someone identifies errors in or improvements to a program and requests program modifications, the Analyze Requirements step begins again. When programmers correct errors or add enhancements to an existing program, they are said to be **maintaining** the program. Program maintenance is an ongoing activity that occurs after a program has been delivered to users, or placed into production.

What Initiates Program Development?

As discussed in Chapter 12, system development consists of five phases: planning; analysis; design; implementation; and operation, support, and security. During the analysis phase, the development team recommends how to handle software needs. Choices include modifying existing programs, purchasing packaged software, building custom software in-house, or outsourcing some or all of the IT activities. If the company opts for in-house development, the design and implementation phases of system development become quite extensive. In the design phase, the systems analyst creates a detailed set of requirements for the programmers. Once the programmers receive the requirements, the implementation phase begins. At this time, the programmer analyzes the requirements of the problem to be solved. The program development life cycle thus begins at the start of the implementation phase in system development. The scope of the requirements largely determines how many programmers work on the program development. If the scope is large, a **programming team** that consists of a group of programmers may develop the programs. If the specifications are simple, a single programmer might complete all the development tasks. Whether a single programmer or a programming team, all the programmers involved must interact with users and members of the development team throughout program development. By following the steps in program development, programmers create programs that are correct (produce accurate information) and maintainable (easy to modify). The following sections address each of the steps in program development.

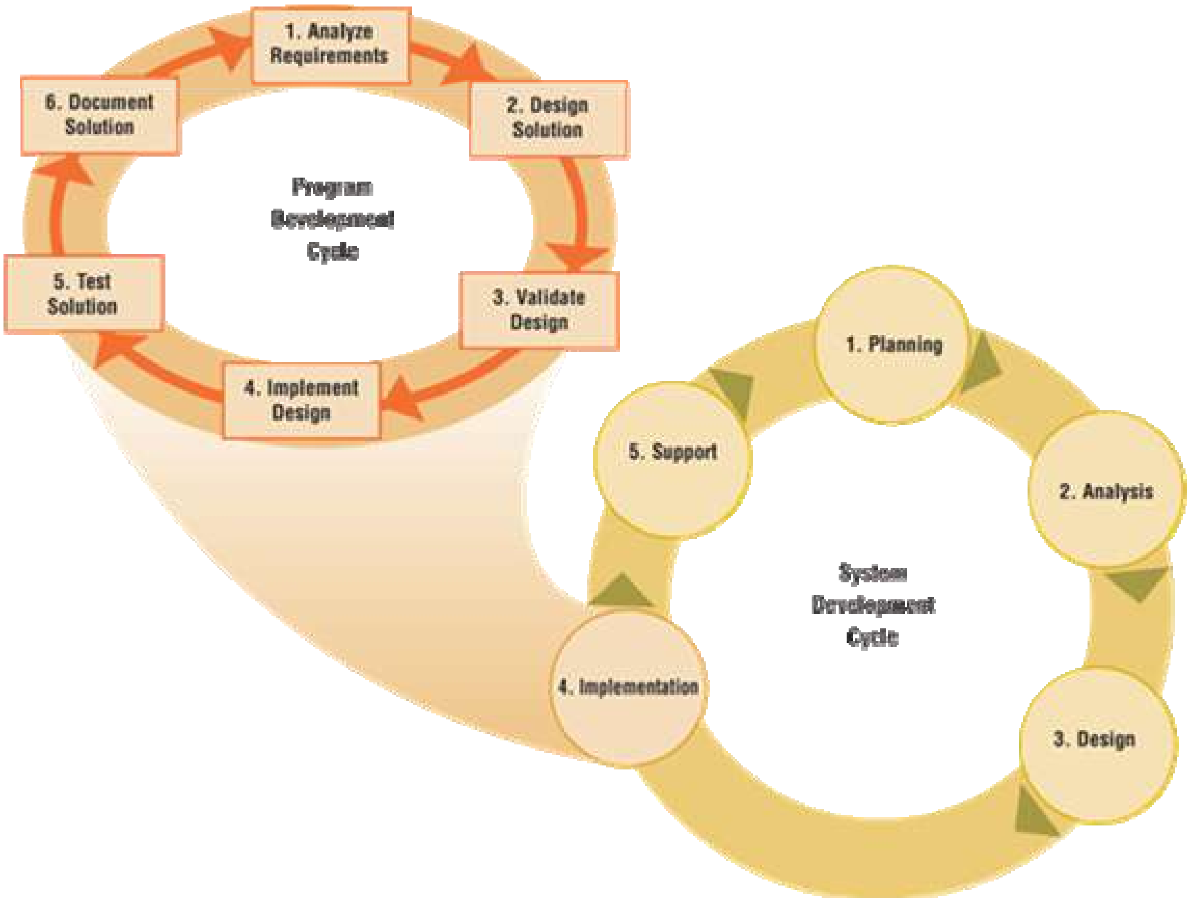


Figure 10-23 The program development life cycle consists of six steps that form a loop. The program development life cycle is part of the implementation phase of the system development life cycle.

Step 1 — Analyze Requirements

The first step in program development is to analyze the requirements of the problem the program(s) should solve, so that the programmer can begin to develop an appropriate solution. In most cases, the solution requires more than one program. The Analyze Requirements step consists of three major tasks: (1) review the requirements, (2) meet with the systems analyst and users, and (3) identify input, processing, output, and data components.

First, the programmer reviews the requirements. The requirements may be in the form of deliverables such as charts, diagrams, and reports. For example, screen and report layout charts illustrate input and output requirements. Structured English, decision tables, and decision trees convey processing requirements. The data dictionary identifies the data requirements. By thoroughly reviewing these deliverables, the programmer understands the nature of the requirements. During this step, the programmer also meets with the systems analyst and the users. This enables the programmer to understand the purpose of the requirements from the users' perspective. Recall from Chapter 12 that a guideline of system development is to involve users throughout the entire system development life cycle. After design specifications are established, the programmer defines the input, processing, output (IPO), and data requirements for each program. Many programmers use an IPO chart to show the input, processing, and output components (Figure 10-24). An *IPO chart* identifies a program's inputs, its outputs, and the processing steps required to transform the inputs into the outputs. Programmers review the contents of the IPO chart with the systems analyst and the users. This allows programmers to be sure that they completely understand the purpose of the program.

IPO Chart

Input	Processing	Output
Regular Time Hours Worked Overtime Hours Worked Hourly Pay Rate	Read regular time hours worked, overtime hours worked, hourly pay rate. Calculate regular time pay. If employee worked overtime, calculate overtime pay. Calculate gross pay. Print gross pay.	Gross Pay

Figure 10-24 An IPO (input, process, output) chart is a tool that assists the programmer in analyzing a program.

Step 2 — Design Solution

The next step is to design the solution that will meet the users' requirements. Designing the solution involves devising a solution algorithm to satisfy the requirements. A *solution algorithm*, also called *program logic*, is a graphical or written description of the step-by-step procedures to solve the problem. Determining the logic for a program often is a programmer's most challenging task. It requires that the programmer understand programming concepts, often database concepts, as well as use creativity in problem solving. Recall from Chapter 12 that a system can be designed using process modeling (structured analysis and design) or object modeling (objectoriented analysis and design). The approach used during system development determines the techniques a programmer uses in designing a solution.

Structured Design

In **structured design**, sometimes called *top-down design*, the programmer typically begins with a general design and moves toward a more detailed design. This approach breaks down the original set of requirements into smaller, more manageable sections. The first step in top-down design is to identify the major function of a program, sometimes called the *main routine* or *main module*. Next, the programmer decomposes (breaks down) the main routine into smaller sections, called *subroutines* or *modules*. Then, the programmer analyzes each subroutine to determine if it can be decomposed further. Programmers use a **hierarchy chart**, also called a *structure chart*, to show program modules graphically (Figure 10-25). A hierarchy chart contains rectangles and lines. The rectangles are the modules. The main module is at the top of the chart. All other modules are placed below the main module. Modules connect by lines to indicate their relationships. In Figure 10-25, for example, the Initialization, Process, and Wrap-Up modules are subordinate to the MAIN module. Programs developed using structured design benefit from their simplicity, reliability, readability, reusability, and maintainability. Structured design, however, does not provide a way to package the data and the program (or procedure) together. Each program has to define how it will use the data. This can result in redundant programming code that must change every time the structure of the data changes. To eliminate this problem, some IT professionals use the object-oriented approach for program development.

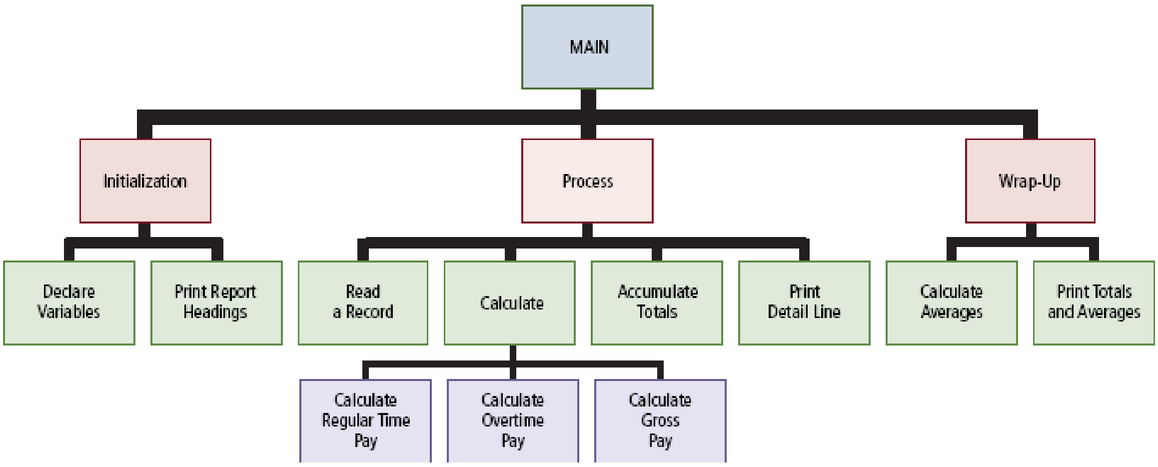


Figure 10-25 The hierarchy chart is a tool the programmer uses during structured design. On the hierarchy chart, program modules are drawn as rectangles. All modules are subordinate to the MAIN module.

Object-Oriented Design

With **object-oriented (OO) design**, the programmer packages the data and the program (or procedure) into a single unit, an object. When the structure of an object changes, any program that accesses the object automatically accesses the change.

The concept of packaging data and procedures into a single object is called *encapsulation*. That is, an object encapsulates (hides) the details of the object. Think of an object as a box, and you cannot see inside the box. The box sends and receives messages. It also contains code and data. For example, when users want to print a document, they click the Print button (the object). They probably do not know how the Print button actually communicates with the hardware to print the document. Thus, the details of the print object are encapsulated (hidden) from the user. Programmers, however, need to know how the object works, so that they can send messages to it and use it effectively. As described in Chapter 12, objects are grouped into classes. To represent classes and their hierarchical relationships graphically, programmers use a class diagram. Figure 10-26 shows a high-level class diagram. In this diagram, a construction site needs many jobs performed, a job is completed by several workers, and each worker receives one paycheck for work performed. The 1 below the Construction Site class indicates that each Construction Site class must have at least one Job class associated with it.

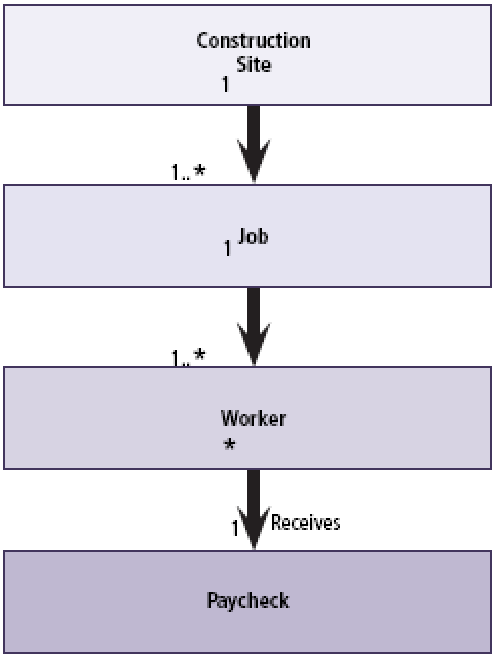


Figure 10-26 A class diagram is a hierarchical tool the programmer uses during object-oriented design.

The 1..* above the Job class indicates that each Job class must be associated with at least one Construction Site class above it. With the high-level class diagram complete, the programmer develops a detailed class diagram that provides a visual representation of each object, its attributes, and its methods. Then, the programmer translates the methods into program instructions.

Control Structures

Whether using structured design or object-oriented design, programmers typically use control structures to describe the tasks a program is to perform. A **control structure**, also known as a *construct*, depicts the logical order of program instructions. Three basic control structures are sequence, selection, and repetition.

Sequence Control Structure

A *sequence control structure* shows one or more actions following each other in order (Figure 10-27). Actions include inputs, processes, and outputs. All actions must be executed; that is, none can be skipped. Examples of actions are reading a record, calculating averages or totals, and printing totals.

Selection Control Structure

A *selection control structure* tells the program which action to take, based on a certain condition. Two common types of selection control structures are the if-then-else and the case. When a program evaluates the condition in an *if-thenelse control structure*, it yields one of two possibilities: true or false. Figure 10-28 shows the condition as a diamond symbol. If the result of the condition is true, then the program performs one action. If the result is false, the program performs a different action. For example, the if-then-else control structure can determine if an employee should receive overtime pay. A possible condition might be the following: Is Hours Worked greater than 40? If the response is yes (true), then the action would calculate overtime pay. If the response is no (false), then the action would set overtime pay equal to 0.

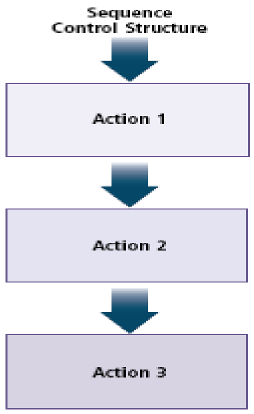


Figure 10-27 The sequence control structure shows one or more actions followed by another.

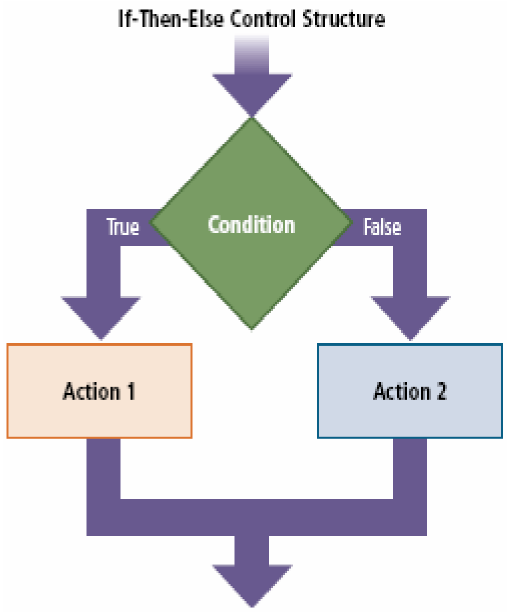


Figure 10-28 The if-then-else control structure directs the program toward one course of action or another based on the evaluation of a condition.

In some cases, a program should perform no action if the result of a condition is false. This variation of the if-then-else is called the if-then control structure because the program performs an action only if the result of the condition is true. With the *case control structure*, a condition can yield one of three or more possibilities (Figure 10-29). The size of a beverage, for example, might be one of these options: small, medium, large, or extra large. A case control structure would determine the price of the beverage based on the size purchased.

Repetition Control Structure The *repetition control structure* enables a program to perform one or more actions repeatedly as long as a certain condition is met. Many programmers refer to this construct as a *loop*. Two forms of the repetition control structure are the do-while and do-until. A *do-while control structure* repeats one or more times as long as a condition is true (Figure 10-30). This control structure tests a condition at the beginning of the loop, a process called a *pretest*. If the result of the condition is true, the program executes the action(s) inside the loop.

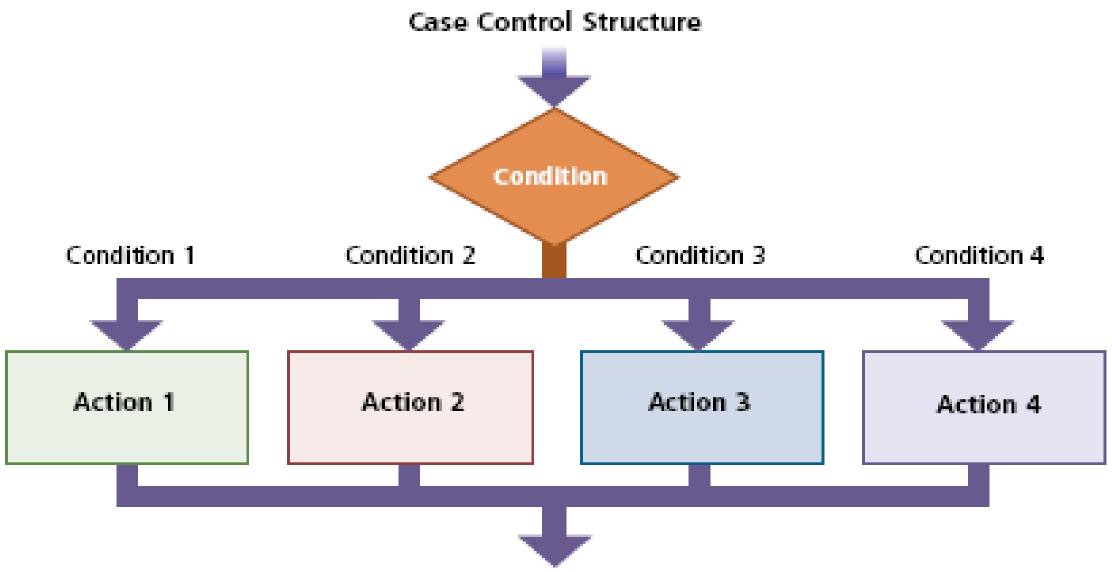


Figure 10-29 The case control structure allows for more than two alternatives when a condition is evaluated.

Then, the program loops back and tests the condition again. If the result of the condition still is true, the program executes the action(s) inside the loop again. This looping process continues until the condition being tested becomes false. At that time, the program stops looping and moves to another set of actions. The do-while control structure normally is used when occurrence of an event is not quantifiable or predictable. For example, programmers frequently use the do-while control structure to process all records in a file. A payroll program using a do-while control structure loops once for each employee. This program stops looping when it processes the last employee's record. The *do-until control structure* is similar to the do-while but has two major differences: where it tests the condition and when it stops looping. First, the do-until control structure tests the condition at the end of the loop, a process called a *posttest* (Figure 10-31). The action(s) in a do-until control structure thus always will execute at least once. The loop in a do-while control structure, by contrast, might not execute at all. That is, if the condition immediately is false, the action or actions in the do-while loop never execute. Second, a do-until control structure continues looping until the condition is true — and then stops. This is different from the do-while control structure, which continues to loop while the condition is true.

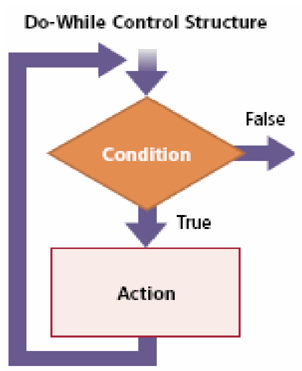


Figure 10-30 The do-while control structure tests the condition at the beginning of the loop. It exits the loop when the result of the condition is false.

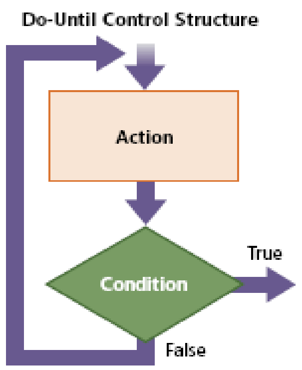


Figure 10-31 The do-until control structure tests the condition at the end of the loop. It exits the loop when the result of the condition is true.

Design Tools

To help document a solution algorithm, programmers use *design tools*. Two structured design tools are program flowcharts and pseudocode. A design tool for object-oriented design is the UML.

- A *program flowchart*, or simply **flowchart**, graphically shows the logic in a solution algorithm. The American National Standards Institute (ANSI) published a set of standards for program flowcharts in the early 1960s. These standards, still used today, specify symbols for various operations in a program's logic (Figure 10-32).

Programmers connect most symbols on a program flowchart with solid lines. These lines show the direction of the program. Dotted lines on a flowchart connect comment symbols. A *comment symbol*, also called an *annotation symbol*, explains or clarifies logic in the solution algorithm. Figure 10-33 shows the program flowchart for three modules of the program shown in the hierarchy chart in Figure 10-25.

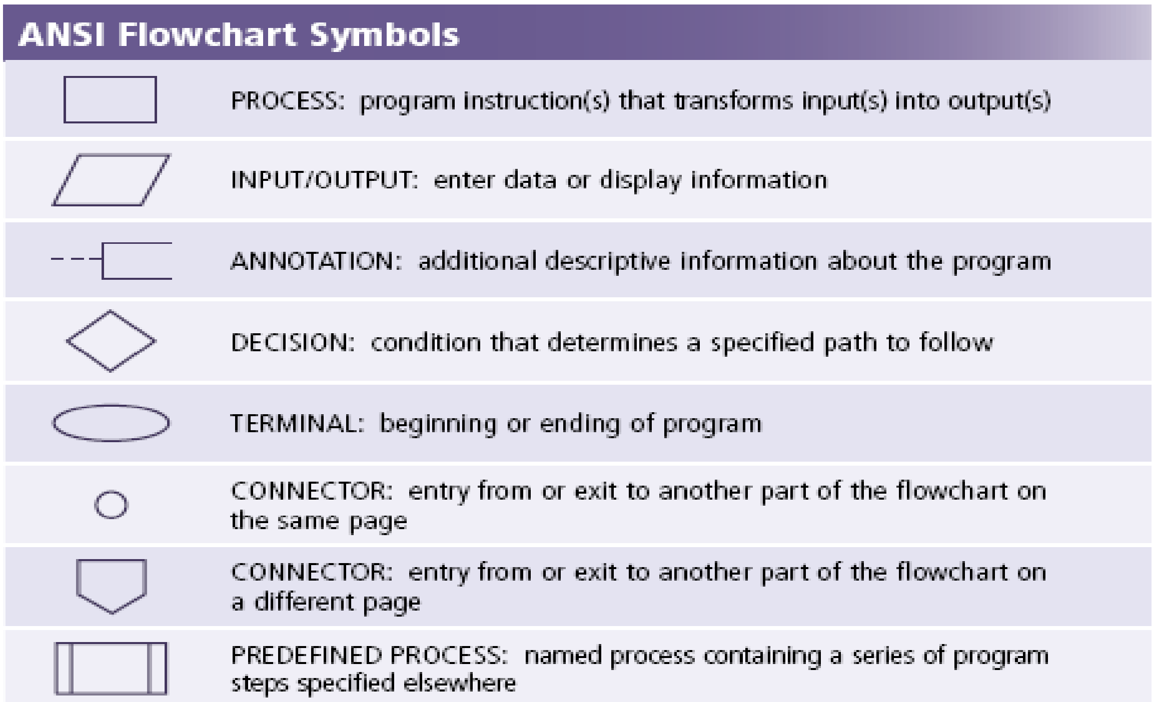


Figure 10-32 Standard symbols used to create program flowcharts.

In the past, programmers used a template to trace the symbols for a flowchart on a piece of paper. Today, programmers use commercial **flowcharting software** to develop flowcharts. This software makes it easy to modify and update flowcharts. Two popular flowcharting programs are SmartDraw (Figure 10-34) and Visio.

Pseudocode uses a condensed form of English to convey program logic. Some programmers prefer to explain the logic of a solution algorithm with words (pseudocode), instead of a graphical flowcharting technique. Pseudo code also uses indentation to identify the control structures. The beginning and ending of the module start at the left margin. The actions within the module are indented. The actions within a selection or repetition control structure are indented again. This allows the programmer to identify the beginning and ending of the control structure clearly. Figure 10-35 shows the pseudocode for the same three program modules as in Figure 10-33 on the previous page.

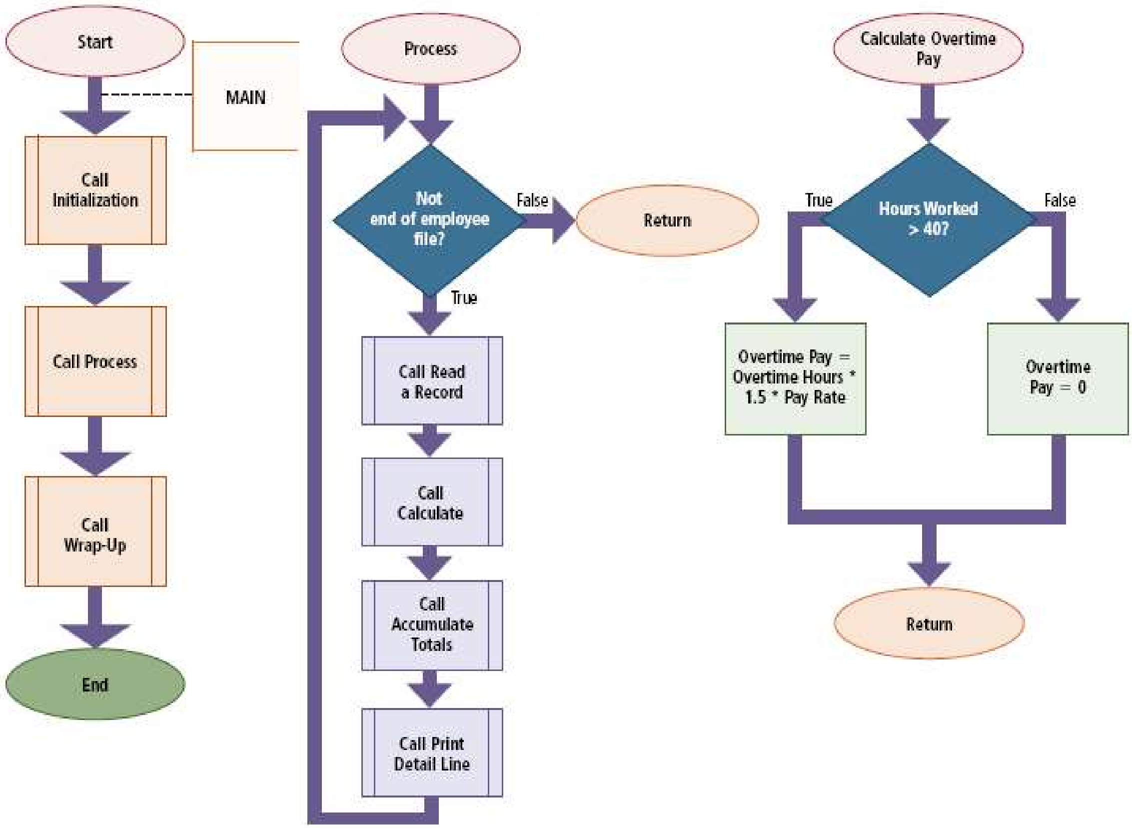


Figure 10-33 This figure shows a program flowchart for three of the modules on the hierarchy chart in Figure 10-25: MAIN, Process, and Calculate Overtime Pay. Notice the MAIN module is terminated with the word, End, whereas the subordinate modules end with the word, Return, because they return to a higher-level module.

```
MAIN MODULE:

       CALL Initialization
       CALL Process
       CALL Wrap-Up

END

PROCESS MODULE:

       DO WHILE Not EOF
              CALL Read a Record
              CALL Calculate
              CALL Accumulate Totals
              CALL Print Detail Line
       ENDDO

RETURN

CALCULATE OVERTIME PAY MODULE:

       IF Hours Worked > 40 THEN
              Overtime Pay = Overtime Hours
                  * 1.5 * Pay Rate
       ELSE
              Overtime Pay = 0
       ENDIF

RETURN
```

Figure 10-35 Pseudocode is another alternative method of showing program logic. This figure shows the same three modules (MAIN, Process, and Calculate Overtime Pay) as illustrated in Figure 10-33 with program flowcharts.

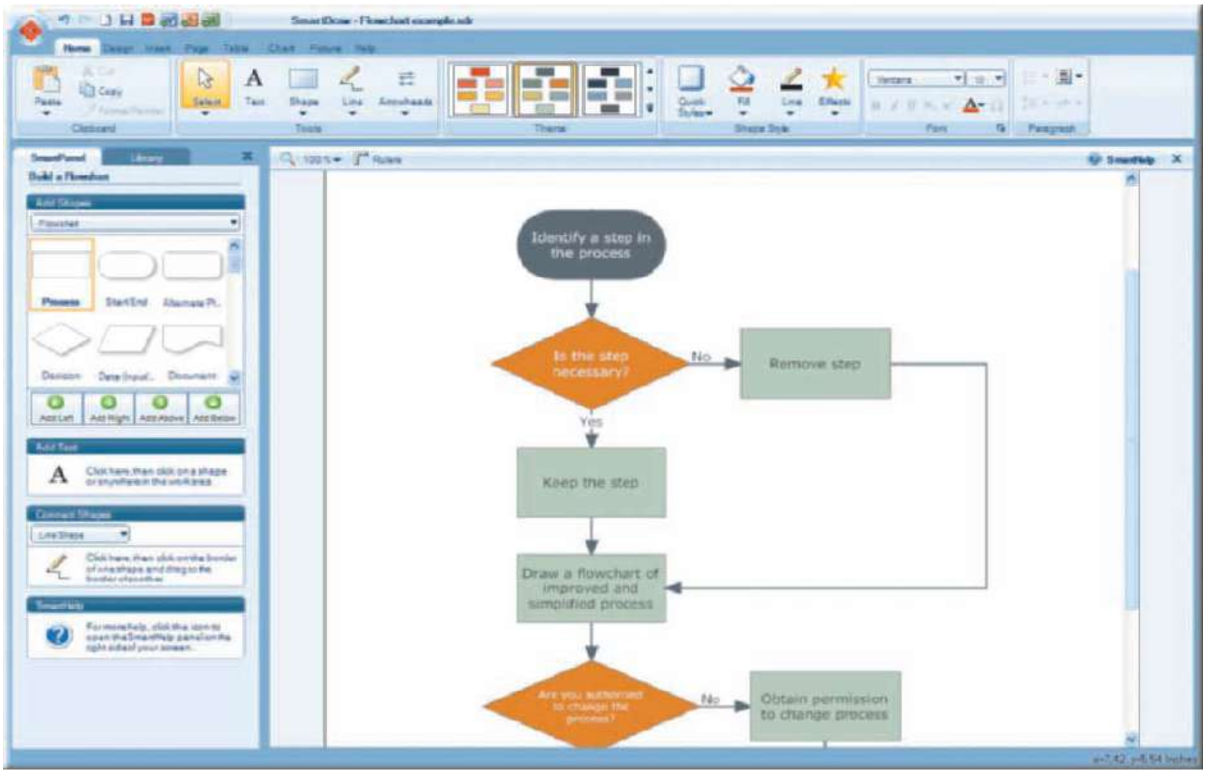


Figure 10-34 SmartDraw is a popular flowcharting program.

• As discussed in Chapter 12, the UML (Unified Modeling Language) has been adopted as a standard notation for object modeling and development. These notations are used in diagrams that present various views of the system being developed. Figure 10-36 identifies some symbols used in each of these types of diagrams.

Two basic categories of diagrams in the UML are structural diagrams and behavioral diagrams. Examples of structural diagrams include class diagrams, component diagrams, and deployment diagrams. A class diagram shows classes and their subclasses and relationships, attributes, operations, and roles. A component diagram shows how the software components of a system interact. A deployment diagram illustrates how hardware components are connected.

Behavioral diagrams illustrate how the processes flow among the components, classes, users, and the system being designed. Examples of behavioral diagrams include use case diagrams, activity diagrams (Figure 10-37), sequence diagrams, and state diagrams. A use case diagram shows how actors interact with the system. An activity diagram shows all the activities that occur within a use case. A sequence diagram identifies all possible paths a message takes as it moves among the actors and objects. A state diagram identifies the various changes that occur to an object over time.

Step 3 — Validate Design

Once programmers develop the solution algorithm, they should *validate*, or check, the program design for accuracy. During this step, the programmer checks the logic for accuracy and attempts to uncover logic errors. A **logic error** is a flaw in the design that causes inaccurate results. Two techniques for reviewing a solution algorithm are a desk check and an inspection.

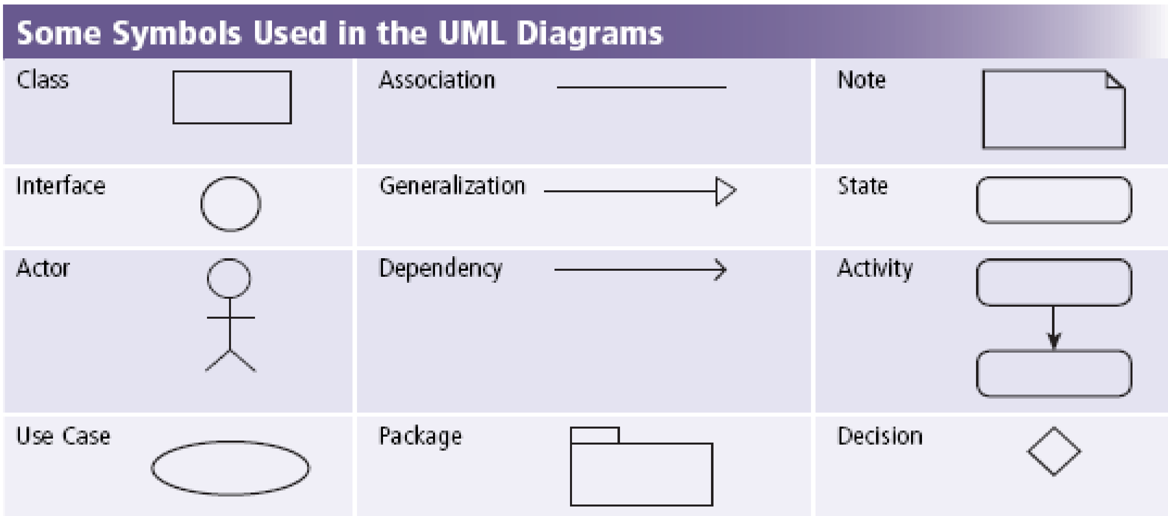


Figure 10-36 Symbols used to create diagrams in the UML.

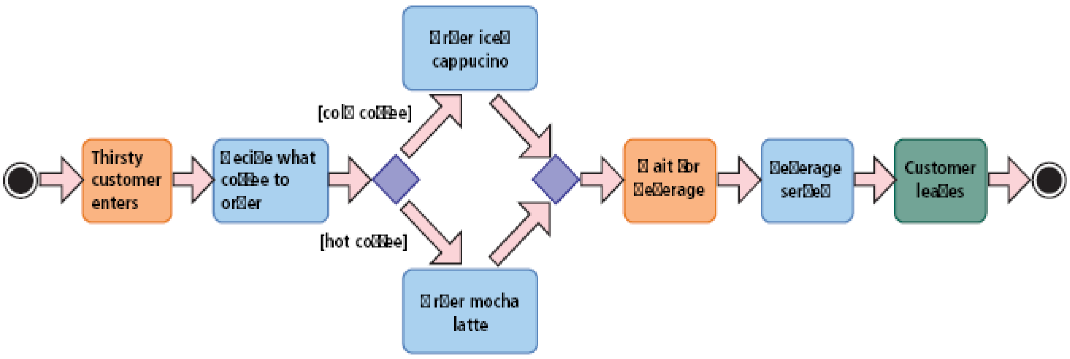


Figure 10-37 A UML activity diagram illustrating a Place Coffee Order use case.

When programmers do a *desk check*, they use test data to step through its logic. **Test data** is sample data that mimics real data the program will process once it is in production. Users should assist in the development of test data. The programmer who developed the solution algorithm usually performs the desk check, but another programmer also can perform this task.

Desk checking involves five steps.

1. Develop various sets of test data (inputs).
2. Determine the expected result (output) for each set of data, without using the solution algorithm.
3. Step through the solution algorithm using one set of test data and write down the actual result obtained (output) using the solution algorithm.
4. Compare the expected result from Step 2 to the actual result from Step 3.
5. Repeat Steps 3 and 4 for each set of test data.

If the expected result and actual result do not match for any set of data, the program has a logic error. When this occurs, the programmer must review the logic of the solution algorithm to determine the reason for the error and then correct it. A more formal technique for checking the solution algorithm is an inspection. As discussed in Chapter 12, a systems analyst often uses an inspection to review deliverables during system development. Likewise, programmers use inspections to review solution algorithms during program development. Usually, a programmer easily can correct errors or improvements identified at this point. After the programmer begins implementing the design, errors are more difficult to fix. Thus, detecting errors and making improvements early in program development reduces the overall time and cost of program development.

Step 4 — Implement Design

Implementation of the design includes using a program development tool that assists the programmer by generating or providing some or all code, or includes writing the code that translates the design into a computer program and, if necessary, creating the user interface. **Coding** a program involves translating the solution algorithm into a programming language (sometimes on paper) and then typing the programming language code into the computer. You enter code using the editor provided with the programming language or any other text editor, such as Notepad, as long as the file is saved with the extension required by the programming language. If you use a standard word processing program, such as Word, you also must save the code as an ASCII file, often called plain text, instead of as a formatted word processing document. An *ASCII file* is a file that does not contain any formatting, that is, no graphics, italics, bold, underlining, styles, bullets, shading, color, etc. As previously mentioned, many different programming languages exist. Each of these has a particular syntax. A language's **syntax** is the set of grammar and rules that specifies how to write instructions for a solution algorithm.

For example, a programmer writes an instruction to add three numbers or creates a user interface differently in each language, according to its syntax. Once the code is entered, it should be reviewed. **Code review** is the process of programmers, quality control testers, and/or peers reviewing code in order to locate and fix errors so that the final programs work correctly. As programmers enter code into a computer, they should document the code thoroughly so that the programs can be maintained easily. Programs should include both global and internal documentation, called *comments* (Figure 10-38). *Global comments*, which usually are at the top of a program, explain the program's purpose and identify the program name, its author, and the date written. *Internal comments*, which appear throughout the body of the program, explain the purpose of the code statements within the program.

Figure 10-38 Thorough documentation leads to maintainable programs. A program should contain global comments (at the top of the program) and internal comments (throughout the body of the program). In this Visual Basic program, the first character of the comment is an apostrophe.

Extreme Programming

As an alternative to coding in this step of program development, some companies use extreme programming to develop programs. *Extreme programming* (*XP*) is a strategy that proposes that programmers should immediately begin coding and testing solutions as soon as requirements are defined. The code continually is tested and refined until it works. This strategy essentially eliminates the Design Solution and Validate Design steps of traditional program development. Extreme programming also suggests that programmers work in pairs, with each communicating code to the other and generating ideas for proper solutions. Proponents of extreme programming claim it reduces the time required for program development. Extreme programming most often is used in object-oriented design.

Step 5 — Test Solution

Once a programmer codes and enters the program, the next step is to test it. Thorough testing is very important. After programmers place the program into production, many users rely on the program and its output to support their daily activities and decisions. The goal of program testing is to ensure the program runs correctly and is error free. Errors uncovered during this step usually are one of two types: (1) syntax errors or (2) logic errors. A **syntax error** occurs when the code violates the syntax, or grammar, of the programming language. Misspelling a command, leaving out required punctuation, or typing command words, called *keywords*, out of order all will cause syntax errors. Programmers usually discover syntax errors the first time they attempt to compile or interpret the program code on the computer. When a syntax error is located, a message either is displayed on the screen immediately or is written to a log file. Either way, the programmer must review and correct all syntax errors. The procedure for testing for logic errors at this step is much like the desk checking techniques used in the Validate Design step.

Another purpose of using test data is to try to cause a **run-time error**, which is an error or event that causes the program to stop running. If the pay rate for employees cannot exceed $55.00 per hour, then the test data should use some valid pay rates, such as $25.00 and $10.50, as well as some invalid ones, such as $-32.00 and $72.50. When entering an invalid pay rate, the program should not stop running but instead should display an error message and allow the user to reenter the pay rate. If the program accepts an invalid pay rate, then it contains a logic error. If it stops running, it has a run-time error. In addition, the program should handle data exception errors such as division by zero. When users run a program, the data they enter should not cause a run-time error. They may experience a run-time error, however, if their computer does not have enough RAM or disk space to run the program.

The process of locating and correcting syntax and logic errors in a program is known as **debugging** the program. The program errors themselves are the **bugs**. Thus, removing the errors is de*bug*ging. The term bug originated when the failure of one of the first computers supposedly was traced to an actual bug. A moth lodged in the computer's electronic components was the cause of the failure (Figure 10-39). Most programming languages include a debug utility. A *debug utility*, or *debugger*, assists programmers with identifying syntax errors and finding logic errors. With a debugger, a programmer examines program values (such as the result of a calculation) while the program runs in slow motion.

Some software companies distribute a beta of their software to users. A **beta** is a program that has most or all of its features and functionality implemented. Users test the beta program and send bug reports to the software company. This enables the software manufacturer to fix any errors before the software is released to the public for sale. If a programmer designs a program properly during the Design Solution step, then testing in this step should not require much time. As a general rule, the more time and effort programmers spend analyzing and designing the solution algorithm, the less time they spend debugging the program.

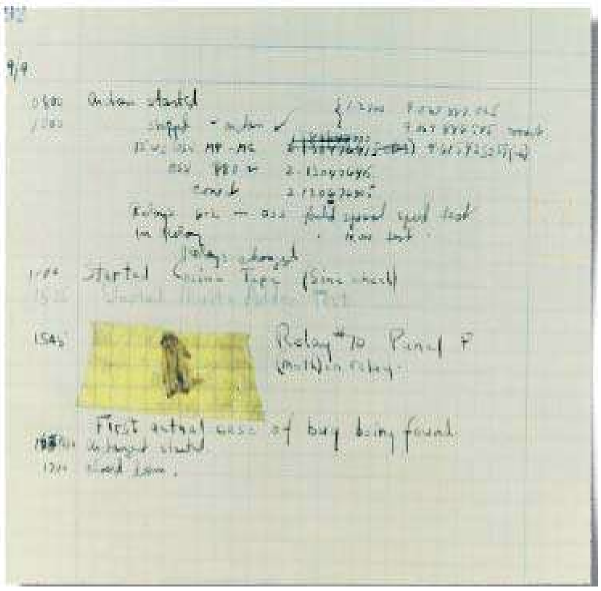


Figure 10-39 The temporary failure of one of the first computers was traced to a dead moth (shown taped to the log book) caught in the electronic components. Some say this event is the origin of the computer term bug.

Step 6 — Document Solution

In documenting the solution, the programmer performs two activities: (1) review the program code and (2) review all the documentation. First, programmers review the program for any dead code and remove it. *Dead code* is any program instructions that a program never executes. When programmers write a program, they often write a section of code at a time. Sometimes, they decide not to use the code, but leave it in the program anyway. This dead (unused) code serves no purpose and should not exist. Next, programmers should run the program one final time to verify it still works. After reviewing the program code, the programmer gives the program and all of its documentation to the systems analyst. The documentation includes all charts, solution algorithms, test data, and program code listings that contain global and internal comments. The programmer should be sure all documentation is complete and accurate. This becomes especially valuable if the program requires changes in the future. Proper documentation greatly reduces the amount of time a new programmer spends learning about existing programs.

Chapter Exercises

True/False **Mark T for True and F for False.**

_____ 1. Just as humans speak a variety of languages, programmers use a variety of programming languages and tools to create programs.

_____ 2. With a procedural language, often called a third-generation language (3GL), a programmer uses a series of English-like words to write instructions.

_____ 3. Programmers use Java Platform, Micro Edition (Java ME) to create programs for smart phones and other mobile devices.

_____ 4. The Microsoft .NET Framework is a set of technologies that allows almost any type of program to run on the Internet or an internal business network, as well as stand-alone computers and mobile devices.

_____ 5. HTML (Hypertext Markup Language) is a special formatting language that programmers use to format documents for display on the Web.

_____ 6. ATOM allows Web developers to design pages specifically for microbrowsers.

_____ 7. An applet usually runs slower than a script.

_____ 8. Ruby on Rails is an open source framework that provides technologies for developing object-oriented, database-driven Web sites.

_____ 9. Expression Web is used strictly on Linux Web servers.

_____ 10. A selection control structure shows one or more actions following each other in order.

Multiple Choice **Select the best answer.**

1. A(n) _____ reads a code statement, converts it to one or more machine language instructions, and then executes those machine language instructions.
a. compiler b. interpreter c. source program d. symbolic address

2. An OOP language is _____, which means an OOP language program checks for and responds to events such as pressing a key or typing a value.
a. event based b. interpreted c. event driven d. compiled

3. When programmers compile a(n) _____ program, the resulting object code is called bytecode, which is machine independent.
a. C b. assembly language c. Java d. all of the above

4. _____ is a popular fourth-generation query language that allows users to manage, update, and retrieve data in a relational DBMS.
a. SQL b. COBOL c. XML d. RPG

5. _____ is a subset of the Visual Basic language that allows programmers to add intelligence and interactivity to Web pages.
a. VBScript b. Flash c. Ajax d. SQL

6. _____ is a Web page authoring program that is part of the Microsoft Office and SharePoint families of products.
a. PHP b. Ajax c. SharePoint Designer d. Flash

7. _____ by Adobe Systems, is a Web page authoring program that allows Web developers to create, maintain, and manage professional Web sites.
a. Ajax b. Flash c. Expression Web d. Dreamweaver

8. The concept of packaging data and procedures into a single object is called _____.
a. object code b. encapsulation c. an object program d. a control structure

Matching Match the terms with their definitions.

_____ 1. Java	a. collection of tools that programmers use to interact with an environment such as a Web site or operating system
_____ 2. C++	
_____ 3. F#	b. process of testing a condition at the end of a loop
_____ 4. 4GL	c. series of statements that instructs an application how to complete a task
_____ 5. macro	d. object-oriented extension of the C programming language
_____ 6. PHP	e. free, open source scripting language
_____ 7. API	f. process of programmers, quality control testers, and/or peers reviewing code in order to locate and fix errors so that the final programs work correctly
_____ 8. pretest	g. object-oriented language that uses a just-in-time compiler
_____ 9. posttest	h. process of testing a condition at the beginning of a loop
_____ 10. code review	i. nonprocedural language that enables users and programmers to access data in a database
	j. combines the benefits of an object-oriented language and a functional language

Short Answer Write a brief answer to each of the following questions.

l. How is a compiler different from an interpreter? ____________ What is the advantage, and disadvantage, of an interpreter? ____________

2. What is a major benefit of OOP? ____________ How is RAD (rapid application development) used for developing software? ____________

3. What is included in an integrated development environment? ____________ Describe the programming languages in the Visual Studio suite. ____________

4. How is XML used? ____________ Describe two applications of XML. ____________

5. Describe two activities performed by the programmer when documenting a solution. ____________ Why is proper documentation important? ____________