Computer Concepts 2012

Parsons :: Oja

1

Computers and Digital Basics

Chapter Contents

Learning Objectives

After reading this chapter, you will be able to answer the following questions by completing the outcomes-based Learning Objectives Checkpoints on page 51.

1. How is technology fueling the digital revolution?

2. What is convergence and how does it apply to the digital devices we use every day?

3. In what ways does digital technology affect society?

4. How do computers work with input, output, processing, storage, and stored programs?

5. What's the difference between an operating system and application software?

6. How do personal computers differ from servers, mainframes, and supercomputers?

7. Are PDAs, portable media players, and smartphones classified as computers?

8. Why are microcontrollers the computers no one sees?

9. Aren't data and information the same thing?

10. What's the difference between analog and digital?

11. How do digital devices use 1s and 0s to work with numbers, text, images, and sound?

12. Why is there so much jargon pertaining to bits and bytes?

13. What hardware components manipulate the bits that represent data?

14. Why do computers need programs?

15. How do a microprocessor's ALU and control unit work?

16. How do hackers steal passwords?

17. How can I create secure passwords?

InfoWebLinks

Visit the InfoWebLinks site to access additional resources **w** that accompany this chapter.

Multimedia and Interactive Elements

When using the BookOnCD or CourseMate eBook, the ▶ icons are clickable to access multimedia resources.

Pre-Assessment Quiz

Take the pre-assessment quiz to find out how much you know about the topics in this chapter. ▶

Apply Your Knowledge The information in this chapter will give you the background to:

- Inventory the digital devices you own
- Put digital technology in the context of history, pop culture, and the global economy
- Read computer ads with an understanding of technical terminology

- Select secure passwords for protecting your computer and Internet logins
- Use a password manager to keep track of all your passwords
- Use digital devices with an awareness of how they might infringe on your privacy

Try It

WHAT'S MY DIGITAL PROFILE?

The average American consumer owns more than 24 digital devices. Before you begin Chapter 1, take an inventory of your digital equipment to find the brands, models, and serial numbers. Tuck this information in a safe place. It can come in handy when you need to call technical support, arrange for repair services, or report missing equipment.

1. Fill in the following table for any digital equipment you own, rent, lease, or use.

	Brand	Model	Serial Number
Computer			
Keyboard			
Mouse			
Monitor			
Printer			
Digital camera			
Digital music player			
Internet or network device			
Mobile phone			
Game console			
Other (list)			

All Things Digital

IN A SIMPLER TIME of poodle skirts, saddle shoes, and ponytails, consumers used a telephone to communicate, switched on a radio for music, watched the television for news, went to a movie theater for entertainment, trudged to the library for research, and headed to the nearest pizza joint for a game of pinball. Today, technology offers an unprecedented number of choices for entertainment, information, and communication. It has changed the fabric of life in significant ways. We're using innovative new products, adjusting to industries in transformation, watching new markets emerge, and grappling with complex issues that have the potential to influence culture, politics, and economics on a global scale. Section A offers an overview of digital technology within the context of social and economic change.

THE DIGITAL REVOLUTION

What is the digital revolution? The **digital revolution** is an ongoing process of social, political, and economic change brought about by digital technology, such as computers and the Internet. The digital revolution became a significant factor in the 1980s, as computers and other digital devices became popular and as the Internet opened global communications.

The term *digital revolution* was probably coined as a parallel to the term *industrial revolution*, and in that sense it promises to bring about a similar level of social and economic change. The digital revolution is creating an Information Society, in which owning, generating, distributing, and manipulating information becomes a significant economic and cultural activity.

The digital revolution is happening now. Every day new digital innovations challenge the status quo and require societies to make adjustments to traditions, lifestyles, and legislation.

What technologies are fueling the digital revolution? The digital revolution revolves around a constellation of technologies, including digital electronics, computers, communications networks, the Web, and digitization. Before you learn about these technologies in greater detail later in the book, the following overview explains the big picture.

What's the significance of digital electronics? Digital electronics use electronic circuits to represent data. In the 1940s and 1950s, engineers began to develop digital electronic devices and refine the electronic components used to build them. Transistors and then integrated circuits, which we call computer chips, were key factors in making electronic devices increasingly smaller and less expensive (Figure 1-1).

Consumers first became acquainted with digital electronics through digital watches that appeared in 1972, and then with handheld electronic calculators popularized by Texas Instruments in 1973. Today, digital electronic devices include computers, portable media players such as iPods, digital cameras and camcorders, cell phones, radios and televisions, GPSs (global positioning systems), DVD and CD players, e-book readers, digital voice recorders, and handheld gaming consoles. Even cars and appliances, such as microwave ovens, refrigerators, and washing machines, include digital electronics for control, monitoring, and fault diagnosis.

FIGURE 1-1

Digital devices, such as this wireless mouse, are built from solid state circuit boards and computer chips, making them small, light, responsive, inexpensive, and durable.

Without digital electronics, you'd be listening to bulky vacuum-tube radios instead of toting sleek iPods; computers would be huge machines, priced far beyond the reach of individuals; and your favorite form of entertainment would probably be foosball.

When did computers enter the picture? Engineers built the first digital computers during World War II for breaking codes and calculating missile trajectories. By the 1950s, a few computers were being used for business data processing applications, such as payroll and inventory management. Businesses adopted computers with increasing enthusiasm as benefits for cutting costs and managing mountains of data became apparent.

During the antiestablishment era of the 1960s, the digital revolution was beginning to transform organizations, but had little effect on ordinary people. As with many technologies, computers were initially viewed with some measure of suspicion by consumers, who worried that impersonal data processing machines were treating people simply as numbers (Figure 1-2).

When the first personal computers became available in 1976, sales got off to a slow start. Without compelling software applications, personal computers, such as the Apple II, seemed to offer little for their $2,400 price. As the variety of software increased, however, consumer interest grew. In 1982, *TIME* magazine's annual Man of the Year award went to the computer, an indication that computers had finally gained a measure of acceptance by the person in the street.

As generations of computer users since that time have discovered, computers are handy devices. They displaced typewriters for creating documents, obsoleted mechanical calculators for number crunching, and took games to an entirely new dimension. Ambitious parents snapped up computers and educational software for their children and school systems set about equipping schools with computer labs.

In 1982, computers might have gained recognition in *TIME* magazine, but fewer than 10% of U.S. households had a computer. Working on a standalone computer wasn't for everyone. People without interest in typing up corporate reports or school papers, crunching numbers for accounting, or playing computer games weren't tempted to become active soldiers in the digital revolution. Social scientists even worried that people would become increasingly isolated as they focused on computer activities rather than social ones. Computer ownership increased at a gradual pace until the mid-1990s, and then it suddenly accelerated as shown in the graph in Figure 1-3.

FIGURE 1-2

In the 1950s and 1960s, data used by government and business computers was coded onto punched cards that contained the warning "Do not fold, tear, or mutilate this card." Similar slogans were used by protesters who were concerned that computers would have a dehumanizing effect on society.

Do not fold, bend, spindle, or mutilate

FIGURE 1-3

Household ownership of personal computers in the United States
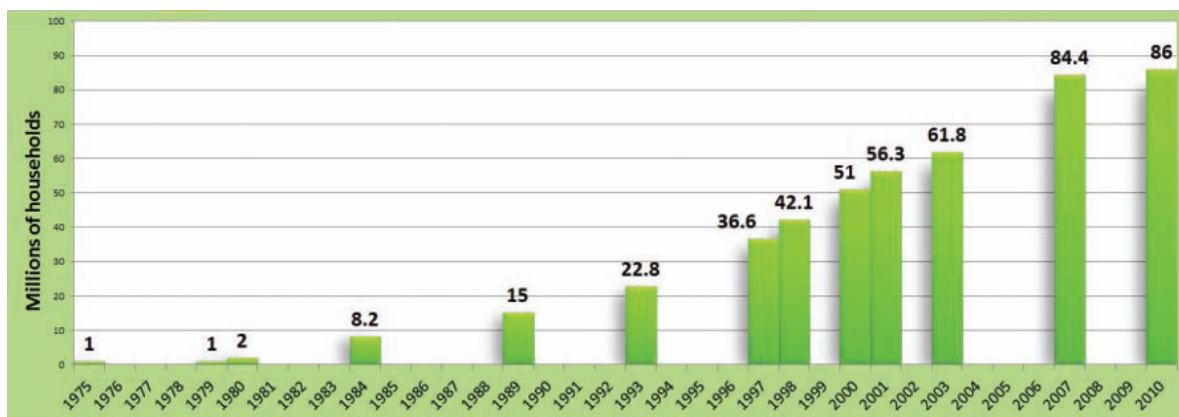
Source: U.S. Census Bureau and Consumer Electronics Association

What caused the sudden upswing in computer ownership?

The second phase of the digital revolution materialized when the Internet was opened to public use. The **Internet** is a global computer network originally developed as a military project, then handed over to the National Science Foundation for research and academic use.

When commercial Internet use was first allowed in 1995, companies such as AOL and CompuServe began to offer Internet access and e-mail to a quickly growing list of subscribers. **E-mail**, a form of electronic communication, was an application for the masses and finally a reason to buy a computer and join the digital revolution.

In addition to e-mail, the Internet offers many ways for people to communicate and interact. The Internet has turned the old idea of social isolation on its head; instead of computers reducing human interaction, computer networks seem to encourage new types of interpersonal communications and relationships.

Electronic communication can be divided into two categories. **Synchronous communication** takes place in real time similar to a phone conversation. Chat groups, Web conferencing, and Internet telephony, such as Skype, are examples of synchronous communications.

Asynchronous communication does not require both parties to be online at the same time. Instead, one person can post a message, which can later be accessed by one or more other people. Blogs (short for Web logs) and your Facebook wall are examples of asynchronous communications.

Online social networks, such as Classmates and Facebook (Figure 1-4), have become wildly popular. They offer a variety of ways to interact and communicate, including e-mail, blogs, chat, and posts. Your Facebook page contains posts that your friends can access asynchronously.

Other social networking options include Twitter, a service for posting short text messages from the Twitter Web site or from compatible applications on mobile phones or other handheld devices. Messages cannot exceed 140 characters. They are posted publicly unless you restrict posts to a list of authorized recipients, called followers.

FIGURE 1-4

Online social networks offer netizens a place to look up old friends and meet friends of friends. ▶ When using a digital version of your textbook, such as the BookOnCD, click the round icon in this figure for an overview of social networking sites.

The Internet allows people to share resources as well as interact. Individuals' computers can be linked together in grid networks with powerful processing capabilities. One of the most ambitious grid computing efforts, SETI@home, uses the Internet to connect personal computers of more than 3 million volunteers from all over the world to analyze deep space radio signals in the search for extraterrestrial life.

A **computer network** is a group of computers linked by wired or wireless technology to share data and resources. Network technology existed before the Internet became popular, but the first computer networks were mainly deployed in schools and businesses. They were complicated to set up, unreliable, and offered only local connectivity. Network technology eventually became consumer-friendly, allowing homeowners to connect multiple computers for sharing printers, files, and an Internet connection.

Wireless networks offer even more advantages. Wi-Fi hotspots provide access to the Internet in coffee shops and many other locations. Whereas the Internet enhances communications, wireless network technology offers convenience and makes digital information as accessible as radio stations.

What about the Web? When historians look back on the digital revolution, they are certain to identify the Web as a major transformative influence. The **Web** (short for *World Wide Web*) is a collection of linked documents, graphics, and sounds that can be accessed over the Internet. The Web has changed centuries-old business models, revolutionized the flow of information, and created a new virtual world.

Online stores pioneered by Amazon.com transformed the face of retailing. Rummage sales have gone global with Web sites such as eBay. Consumers now have more direct access to products and services, such as music downloads and airline reservations.

The publisher of telephone's ubiquitous Yellow Pages used to advertise "Let your fingers do the walking." That catchphrase has never been more true as Web surfers' fingers jog miles over their keyboards each day to find answers, read the news, get sports scores, and check the weather forecast. In 2010, there were more than 234 million Web sites, each with hundreds or thousands of pages containing information.

Fallout from the massive pool of Web-based information includes the proliferation of misinformation and disinformation. Anyone can post virtually anything on the Web, so researchers and ordinary netizens who use the Web have had to develop strategies to sift for the truth.

A key aspect of the Web is that it adds content and substance to the Internet. Without the Web, the Internet would be like a library without any books or a railroad without any trains. From storefronts to online magazines to multiplayer games, the Web has made Internet access a compelling digital technology for just about everyone.

Cyberspace is a term that refers to entities that exist largely within computer networks (Figure 1-5). The virtual world isn't reality in the sense of bricks and mortar, or flesh and blood. You might envision online stores as similar to shops in your local mall, but in reality they are simply a collection of data and images stored at a Web site. The Web defines much of the landscape of cyberspace, and its graphics and sounds make things seem real.

How does digitization factor into the digital revolution? **Digitization** is the process of converting text, numbers, sound, photos, and video into data that can be processed by digital devices. Some of the most obvious effects of the digital revolution can be attributed to digitization.

FIGURE 1-5

The term *cyberspace* was coined by science fiction writer William Gibson in his novelette *Burning Chrome.*
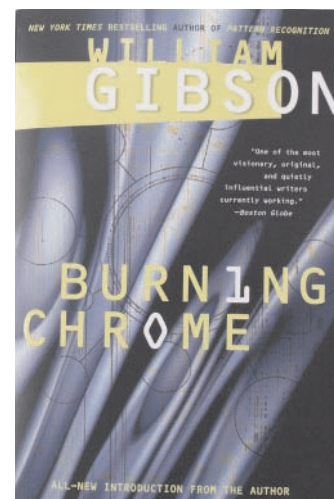
Digital images have changed the photographic industry. More than 99% of all cameras sold are digital, and the market for camera film is dwindling rapidly. One-hour photo processing labs, so popular in the 1990s, are disappearing from the strip-market landscape now that consumers can easily print their snapshots at home or from a Walmart photo kiosk. Digital images can also be easily modified, encouraging all sorts of creative uses, but rendering photographic evidence somewhat less authoritative than it was in the pre-digital past.

Digital imaging, such as computed tomography used in CT scans, has had profound effects in medicine. The advantage of digital images is that they can be easily stored and transmitted. For example, rather than sending an X-ray to a consulting physician by overnight mail, a digital X-ray can be quickly transmitted over the Internet.

Digital video is responsible for special effects in movies, new trends in 3-D animation, portable video, and surging consumer interest in home video. The film industry has become much more technology oriented and job openings reflect the need for specialists in graphics and motion video. Feature-length 3-D animated films are responsible for stunning technology breakthroughs, such as the ability to realistically depict the movement of clothing on a moving character and animate individual strands of hair or fur (Figure 1-6).

FIGURE 1-6

Animators at Pixar Animation Studios created software called Fizt to individually simulate each of the 3 million hairs that flow and flutter on furry animated characters.

At the consumer level, computer gaming is probably the most significant force driving research into faster computers and more sophisticated graphics processing.

Digital music first became popular when Internet-based file-sharing networks like Napster offered free music downloads. The term **download** refers to the practice of copying a file from a remote computer to a local computer, such as when you copy a song from the Internet to your computer's hard disk. By disregarding copyrights and enabling users to pirate copyrighted music, file-sharing networks ran afoul of the law and many were forced to shut down. Apple and other astute companies saw a business opportunity in digital music, and online music stores, such as iTunes, quickly became popular.

Online music stores are transforming the industry by changing the way music is marketed, bought, and played. The ability to purchase a single song, rather than an entire album, is making recording artists reconsider some of the shovelware they've been producing to bulk up albums.

Human speech can also be digitized. Weather reports on weatherband radio are read by computerized voice synthesizers. Automated telephone systems understand caller comments by using voice recognition. United Airlines' sophisticated telephone-based automated reservation system can handle an entire reservation by collecting customers' verbal responses to computerized questions about routes and travel dates.

CONVERGENCE

What is convergence? Your cell phone has a camera. Your clock has a radio. Your watch functions as a compass. You can watch movies on your iPod touch. All these are examples of technological **convergence**, a process by which several technologies with distinct functionalities evolve to form a single product.

In the pre-digital days, convergence often meant combining two technologically different devices in a single box. Old clock radios, for example,

combined a transistor radio and wind-up clock into a single case. Digital technology makes convergence much easier. Modern digital clock radios use a single microchip programmed for clock and radio functionality.

Convergence is currently working its magic on cell phones, PDAs, computers, portable media players, digital cameras, GPSs, watches, and e-book readers. These devices are gradually acquiring overlapping features and seem to be headed toward becoming a single device.

Another technology in convergence is voice communication. The current mix of land lines, cell phones, and Voice over IP burdens consumers with multiple handsets, numbers, and rate plans. Most people would like to have a single telephone number that can be used while at home, at work, or traveling. The phone must have a full set of features, such as emergency 911, caller ID, and voice mail. One vision for voice communication convergence is a Voice over IP phone that operates over home-, school-, or work-based broadband Internet connections, and switches automatically to a mobile network for use in other locations.

How does convergence affect consumers? Convergence tends to offer enhanced functionality and convenience. An average consumer owns more than 24 digital devices. Rather than juggle a cell phone, portable media player, camera, GPS, and computer, combining their features puts your data in a single device with a single charger.

Why does convergence seem to take so long? Technology sometimes outstrips society's ability to deal with it. Many aspects of the digital revolution challenge the adaptability of societies and individuals. Laws and customs tend to change more slowly than technology; therefore technologies might be ready for deployment, but people and institutions are not ready to use them productively or responsibly.

Apple's foray into handheld computers illustrates the barriers that can hinder convergence. In 1993, Apple introduced a handheld device called the Newton that featured a small screen, personal organizer software, e-mail, and network connectivity (Figure 1-7). You'll recognize these features as being similar to today's iPod. Unfortunately, the Newton was too large to fit in a shirt pocket and its handwriting module failed to recognize all but the most painstakingly printed characters. But the real problem was that people just didn't have much use for the product and so it was discontinued.

In 2004, Apple risked another foray into the handheld market, this time with a portable media player called the iPod. In contrast to the Newton, the iPod became an immediate hit because a huge population of young music lovers immediately recognized its value.

Technologies don't necessarily develop evenly and sometimes bottlenecks prevent or delay convergence. In an ideal world, an iPhone could be used as a mobile phone, portable media player, GPS, and Web browser. It might also be used to serve as a wireless link between a full-size portable computer and the Internet. But as many users have discovered, today's batteries are quickly drained by watching a movie or providing Internet service to other devices.

iPhone-based activities are also limited by cell service capacity. If you aren't in a 4G service area, access to the Internet can be slow. By the time GPS maps appear, you might have traveled so far that you are outside of the map's boundaries.

Convergence successfully takes place only when a series of technologies come into alignment, and when a clear social or economic necessity exists.

TERMINOLOGY NOTE

Voice over IP (VoIP) refers to voice conversations that are routed over the Internet, rather than over land lines or cellular phones. It is also called IP telephony or Internet telephony.

FIGURE 1-7

The Apple Newton was an early attempt to develop a handheld computing device that combined an appointment book, contact manager, clock, alarm, and calculator. It lacked a key element for success, which turned out to be the ability to work with digital music.

DIGITAL SOCIETY

How does digital technology affect freedom and democracy?

Freedom of speech is the cornerstone of democracy. It can be defined as being able to speak freely without censorship or fear of reprisal. The concept is not limited to speaking, but includes all forms of expression, including writing, art, and symbolic actions. The more inclusive term *freedom of expression* is sometimes used instead of *freedom of speech*.

Freedom of speech is not an absolute. Most societies prohibit or repress some types of expression, such as hate speech, libel, pornography, and flag burning. Although freedom of expression is guaranteed under the U.S. Constitution, the European Convention on Human Rights, and the Universal Declaration of Human Rights, these documents recognize the necessity for some restrictions, which might vary from one society to the next. Incidents ranging from the controversy over teaching evolution in schools to the Arab world's fury over cartoons of Mohammed illustrate that societies draw the freedom of speech line in different places. The types of expression that are allowed or prohibited in a particular country are, in many respects, a reflection of its culture (Figure 1-8).

FIGURE 1-8

The 1960 movie *Inherit the Wind* was based on the trial of John Scopes, who was accused of violating a state law that prohibited teaching evolution in state-funded schools.

Digital technologies and communications networks make it easy to cross cultural and geographic boundaries. News, television shows, music, and art from all over the globe are accessible on the Internet. The Internet has the potential to expand freedom of speech by offering every person on the globe a forum for personal expression using personal Web sites, blogs, chat groups, and collaborative Wikis. Anonymous Internet sites such as Freenet and **anonymizer tools** that cloak a person's identity even make it possible to exercise freedom of speech in situations where reprisals might repress it.

Internet information that seems innocuous in some cultures is not acceptable in others. Governments, parents, and organizations sometimes find it necessary to censor the Internet by limiting access and filtering content. China has some of the most draconian Internet censorship in the world. It blocks access to Web sites such as the BBC, The New York Times, Amnesty International, and Human Rights Watch. U.S. firms allegedly supplied the Chinese government with software necessary to erect its sophisticated filtering system.

Chinese Internet censorship might seem excessive, but it is by no means the only instance of free speech suppression. eBay has banned listings for any merchandise that could "promote or glorify hatred, violence or racial intolerance, or items that promote organizations with such views (e.g., KKK, Nazis, neo-Nazis, Skinhead Aryan Nation)." Parents frequently use filtering software such as Net Nanny and Safe Eyes. The U.S. Digital Millennium Copyright Act essentially censors technical information by making it a crime to publish information about cracking DVD and CD copy protection.

Despite attempts to censor and filter speech on the Internet, it seems clear that digital technology opens the door to freedom of expression in unprecedented ways. Limitations on Internet speech are likely to change, too, as technology evolves and as societies come to grips with the balance between freedom and responsibility.

TERMINOLOGY NOTE

A Wiki is one or more collaborative documents posted on the Web that can be viewed and changed by users. For example, Wikipedia is a collection of documents that form an encyclopedia. Visitors to the Wikipedia Web site can view definitions and information on a huge variety of topics and make changes to entries that are not correct or complete.

Has digital technology changed the way we view privacy?

Citizens of free societies have an expectation of privacy, which in the words of Supreme Court Justices Warren and Brandeis is "the right to be let alone." Digital technology use has exerted substantial pressure to diminish privacy by making it possible to easily collect and distribute data about individuals without their knowledge or consent.

In the United States, the expectation of privacy is derived from Fourth Amendment protections against unreasonable searches and seizures. The Fourth Amendment was formulated long before digital technologies such as e-mail and GPS devices. Legislation and court decisions pertaining to new technologies do not always strike the right balance between privacy and competing principles, such as free speech or free trade.

Privacy also encompasses confidentiality—the expectation that personal information will not be collected or divulged without permission. Internet marketers have a whole bag of tricks for getting personal information, and hackers are adept at breaking into sensitive databases to obtain confidential information.

Surveillance is viewed by many people as an invasion of privacy. Digital technology, such as GPS devices embedded in cell phones and cars, makes it much too easy to track people without their knowledge.

Some individuals dismiss the erosion of privacy saying, "I have nothing to hide, so I don't care." But even they typically don't want stores, hackers, and curious onlookers to have access to data about what they buy, read, and watch, who they call, where they travel, and what they say.

Digital technology has not so much changed the way we view privacy—most citizens still have a reasonable expectation that their private lives will remain so. Instead, technology may help us develop a better appreciation for privacy and an understanding of the nuances that differentiate private and public spaces.

How does digital technology affect intellectual property? **Intellectual property**

refers to the ownership of certain types of information, ideas, or representations. It includes patented, trademarked, and copyrighted material, such as music, photos, software, books, and films. In the past, such works were difficult and expensive to copy.

Digital technology has made it easy to produce copies with no loss in quality from the original. Pirating—illegal copying and distribution of copyrighted material—is simple and inexpensive. It has caused significant revenue loss for software publishers, recording studios, and film producers. The fight against piracy takes many forms, from passing strict anti-piracy laws, to scrambling, encryption, digital rights management schemes that physically prevent copying, and anti-piracy videos (Figure 1-9).

Digital technology adds complexity to intellectual property issues. For example, artists used to think nothing of cutting out various photos from magazines and pasting them together to form a collage. It is even easier
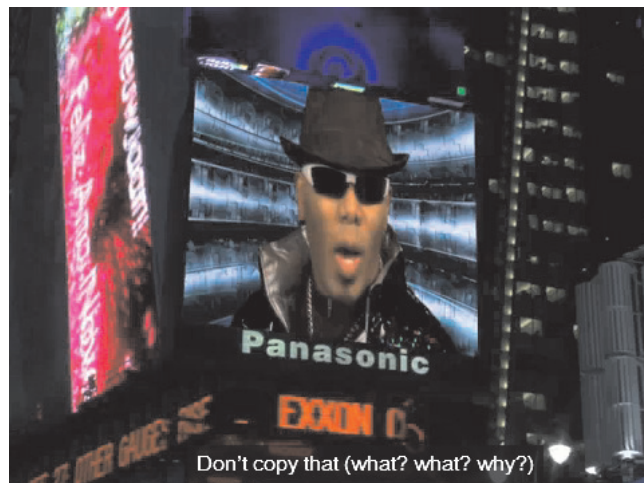
Don't copy that (what? what? why?)

FIGURE 1-9

Most moviegoers have seen the rock-video style "Don't Copy" trailer. Consumer education is one front in the war against piracy. ▶ You can view this video from your digital textbook.

to download digital images from the Web and paste them into reports, add them to Web pages, and incorporate them into works of art. Without permission, however, such digital cut and paste is not allowed.

Some films contain scenes that parents would rather their children not see. Even some scenes from family-oriented Harry Potter films might be too intense for young viewers. So, why not simply edit them out digitally to make a new DVD that the little tykes can watch? Such modifications are not allowed under current U.S. law, even for private viewing.

In the U.S. it is legal to make a backup copy of software CDs or DVDs that you own. However, if a CD, for example, is copy protected to prevent you from making a copy, it is against the law to break the copy protection. So, legally you have a right to a backup, but you don't have the right to circumvent the copy protection to legally create one!

Bucking protectionist trends are **open source** projects that promote copying, free distribution, peer review, and user modification. Linux is an open-source computer operating system that can be modified and freely distributed. Open source application software includes the popular OpenOffice.org suite, Firefox Web browser, Thunderbird e-mail, and ClamWin antivirus.

Digital technology makes it possible to copy and modify films, music, software, and other data, but a tricky balancing act is required to allow consumers flexibility to use data while protecting the income stream to artists, performers, and publishers.

What effect does digital technology have on the economy?

Digital technology is an important factor in global and national economies, in addition to affecting the economic status of individuals. **Globalization** can be defined as the worldwide economic interdependence of countries that occurs as cross-border commerce increases and as money flows more freely among countries. Consumers gain access to a wide variety of products, including technology products manufactured in locations scattered all over the globe. Countries that benefit from significant technology output include the United States, Japan, China, India, South Korea, and Finland (Figure 1-10).

Global communications technology offers opportunities for teleworkers in distant countries. Customer service lines for U.S.-based companies, such as IBM, Dell, and Hewlett-Packard, are often staffed by offshore technicians who earn far more than they could if working for a company in their home country.

Globalization, fueled by digital technology, has controversial aspects, however. Worker advocates object to the use of cheap offshore labor that displaces onshore employees.

Some individuals are affected by the **digital divide**, a term that refers to the gap between people who have access to technology and those who do not. Typically, digital have-nots face economic barriers. They cannot afford

FIGURE 1-10

Finland is a world leader in wireless technology. Its flagship technology company, Nokia, is responsible for about 25% of the country's exports.

computers, cell phones, and Internet access, or they are located in an economically depressed region where electricity is not available to run digital devices, power satellite dishes, and pick up Internet signals. But technology offers opportunity even to digital have-nots. For example, the Village Phone Project provides a small loan to entrepreneurs known as "village phone ladies" who sell minutes on their cell phones to neighbors who cannot afford their own land lines or cell phones (Figure 1-11).

Globalization is an ongoing process that will have far reaching effects on people in countries with developed technologies and those with emerging economies. Digital technology will be called upon to open additional economic opportunities without disrupting the lifestyles of currently prosperous nations.

So what's the point? Learning about digital technology is not just about circuits and electronics, nor is it only about digital gadgets, such as computers and portable music players. Digital technology permeates the very core of modern life. Understanding how this technology works and thinking about its potential can help you comprehend many issues related to privacy, security, freedom of speech, and intellectual property. It will help you become a better consumer and give you insights into local and world events.

You might even come to realize that some people who are responsible for making decisions about technology have only a vague idea of how it works. Without a solid grasp of technology problems, business leaders have little hope of finding effective solutions and politicians will be unable to make valid decisions pertaining to technology legislation.

As you continue to read this textbook, don't lose sight of the big picture. On one level, in this course you might be simply learning about how to use a computer and software. On a more profound level, however, you are accumulating knowledge about digital technology that applies to broader cultural and legal issues that are certain to affect your life far into the future.

FIGURE 1-11

In less technically developed countries such as Uganda and Bangladesh, women make a living by selling cell phone time to their neighbors.

QuickCheck

1. Transistors and [＿＿＿＿] circuits were responsible for making electronic devices smaller and less expensive.

2. The [＿＿＿＿] revolution was fueled by technologies such as computers and the Internet.

3. A computer [＿＿＿＿] is a group of computers linked together to share data and resources.

4. The process of converting text, numbers, sound, photos, or video into data that can be processed by a computer is called [＿＿＿＿].

5. A(n) [＿＿＿＿] is one or more collaborative documents, such as an encyclopedia, posted on the Web that can be viewed and changed by the public.

▶ CHECK ANSWERS

Digital Devices

WHETHER YOU REALIZE IT or not, you already know a lot about the devices that fuel the digital revolution. You've picked up information from commercials and news articles, from books and movies, from conversations and correspondence—perhaps even from using a variety of digital devices and trying to figure out why they don't always work! The quintessential digital device is the computer. Section B provides an overview that's designed to help you start organizing what you know about digital devices, beginning with computers.

COMPUTER BASICS

What is a computer? The word *computer* has been part of the English language since 1646; but if you look in a dictionary printed before 1940, you might be surprised to find a computer defined as a person who performs calculations! Prior to 1940, machines designed to perform calculations were referred to as calculators and tabulators, not computers. The modern definition and use of the term *computer* emerged in the 1940s, when the first electronic computing devices were developed.

Most people can formulate a mental picture of a computer, but computers do so many things and come in such a variety of shapes and sizes that it might seem difficult to distill their common characteristics into an all-purpose definition. At its core, a **computer** is a multipurpose device that accepts input, processes data, stores data, and produces output, all according to a series of stored instructions (Figure 1-12).

Computers produce output on devices such as screens and printers.

A computer accepts input from an input device, such as a keyboard, mouse, scanner, or digital camera.

Data is processed in the CPU according to instructions that have been loaded into the computer's memory.

A computer uses disks, CDs, DVDs, and flash drives to permanently store data.
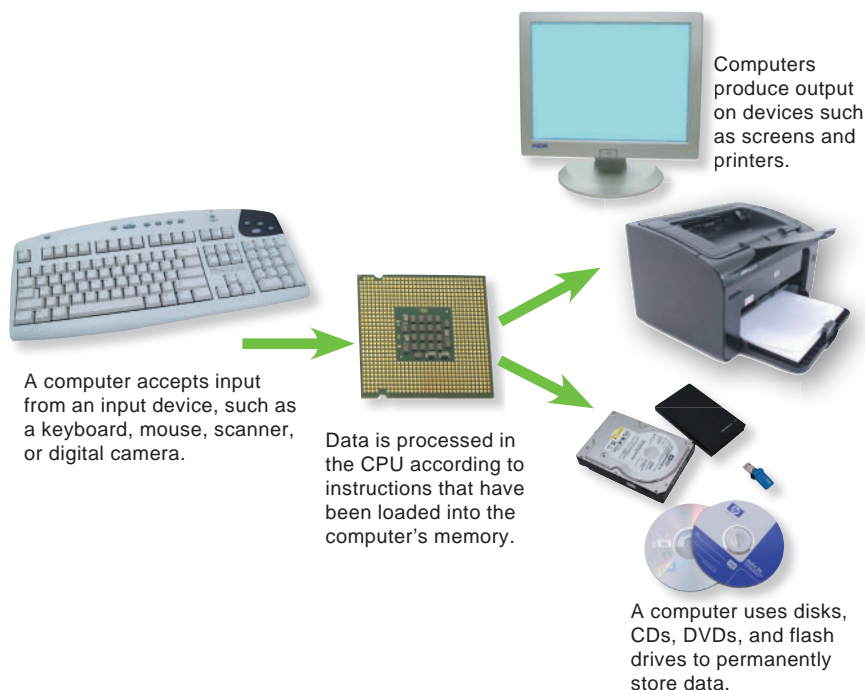
FIGURE 1-12

A computer can be defined by its ability to accept input, process data, store data, and produce output, all according to a set of instructions from a computer program.

What is input? Computer **input** is whatever is typed, submitted, or transmitted to a computer system. Input can be supplied by a person, by the environment, or by another computer. Examples of the kinds of input that computers can accept include words and symbols in a document, numbers for a calculation, pictures, temperatures from a thermostat, audio signals from a microphone, and instructions from a computer program. An input device, such as a keyboard or mouse, gathers data and transforms it into a series of electronic signals for the computer to store and manipulate.

What is output? **Output** is the result produced by a computer. Some examples of computer output include reports, documents, music, graphs, and pictures. Output devices display, print, or transmit the results of processing.

What does *process data* mean? Technically speaking, **data** refers to the symbols that represent facts, objects, and ideas. Computers manipulate data in many ways, and this manipulation is called **processing**. Some of the ways that a computer can process data include performing calculations, modifying documents and pictures, keeping track of your score in a fast-action game, drawing graphs, and sorting lists of words or numbers (Figure 1-13).

In a computer, most processing takes place in a component called the **central processing unit** or **CPU**. The CPU of most modern computers is a **microprocessor**, which is an electronic component that can be programmed to perform tasks based on data it receives. You'll learn more about microprocessors later in the chapter. For now, visualize a microprocessor as the little black box that's the brain of a digital device.

How do computers store data? A computer stores data so that it will be available for processing. Most computers have more than one place to put data, depending on how the data is being used. **Memory** is an area of a computer that temporarily holds data waiting to be processed, stored, or output. **Storage** is the area where data can be left on a permanent basis when it is not immediately needed for processing.

Data is typically stored in files. A computer file, usually referred to simply as a **file**, is a named collection of data that exists on a storage medium, such as a hard disk, CD, DVD, or flash drive. A file can contain data for a term paper, Web page, e-mail message, or music video. Some files also contain instructions that tell the computer how to perform various tasks.

What's so significant about a computer's ability to store instructions? The series of instructions that tells a computer how to carry out processing tasks is referred to as a **computer program**, or simply a program. These programs form the **software** that sets up a computer to do a specific task. When a computer *runs* software, it performs the instructions to carry out a task.

Take a moment to think about the way you use a simple handheld calculator to balance your checkbook each month. You're forced to do the calculations in stages. Although you can store data from one stage and use it in the next stage, you cannot store the sequence of formulas—the program—required to balance your checkbook. Every month, therefore, you have to perform a similar set of calculations. The process would be much simpler if your calculator remembered the sequence of calculations and just asked you for this month's checkbook entries.

FIGURE 1-13

An unsorted list is input into the computer, where it is processed in the CPU and output as a sorted list.
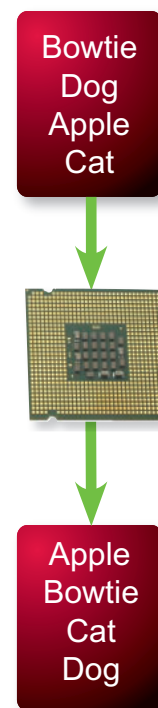
The idea of a **stored program** means that a series of instructions for a computing task can be loaded into a computer's memory. These instructions can easily be replaced by a different set of instructions when it is time for the computer to perform another task. This ability to switch programs makes computers multipurpose machines.

The stored program concept allows you to use your computer for one task, such as word processing, and then easily switch to a different type of computing task, such as editing a photo or sending an e-mail message. It is the single most important characteristic that distinguishes a computer from other simpler and less versatile digital devices, such as watches, calculators, and pocket-sized electronic dictionaries.

What kinds of software do computers run? Computers run two main types of software: application software and system software. A computer can be applied to many tasks, such as writing, number crunching, video editing, and online shopping. **Application software** is a set of computer programs that helps a person carry out a task. Word processing software, for example, helps people create, edit, and print documents. Personal finance software helps people keep track of their money and investments. Video editing software helps people create and edit home movies—and even some professional films.

Whereas application software is designed to help a person carry out a task, the primary purpose of **system software** is to help the computer system monitor itself in order to function efficiently. An example of system software is a computer **operating system** (OS), which is essentially the master controller for all the activities that take place within a computer. Although an operating system does not directly help people perform application-specific tasks, such as word processing, people do interact with the operating system for certain operational and storage tasks, such as starting programs and locating data files.

PERSONAL COMPUTERS, SERVERS, MAINFRAMES, AND SUPERCOMPUTERS

Are computers categorized in any way? At one time it was possible to define three distinct categories of computers. Mainframes were housed in large, closet-sized metal frames. Minicomputers were smaller, less expensive, and less powerful computers that were able, nevertheless, to provide adequate computing power for small businesses. Microcomputers were clearly differentiated from computers in other categories because their CPUs consisted of a single microprocessor chip.

Today, microprocessors are no longer a distinction between computer categories because just about every computer uses one or more microprocessors as its CPU. The term *minicomputer* has fallen into disuse and the terms *microcomputer* and *mainframe* are used with less and less frequency.

Computers are versatile machines that can perform a truly amazing assortment of tasks, but some computers are better suited than others for certain tasks. Categorizing computers is a way of grouping them according to criteria such as usage, cost, size, and capability. Experts don't necessarily agree on the categories or the devices placed in each category, but commonly used computer categories include personal computers, servers, mainframes, and supercomputers.

TERMINOLOGY NOTE

The term *personal computer* is sometimes abbreviated as *PC*. However, *PC* can also refer to a specific type of personal computer that descended from the original IBM PC and runs Windows software.

In this book, *PC* refers to IBM PC descendants. It is not used as an abbreviation for *personal computer*.

What is a personal computer? A **personal computer** is a microprocessor-based computing device designed to meet the computing needs of an individual. It typically provides access to a wide variety of computing applications, such as word processing, photo editing, and e-mail.

Personal computers are available as desktop or portable models, and in a variety of shapes, sizes, and colors. You'll learn more about the wide variety of personal computer in the Hardware chapter. For now, simply remember that computers like those pictured in Figure 1-14 are classified as personal computers.

FIGURE 1-14

Personal computer designs run the gamut from drab gray boxes to colorful curvy cases.

What is a workstation? The term **workstation** has two meanings. It can simply refer to an ordinary personal computer that is connected to a network. A second meaning refers to powerful desktop computers used for high-performance tasks, such as medical imaging and computer-aided design, that require a lot of processing speed. Some workstations contain more than one microprocessor, and most have circuitry specially designed for creating and displaying three-dimensional and animated graphics. Workstations, such as the one pictured in Figure 1-15, typically cost a bit more than an average personal computer.

FIGURE 1-15

A workstation resembles a desktop computer, but typically features more processing power and storage capacity.

Is an Xbox a personal computer? A **videogame console**, such as Nintendo's Wii, Sony's PlayStation, or Microsoft's Xbox, is not generally referred to as a personal computer because of its history as a dedicated game device. Videogame consoles originated as simple digital devices that connected to a TV set and provided only a pair of joysticks for input.

Today's videogame consoles contain microprocessors that are equivalent to any found in a fast personal computer, and they are equipped to produce graphics that rival those on sophisticated workstations. Add-ons such as keyboards, DVD players, and Internet access make it possible to use a videogame console to watch DVD movies, send and receive e-mail, and participate in online activities such as multiplayer games. Despite these features, videogame consoles like the one in Figure 1-16 fill a specialized niche and are not considered a replacement for a personal computer.

FIGURE 1-16

A videogame console includes circuitry similar to a personal computer's, but its input and output devices are optimized for gaming.

What makes a computer a server? In the computer industry, the term *server* has several meanings. It can refer to computer hardware, to a specific type of software, or to a combination of hardware and software. In any case, the purpose of a **server** is to serve computers on a network (such as the Internet or a home network) by supplying them with data.

Any software or digital device, such as a computer, that requests data from a server is referred to as a **client**. For example, on the Internet, a server might respond to a client's request for a Web page. Servers also handle the steady stream of e-mail that travels among clients from all over the Internet. A server might also allow clients within a home, school, or business network to share files or access a centralized printer.

Remarkably, just about any personal computer, workstation, mainframe, or supercomputer can be configured to perform the work of a server. That fact should emphasize the concept that a server does not require a specific type of hardware. Nonetheless, computer manufacturers such as IBM, SGI, HP, and Dell offer devices called blade servers and storage servers (Figure 1-17) that are especially suited for storing and distributing data on a network. Server prices vary, depending on configuration, but tend to be more similar to workstation prices than personal computer prices. Despite impressive performance on server-related tasks, these machines do not offer features such as sound cards, DVD players, and other fun accessories, so they are not a suitable alternative to a personal computer.

What's so special about a mainframe computer? A **mainframe computer** (or simply a mainframe) is a large and expensive computer capable of simultaneously processing data for hundreds or thousands of users. Mainframes are generally used by businesses or governments to provide centralized storage, processing, and management for large amounts of data. Mainframes remain the computer of choice in situations where reliability, data security, and centralized control are necessary.

The price of a mainframe computer typically starts at $100,000 and can easily exceed $1 million. Its main processing circuitry is housed in a closet-sized cabinet (Figure 1-18); but after large components are added for storage and output, a mainframe computer system can fill a good-sized room.

How powerful is a supercomputer? A computer falls into the **supercomputer** category if it is, at the time of construction, one of the fastest computers in the world (Figure 1-19).

FIGURE 1-17

Some servers look like personal computers, whereas others are housed in industrial-looking cases.

FIGURE 1-18

This IBM z10 E12 mainframe computer weighs 2,807 pounds and is about 6.5 feet tall.

FIGURE 1-19

In 2010, a Cray XT5HE computer named Jaguar was the fastest supercomputer. Using more than 18,000 processors, the Jaguar clocks peak performance speeds of 2.3 petaflops or 2.3 quadrillion operations per second.

Because of their speed, supercomputers can tackle complex tasks and compute-intensive problems that just would not be practical for other computers. A **compute-intensive** problem is one that requires massive amounts of data to be processed using complex mathematical calculations. Molecular calculations, atmospheric models, and climate research are all examples of projects that require massive numbers of data points to be manipulated, processed, and analyzed.

Common uses for supercomputers include breaking codes, modeling worldwide weather systems, and simulating nuclear explosions. One impressive simulation, which was designed to run on a supercomputer, tracked the movement of thousands of dust particles as they were tossed about by a tornado.

At one time, supercomputer designers focused on building specialized, very fast, and very large CPUs. Today, most supercomputer CPUs are constructed from thousands of microprocessors. Of the 500 fastest supercomputers in the world, the majority use microprocessor technology.

HANDHELD DEVICES

Are handheld devices computers? Handheld digital devices include familiar gadgets such as iPhones, iPods, Garmin GPSs, Blackberry Torches, and Kindles. These devices incorporate many computer characteristics. They accept input, produce output, process data, and include storage capabilities. Handheld devices vary in their programmability and their versatility. Technically, most of these devices could be classified as computers, but they are customarily referred to by function, for example, as mobile phones or portable media players.

What is a PDA? The first handheld digital devices were PDAs. A **PDA** (personal digital assistant) is a pocket-sized digital appointment book with a small keyboard or a touch-sensitive screen, designed to run on batteries and be used while holding it. PDAs synchronize appointment data and contact lists with desktop computers by exchanging data over a dedicated wired or wireless connection. Originally, PDAs were not equipped for voice communications, which distinguished them from cell phones. The term *PDA* is falling into disuse now that mobile phones offer scheduling and contact management features.

How do mobile phones fit into the picture? Cell phones were originally designed exclusively for voice communications. They have since evolved into devices such as those in Figure 1-20 that offer sophisticated features such as touch screen, full qwerty keypad, text messaging, e-mail, Web access, removable storage, camera, FM radio, digital music player, GPS navigation, and a wide selection of applications and maps.

FIGURE 1-20

Many mobile phones feature a small keyboard, others accept handwriting input, and some work with touch screen icons.

Feature rich mobile phones are sometimes called **smartphones**. These devices contain a microprocessor and have many characteristics of computers, but they are not usually referred to as computers because of their origins as simple cell phones.

How are iPods classified? iPods are enhanced MP3 players. The basic idea behind MP3 players is to store music that has been converted into digital format from CDs or downloaded from the Web. The music is stored in a type of file called MP3, which stands for MPEG-1 Audio Layer-3.

Sharing MP3 files on the Web became hugely popular despite its questionable legality. After many music sharing sites were shut down, Apple created a legal Web-based music store called iTunes where music is stored in a proprietary, copy-protected file format and sold by the song or by the album. The iPod (Figure 1-21) was designed as a portable music player, and enhanced versions of the device now store and play video and photos as well.

iPods and similar devices are classified as **portable media players** because their main strength is playing music, showing videos, and storing photos. Like other handheld digital devices, these players have many computer characteristics. An iPod, for example, contains a microprocessor, accepts input, has significant storage capacity on its built-in hard disk, and outputs stored music, video, and images. Some portable media players have limited programmability. They are not designed for users to add software and their lack of a keyboard or touch screen puts severe limits on data entry.

What about apps? When iPhone ads say "There's an app for that," it means that the device is programmable and, like a full-size computer, can run various **apps** (applications) that include games, calendars, stock market trackers, tour guides, highway traffic monitors, and news feeds. Devices such as the iPhone, iPod touch, iPad, and Android phones are programmable and can run apps.

Apps for handheld devices are typically more limited than the applications available for full-size desktop or notebook computers. Small screens and tiny keyboards impose some limits on the types of applications that function effectively. Hardware limitations from memory and storage capacity, processor speed, and battery life also limit the sophistication of apps for handheld devices.

MICROCONTROLLERS

What is a microcontroller? Have you ever wondered how a guided missile reaches its target or how your refrigerator knows when to initiate a defrost cycle? What controls your microwave oven, digital video recorder, washing machine, and watch? Many common appliances and machines are controlled by embedded microcontrollers. A **microcontroller** is a special-purpose microprocessor that is built into the machine it controls. A microcontroller is sometimes called a computer-on-a-chip or an embedded computer because it includes many of the elements common to computers.

How does a microcontroller work? Consider the microcontroller in a Sub-Zero refrigerator. It accepts user input for desired temperatures in the refrigerator and freezer compartments. It stores these desired temperatures in memory. Temperature sensors collect additional input of the actual temperatures. The microcontroller processes the input data by comparing the actual temperature to the desired temperature. As output, the microcontroller sends signals to activate the cooling motor as necessary. It also generates a digital readout of the refrigerator and freezer temperatures.

Is a microcontroller really a computer? Recall that a computer is defined as a multipurpose device that accepts input, produces output, stores data, and processes it according to a stored program. A microcontroller seems to fit the input, processing, output, and storage criteria that define computers. Some microcontrollers can even be reprogrammed to perform different tasks.

Technically, a microcontroller could be classified as a computer, just as mobile phones and portable media players can be. Despite this technicality, however, microcontrollers tend to be referred to as processors rather than as computers because in practice they are used for dedicated applications, not as multipurpose devices.

Why are microcontrollers significant? Microcontrollers, such as the one in Figure 1-22, can be embedded in all sorts of everyday devices, enabling machines to perform sophisticated tasks that require awareness and feedback from the environment. When combined with wireless networks, devices with embedded processors can relay information to Web sites, cell phones, and a variety of data collection devices. Machines and appliances with embedded processors tend to be smarter about their use of resources—such as electricity and water—which makes them environmentally friendly.

Perhaps the most significant effect of microcontrollers is that they are an almost invisible technology, one that doesn't require much adaptation or learning on the part of the people who interact with microcontrolled devices. However, because microcontrollers remain mostly out-of-sight and out-of-mind, it is easy for their use to creep into areas that could be detrimental to quality of life, privacy, and freedom. That innocuous GPS chip in your cell phone, for example, can be useful if you're lost and need 911 assistance, but it could potentially be used by marketers, law enforcement, and others who want to track your location without your consent.

FIGURE 1-22

A microcontroller is usually mounted on a circuit board and then installed in a machine or appliance using wires to carry input and output signals.

QuickCheck

1. A computer is a digital device that processes data according to a series of [_____] instructions.

2. Computer data is temporarily stored in [_____], but is usually transferred to [_____] where it can be left on a more permanent basis.

3. [_____] computers are available in desktop and portable models.

4. A digital device, such as a computer, is called a(n) [_____] when it requests data from a server.

5. A(n) [_____] is a special-purpose microprocessor that is built into the machine it controls.

▶ CHECK ANSWERS

Digital Data Representation

COMPUTERS AND OTHER DIGITAL DEVICES work with all sorts of "stuff," including text, numbers, music, images, speech, and video. The amazing aspect of digital technology is that it distills all these different elements down to simple pulses of electricity and stores them as 0s and 1s. Understanding the data representation concepts presented in Section C will help you grasp the essence of the digital world and get a handle on all the jargon pertaining to bits, bytes, megahertz, and gigabytes.

DATA REPRESENTATION BASICS

What is data? As you learned earlier in the chapter, *data* refers to the symbols that represent people, events, things, and ideas. Data can be a name, a number, the colors in a photograph, or the notes in a musical composition.

Is there a difference between data and information? In everyday conversation, people use the terms *data* and *information* interchangeably. Nevertheless, some technology professionals make a distinction between the two terms. They define data as the symbols that represent people, events, things, and ideas. Data becomes information when it is presented in a format that people can understand and use. As a general rule, remember that (technically speaking) data is used by machines, such as computers; information is used by humans.

What is data representation? **Data representation** refers to the form in which data is stored, processed, and transmitted. For example, devices such as mobile phones, iPods, and computers store numbers, text, music, photos, and videos in formats that can be handled by electronic circuitry. Those formats are data representations. Data can be represented using digital or analog methods.

What's the difference between analog and digital? For a simple illustration of the difference between analog and digital, consider the way you can control the lights in a room using a traditional light switch or a dimmer switch (Figure 1-23). A traditional light switch has two discrete states: on and off. There are no in-between states, so this type of light switch is digital. A dimmer switch, on the other hand, has a rotating dial that controls a continuous range of brightness. It is, therefore, analog.

Digital data is text, numbers, graphics, sound, and video that has been converted into discrete digits such as 0s and 1s. In contrast, **analog data** is represented using an infinite scale of values.

How does digital data work? Imagine that you want to send a message by flashing a light. Your light switch offers two states: on and off. You could use sequences of ons and offs to represent various letters of the alphabet. To write down the representation for each letter, you can use 0s and 1s. The 0s represent the off state of your light switch; the 1s indicate the on state. For example, the sequence on on off off would be written 1100, and you might decide that sequence represents the letter *A*.

FIGURE 1-23

A computer is a digital device, more like a standard light switch than a dimmer switch.

Digital devices are electronic and so you can envision data flowing within these devices as pulses of light. In reality, digital signals are represented by two different voltages, such as +5 volts and 0 volts. They can also be represented by two different tones as they flow over a phone line. Digital data can also take the form of light and dark spots etched onto the surface of a CD or the positive and negative orientation of magnetic particles on the surface of a hard disk. Regardless of the technology, however, digital data is always represented by two states denoted as 0 and 1.

The 0s and 1s used to represent digital data are referred to as binary digits. It is from this term that we get the word *bit—bi*nary digi*t*. A **bit** is a 0 or 1 used in the digital representation of data.

REPRESENTING NUMBERS, TEXT, IMAGES, AND SOUND

How do digital devices represent numbers? **Numeric data** consists of numbers that might be used in arithmetic operations. For example, your annual income is numeric data, as is your age. The price of a bicycle is numeric data. So is the average gas mileage for a vehicle, such as a car or an SUV. Digital devices can represent numeric data using the binary number system, also called base 2.

The **binary number system** has only two digits: 0 and 1. No numeral like 2 exists in this system, so the number two is represented in binary as 10 (pronounced *one zero*). You'll understand why if you think about what happens when you're counting from 1 to 10 in the familiar decimal system. After you reach 9, you run out of digits. For ten, you have to use the digits 10—zero is a placeholder and the 1 indicates one group of tens.

In binary, you just run out of digits sooner—right after you count to 1. To get to the next number, you have to use the zero as a placeholder and the 1 indicates one group of 2s. In binary then, you count 0 (zero), 1 (one), 10 (one zero), instead of counting 0, 1, 2 in decimal. If you need to brush up on binary numbers, refer to Figure 1-24 and to the lab at the end of the chapter.

The important point to understand is that the binary number system allows digital devices to represent virtually any number simply by using 0s and 1s. Digital devices can then perform calculations using these numbers.

Decimal (Base 10)	Binary (Base 2)
0	0
1	1
2	10
3	11
4	100
5	101
6	110
7	111
8	1000
9	1001
10	1010
11	1011
1000	1111101000

FIGURE 1-24

The decimal system uses ten symbols to represent numbers: 0, 1, 2, 3, 4, 5, 6, 7, 8, and 9. The binary number system uses only two symbols: 0 and 1.

How do digital devices represent words and letters?

Character data is composed of letters, symbols, and numerals that are not used in arithmetic operations. Examples of character data include your name, address, and hair color. Just as Morse code uses dashes and dots to represent the letters of the alphabet, a digital computer uses a series of bits to represent letters, characters, and numerals. Figure 1-25 illustrates how a computer can use 0s and 1s to represent the letters and symbols in the text *HI!*

Digital devices employ several types of codes to represent character data, including ASCII, EBCDIC, and Unicode. **ASCII** (American Standard Code for Information Interchange, pronounced *ASK* ee) requires only seven bits for each character. For example, the ASCII code for an uppercase *A* is 1000001. ASCII provides codes for 128 characters, including uppercase letters, lowercase letters, punctuation symbols, and numerals.

A superset of ASCII, called **Extended ASCII**, uses eight bits to represent each character. For example, Extended ASCII represents the uppercase letter *A* as 01000001. Using eight bits instead of seven bits allows Extended ASCII to provide codes for 256 characters. The additional Extended ASCII characters include boxes and other graphical symbols. Figure 1-26 lists the Extended ASCII character set.

FIGURE 1-25

A computer treats the letters and symbols in the word *HI!* as character data, which can be represented by a string of 0s and 1s.

HI!

01001000   01001001   00100001

FIGURE 1-26

The Extended ASCII code uses eight 1s and 0s to represent letters, symbols, and numerals. The first 32 ASCII characters are not shown in the table because they represent special control sequences that cannot be printed. The two blank entries are space characters.

	Code		Code		Code		Code		Code		Code		Code		Code
	00100000	>	00111110	\	01011100	z	01111010	ÿ	10011000	╢	10110110	╘	11010100	≥	11110010
!	00100001	?	00111111	]	01011101	{	01111011	Ö	10011001	╖	10110111	╒	11010101	≤	11110011
"	00100010	@	01000000	^	01011110	|	01111100	Ü	10011010	╕	10111000	╓	11010110	⌠	11110100
#	00100011	A	01000001	_	01011111	}	01111101	¢	10011011	╣	10111001	╫	11010111	⌡	11110101
$	00100100	B	01000010	`	01100000	~	01111110	£	10011100	║	10111010	╪	11011000	÷	11110110
%	00100101	C	01000011	a	01100001	⌂	01111111	¥	10011101	╗	10111011	┘	11011001	≈	11110111
&	00100110	D	01000100	b	01100010	Ç	10000000	₧	10011110	╝	10111100	┌	11011010	°	11111000
'	00100111	E	01000101	c	01100011	ü	10000001	ƒ	10011111	╜	10111101	█	11011011	∙	11111001
(	00101000	F	01000110	d	01100100	é	10000010	á	10100000	╛	10111110	▄	11011100	·	11111010
)	00101001	G	01000111	e	01100101	â	10000011	í	10100001	┐	10111111	▌	11011101	√	11111011
*	00101010	H	01001000	f	01100110	ä	10000100	ó	10100010	└	11000000	▐	11011110	ⁿ	11111100
+	00101011	I	01001001	g	01100111	à	10000101	ú	10100011	┴	11000001	▀	11011111	²	11111101
,	00101100	J	01001010	h	01101000	å	10000110	ñ	10100100	┬	11000010	α	11100000	■	11111110
-	00101101	K	01001011	i	01101001	ç	10000111	Ñ	10100101	├	11000011	ß	11100001		11111111
.	00101110	L	01001100	j	01101010	ê	10001000	ª	10100110	─	11000100	Γ	11100010		
/	00101111	M	01001101	k	01101011	ë	10001001	º	10100111	┼	11000101	π	11100011		
0	00110000	N	01001110	l	01101100	è	10001010	¿	10101000	╞	11000110	Σ	11100100		
1	00110001	O	01001111	m	01101101	ï	10001011	⌐	10101001	╟	11000111	σ	11100101		
2	00110010	P	01010000	n	01101110	î	10001100	¬	10101010	╚	11001000	µ	11100110		
3	00110011	Q	01010001	o	01101111	ì	10001101	½	10101011	╔	11001001	τ	11100111		
4	00110100	R	01010010	p	01110000	Ä	10001110	¼	10101100	╩	11001010	Φ	11101000		
5	00110101	S	01010011	q	01110001	Å	10001111	¡	10101101	╦	11001011	Θ	11101001		
6	00110110	T	01010100	r	01110010	É	10010000	«	10101110	╠	11001100	Ω	11101010		
7	00110111	U	01010101	s	01110011	æ	10010001	»	10101111	═	11001101	δ	11101011		
8	00111000	V	01010110	t	01110100	Æ	10010010	░	10110000	╬	11001110	∞	11101100		
9	00111001	W	01010111	u	01110101	ô	10010011	▒	10110001	╧	11001111	φ	11101101		
:	00111010	X	01011000	v	01110110	ö	10010100	▓	10110010	╨	11010000	ε	11101110		
;	00111011	Y	01011001	w	01110111	ò	10010101	│	10110011	╤	11010001	∩	11101111		
<	00111100	Z	01011010	x	01111000	û	10010110	┤	10110100	╥	11010010	≡	11110000		
=	00111101	[	01011011	y	01111001	ù	10010111	╡	10110101	╙	11010011	±	11110001		

An alternative to the 8-bit Extended ASCII code, called **EBCDIC** (Extended Binary-Coded Decimal Interchange Code, pronounced *EB seh dick*), is usually used only by older, IBM mainframe computers.

Unicode (pronounced *YOU ni code*) uses sixteen bits and provides codes for 65,000 characters—a real bonus for representing the alphabets of multiple languages. For example, Unicode represents an uppercase *A* in the Russian Cyrillic alphabet as 0000010000010000.

Why do ASCII and Extended ASCII provide codes for 0, 1, 2, 3, 4, 5, 6, 7, 8, and 9? While glancing at the table of ASCII codes in Figure 1-26, you might have wondered why the table contains codes for 0, 1, 2, 3, and so on. Aren't these numbers represented by the binary number system? A computer uses Extended ASCII character codes for 0, 1, 2, 3 , etc. to represent numerals that are not used for calculations. For example, you don't typically use your Social Security number in calculations, so it is considered character data and represented using Extended ASCII. Likewise, the numbers in your street address can be represented by character codes rather than binary numbers.

How can bits be used to store images? Images, such as photos, pictures, line art, and graphs, are not small, discrete objects like numbers or the letters of the alphabet. To work with images, they must be digitized.

Images can be digitized by treating them as a series of colored dots. Each dot is assigned a binary number according to its color. For example, a green dot might be represented by 0010 and a red dot by 1100, as shown in Figure 1-27. A digital image is simply a list of color numbers for all the dots it contains.

How can bits be used to store sound? Sound, such as music and speech, is characterized by the properties of a sound wave. You can create a comparable wave by etching it onto a vinyl platter—essentially how records were made in the days of jukeboxes and record players. You can also represent that sound wave digitally by sampling it at various points, and then converting those points into digital numbers. The more samples you take, the closer your points come to approximating the full wave pattern. This process of sampling, illustrated in Figure 1-28, is how digital recordings are made.

An image can be digitized by assigning a binary number to each dot.

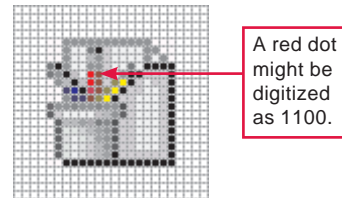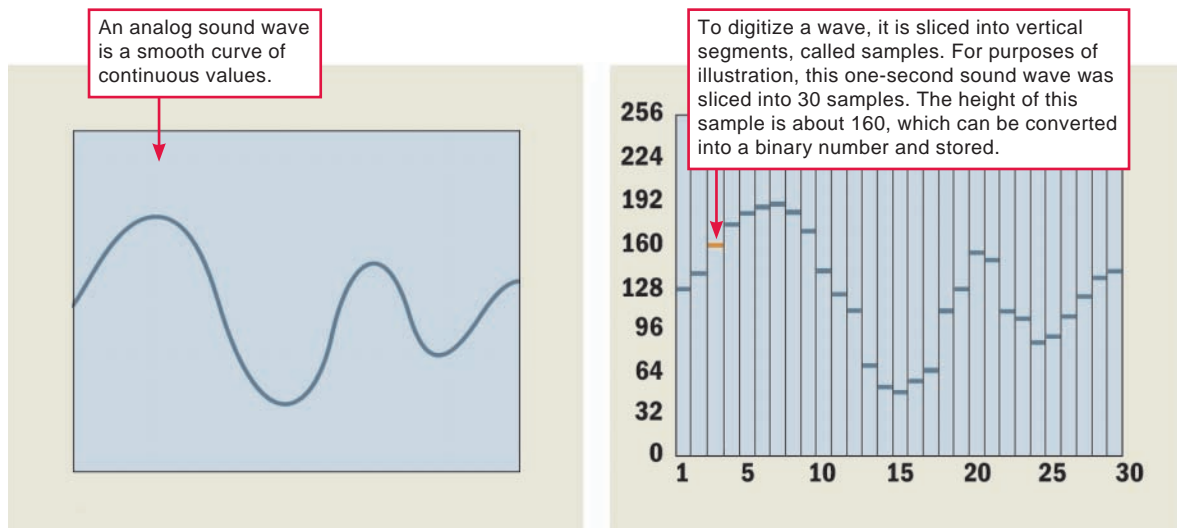A red dot might be digitized as 1100.

A sound wave can be sampled at fraction-of-a-second time intervals. Each sample is recorded as a binary number and stored.

An analog sound wave is a smooth curve of continuous values.

To digitize a wave, it is sliced into vertical segments, called samples. For purposes of illustration, this one-second sound wave was sliced into 30 samples. The height of this sample is about 160, which can be converted into a binary number and stored.

QUANTIFYING BITS AND BYTES

How can I tell the difference between bits and bytes? The ads for digital devices typically include lots of abbreviations relating to bits and bytes. A few key concepts can help you understand what these abbreviations mean. Even though the word *bit* is an abbreviation for *binary digit*, it can be further abbreviated, usually as a lowercase *b*.

On older digital devices, bits were handled in groups, and terminology from that era is still used. A group of eight bits is called a **byte** and is usually abbreviated as an uppercase *B*.

Transmission speeds are typically expressed in bits, whereas storage space is typically expressed in bytes. For example, a cable Internet connection might transfer data from the Internet to your computer at 8 mega*bits* per second. In an iPod ad, you might notice that it can store up to 60 giga*bytes* of music and video.

What do the prefixes *kilo-*, *mega-*, *giga-*, and *tera-* mean? When reading about digital devices, you'll frequently encounter references such as 50 kilobits per second, 1.44 megabytes, 2.8 gigahertz, and 2 terabytes. Kilo, mega, giga, tera, and similar terms are used to quantify digital data.

In common usage, *kilo*, abbreviated as K, means a thousand. For example, $50K means $50,000. In the context of computers, however, 50K means 51,200. Why the difference? In the decimal number system we use on a daily basis, the number 1,000 is 10 to the third power, or 10^3. For digital devices where base 2 is the norm, a kilo is precisely 1,024, or 2^{10}. A **kilobit** (abbreviated Kb or Kbit) is 1,024 bits. A **kilobyte** (abbreviated KB or Kbyte) is 1,024 bytes. Kilobytes are often used when referring to the size of small computer files.

The prefix *mega* means a million, or in the context of bits and bytes, precisely 1,048,576 (the equivalent of 2^{20}). A **megabit** (Mb or Mbit) is 1,048,576 bits. A **megabyte** (MB or MByte) is 1,048,576 bytes. Megabytes are often used when referring to the size of medium to large computer files.

In technology lingo, the prefix *giga* refers to a billion, or precisely 1,073,741,824. As you might expect, a **gigabit** (Gb or Gbit) is approximately 1 billion bits. A **gigabyte** (GB or GByte) is 1 billion bytes. Gigabytes are typically used to refer to storage capacity.

Computers—especially mainframes and supercomputers—sometimes work with huge amounts of data, and so terms such as *tera* (trillion), *peta* (thousand trillion), and *exa* (quintillion) are also handy. Figure 1-29 summarizes the terms commonly used to quantify computer data.

What's a kibibyte? Some computer scientists have proposed alternative terminology to dispel the ambiguity in terms such as *mega* that can mean 1,000 or 1,024. They suggest the following prefixes:

Kibi = 1,024

Mebi = 1,048,576

Gibi = 1,073,741,824

Bit	One binary digit	Gigabit	2^{30} bits
Byte	8 bits	Gigabyte	2^{30} bytes
Kilobit	1,024 or 2^{10} bits	Terabyte	2^{40} bytes
Kilobyte	1,024 or 2^{10} bytes	Petabyte	2^{50} bytes
Megabit	1,048,576 or 2^{20} bits	Exabyte	2^{60} bytes
Megabyte	1,048,576 or 2^{20} bytes		

FIGURE 1-29

Quantifying Digital Data

CIRCUITS AND CHIPS

How do digital devices store and transport all those bits?

Because most digital devices are electronic, bits take the form of electrical pulses that can travel over circuits in much the same way that electricity flows over a wire when you turn on a light switch. All the circuits, chips, and mechanical components that form a digital device are designed to work with bits.

At the simplest level, you can envision bits as two states of an electric circuit; the state used for a 1 bit would be on and the state for a 0 bit would be off. In practice, the 1 bit might be represented by an elevated voltage, such as +5 volts, whereas a 0 bit is represented by a low voltage, such as 0.

What's inside?

If it weren't for the miniaturization made possible by digital electronic technology, computers, cell phones, and portable media players would be huge, and contain a complex jumble of wires and other electronic gizmos. Instead, today's digital devices contain relatively few parts—just a few wires, some microchips, and one or more circuit boards.

What's a computer chip?

The terms *computer chip, microchip*, and *chip* originated as technical jargon for integrated circuit. An **integrated circuit** (IC), such as the one pictured in Figure 1-30, is a super-thin slice of semiconducting material packed with microscopic circuit elements, such as wires, transistors, capacitors, logic gates, and resistors.

Semiconducting materials (or semiconductors), such as silicon and germanium, are substances with properties between those of a conductor (like copper) and an insulator (like wood). To fabricate a chip, the conductive properties of selective parts of the semiconducting material can be enhanced to essentially create miniature electronic pathways and components, such as transistors.

Integrated circuits are packaged in protective carriers that vary in shape and size. Figure 1-31 illustrates some chip carriers, including small rectangular DIPs (dual in-line packages) with caterpillar-like legs protruding from a black, rectangular body; and pincushion-like PGAs (pin-grid arrays).

FIGURE 1-30

The first computer chips contained fewer than 100 miniaturized components, such as diodes and transistors. The chips used as the CPUs for today's computers and cutting edge graphics cards contain billions of transistors.
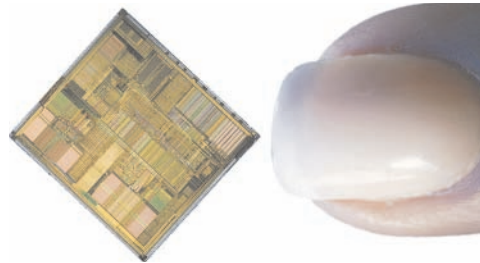

A DIP has two rows of pins that connect the IC circuitry to a circuit board.

A PGA is a square chip package with pins arranged in concentric squares, typically used for microprocessors.

FIGURE 1-31

Integrated circuits can be used for microprocessors, memory, and support circuitry. They are housed within a ceramic carrier. These carriers exist in several configurations, or chip packages, such as DIPs and PGAs.

How do chips fit together? The electronic components of most digital devices are mounted on a circuit board called a system board, mother-board, or main board. The **system board** houses all essential chips and provides connecting circuitry between them. In Figure 1-32, you can see what's inside a typical desktop computer, a handheld computer, and a cell phone.

FIGURE 1-32

The electronic components of computers and handheld devices have many similar elements, including microchips and circuit boards. Circuit boards are usually green, whereas microchips are usually black.

QuickCheck   SECTION C

1. Data [_____] refers to the format in which data is stored, processed, and transferred.

2. Digital devices often use the [_____] number system to represent numeric data.

3. Most computers use Unicode or Extended [_____] code to represent character data. (Hint: Use the acronym.)

4. KB is the abbreviation for [_____].

5. Integrated circuits are fabricated from [_____] materials that have properties of a conductor and an insulator.

▶ CHECK ANSWERS

Digital Processing

SECTION D

COMPUTERS AND OTHER DIGITAL DEVICES pro-
cess data, but how do they know what to do with it? The instructions you
issue aren't 0s and 1s that a digital device can work with. So what goes on
inside the box? Section D explains the programs that make digital devices
tick. You'll discover that although digital devices appear to perform very
complex tasks, under the hood they are really performing some very simple
operations, but doing them at lightning speed.

PROGRAMS AND INSTRUCTION SETS

How do digital devices process data? Computers, portable media
players, PDAs, and smartphones all work with digital data. That data is
manipulated under the control of a computer program, or software. But
how do digital circuits know what those program instructions mean? Let's
take a closer look at programs to see how they are created and how digital
devices work with them.

Who creates programs? Computer programmers create programs
that control digital devices. These programs are usually written in a high-
level **programming language**, such as C, BASIC, COBOL, or Java.

Programming languages use a limited set of command words such as
Print, *If*, *Write*, *Display*, and *Get* to form sentence-like statements designed
as step-by-step directives for the processor chip. An important characteris-
tic of most programming languages is that they can be written with simple
tools, such as a word processor, and they can be understood by program-
mers. A simple program to select a song on your iPod might contain the
statements shown in Figure 1-33.

FIGURE 1-33

The program for an iPod dis-
plays a list of songs that the
user can choose to play. A pro-
gram works behind the scenes
to display the list, get your
selection, process it, and play
the song.


```
Display Playlist

Get Song

Play Song
```

The human-readable version of a program, like the one above, created in a
high-level language by a programmer is called **source code**. Source code
is an important first step in programming application software, batch files,
and scripts that you'll learn about in later chapters. However, just as a digi-
tal device can't work directly with text, sounds, or images until they have
been digitized, source code has to be converted into a digital format before
the processor can use it.

How does source code get converted? The procedure for translating source code into 0s and 1s can be accomplished by a compiler or an interpreter. A **compiler** converts all the statements in a program in a single batch, and the resulting collection of instructions, called **object code**, is placed in a new file (Figure 1-34). Most of the program files distributed as software contain object code that is ready for the processor to execute.
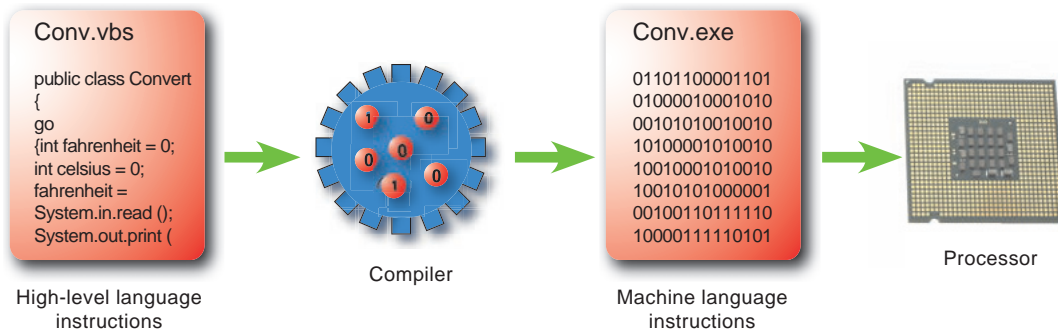
```
Conv.vbs

public class Convert
{
go
{int fahrenheit = 0;
int celsius = 0;
fahrenheit =
System.in.read ();
System.out.print (
```

High-level language
instructions

Compiler

```
Conv.exe

01101100001101
01000010001010
00101010010010
10100001010010
10010001010010
10010101000001
00100110111110
10000111110101
```

Machine language
instructions

Processor

As an alternative to a compiler, an **interpreter** converts and executes one statement at a time while the program is running. After a statement is executed, the interpreter converts and executes the next statement, and so on (Figure 1-35).
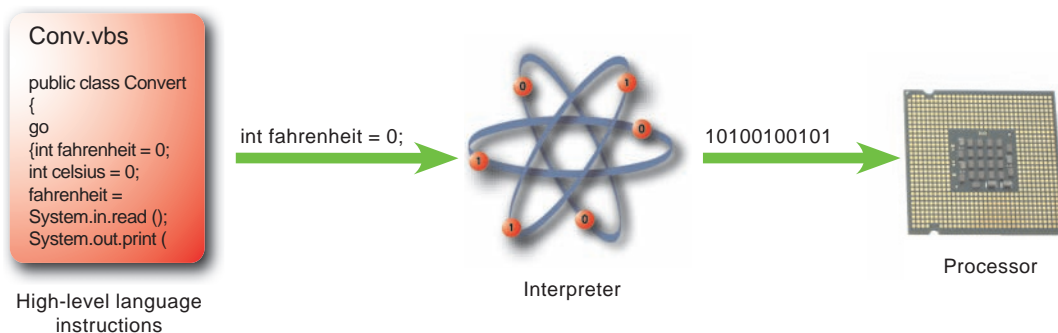
```
Conv.vbs

public class Convert
{
go
{int fahrenheit = 0;
int celsius = 0;
fahrenheit =
System.in.read ();
System.out.print (
```

High-level language
instructions

int fahrenheit = 0;

Interpreter

10100100101

Processor

Compilers and interpreters don't simply convert the characters from source code into 0s and 1s. For example, in the first line of the iPod program, Display Playlist, a compiler would not simply convert the *D* into its ASCII equivalent. No, computers are a little trickier than that.

What does the conversion process produce? A microprocessor is hard-wired to perform a limited set of activities, such as addition, subtraction, counting, and comparisons. This collection of preprogrammed activities is called an **instruction set**. Instruction sets are not designed to carry out any specific task, such as word processing or playing music. Instead, an instruction set is designed to be general purpose so that programmers can use it in creative ways for the wide variety of tasks performed by all kinds of digital devices.

Each instruction has a corresponding sequence of 0s and 1s. For example, 00000100 might correspond to *Add*. The list of codes for a microprocessor's instruction set, called **machine language**, can be directly executed by the processor's circuitry. A set of machine language instructions for a program is called **machine code**.

A machine language instruction has two parts: the op code and the operands. An **op code**, which is short for *operation code*, is a command word for an operation such as add, compare, or jump. The **operand** for an instruction specifies the data, or the address of the data, for the operation. In the following instruction, the op code means add and the operand is 1, so the instruction means Add 1.

Op code ➜ 00000100   00000001 ⬅ Operand

A single high-level instruction very often converts into multiple machine language instructions. Figure 1-36 illustrates the number of machine language instructions that correspond to a simple high-level program.

```
#include <stdio.h>
int main ()
{
int i;

for (i=1; i<=100; i=i+1)
  printf("%d\t",i);
return(0);
}
```

```
0010011110111101111111111111100000
1010111110111111100000000000010100
1010111110100100000000000000100000
1010111110100101000000000000100100
1010111110100000000000000000011000
1010111110100000000000000000011100
1000111110101110000000000000011100
1000111110111000000000000000011000
0000000111001110000000000000011001
0010010111001000000000000000000001
0010100100000001000000000001100101
1010111110101000000000000000011100
0000000000000000111110000010010
0000001100001111110010000010001
0001010000100001111111111110111
1010111110111001000000000000011000
0011110000000100000100000000000
1000111110100101000000000000011000
0000110000010000000000000111101100
0010010010000100000000010000110000
```

FIGURE 1-36

The source code program on the left prints numbers from 1 to 100. This source code is converted to machine language instructions shown in the right column that the computer can directly process.

To summarize what you should now know about programs and instruction sets, a programmer creates human-readable source code using a programming language. A compiler or interpreter converts source code into machine code. Machine code instructions are a series of 0s and 1s that correspond to a processor's instruction set.

PROCESSOR LOGIC

What happens inside a computer chip? A microprocessor contains miles of microscopic circuitry and millions of miniature components divided into different kinds of operational units, such as the ALU and the control unit.

The **ALU** (arithmetic logic unit) is the part of the microprocessor that performs arithmetic operations, such as addition and subtraction. It also performs logical operations, such as comparing two numbers to see if they are the same. The ALU uses **registers** to hold data that is being processed, just as you use a mixing bowl to hold the ingredients for a batch of cookies.

The microprocessor's **control unit** fetches each instruction, just as you get each ingredient out of a cupboard or the refrigerator. Data is loaded into the ALU's registers, just as you add all the ingredients to the mixing bowl. Finally, the control unit gives the ALU the green light to begin processing, just as you flip the switch on your electric mixer to begin blending the cookie ingredients. Figure 1-37 illustrates a microprocessor control unit and an ALU preparing to add 2 + 3.

FIGURE 1-37

The control unit fetches the ADD instruction, then loads data into the ALU's registers where it is processed.

Control Unit
ADD
ALU
Register 2
Register 3
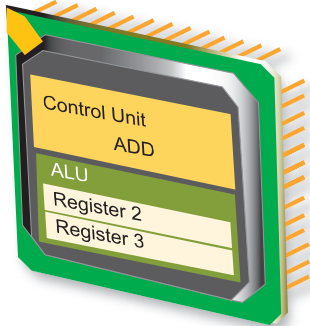
What happens when a computer executes an instruction? The term **instruction cycle** refers to the process in which a computer executes a single instruction. Some parts of the instruction cycle are performed by the microprocessor's control unit; other parts of the cycle are performed by the ALU. The steps in this cycle are summarized in Figure 1-38.
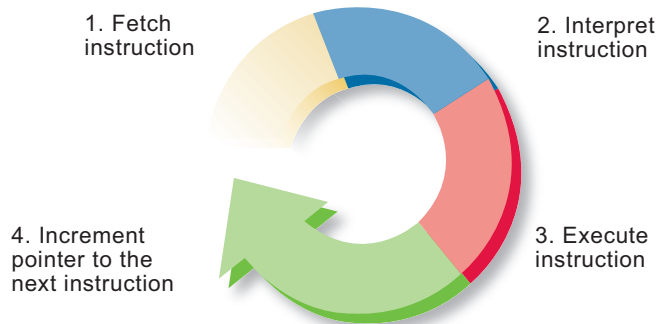

1. Fetch instruction

2. Interpret instruction

4. Increment pointer to the next instruction

3. Execute instruction

FIGURE 1-38

The instruction cycle includes four activities.

What role does the control unit play? The instructions that a computer is supposed to process for a particular program are held in memory. When the program begins, the memory address of the first instruction is placed in a part of the microprocessor's control unit called an instruction pointer. The control unit can then fetch the instruction by copying data from that address into its instruction register. From there, the control unit can interpret the instruction, gather the specified data, or tell the ALU to begin processing. Figure 1-39 helps you visualize the control unit's role in processing an instruction.
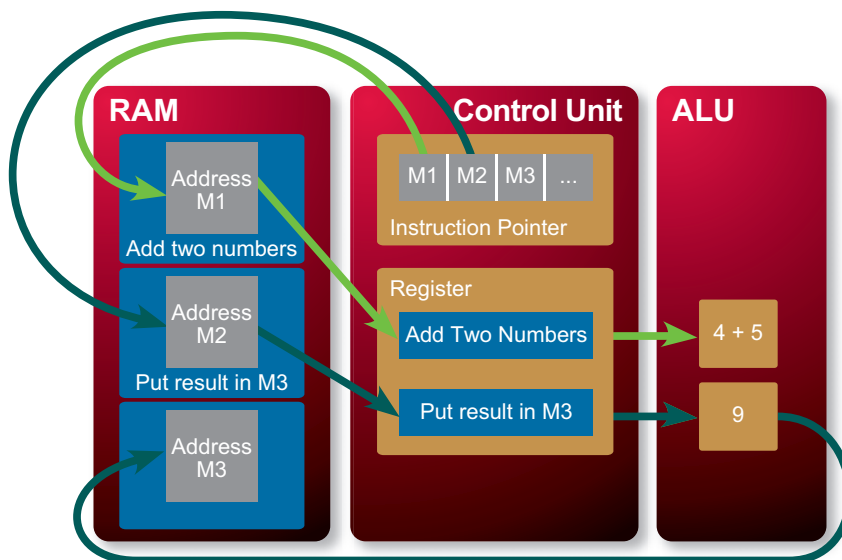
FIGURE 1-39

The control unit's instruction pointer indicates M1, a location in memory. The control unit fetches the "Add two numbers" instruction from M1. This instruction is then sent to the ALU. The instruction pointer then changes to M2. The processor fetches the instruction located in M2, moves it to a register, and executes it

RAM

Address M1 — Add two numbers

Address M2 — Put result in M3

Address M3

Control Unit

M1 | M2 | M3 | ...
Instruction Pointer

Register
Add Two Numbers
Put result in M3

ALU

4 + 5

9

When does the ALU swing into action? The ALU is responsible for performing arithmetic and logical operations. It uses registers to hold data ready to be processed. When it gets the go-ahead signal from the control unit, the ALU processes the data and places the result in an accumulator. From the accumulator, the data can be sent to memory or used for further processing. Figure 1-40 on the next page helps you visualize what happens in the ALU as the computer processes data.
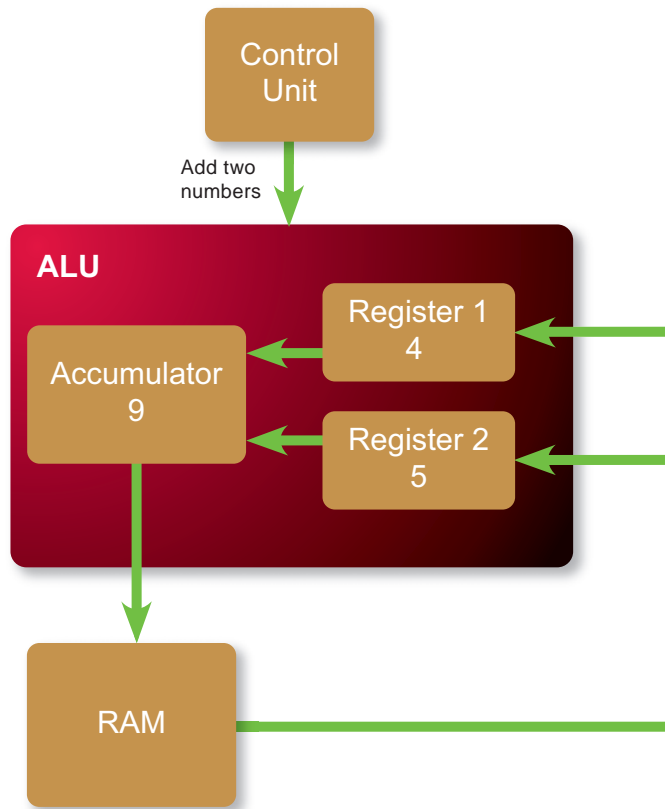
What happens after an instruction is executed? When the computer completes an instruction, the control unit increments the instruction pointer to the memory address of the next instruction, and the instruction cycle begins again.

Do I need to know all this detailed stuff? What you should take away from the discussion about programming and instruction sets is the idea that computers and other digital devices accomplish a wide array of complex tasks by performing a very limited set of machine language instructions very fast.

These concepts about how processors work will help you understand the significance of microprocessor performance, such as speed and word size, which you'll learn about in the next chapter.

QuickCheck

SECTION D

1. A(n) [_____] converts all of the source code instructions into object code, which becomes a new file containing [_____] code.

2. A microprocessor is hard-wired to perform a set of activities called a(n) [_____] set.

3. A machine language instruction has two parts: a(n) [_____] code and an operand.

4. The ALU in your computer's microprocessor holds data in [_____].

5. The microprocessor's control unit contains a(n) [_____] pointer that holds the address of the instruction being executed.

▶ CHECK ANSWERS

Password Security

USER IDS, passwords, and personal identification numbers (PINs) are a fact of everyday life in the information age. They are required for activities such as using ATMs and debit cards, logging into Windows, accessing wireless networks, making an iTunes purchase, instant messaging, reading e-mail, and file sharing. Many Web sites encourage you to sign up for membership by choosing a user ID and password. Section E provides information about selecting secure passwords and managing the mountain of passwords you collect and tend to forget.

AUTHENTICATION PROTOCOLS

What is an authentication protocol? Security experts use the term **authentication protocol** to refer to any method that confirms a person's identity using something the person knows, something the person possesses, or something the person is. For example, a person might know a password or PIN. A person might possess an ATM card or a credit card. A person can also be identified by **biometrics**, such as a fingerprint, facial features (photo), or a retinal pattern (Figure 1-41).

Authentication protocols that use more than one means of identification are more secure than others. Two-factor authentication, which verifies identity using two independent elements of confirmation such as an ATM card and PIN, is more secure than single-factor authentication, such as a password. Computer-related security is primarily based on passwords associated with user IDs. The level of protection offered by single-factor authentication depends on good password selection and management on the part of users.

What is a user ID? A **user ID** is a series of characters—letters and possibly numbers or special symbols—that becomes a person's unique identifier, similar to a Social Security number. It is also referred to as a user name, login, screen name, online nickname, or handle. User IDs are typically public. Because they are not secret, they do not offer any level of security.

User IDs are significant because they are the name on an account, such as e-mail or iTunes, that requires a password. When you first apply for or set up an account, you might be supplied with a user ID or you might be asked to create one. Often a user ID is a variation of your name. Brunhilde Jefferson's user ID might be bjeffe, bjefferson, brunhilde_jefferson, or bjeff0918445. It is also becoming common to use your e-mail address as a user ID.

The rules for creating a user ID are not consistent throughout all applications, so it is important to read instructions carefully before finalizing your user ID. For example, spaces might not be allowed in a user ID. Hence, the underline in brunhilde_jefferson is used instead of a space. There might be a length limitation, so Ms. Jefferson might have to choose a short user ID, such as bjeffe.

FIGURE 1-41

Biometric authentication protocols include retinal scans that identify unique patterns of blood vessels in the eye.

Some computers that host password-protected resources don't differentiate between uppercase and lowercase letters, and would consider the user IDs B_Jefferson and b_jefferson to be the same. Other computers are **case sensitive** and differentiate between uppercase and lowercase. On such computers, if Ms. Jefferson selected Brun_Jeff as her user ID, she would not be able to gain access by typing brun_jeff. To avoid such problems, most people stick to lowercase letters for their user IDs.

What is a password? A **password** is a series of characters that verifies a user ID and guarantees that you are the person you claim to be. Although you might be assigned a password, typically you are asked to provide your own. In some situations you might be given a temporary password, and then asked to change it as soon as you successfully log in for the first time. Passwords and user IDs are typically created on a registration or enrollment screen similar to the one in Figure 1-42.

User Name & Password

*Enter a User name: _____ (Must be at least 8 characters)

*Enter a Password: _____ (Must be at least 8 characters and include one number)

*Confirm Password: _____

View our privacy policy to learn how we protect your information.

ENROLL NOW! »

When you create an account, you are typically asked to enter a user ID and password.

What if I forget my password? Login screens for many applications provide a "forgot my password" link. Clicking this link checks your identity using your answer to a personal question. If your identity checks out, your password is e-mailed to you. A personal question provides an alternative authentication protocol to ensure that you are not a hacker pretending to be a legitimate user who has lost a password.

Personal questions and answers are usually set up at the same time you create an account. After selecting a password, you are required to choose a question that you must answer before your forgotten password is e-mailed to you. This question might be something like: *What is your mother's maiden name?*, *What is your favorite color?*, or *Where were you born?* You should be careful about the question you choose because public information like your mother's maiden name or the town of your birth can be researched by any hacker.

What is the difference between a password and a PIN? Both passwords and PINs are classified as *something-the-user-knows* authentication methods. In practice, PINs tend to be a short sequence of numbers that can be entered using a numeric keypad, whereas passwords tend to be longer sequences of letters, numbers, and special characters that require a full qwerty keyboard for entry. PINs are typically used with two-factor authentication protocols, whereas passwords are used in conjunction with single-factor authentication protocols.

For example, ATMs require a bank card (something you possess) and a PIN (something you know). In contrast, passwords are associated with single-factor authentication used for networks, Web sites, and other situations in which the hardware for dealing with ID cards is not available.

PASSWORD HACKS

How serious is password theft? To a hacker, obtaining the password for a specific user ID can be even more rewarding than a burglar figuring out the combination to a house safe. Once hackers get into a user account, a wealth of personal information can be at their fingertips. This information could be anything from juicy e-mail gossip to Social Security numbers, credit card numbers, bank account numbers, health data, and other private details. When someone gains unauthorized access to your personal data and uses it illegally, it is called **identity theft**. Victims of this increasingly common crime often don't realize what is happening until it's too late.

Armed with your password and other personal data, a cybercriminal can rack up bills using your credit card, apply for a mortgage using your financial data, create fake accounts in your name, send embarrassing e-mail messages, or wreak havoc on your bank account. Once a thief breaks into an online account, he or she can also change your password and you will no longer be able to log in. Password theft is serious and pervasive, so it is important to understand how hackers get passwords and how you can protect yours.

How can hackers get my password? Hackers employ a whole range of ways to steal passwords. Some primitive means include shoulder surfing, which is looking over your shoulder as you type in your password, and dumpster diving, which is going through your trash.

Password thieves can easily find your password if you write it down on a yellow sticky note hidden under your keyboard or in plain sight on top of your monitor. If a hacker doesn't have physical access to your work area but your computer is connected to a network, your password can be discovered by a hacker using a remote computer and software tools that systematically guess your password, intercept it, or trick you into revealing it.

A **dictionary attack** helps hackers guess your password by stepping through a dictionary containing thousands of the most commonly used passwords. Password dictionaries can be found on black hat sites and packaged with password-cracking software, such as John the Ripper. Unfortunately, dictionary attacks are often enough to break a password because many users choose passwords that are easy to remember and likely to be in the most commonly used list (Figure 1-43).

TERMINOLOGY NOTE

Hacker can refer to a skilled programmer or to a person who manipulates computers with malicious intent. The terms *black hat* and *cracker* are also used to refer to a malicious or criminal hacker.

FIGURE 1-43

Some of the most commonly used passwords are included in the dictionaries packaged with password-cracking software. These passwords (listed in order of popularity) should not be used.

12345	internet	jordan	alex	newyork	jonathan
abc123	service	michael	apple	soccer	love
password	canada	michelle	avalon	thomas	marina
computer	hello	mindy	brandy	wizard	master
123456	ranger	patrick	chelsea	Monday	missy
tigger	shadow	123abc	coffee	asdfgh	monday
1234	baseball	andrew	dave	bandit	monkey
a1b2c3	donald	bear	falcon	batman	natasha
qwerty	harley	calvin	freedom	boris	ncc1701
123	hockey	changeme	gandalf	dorothy	newpass
xxx	letmein	diamond	golf	eeyore	pamela
money	maggie	matthew	green	fishing	pepper
test	mike	miller	helpme	football	piglet
carmen	mustang	ou812	linda	george	poohbear
mickey	snoopy	tiger	magic	happy	pookie
secret	buster	trustno1	merlin	iloveyou	rabbit
summer	dragon	12345678	molson	jennifer	rachel

The **brute force attack** also uses password-cracking software, but its range is much more extensive than the dictionary attack. Because it exhausts all possible combinations of letters to decrypt a password, a brute force attack can run for days or even as long as a week to crack some passwords.

If hackers can't guess a password, they can use another technique called **sniffing**, which intercepts information sent out over computer networks. Sniffing software is used legitimately by network administrators to record network traffic for monitoring and maintenance purposes. The same software can also be used for illicit activities. If your user ID and password travel over a network as unencrypted text, they can easily fall into the hands of a password thief.

An even more sophisticated approach to password theft is **phishing**, in which a hacker poses as a legitimate representative of an official organization such as your ISP, your bank, or an online payment service in order to persuade you to disclose highly confidential information. Mostly through e-mail or instant messaging, a fake customer representative or administrator asks you to visit a Web page to confirm billing information or verify your account by providing your password, credit card number, or Social Security number.

If you examine phishing messages more closely, you might realize that the Web sites referred to are fake. However, seasoned hackers try to make the URLs look as close as possible to the official Web sites they claim to represent (Figure 1-44).
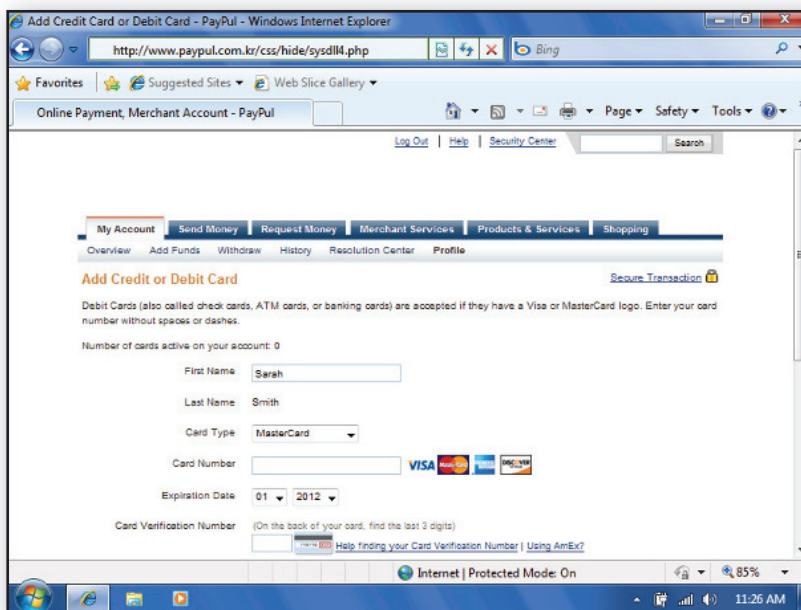

FIGURE 1-44

A fake Web site can look very similar to the real thing, but this fraudulent site originates in Korea. You should avoid clicking links in e-mail messages that attempt to get you to confirm or renew account data.
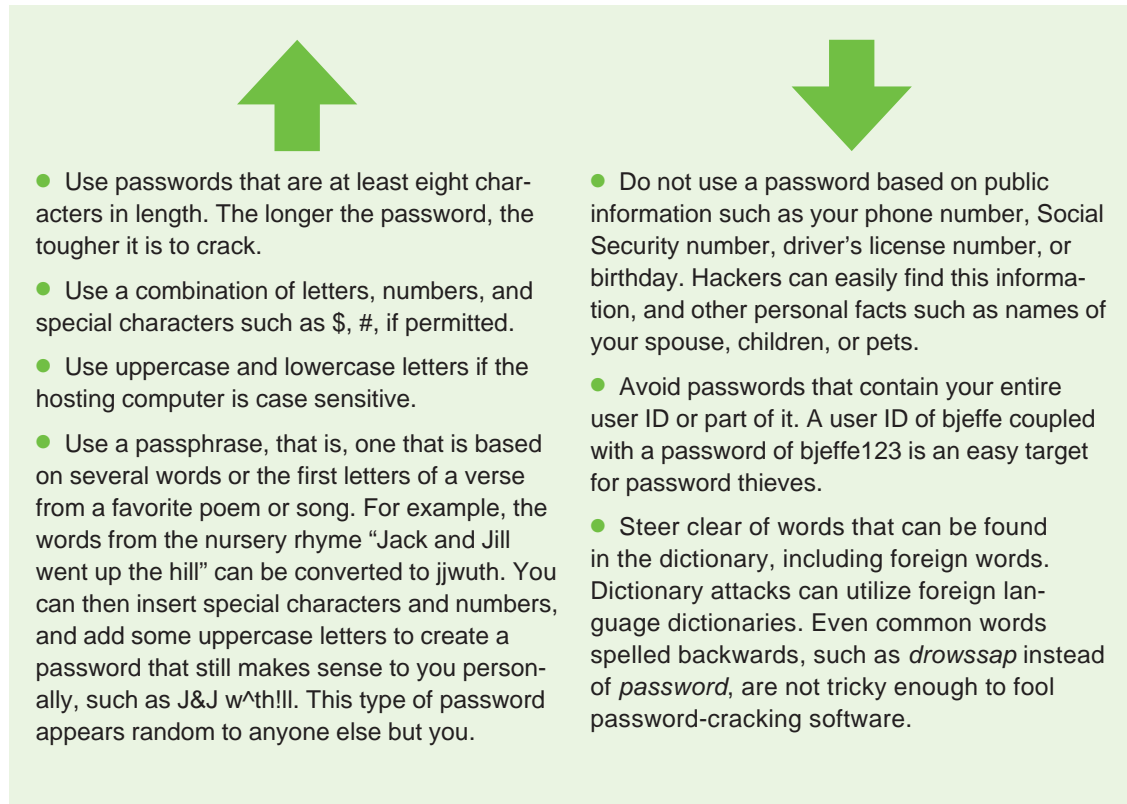
As users became better at identifying phishing messages, password thieves resorted to the use of keyloggers. Short for *keystroke logging*, a **keylogger** is software that secretly records a user's keystrokes and sends the information to a hacker. A keylogger is a form of malicious code called a Trojan horse, or Trojan. Trojans are computer programs that seem to perform one function while actually doing something else. They can be embedded in e-mail attachments, software downloads, and even files. Trojans are discussed in more detail in the security section of the Software chapter.

SECURE PASSWORDS

How do I create a secure password? With password theft becoming more and more widespread, security experts recommend using a strong, secure password for financial transactions such as those that involve PayPal or bank accounts. A strong, secure password is one that is easy to remember but difficult to crack. Figure 1-45 offers guidelines for selecting secure passwords and avoiding ones that are easily crackable.

- Use passwords that are at least eight characters in length. The longer the password, the tougher it is to crack.

- Use a combination of letters, numbers, and special characters such as $, #, if permitted.

- Use uppercase and lowercase letters if the hosting computer is case sensitive.

- Use a passphrase, that is, one that is based on several words or the first letters of a verse from a favorite poem or song. For example, the words from the nursery rhyme "Jack and Jill went up the hill" can be converted to jjwuth. You can then insert special characters and numbers, and add some uppercase letters to create a password that still makes sense to you personally, such as J&J w^th!ll. This type of password appears random to anyone else but you.

- Do not use a password based on public information such as your phone number, Social Security number, driver's license number, or birthday. Hackers can easily find this information, and other personal facts such as names of your spouse, children, or pets.

- Avoid passwords that contain your entire user ID or part of it. A user ID of bjeffe coupled with a password of bjeffe123 is an easy target for password thieves.

- Steer clear of words that can be found in the dictionary, including foreign words. Dictionary attacks can utilize foreign language dictionaries. Even common words spelled backwards, such as *drowssap* instead of *password*, are not tricky enough to fool password-cracking software.

How do I protect my password? Once you have selected a strong password, you must take steps to keep it safe. Do not share your password with anyone. Avoid writing down a password. If possible, memorize it. If you must write down a password, do not leave it in an obvious place such as under your keyboard or mouse pad. Recording passwords in an unencrypted file stored on your computer is risky, too, especially if you have more than one password. A hacker who gains access to that file can use the passwords to access all your accounts.

If you think one of your passwords has been compromised, change it immediately. Even if you have no evidence of password tampering, security experts recommend that you change passwords periodically, say every six months. When you change your passwords, do not just make a slight variation to your current one. For example, do not change just4Me1 to just4Me2. You should not reuse your old passwords either, so it's best to keep a password history list.

Aside from good password maintenance habits, computer maintenance is also essential. Make sure that your entire computer is protected by security software, which is explained in the Software chapter.

How do I deal with all my passwords and user IDs? You can accumulate many passwords and user IDs—for logging into Windows, accessing online banking, using e-mail, shopping online, downloading music, and getting into your Facebook account. The more passwords and user IDs you have, the more difficult they become to remember.

How many times have you had to click on the "I forgot my password" link when you logged in to an online account? Your passwords provide the most protection if they are unique, but accessing even 25 different Web sites that require 25 different user IDs and 25 corresponding passwords requires quite a memory. To add to the confusion, you must also regularly change passwords to your critical accounts!

Instead of using 25 different user IDs and passwords, you need some way to reduce the number of things you have to memorize. First, strive to select a unique user ID that you can use for more than one site. Remember that people with your name who selected user IDs before you might have already taken the obvious user IDs. For example, when John Smith selects a user ID, you can bet that other people have already used johnsmith, jsmith, and john_smith. To keep his user ID unique, John might instead select jsl2wm (the first letters in "John Smith loves 2 watch movies").

Next, you can maintain two or three tiers of passwords—the top level for high security, the second level for medium security, and the third level for low security. If you do not have too many accounts, you can opt for just two tiers—for high and low security. You can then select two passwords. Use the high-security password for accessing critical data, such as online banking, for managing an online stock portfolio, or for your account at an online bookstore that stores a copy of your billing and credit card information.

Use your low-security password in situations where you don't really care if your security is compromised. Some places on the Internet want you to establish an account with a user ID and password just so that they can put you on a mailing list. At other sites, your user ID and password provide access to information, but none of your critical personal or financial data is stored there. It is not necessary to change your low-security password very often. Figure 1-46 provides more information about tiered passwords.

Tier 1: High security
Password: BBx98$$NN26
Uses:
Online banking
PayPal
iTunes
Amazon.com

Tier 2: Low security
Password: Rover
Uses:
New York Times archive
Google
Wikipedia
photoSIG

FIGURE 1-46

Tiered passwords reduce the number of user IDs and passwords that you have to remember; however, the disadvantage is that a hacker who discovers one of your passwords will be able to use it to access many of your accounts.

Can my computer help me to remember passwords? Your computer's operating system, Web browser, or other software might include a password manager to help you keep track of user IDs and passwords. A **password manager** stores user IDs with their corresponding passwords and automatically fills in login forms. For example, when you register at a Web site while using a browser such as Internet Explorer, the browser stores your new ID and password in an encrypted file on your computer's hard disk. The next time you visit the Web site, your ID and password are automatically filled in on the login screen (Figure 1-47).

The drawback to password managers that are built into browsers, operating systems, or other software is that if you switch to different software or to a different computer, you will not have access to the stored passwords. Standalone password manager software offers a more inclusive approach to creating and retrieving passwords.

What is password manager software? A standalone password manager is a software application that feeds passwords into login forms regardless of the software you're using. As with built-in password managers, a standalone password manager stores user IDs and passwords in an encrypted file. You can access this file using a master password. This type of password manager can be moved from one computer to another, for example, if you purchase a new computer.
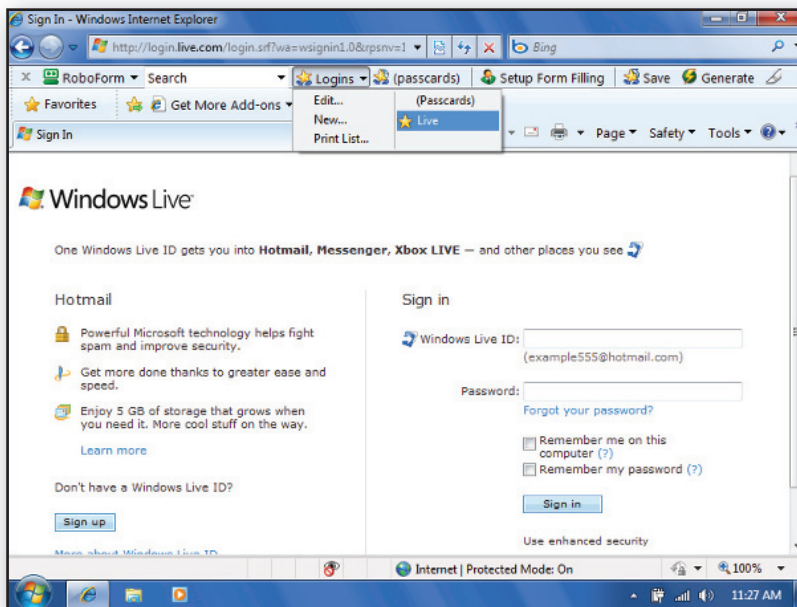
A standalone password manager can also generate secure "nonsense passwords." You don't have to worry if the passwords are difficult to remember because the password manager software can keep track of them (Figure 1-48).

In addition to generating and tracking your passwords, most password manager software provides other features, such as password strength meters and form fillers.

A password strength meter indicates whether your passwords are secure enough—a feature that is useful if you've created your own passwords, rather than using your password manager to generate them.

Form fillers automatically enter data into online Web forms such as those that request billing data when you order at an online shopping site. Many form fillers also match a Web form's URL against a set of valid URLs that you have provided in order to avoid sending data to a fake Web site that you have been lured to visit by a phishing message. When entering passwords, form fillers are not collecting your password from the keyboard; therefore, a hacker's keylogger cannot secretly record keystrokes.

There are several free, shareware, or open source password managers, such as KeePass, RoboForm, and SurfSecret KeyPad. Some password manager software is portable, which means that it does not have to be installed on a computer before it is used. Instead, you can carry it around on a USB flash drive so that your passwords are available wherever you use a computer, such as in your school lab, at the library, or at work. When you remove the flash drive, your portable password manager leaves no traces of passwords behind (Figure 1-49).

For extra protection against intruders who might search your computer for passwords, a flash drive that contains a password manager can be unplugged when you are not accessing password protected sites. You can also remove the flash drive from your computer when you're out so that your nosy roommate can't snoop through your computer files.

New password management techniques are being developed, but some offer their own set of potential security problems. For example, Web-based password managers can be attractive targets for password thieves. By breaking into a single site, a password thief could harvest thousands of passwords. As new password management technologies appear, make sure you evaluate them carefully before trusting them with your valuable data.

FIGURE 1-49

Some password managers are portable so that you can carry them with you on a USB flash drive.

INFOWEBLINKS

Visit the **Password Management InfoWeb** to learn more about creating and managing all your user IDs and passwords.

W **CLICK TO CONNECT**
www.infoweblinks.com/np2012/ch01

QuickCheck   SECTION E

1. An authentication _____ is any method that confirms a person's identity using something the person knows, something the person possesses, or something the person is.

2. On a(n) _____-sensitive server, the user ID BJP is different than bjp.

3. A(n) _____ attack can guess your password if you are using common passwords or everyday words.

4. A(n) _____ scam looks like a request from your bank or an online payment service, but is actually a hacker who wants you to disclose your user ID and password.

5. Most browsers include a built-in password _____ that remembers the user IDs and passwords you use when logging into Web sites or online e-mail.

▶ CHECK ANSWERS

Issue: Are You Being Tracked?

IN THE BOOK *Harry Potter and the Prisoner of Azkaban*, Harry acquires a magical item called the Marauder's Map, which shows the location of every teacher and student at the Hogwarts School of Witchcraft and Wizardry. A group of students at the Massachusetts Institute of Technology became fascinated by the idea of a tracking map and constructed one of their own. It is rather amazing that a fictional magic device could so easily become reality.

In the context of Harry Potter, tracking technology seems fun; but in real life this apparently innocent tracking technology could be used by governments, corporations, and possibly criminals to monitor the daily activities of ordinary people. Location privacy can be defined as the ability to prevent other parties from learning one's current or past location. Tracking technology could have a significant effect on our ability to keep our daily lives private.

A location-enabled device (sometimes referred to as a location-aware device) is one that can determine its geographic location. Most are handheld mobile devices, but tracking chips can also be embedded in items as varied as cars, shipping cartons, product labels, clothing, and passports. Three technologies are used to equip devices with location awareness: GPS, cellular networks, and RFID (radio frequency identification).

A global positioning system, or GPS, uses a receiver inside a mobile device to triangulate a location based on signals from three or more Earth-orbiting satellites. GPS technology is used for handheld GPS locator devices and automobile tracking services such as OnStar.

GPS is a one-way technology; data travels to the GPS device, but the device does not transmit its position back to a satellite. However, coordinates from a GPS can be transmitted over a different network, such as the cellular phone system or wireless network. For example, a tourist might rent a virtual tour guide device that narrates points of interest on a walking tour. The device collects information from a GPS satellite and when the tourist reaches an attraction, begins narrating. Unbeknownst to the tourist, however, the device can transmit its location to the tour operator's office. Not only does the tour operator know the tourist's location, but that information could be passed to a third-party marketer or to immigration officials.

Wireless networks, such as a cellular phone system, can determine location based on the antenna to which they broadcast. An antenna's coverage area ranges from a few miles up to 20 miles. The location of a mobile device and the person using it can be roughly determined to be within the range of the antenna it is currently transmitting to. A more precise location can be triangulated using multiple antennas. With current technology, triangulation from cellular phone antennas is less accurate than with GPS; current technology pinpoints a location to within 50–150 meters. Locations can be tracked only within range of cell towers. In contrast, GPS tracking is essentially worldwide.

Wireless transmissions are bi-directional; unlike one-way GPS, most mobile devices can transmit a location back to a base station. Cellular phone companies originally used this capability to determine when customers were roaming out of their home coverage area.

Currently, location data from cellular phones is also available for use by emergency responders to locate people in need of assistance. More controversially, bi-directional tracking devices have been embedded in rental cars to determine whether the car is exceeding the speed limit or is being used for unauthorized travel across state lines.

New child-tracking services offered by cellular phone carriers allow parents to track their cell-phone equipped children on a Web-based map. Parents can even set up boundaries and if their child crosses out of the approved area, an alarm sounds on the parent's computer or cell phone.

Law enforcement agencies have tried to gain access to location information to track suspected criminals. In some states, motor vehicle officials are considering plans to implant tracking devices in license plates.

RFID technology is based on a special-purpose computer chip equipped with a microscopic antenna that receives and responds to radio-frequency queries from a transceiver. Whenever the chip is within range of a transceiver, its signal can be picked up. RFID chips are so small that they are almost unnoticeable. They can be implanted in animals or people, incorporated into a credit card or passport, and tucked away in clothing labels or commercial products.

RFID product labels were originally designed to streamline warehouse and retail store operations, so that products could be scanned without removing them from shipping crates or shopping carts. They became controversial because consumers were not necessarily able to locate or remove the RFID device. Further, RFID-enabled items could be linked to a specific individual if an RFID labeled item was purchased with a credit card. It also seemed possible that unauthorized people could hijack RFID signals and track a person by, for example, picking up the signals emitted by her Benetton sweater.

Tracking technology has many uses. Employers can use location data to make sure employees are not spending too much time in the smoking area or break room. Cell phone carriers can collaborate with aggressive marketers to turn your cell phone into a handheld carnival barker who tries to coax you into nearby stores or restaurants. Data from a location-enabled device could be correlated with health clinics, bars, or adult bookstores allowing trackers to make inferences about a person's lifestyle.

The use of tracking technology is spreading and it seems clear that laws and regulations are necessary to prevent abusive practices. The Communications Act of 1934 requires that carriers only use a customer's confidential information for providing services specifically requested by that customer. The so-called E911 Act that required wireless service providers to equip phones with GPS capability added location data to the list of information that is supposed to be kept confidential, and it prohibited certain marketing uses of customers' location data. Unfortunately, a bill that was proposed in 2001, requiring location-based services to obtain permission from customers before disclosing location information, was not passed into law.

Privacy advocates are demanding strict protocols for collecting, using, storing, and distributing location information. They face opposition, however, from law enforcement officials who would like to explore ways location technology can be used to track criminals and prevent terrorism. Commercial interest in this technology for marketing and advertising is also high and consumers might be willing to give up some measure of privacy for economic incentives, such as free OnStar service in exchange for listening to location-based advertising while driving.

The outcome of conflicting interests will determine if location-tracking technology can be implemented in such a way that the rights and privacy of individuals are protected.

INFOWEBLINKS

You'll find lots more information about tracking devices at the **Digital Surveillance InfoWeb**.

Ⓦ **CLICK TO CONNECT**
www.infoweblinks.com/np2012/ch01

What Do You Think?

ISSUE

1. Should users of location-enabled devices be informed when location tracking is in use?

◯ Yes ◯ No ◯ Not sure

2. Do you think most people are aware of the privacy issues associated with location-enabled devices?

◯ Yes ◯ No ◯ Not sure

3. Should users of location-aware devices be permitted to enable and disable tracking features on their devices?

◯ Yes ◯ No ◯ Not sure

▶ SAVE RESPONSES

Computers in Context: Marketing

WALKING OUT THE GATE of ancient Pompeii, you might have come across an eye-catching sign extolling the virtues of a popular tavern in the next town. The sign was a clever bit of marketing designed to target thirsty travelers and drum up business. Throughout the centuries, handbills, newspaper ads, television commercials, radio spots, and mass mail campaigns were all important tools of the marketing industry. Now, computers have opened new vistas for communicating with consumers.

The American Marketing Association defines marketing as an organizational function and a set of processes for creating, communicating, and delivering value to customers and for managing customer relationships in ways that benefit the organization and its stakeholders. A person-in-the-street definition might simply be that marketing is an attempt to sell products.

Computers first played a role in marketing as a research tool for quickly crunching numbers from consumer surveys and sales figures. Statistics derived from that data helped companies focus development efforts on the most promising products and market them effectively. Marketing research data made one fact very clear: even the most effective advertising cannot convince everyone to buy a particular product. A costly prime-time television ad, for example, might be seen by millions of viewers, but many of them have no interest in the advertised product. To better target potential buyers, marketers turned to direct marketing.

Direct marketing attempts to establish a one-to-one relationship with prospective customers rather than waiting for them to learn about a product from general, impersonal forms of advertising, such as billboards, radio spots, television commercials, and newspaper ads. The first direct marketing techniques included personalized let-

It's easy to make Sodas and Sparkling Drinks at home!

CANADA DRY WATER

FREE!

CANADA DRY WATER WORLD FAMOUS

ters, catalogs, and telemarketing. Customer names, addresses, and phone numbers were mined from computer databases maintained by mailing list brokers. Lists could be tailored in rudimentary ways to fit target markets. Selling snow tires? Get a list of consumers in northern states. Looking for Peace Corps volunteers? Get a list of college students.

"Dear Carmen Smith, you might already have won…" Just about everyone in America has received a personalized sweepstakes mailing. Initially, personalized names were crudely inserted using dot matrix printers, but today high-speed laser printers dash off thousands of personalized letters per hour and use graphics capabilities to affix signatures that appear to have been hand-signed in ink.

Telemarketing is a technique for telephone solicitation. Computerized autodialers make it possible for telemarketers to work efficiently. An autodialer is a device that can dial telephone numbers stored in a list. It can also generate and dial telephone numbers using a random or sequential number generator.

A smart autodialer, called a predictive dialer, increases a telemarketer's efficiency even more by automatically calling several numbers at the same time and only passing a call to the marketer when a person answers.

If you've picked up the telephone only to hear silence or a disconnect, it was likely an autodialer that connected to more than one person at the same time and dropped your call. Predictive dialers eliminate telemarketing time that would be otherwise wasted with busy signals, answering machines, and so on.

The Internet opened up dramatic new horizons in direct marketing by providing an inexpensive conduit for collecting information about potential customers and distributing targeted direct marketing. According to author Jim Sterne, "The Internet and the World

Wide Web have become the most important new communication media since television, and ones that are fundamentally reshaping contemporary understanding of sales and marketing." Today, a vast amount of information flows over the Internet and marketers are trying to harness that information to most efficiently communicate their messages to prospective customers.

Market analysts are interested in consumer opinions about companies and products. Analysts for companies like Ford, Microsoft, and Sony track opinions on the Internet by monitoring message boards, discussion sites, and blogs.

E-commerce Web sites offer a global distribution channel for small entrepreneurs as well as multinational corporations. Consumers can locate e-commerce sites using a search engine. Some search engines allow paid advertising to appear on their sites. Clever marketers use search engine optimization techniques to get their Web sites to the top of search engine lists.

Another way to drive traffic to an e-commerce site is banner advertising that clutters up Web pages with inviting tag lines for free products. Clicking the ad connects consumers to the site. The cost of placing a banner ad depends on the click-through rate—the number of consumers who click an ad. Sophisticated banner ad software displays the banner ad across an entire network and monitors click-through rates. Not only does this software keep track of click throughs for billing purposes, it can automatically adjust the sites that carry each ad to maximize click-through rates.

Internet marketing is often associated with the tidal wave of spam that's currently crashing into everyone's Inbox. These mass spam e-mails, however bothersome, are a very crude form of direct marketing. Typically, spammers use unscrubbed mailing lists containing many expired, blocked, and invalid e-mail addresses. This hit-or-miss strategy is cheap. Ten million e-mail addresses can be rented for as low as $100 and server bandwidth provided by e-mail brokers costs about $300 per million messages sent.

Marketing professionals regard massive e-mail spamming with some degree of scorn because most lists don't narrow the focus to the most promising customers. Worse yet, consumers react by installing spam filters. Some spammers try to evade spam filters. More than one Web site offers marketers a free service that analyzes mass e-mail solicitations using a spam filter simulator. If the solicitation can't get through the filter, the service offers suggestions on what to change so the message slips through.

In contrast to gratuitous spammers, marketing professionals have learned that opt-in mailing lists have much higher success rates. Consumers who have asked for information more often appreciate receiving it and act on it. Opt-in consumers are also more willing to divulge information that develops an accurate profile of their lifestyle so marketers can offer them the most appropriate products.

Most consumers would agree that the marketing industry needs professionals who are socially responsible. In describing the qualifications for marketing professionals, the Bureau of Labor Statistics states the obvious when it says, "Computer skills are vital because marketing, product promotion, and advertising on the Internet are increasingly common."

In preparing for a marketing career, a knowledge of computers, the Web, and the Internet are important. Equally important is preparation in statistical analysis, psychology, and ethics, along with coursework that covers legal and regulatory aspects of the technology-driven marketing industry.

INFOWEBLINKS

You'll find additional information about this Computers in Context topic by visiting the **Computers and Marketing InfoWeb**.

W CLICK TO CONNECT
www.infowinklinks.com/np2012/ch01

New Perspectives Labs

On the BookOnCD

To access the New Perspectives Labs for Chapter 1, start the BookOnCD and then click the icon next to the lab title below.

▶ OPERATING A PERSONAL COMPUTER

IN THIS LAB YOU'LL LEARN:

- How to start a Windows computer
- What to do when a computer is in sleep mode
- How to deactivate a screensaver
- How to select a different screensaver
- How to use the Alt, Ctrl, Esc, Num Lock, Caps Lock, Windows, Fn, Backspace, Delete, and arrow keys
- The difference between forward and backward slashes
- How to start and exit a program
- How to close a program that is not responding
- When to use the reset button
- How to shut down Windows

LAB ASSIGNMENTS

1. Start the interactive part of the lab. Make sure you've enabled Tracking if you want to save your QuickCheck results. Perform each lab step as directed, and answer all the lab QuickCheck questions. When you exit the lab, your answers are automatically graded and your results are displayed.

2. Make a note of the brand and location of the computer you're using to complete these lab assignments.

3. Use the Start button to access your computer's Control Panel folder. Describe the status of your computer's power saver settings.

4. Preview the available screensavers on the computer you use most frequently. Select the screensaver you like the best and describe it in a few sentences.

5. What is the purpose of an Fn key? Does your computer keyboard include an Fn key? Explain why or why not.

6. In your own words, describe what happens when you (a) click the Close button, (b) hold down the Ctrl, Alt, and Del keys, (c) press the reset button, and (d) select the Shut Down option.

▶ WORKING WITH BINARY NUMBERS

IN THIS LAB YOU'LL LEARN:

- The difference between the binary number system and the decimal number system
- How to count in binary
- How to convert decimal numbers into binary numbers
- How to convert binary numbers into decimal numbers
- How to use the Windows Calculator to convert numbers
- How to work with powers of two

LAB ASSIGNMENTS

1. Start the interactive part of the lab. Make sure you've enabled Tracking if you want to save your QuickCheck results. Perform each lab step as directed, and answer all the lab QuickCheck questions. When you exit the lab, your answers are automatically graded and your results are displayed.

2. Using paper and pencil, manually convert the following decimal numbers into binary numbers. Your instructor might ask you to show the process that you used for each conversion.

    a. 100   b. 1,000   c. 256
    d. 27   e. 48   f. 112
    g. 96   h. 1,024

3. Using paper and pencil, manually convert the following binary numbers into decimal numbers. Your instructor might ask you to show the process that you used for each conversion.

    a. 100   b. 101   c. 1100
    d. 10101   e. 1111   f. 10000
    g. 1111000   h. 110110

4. Describe what is wrong with the following sequence:

    10 100 110 1000 1001 1100 1110 10000

5. What is the decimal equivalent of 2^0? 2^1? 2^8?

Key Terms

Make sure you understand all the boldfaced key terms presented in this chapter. With the NP2012 BookOnCD, you can use this list of terms as an interactive study activity. First, try to define a term in your own words, and then click the term to compare your definition with the definition presented in the chapter. Online, try your hand at the TechTerm Flashcards.

ALU, 31
Analog data, 22
Anonymizer tools, 10
Application software, 16
Apps, 20
ASCII, 24
Asynchronous communication, 6
Authentication protocol, 34
Binary number system, 23
Biometrics, 34
Bit, 23
Brute force attack, 37
Byte, 26
Case sensitive, 35
Central processing unit, 15
Character data, 24
Client, 18
Compiler, 30
Compute-intensive, 19
Computer, 14
Computer network, 7
Computer program, 15
Control unit, 31
Convergence, 8
CPU, 15
Cyberspace, 7
Data, 15
Data representation, 22
Dictionary attack, 36
Digital data, 22
Digital divide, 12
Digital revolution, 4
Digitization, 7

Download, 8
EBCDIC, 25
E-mail, 6
Extended ASCII, 24
File, 15
Gigabit, 26
Gigabyte, 26
Globalization, 12
Identity theft, 36
Input, 15
Instruction cycle, 32
Instruction set, 30
Integrated circuit, 27
Intellectual property, 11
Internet, 6
Interpreter, 30
Keylogger, 37
Kilobit, 26
Kilobyte, 26
Machine code, 30
Machine language, 30
Mainframe computer, 18
Megabit, 26
Megabyte, 26
Memory, 15
Microcontroller, 20
Microprocessor, 15
Numeric data, 23
Object code, 30
Online social networks, 6
Op code, 31
Open source, 12
Operand, 31

Operating system, 16
Output, 15
Password, 35
Password manager, 40
PDA, 19
Personal computer, 17
Phishing, 37
Portable media players, 20
Processing, 15
Programming language, 29
Registers, 31
Semiconducting materials, 27
Server, 18
Smartphone, 20
Sniffing, 37
Software, 15
Source code, 29
Storage, 15
Stored program, 16
Supercomputer, 18
Synchronous communication, 6
System board, 28
System software, 16
Unicode, 25
User ID, 34
Videogame console, 17
Web, 7
Workstation, 17

Interactive Summary

To review important concepts from this chapter, fill in the blanks to best complete each sentence. When using the NP2012 BookOnCD, click the Check Answers buttons to automatically score your answers.

SECTION A: The [_____] revolution is an ongoing process of social, political, and economic change brought about by technologies such as computers and networks. The [_____] is a global computer network originally developed as a military project, adapted for research and academic use, and then for commercial use. [_____], a form of electronic communication, was an application for the masses and finally a reason to buy a computer and join the digital revolution. Another aspect of the digital revolution is [_____], a process by which several technologies with distinct functionalities evolve to form a single product. Technology has the potential to spread ideas, such as freedom and democracy, but it might have a chilling effect on [_____], or "the right to be left alone." It might also affect intellectual [_____] because digital technology has made it easy to produce copies with no loss in quality from the original. And although technology-driven [_____] has an effect on the economy, activists worry about the digital [_____] that separates people who have access to technology and those who do not.

▶ CHECK ANSWERS

SECTION B: A(n) [_____] is a multipurpose device that accepts input, processes data, stores data, and produces output according to a series of stored instructions. The data a computer is getting ready to process is temporarily held in [_____]. This data is then processed in the central processing [_____]. The series of instructions that tells a computer how to carry out processing tasks is referred to as a computer [_____], which forms the [_____] that sets up a computer to do a specific task. Data is typically stored in a(n) [_____] which is a named collection of data that exists on a storage medium, such as a hard disk, CD, DVD, Blu-ray disc, or USB flash drive. The idea of a [_____] program means that a series of instructions for a computing task can be loaded into a computer's memory. [_____] software is a set of computer programs that helps a person carry out a task. [_____] software helps the computer system monitor itself in order to function efficiently. For example, a computer [_____] system (OS) is essentially the master controller for all the activities that take place within a computer. Computers can be grouped into categories. A(n) [_____] computer is a type of microcomputer designed to meet the needs of an individual. The term [_____] can refer to an ordinary personal computer that is connected to a network or to a powerful desktop computer designed for high-performance tasks. A(n) [_____] is, at the time of its construction, one of the fastest computers in the world. A(n) [_____] computer is large, expensive, and capable of simultaneously processing data for hundreds or thousands of users. Mobile phones and portable media players can be classified as [_____] digital devices. A(n) [_____] is a special-purpose microprocessor that can control a device, such as a refrigerator or microwave oven.

▶ CHECK ANSWERS

SECTION C: [_____] data is processed, stored, and transmitted as a series of 1s and 0s. Each 1 or 0 is called a(n) [_____] . A series of eight 0s and 1s, called a(n) [_____] , represents one character—a letter, number, or punctuation mark. Data becomes [_____] when it is presented in a format that people can understand and use. [_____] data consists of numbers that might be used in arithmetic operations. It can be represented digitally using the [_____] number system. [_____] data is composed of letters, symbols, and numerals that are not used in arithmetic operations. Computers represent this type of data using [_____] , EBCDIC, or Unicode. Data is quantified using terms such as [_____] or kibibyte (1024 bytes), and prefixes, such as [_____] or mebi (1,048,576), and giga or [_____] (1,073,741,824). The bits that represent data travel as electronic pulses through [_____] circuits, sometimes called computer chips. These chips are made from [_____] materials and are housed in chip carriers that can be plugged into the [_____] board of a digital device. ▶ CHECK ANSWERS

SECTION D: Software is usually written in high-level languages, such as C, BASIC, COBOL, and Java. The human-readable version of a program, created in a high-level language by a programmer, is called [_____] code. A(n) [_____] or an interpreter converts this high-level code into [_____] code. A microprocessor is hard-wired to perform a limited set of activities, such as addition, subtraction, counting, and comparisons. This collection of preprogrammed activities is called a(n) [_____] set. Each instruction begins with a(n) [_____] code, which is a command word for an operation such as add, subtract, compare, or jump. Most instructions also include a(n) [_____] that specifies the data, or the address of the data, for the operation. The processor's ALU uses [_____] to hold data that is being processed. The processor's [_____] unit fetches each instruction, sends data to the registers, and then signals the ALU to begin processing. ▶ CHECK ANSWERS

SECTION E: Passwords and user IDs are the most common authentication [_____] . Password theft has become a serious security problem that has led to many cases of [_____] theft, when unauthorized individuals gain access to personal data. Hackers guess, discover, and steal passwords using a variety of techniques. A(n) [_____] attack tries passwords from a list of commonly used passwords. A(n) [_____] force attack tries every possible combination of letters and numbers. [_____] intercepts information sent out over computer networks. [_____] uses fraudulent Web sites or e-mail messages to fool unsuspecting readers into entering passwords and other personal information. A(n) [_____] is software that secretly records a user's keystrokes and sends them to a hacker. To keep passwords safe, you should consider using tiered passwords or standalone password [_____] software that generates secure passwords and keeps track of which password corresponds to each site you access. ▶ CHECK ANSWERS

Interactive Situation Questions

Apply what you've learned to some typical computing situations. When using the NP2012 BookOnCD, you can type your answers, and then use the Check Answers button to automatically score your responses.

1. Suppose that you walk into an office and see the devices pictured to the right. You would probably assume that they are the screen, keyboard, and mouse for a(n) [_____] computer, workstation, or server.

2. You receive an e-mail message asking you to join a circle of friends. You assume that the message was generated in conjunction with an online [_____] network, such as Facebook, and if you become a member, you will be able to socialize online.

3. You go to the iTunes music store and purchase an album. When you see the [_____] message at the top of the screen, you know that the songs are being transferred from the remote iTunes server to your local computer.

4. You're visiting an antique shop and notice a collection of old fashioned radios. They actually feature a dial for tuning in different radio stations. You immediately recognize this as a(n) [_____] device because it deals with an infinite scale of values, rather than discrete values.

5. While attending a meeting at work, you hear one of the executives wondering if "unit code" would be helpful. After a moment of puzzlement, you realize that the executive really meant [_____] , and that it would allow your company software to be translated into the Cyrillic alphabet used by the Russian language.

6. You have a new storage device that offers 2 GB of storage space. It is currently empty. Your friend wants to give you a large digital photo that's 16 MB. Will it fit on your storage device? [____]

7. Your bank is giving customers the choice of using a four-digit PIN or a password that can contain up to ten letters and numbers. The [_____] is more secure, so that's what you decide to use.

8. You need to select a password for your online PayPal account. Which of the following passwords would be the LEAST secure: jeff683, hddtmrutc, gargantuan, fanhotshot, bb#ii22jeffry, or high348? [_____]

▶ CHECK ANSWERS

Interactive Practice Tests

Practice tests that consist of ten multiple-choice, true/false, and fill-in-the-blank questions are available on both the NP2012 BookOnCD and the NP2012 CourseMate Web site. BookOnCD test questions are selected at random from a large test bank, so each time you take a test, you'll receive a different set of questions. Your tests are scored immediately, and you can print study guides that help you find the correct answers for any questions that you missed. Online, you'll find a Practice Test for each section of the chapter. Your results from online tests are saved by Engagement Tracker.

▶ CLICK TO START

# Learning Objectives Checkpoints

1

Learning Objectives Checkpoints are designed to help you assess whether you have achieved the major learning objectives for this chapter. You can use paper and pencil or word processing software to complete most of the activities.

1. List five technologies that are fueling the digital revolution.

2. Define the term *convergence* and provide examples of at least five devices that are converging.

3. Describe at least two social, political, and economic effects of the digital revolution.

4. Draw a diagram to explain how a computer makes use of input, processing, storage, memory, output, and stored programs.

5. Describe the difference between system software, an operating system, application software, and a computer program.

6. List, briefly describe, and rank (in terms of computing capacity) the characteristics of each computer category described in Section B of this chapter.

7. List the characteristics that smartphones, PDAs, and portable media players have in common with personal computers, and list factors by which they differ.

8. Define the term *microcontroller* and provide three examples of devices in which microcontrollers are found.

9. Explain the technical difference between data and information.

10. Provide three examples of digital devices and three examples of analog devices.

11. List the ASCII representation for *B* and the binary representation for 18; draw a stepped waveform showing a digital sound; and draw a diagram showing how color is represented in a graphic.

12. List and define all the chapter terms, such as bit, byte, and kibibyte, that pertain to quantifying data.

13. Use the terms *integrated circuits*, *microprocessor*, and *system board* in a meaningful sentence.

14. Describe how compilers and interpreters work with high-level programming languages, source code, and object code.

15. Make a storyboard showing how a microprocessor's ALU would add the numbers 2 and 8.

16. Explain how hackers use dictionary and brute force attacks.

17. Provide examples of five secure passwords and five passwords that might be easy to crack.

Study Tip: Make sure you can use your own words to correctly answer each of the red focus questions that appear throughout the chapter.

Concept Map

Fill in the blanks to show that you understand the relationships between programming concepts presented in the chapter.

CHECK ANSWERS
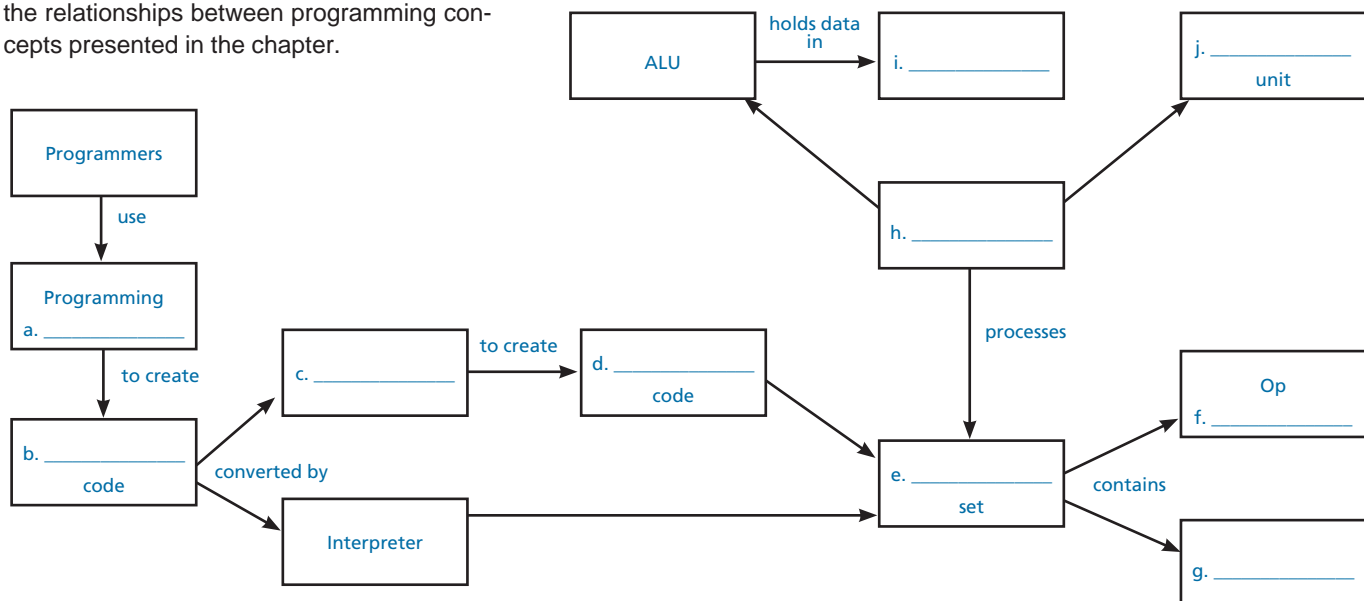
Projects

CRITICAL THINKING

Whether you're taking this course to fulfill a graduation requirement, to improve your career options, or just for fun, take a few minutes to evaluate what you expect to gain from this course. Look through the table of contents of this textbook and select the five sections that you think will be most interesting, and the five sections that seem to be the least relevant to you. Incorporate your thoughts in two or three paragraphs that you e-mail to your instructor.

GROUP PROJECT

Form a group with four or five other students. Each student in the group should ask at least five friends if they have 1) a computer, 2) a cell phone, 3) a portable music player, 4) dial-up Internet access, 5) high-speed Internet access. Consolidate the data from all members of your group into an Excel spreadsheet, and then graph it. How do your statistics coincide with nationwide statistics for digital ownership? Graph or write a summary and make sure you cite your sources for national statistics.

CYBERCLASSROOM

Your instructor should provide each student with the e-mail addresses of four or five other students who will form a team, and designate a team leader. The team leader should find a news story about a technology issue from a source such as *news.google.com* and send it to one of the other students on the team. That student should add his or her opinion and comments, then send the message to another student in the group. Each student should use a different font color and initial their comments. When the message has circulated to all team members, it should be sent to your instructor. Make sure every member of the team is using antivirus software because, as you learned in the chapter, hackers can take advantage of unprotected computers.

MULTIMEDIA PROJECT

Screenshots can be useful tools for learning, documentation, and troubleshooting. Any time you need to show someone what's displayed on your computer screen, you can press the Print Screen (PrtScr) key, which stores a copy of the screen into memory. On a Mac, hold down the Command (Apple) key while you press the Shift key and the 3 key. From there, you can paste the screenshot into a document you're creating with a word processor. You can also paste it into a graphics program, such as Microsoft Paint, and then edit it. For this project, take a screenshot and paste it into a Word document. Under the screenshot, enter a description of the software and the purpose of the screen you captured.

RESUME BUILDER

Several Web sites offer career aptitude assessments that claim to help you select a career that's suited to your personality and background. Use a search engine to locate three free Web-based career aptitude tests. Take the tests. If you are asked to sign up, make sure you exercise caution in the amount of personal information you divulge. After completing the tests, compare the results. Do they all point you in a similar career direction? What is your reaction to the results? Which test do you think was the most valid and why? Provide your instructor with your analysis, along with the URLs for the Web sites that provided the tests.

GLOBALIZATION

Although the Internet provides a global communications network, communication between people still depends on finding a common language. For this project, explore the Web and experiment with ways in which technology is being used to close the language gap. You might start at Google or Wikipedia and look at the selection of languages they offer. Chronicle your exploration, making sure to document the Web sites you visited. What are your conclusions about Internet use by non-English speakers?

ISSUE

The Issue section of this chapter focused on the increasing use of digital devices that can track a person's location. Tracking technology has advantages and disadvantages. It has been used to track down terrorists and to find missing children, but it can also be abused by government and private companies. For this project, begin by scanning some of the links at the Digital Surveillance InfoWeb. Add to your knowledge by using a search engine, such as Google, to scan recent information about location-aware devices. Make a list of at least ten legitimate and useful applications of digital tracking. Make another list of ten abusive uses of tracking technology. Cite your sources for each item you list.

COMPUTERS IN CONTEXT

The Computers in Context section highlighted new technologies used in the marketing industry. Think of a product that you recently bought. Now, suppose you work for the company that produces the product and you've been assigned to create a marketing campaign. Create a table in which the first column contains a short description of every way you can think of to market the product. In the second column of the table, indicate the main technology used to communicate the marketing message. In column 3, indicate which of the methods would be considered direct marketing. In column 4, rank the marketing methods from most expensive (10) to least expensive (1). (You can use the Web to get estimated costs for various types of advertising.) Finally, in column 5, rank the marketing methods from most effective (10) to least effective (1). Submit your table following your instructor's guidelines for format and style.

On the Web

STUDENT EDITION LABS

When you purchase access to the NP2012 CourseMate Web site, you'll find targeted learning materials to help you understand key concepts and prepare for exams. See page O-41 in the Orientation Chapter for login instructions.
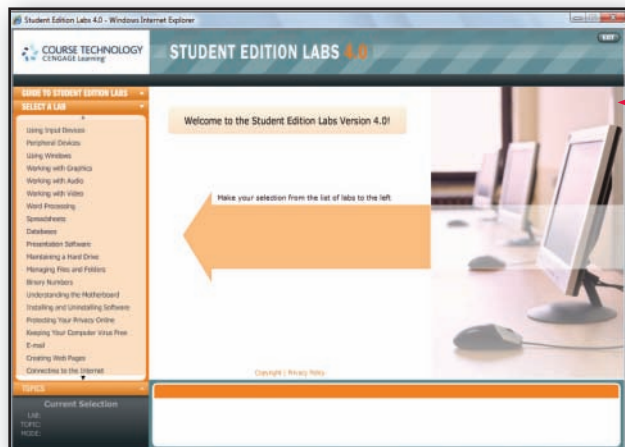
Work hands-on in structured simulations practicing important skills and concepts

BINARY NUMBERS

In the Binary Numbers Student Edition Lab, you will learn about the following topics:

- Comparing binary numbers to decimal numbers
- Adding binary numbers manually
- Converting binary numbers to decimal equivalents

UNDERSTANDING THE MOTHERBOARD

In the Understanding the Motherboard Student Edition Lab, you will learn about the following topics:

- Identifying components of the motherboard, such as integrated circuits, the CPU, RAM, ROM, and expansion slots and cards
- Modifying the way Windows handles virtual memory on a system
- Installing expansion cards into a PC

CHAPTER OVERVIEW COURSECAST

Use your computer or iPod to hear a five-minute audio presentation of chapter highlights.

PRACTICE TESTS

Review chapter material by taking these ten-question tests. Your results are saved by Engagement Tracker.

AUDIO FLASHCARDS

Interact with audio flashcards to review key concepts from the chapter.

ONLINE GAMES

Have some fun while refreshing your memory about key concepts that might appear on the next test.

DETAILED OBJECTIVES

Make sure that you've achieved all the objectives for a chapter before it's time for your test!

AND MORE!

At the NP2012 CourseMate Web site you'll also find the NP2012 eBook, TechTerm Flashcards, Online Glossary, and What Do You Think? opinion polls.