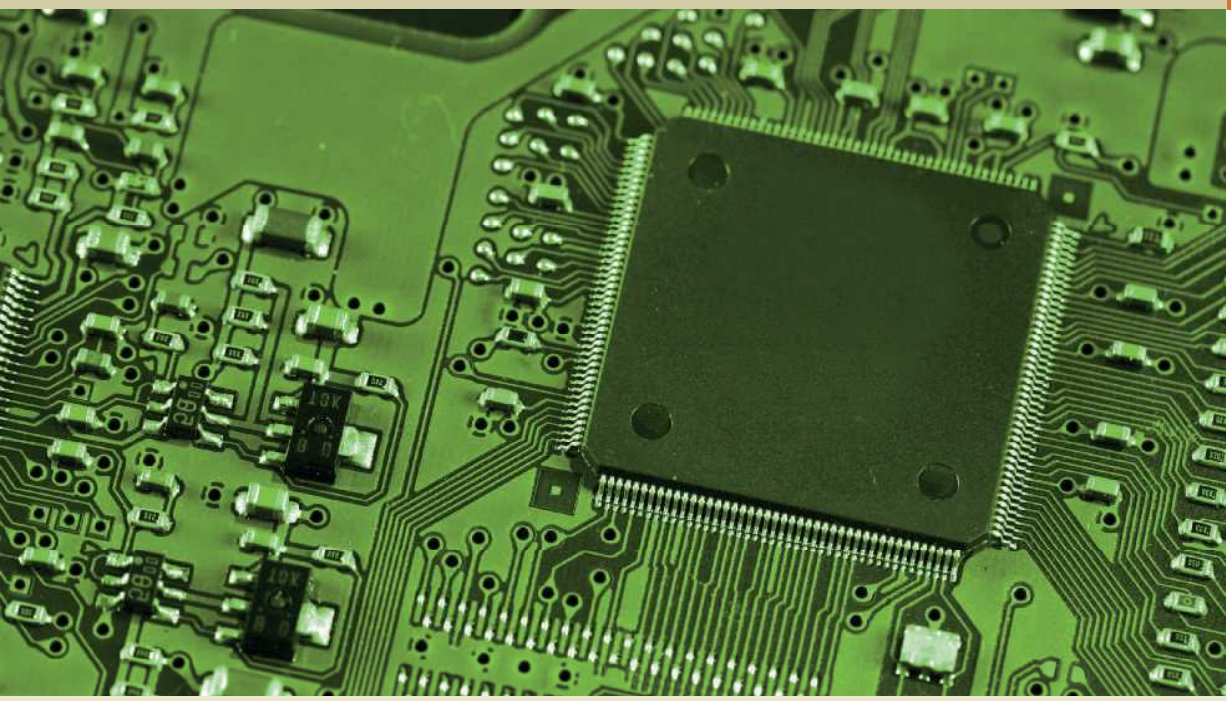
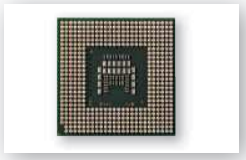
COMPUTING COMPONENTS:
Processors, Memory, the Cloud, and More

6



Computers and mobile devices contain a variety of electronic components.

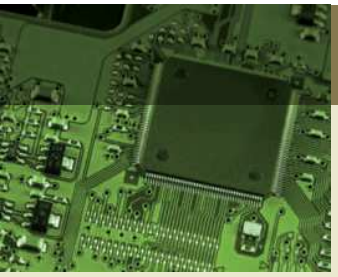


"I bought my laptop a couple of years ago, and it appears to be working well. Although at times it runs a little slow and generates a lot of heat, I really have not had problems with it. Why would I need to learn about hardware inside my laptop and other devices?"

While you may be familiar with some of the content in this chapter, do you know how to . . .

- Protect computers and mobile devices from theft?
- Select the right processor?
- Recognize the Internet of Things?
- Make use of cloud computing services?
- Prevent a computer from overheating?
- Determine memory requirements?
- Install memory?
- Erase your mobile phone's memory?
- Familiarize yourself with efforts related to technology products made with fair trade practices?
- Identify which ports you might need on a computer or mobile device?
- Clean a computer or mobile device?
- Conserve battery life on mobile computers and devices?

In this chapter, you will discover how to perform these tasks along with much more information essential to this course. For additional content available that accompanies this chapter, visit the free resources and premium content. Refer to the Preface and the Intro chapter for information about how to access these and other additional instructor-assigned support materials.



Objectives

After completing this chapter, you will be able to:

1. Describe the various computer and mobile device cases and the contents they protect
2. Describe multi-core processors, the components of a processor, and the four steps in a machine cycle
3. Identify characteristics of various personal computer processors on the market today, and describe the ways processors are cooled
4. Describe what is meant by the Internet of Things
5. Explain the advantages and services of cloud computing
6. Define a bit, and describe how a series of bits represents data
7. Explain how program and application instructions transfer in and out of memory
8. Differentiate among the various types of memory: RAM, cache, ROM, flash memory, and CMOS
9. Describe the purpose of adapter cards and USB adapters
10. Explain the function of a bus
11. Explain the purpose of a power supply and batteries
12. Describe how to care for computers and mobile devices

Inside the Case

Whether you are a home user or a business user, you most likely will purchase a new computer or mobile device, or upgrade an existing computer at some time in the future. Thus, you should understand the purpose of each component in a computer or mobile device. As Chapter 1 discussed, computers and mobile devices include components that are used for input, processing, output, storage, and communications. Many of these components are inside the case that contains and protects the electronics of the computer or mobile device from damage. These cases, which are made of metal or plastic, are available in a variety of shapes and sizes (Figure 6-1).

- Recall that the term, *system unit* (or *chassis*), refers to the case on a desktop that contains and protects the motherboard, hard drive, memory, and other electronic components. Some desktops have a tower system unit that is a device separate from the monitor. Others that house the display and the system unit in the same case are called an all-in-one. Peripheral devices normally occupy space outside the system unit and communicate with the system unit using wired or wireless technology.
- On most laptops, including ultrathin laptops, the keyboard and pointing device often occupy the area on top of the case, and the display attaches to the case by hinges.
- With a slate tablet, which typically does not include a physical keyboard, the case is behind the display. Keyboard options for slate tablets include an on-screen keyboard, a wireless keyboard, or a keyboard that attaches to the slate via a clip, magnets, or other mechanism. On a convertible tablet, by contrast, the case is positioned below a keyboard, providing functionality similar to a laptop. The difference is that the display attaches to the case with a swivel-type hinge, enabling the user to rotate the display and fold it down over the keyboard to look like a slate tablet.
- With game consoles, the input and output devices, such as controllers and a television, reside outside the case.
- Like a slate tablet, the case on a smartphone often is behind the display.
- The case on wearable devices, portable media players, digital cameras, and handheld game devices typically consumes the entire device and houses the display and input devices.

Figure 6-1 Cases for computers and mobile devices are available in a variety of shapes and sizes.

© iStockPhoto / Believe_In_Me; © Igor Lateci / Shutterstock; © iStockPhoto / rasslava; © iStockPhoto / rasslava; © iStockPhoto / Erikflyg; © iStockPhoto / BsWei; © iStockPhoto / Buriy; © iStockPhoto / scanrail; Courtesy of Samsung; © iStockPhoto / Anthony Rosenberg; Courtesy of Samsung

Internet Research
Which laptops are the most popular?
Search for: laptop market share

At some point, you might have to open the case on a desktop or access panels on a laptop to replace or install a new electronic component, or hire a professional to assist with this task. For this reason, you should be familiar with the electronic components inside the case, some of which are shown in Figure 6-2 and discussed in this chapter. Read Secure IT 6-1 for tips related to protecting your computers and mobile devices from theft.

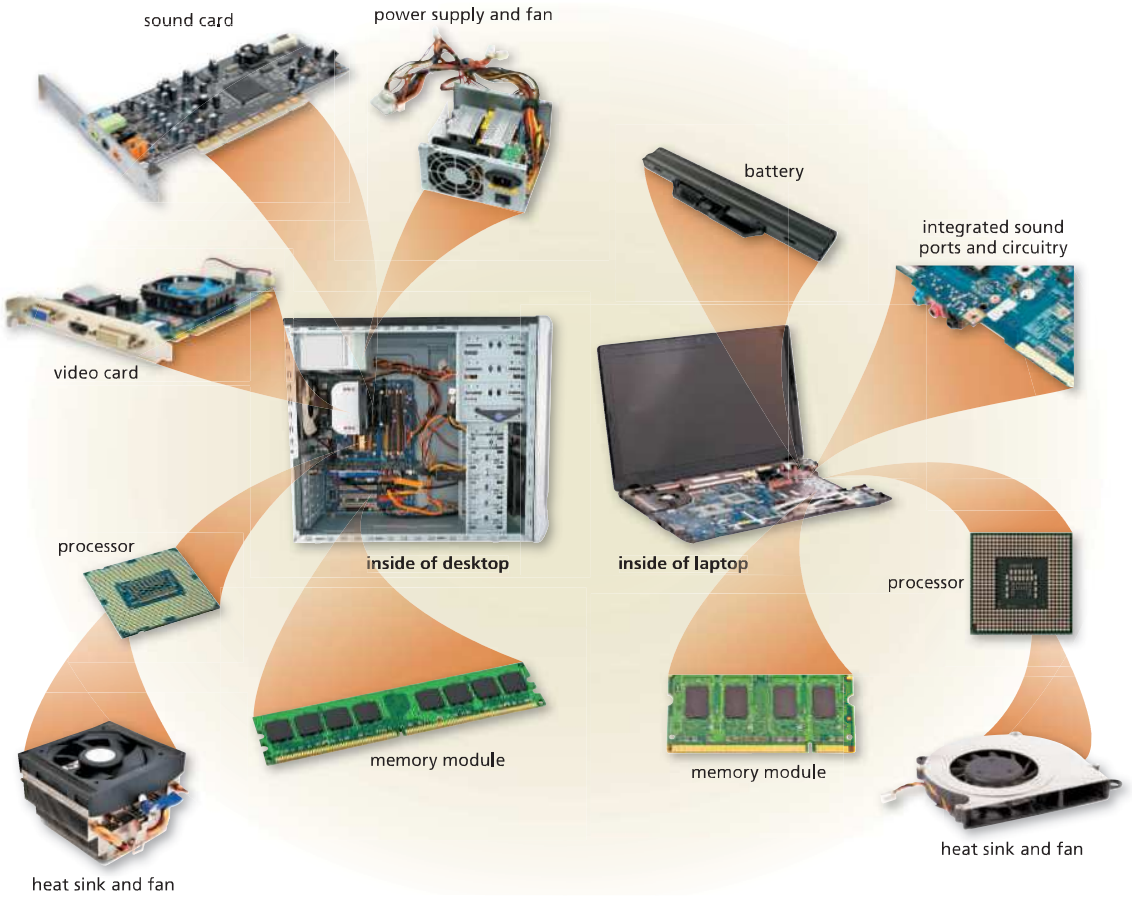


Figure 6-2 This figure shows typical components in a higher-end desktop and laptop. Many basic desktops have integrated video and sound capability, similar to the laptop image shown here.

The Motherboard

The **motherboard**, sometimes called a *system board*, is the main circuit board of the computer. Many electronic components, such as the processor and memory, attach to the motherboard; others are built into it. Figure 6-3 shows photos of current desktop and laptop motherboards.

On personal computers, the circuitry for the processor, memory, and other components reside on a computer chip(s). A computer **chip** is a small piece of semiconducting material, usually silicon, on which integrated circuits are etched. An *integrated circuit* contains many microscopic pathways capable of carrying electrical current. Each integrated circuit can contain millions of elements such as resistors, capacitors, and transistors. A *transistor*, for example, can act as an electronic switch that opens or closes the circuit for electrical charges. Today's computer chips contain millions or billions of transistors.

Most chips are no bigger than one-half-inch square. Manufacturers package chips so that the chips can be attached to a circuit board, such as a motherboard.

SECURE IT 6-1

Securing Computers and Mobile Devices

Millions of smartphones, mobile devices, and computers are stolen in the United States every year, but only a small percent of these devices are recovered. Many devices can help deter potential thieves and also help trace and recover stolen goods. The following products may be useful in securing and tracking hardware.

- **Clamps, cables, and locks:** Lock kits include mounting plates, glue, cables, and padlocks to protect desktops, monitors, laptops, and peripheral devices.
- **Ultrasonic sensors:** Thieves do not need to remove a computer from an office building or school to commit their crimes; instead, they can open the case on a desktop or server on site and then remove a hard drive or other expensive component. To prevent such tampering, hardware manufacturers have developed an alarm system to install in the case. If the computer is moved or the case is opened, an ear-piercing alarm sounds and a security company is alerted.
- **Tracking software:** Many smartphones and mobile devices have software that shows the approximate location of devices and computers. The owner can issue commands remotely to have the device play a sound, lock the screen, display a message, or erase all personal information.
- **Asset tags:** Metal security plates affixed to hardware contain unique bar codes that are registered to the owner and are stored in a security company's database. If a lost or stolen device is recovered, the finder can call the phone number on the tag, and the company will notify the owner.
- **Personal safes:** Protective cases that are approximately the size of a cereal box can store a smartphone, keys, tablet, and other valuables. The attached security cable can be secured to a stationary object, such as a chair or table. Some personal safes have built-in electronic locks; others can be secured with a combination lock. The safe can be useful in a hotel room, at the gym, or on campus.

Consider This: Have you seen any of these security devices at school or at businesses? If so, where? Do you know someone whose computer or mobile device was lost or stolen? If so, was the hardware recovered? What other measures can organizations take to prevent security breaches?

Courtesy of SentrySafe

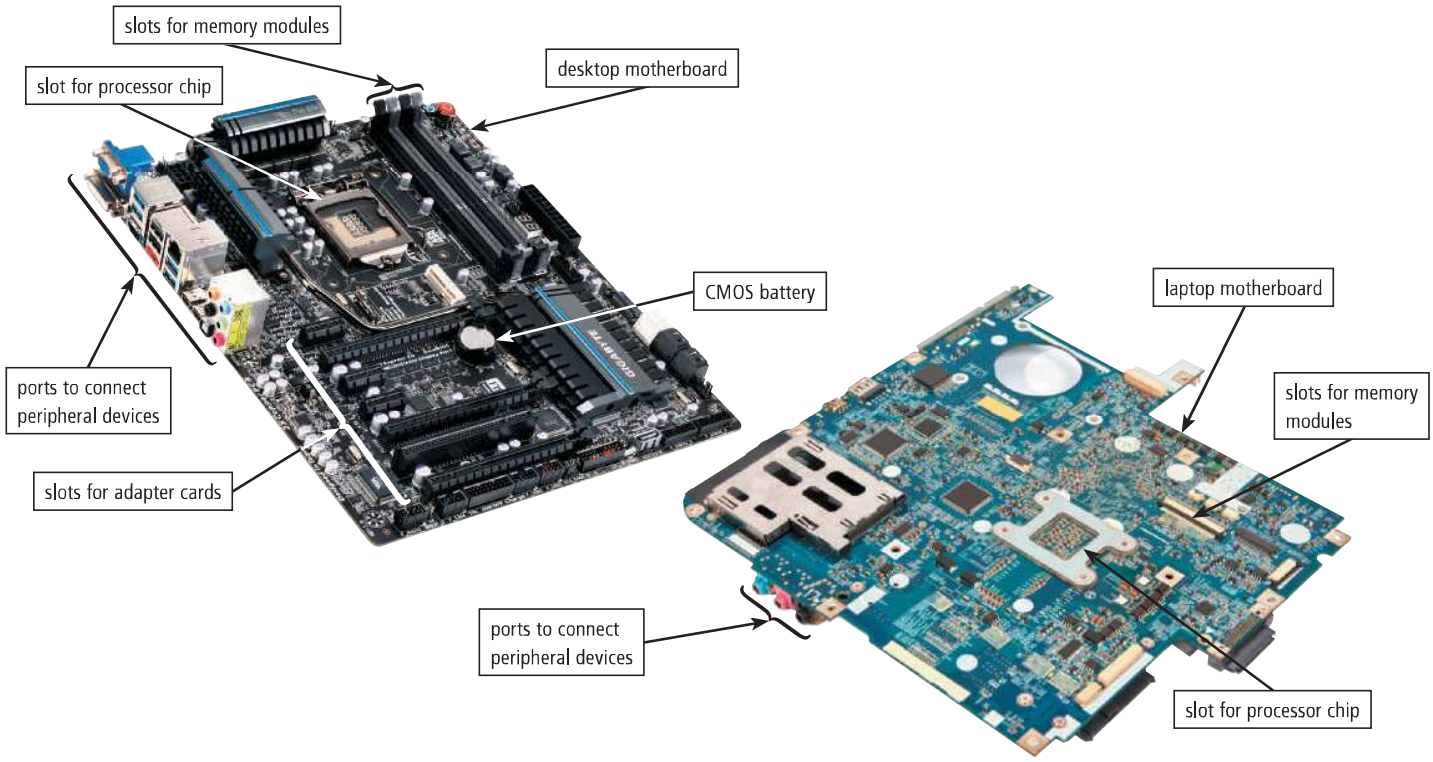


Figure 6-3 A desktop motherboard and a laptop motherboard.
Courtesy of GIGABYTE; © iStockphoto / RAW group

BTW
Technology Trend
Discover More: Visit this chapter's free resources to learn about medical robotics.

Processors

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

Most processor chip manufacturers now offer multi-core processors. A processor core, or simply core, contains the circuitry necessary to execute instructions. The operating system views each processor core as a separate processor. A **multi-core processor** is a single chip with two or more separate processor cores. Multi-core processors are used in all sizes of computers. Read Secure IT 6-2 to learn how chips can help to identify and secure animals.

CONSIDER THIS

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

SECURE IT 6-2

Chip Implants Secure Animals' Identity

The search for lost dogs or cats can be traumatic for their owners. The animals' safe return home may be based on data stored on a chip that veterinarians have implanted under the skin, usually at the neck or shoulder blades.

The chip — sometimes called a microchip because it is so small (about the size of a grain of rice) — has a unique number that is registered to the owner's name and address. It contains an antenna and transponder encased in a glass tube. The antenna receives low-frequency radio waves when a scanning device passes over the chip, and the transponder sends a signal with the chip's number back to the scanner.

Shelters and animal control centers routinely scan runaway pets for chips in an attempt to reunite animals with their owners. Most shelters require pets to have the implant before the animals are adopted or before a once-lost pet is returned to its owner. Some veterinarians also scan new pets for chips to ensure the animal does not belong to someone else.

Some pet owners are concerned that microchipping can cause health problems, particularly if the chip moves from its original injection site. Most humane societies and veterinarians, however, state that no long-term adverse health effects or discomfort occurs.

Microchips also are implanted or attached externally in other animals, including horses, elephants, cows, birds, fish, lizards, and snakes. Breeders, farmers, and animal associations implant the chips to deter thieves. Chips also can monitor an animal's temperature, so that a farmer can prevent the spread of disease by identifying and removing an ill animal from a herd.

Researchers, including those at the U.S. Fish and Wildlife Service, also use this technology to track migration of wild animals, reptiles, and fish. They study how these species interact with their environment, and conservation authorities can identify endangered species, such as sea turtles, that have been confiscated from smugglers.

Consider This: Do you have or know anyone who has a pet that has been implanted with a chip? If so, why do you think they did it? Besides possible health problems, why might some people oppose mandatory animal chipping? Do you think people someday might choose to have a chip implanted to eliminate the need to carry identification? Why or why not?

Processors contain a control unit and an arithmetic logic unit (ALU). These two components work together to perform processing operations. Figure 6-4 illustrates how other devices connected to the computer communicate with the processor to carry out a task. When a user runs an application, for example, its instructions transfer from a storage device to memory. Data needed by programs and applications enters memory from either an input device or a storage device. The control unit interprets and executes instructions in memory, and the arithmetic logic unit performs calculations on the data in memory. Resulting information is stored in memory, from which it can be sent to an output device or a storage device for future access, as needed.

Discover More: Visit this chapter's free resources to learn more about processor chip manufacturers and multi-core processors.

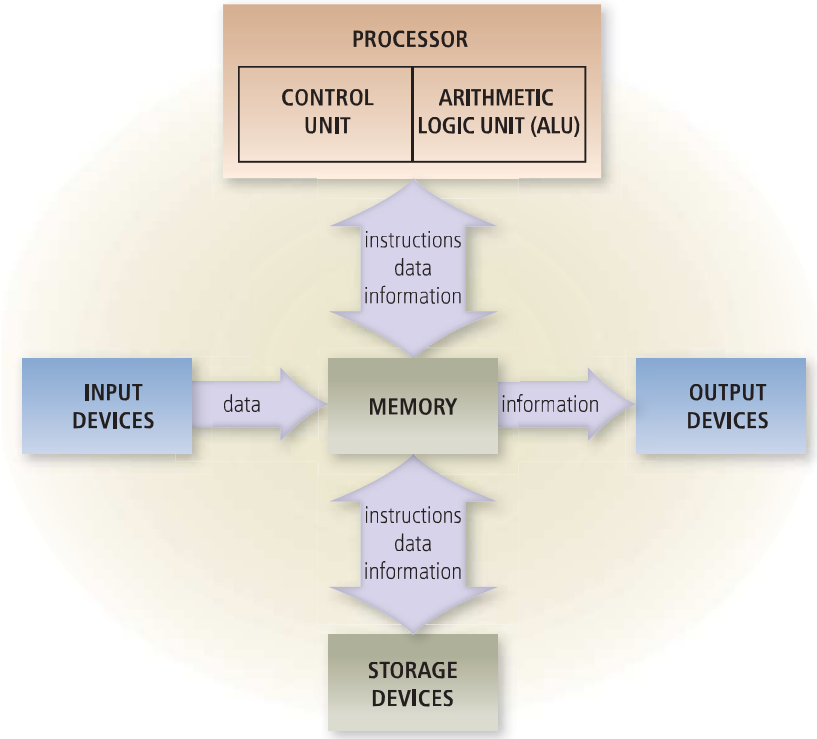


Figure 6-4 Most devices connected to the computer communicate with the processor to carry out a task.

The Control Unit

The **control unit** is the component of the processor that directs and coordinates most of the operations in the computer. That is, it interprets each instruction issued by a program or an application and then initiates the appropriate action to carry out the instruction. Types of internal components that the control unit directs include the arithmetic logic unit, registers, and buses, each discussed in this chapter.

Internet Research
What is Moore's Law?
Search for: moores law

The Arithmetic Logic Unit

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

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

Internet Research
What is Wolfram|Alpha?
Search for: wolfram alpha

Machine Cycle

For every instruction, a processor repeats a set of four basic operations, which comprise a *machine cycle:* (1) fetching, (2) decoding, (3) executing, and, if necessary, (4) storing.

- *Fetching* is the process of obtaining a program or an application instruction or data item from memory.
- *Decoding* refers to the process of translating the instruction into signals the computer can execute.
- *Executing* is the process of carrying out the commands.
- *Storing*, in this context, means writing the result to memory (not to a storage medium).

Figure 6-5 illustrates the steps in a machine cycle. In some computers, the processor fetches, decodes, executes, and stores only one instruction at a time. With others, the processor fetches a second instruction before the first instruction completes its machine cycle, resulting in faster processing. Some use multiple processors simultaneously to increase processing times.

Discover More: Visit this chapter's free resources to learn about two additional ways to increase processing times, pipelining and parallel processing.

The Steps in a Machine Cycle

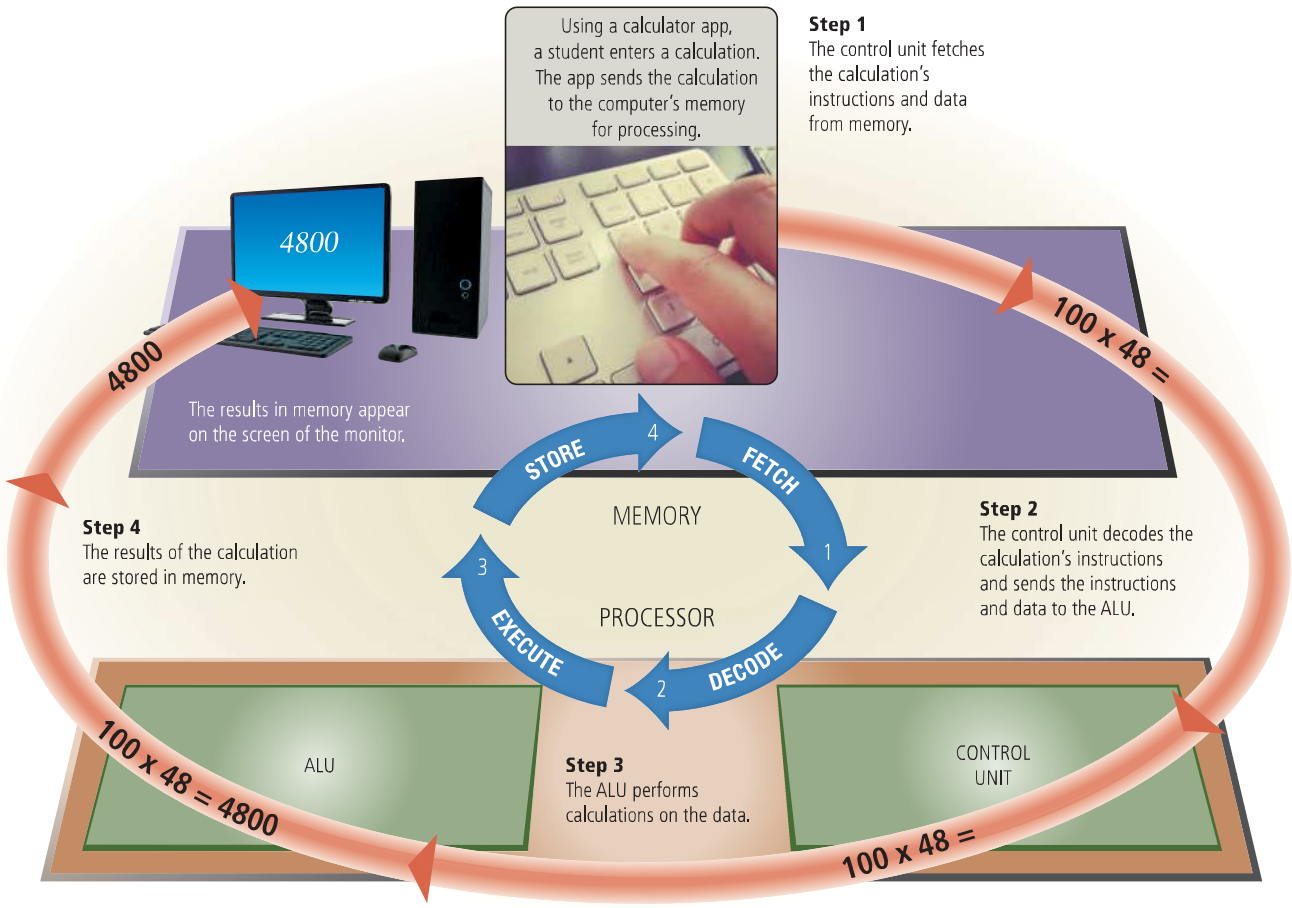


Figure 6-5 This figure shows the steps in a machine cycle.

Registers

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

BTW

System Clock and Peripheral Devices

The speed of the system clock has no effect on peripheral devices such as a printer or hard drive.

The System Clock

The processor relies on a small quartz crystal circuit called the **system clock** to control the timing of all computer operations. Just as your heart beats at a regular rate to keep your body functioning, the system clock generates regular electronic pulses, or ticks, that set the operating pace of components of the system unit.

Each tick equates to a *clock cycle*. Processors today typically are *superscalar*, which means they can execute more than one instruction per clock cycle.

The pace of the system clock, called the **clock speed**, is measured by the number of ticks per second. Current personal computer processors have clock speeds in the gigahertz range. Giga is a prefix that stands for billion, and a *hertz* is one cycle per second. Thus, one **gigahertz (GHz)** equals one billion ticks of the system clock per second. A computer that operates at 3 GHz has 3 billion (giga) clock cycles in one second (hertz).

The faster the clock speed, the more instructions the processor can execute per second. The speed of the system clock is just one factor that influences a computer's performance. Other factors, such as the type of processor chip, amount of cache, memory access time, bus width, and bus clock speed, are discussed later in this chapter.

Internet Research
What are the fastest processor clock speeds?
Search for: fastest processor

CONSIDER THIS

Does the system clock also keep track of the current date and time?
No, a separate battery-backed chip, called the *real-time clock*, keeps track of the date and time in a computer. The battery continues to run the real-time clock even when the computer is off.

Personal Computer and Mobile Device Processors

The leading manufacturers of personal computer processor chips are Intel and AMD. AMD manufactures *Intel-compatible processors*, which have an internal design similar to Intel processors, perform the same functions, and can be as powerful, but often are less expensive. These manufacturers often identify their processor chips by a model name or model number. Read How To 6-1 for items to consider when selecting a processor for a computer.

In the past, chip manufacturers listed a processor's clock speed in marketing literature and advertisements. As previously mentioned, though, clock speed is only one factor that impacts processing speed in today's computers. To help consumers evaluate various processors, manufacturers such as Intel and AMD now use a numbering scheme that more accurately reflects the processing speed of their chips.

BTW
Technology Innovators
Discover More: Visit this chapter's free resources to learn about Intel, Gordon Moore, and AMD.

HOW TO 6-1

Select the Right Processor

When you are shopping for a new computer, it is important to select one with a processor that will meet your needs. For example, some processors are designed for home users, some are designed for power users, and others are designed for mobile users. Performing basic research before you shop for a new computer can help you select the most appropriate processor. The following steps describe how to select the right processor.

1. **Determine your needs.** Think about how you will use your computer and the programs and applications you plan to run. If you will be using your computer for basic tasks, such as web browsing or checking email, you may require a less expensive processor than a user who will be running many programs and applications simultaneously.
2. **Determine your current processor.** If you are replacing your existing computer with a new computer, determine the processor in your existing computer so that you can make sure the new processor is better and faster than the one in use currently.
3. **Research processor models.** While shopping for computers in your price range, pay attention to the types of processors they include. Visit the processor manufacturer's website and verify that the processor will meet your computing needs adequately. Reviewing the minimum system requirements on the programs and apps you wish to run may help you determine the processor you need. Choose a processor that exceeds the minimum system requirements of the programs and apps you wish to run, but remember that it is not always necessary to purchase the most expensive computer with the fastest processor.

Consider This: What type of processor is in your current computer? If you were to upgrade your processor, which one would you choose? Why?

Courtesy of Intel

BTW
Technology Innovator
Discover More: Visit this chapter's free resources to learn about Nvidia, maker of high-performance graphics processors.

Processor chips include technologies to improve processing performance (for example, to improve performance of media and 3-D graphics). Some also include technology to track computer hardware and software, diagnose and resolve computer problems, and secure computers from outside threats. Processors for mobile computers also include technology to optimize and extend battery life and integrate wireless capabilities. Smaller mobile devices often use more compact processors that consume less power, yet offer high performance.

Discover More: Visit this chapter's free resources to learn more about processor chips.

CONSIDER THIS

Can you upgrade an existing computer's processor?
You might be able to upgrade a processor to increase the computer's performance. Be certain the processor you buy is compatible with your computer's motherboard; otherwise, you will have to replace the motherboard, too.

BTW
Mobile Device Cooling
Mobile devices often use low-voltage processors, which have such low power demands that they do not require additional cooling.

Processor Cooling

Processor chips for laptops, desktops, and servers can generate quite a bit of heat, which could cause the chip to malfunction or fail. Although the power supply on some computers contains a main fan to generate airflow, today's personal computer processors often require additional cooling. Some computer cases locate additional fans near certain components, such as a processor, to provide additional cooling. Heat sinks, liquid cooling technologies, and cooling mats often are used to help further dissipate processor heat.

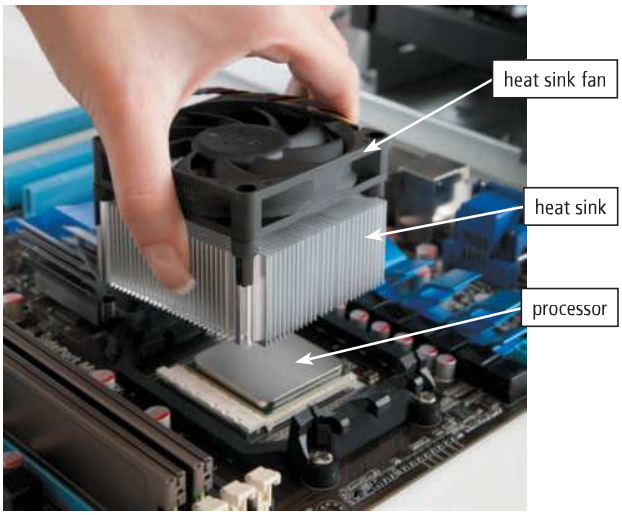


Figure 6-6 This photo shows a heat sink being attached to the top of a processor to prevent the chip from overheating.
© Claudio Bravo / Shutterstock.com

A *heat sink* is a small ceramic or metal component with fins on its surface that absorbs and disperses heat produced by electrical components, such as a processor. Many heat sinks have fans to help distribute air dissipated by the heat sink. Some heat sinks are packaged as part of a processor chip. Others are installed on the top or the side of the chip (Figure 6-6).

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

Laptop users often use a cooling pad to help further reduce the heat generated by their computer. A *cooling pad* rests below a laptop and protects the computer from overheating and also the user's lap from excessive heat (Figure 6-7). Some cooling pads contain a small fan to transfer heat away from the laptop. These types of cooling pads often draw power from a USB port. Instead of using power, other pads absorb heat through a conductive material inside the pad.

Figure 6-7 A laptop cooling pad helps reduce heat generated by a laptop.
Courtesy of Targus Group International, Inc; Courtesy of Targus Group International, Inc.

Mini Feature 6-1: The Internet of Things

The *Internet of Things* (*IoT*) describes a computing environment where everyday objects, or things, are connected to the Internet. Sensors connected to these objects may gather, share, transmit, and receive data about the objects with other devices or servers online. Users can

access the data or control individual objects using web or mobile apps. Read Mini Feature 6-1 to learn about types of devices used as things and technologies used to enable the IoT. Read Ethics & Issues 6-1 to consider whether the IoT discriminates, and read Secure IT 6-3 for privacy issues related to the IoT.

BTW
Technology Trend
Discover More: Visit this chapter's free resources to learn about self-driving cars.

MINI FEATURE 6-1

The Internet of Things

Analysts predict that the IoT will be a multitrillion-dollar business as the number of "smart" devices and things connected to the Internet continues to increase. As watches, thermostats, fitness trackers, appliances, clothing, and other "things" become equipped with sensors that can transmit data to and from the Internet, keeping every "thing" connected could become one of the world's largest industries.

From Devices to Things

Computers and mobile devices are not the only things that connect to the Internet. You can buy a thermostat, such as the one from Nest Labs shown in the figure, that allows you to adjust the temperature of your home from anywhere using an app on your smartphone. The thermostat contains a temperature sensor that can send and receive data. A wireless chip attached to your medicine bottle can send text messages to remind you to take your medication and then contact your pharmacy to refill the prescription when it is due for a refill. Smart trash cans in public places have sensors that monitor the amount of trash deposited and then send a message notifying owners when the containers need to be emptied. This saves garbage collectors from checking the containers every day; instead, they can empty the containers only when receiving a message that they are full.

Source: Nest Labs

Wearable technology, such as smartwatches and wristbands, can track your pulse and heart rate, as well as accept calls and display notifications from a smartphone. Many public buses and subways have GPS sensors that report their locations so that travelers can track them with mobile apps. Retailers can use beacons, which are devices that send low-energy Bluetooth signals to nearby smartphones, to notify customers who use a payment app such as Paypal, of personalized offers in their stores.

Washers and dryers in many college dormitory laundry rooms are connected to sensors that report the availability of an individual machine. Students can visit a website, use a mobile app, or request text message alerts to locate available machines before carrying their laundry to the laundry room.

Source: Mac-Gray Corporation

Technologies Enable the IoT

The IoT brings together several recent technology developments. Communications technologies, such as Bluetooth, RFID tags, near-field communications (NFC) tags, and sensors tracking heat (temperature), light, weight, or location have become readily available. Sensors and tags can transmit messages to a server on the Internet over a wireless network at frequent intervals for analysis and storage. Developments in Big Data have made it possible to access, store, and process all of this data reported by sensors efficiently. (To learn more about Big Data, read Mini Feature 11-1 in Chapter 11.) Mobile service providers offer connectivity to a variety of devices at broadband speeds, so transmitting and retrieving data can take place quickly. The size and cost of wireless radios has decreased, enabling more things to have embedded sensors, tags, and transmitters.

The capability of computers, devices, and everyday objects to communicate with one another over the Internet has opened new possibilities for both consumers and the enterprise to be more productive, efficient, and informed.

Discover More: Visit this chapter's free resources to learn more about the Internet of Things.

Consider This: Research one of the smart products described in the "From Devices to Things" section of this mini feature. Who manufactures or uses it? How does it work? What are the benefits to such a smart product? What object or thing do you wish was connected to the Internet? What data would you like it to send or capture? How might an app help you to control this object or access information about it? How would this improve your life?

ETHICS & ISSUES 6-1

Does the Internet of Things Discriminate?

Technology experts expect that the advantages brought by the expansion of the Internet of Things (IoT) will enhance the comfort, safety, and efficiency of a large population across the globe. Where does that leave people who are struggling to make ends meet? What about those who live in developing countries?

Among the IoT technologies that exist or are in development include the following examples. Students can find accurate information quickly and use cloud-based apps to store data so that it is accessible. The coordination of traffic lights based on GPS data will lead to a lessening of commute times. Wearable and implanted devices can collect and communicate health-related data. Sensors that monitor temperature, air and water quality and usage, and more, will reduce home ownership costs and security risks. Agricultural devices can monitor, track, and provide assessment of livestock and crops to lower costs and improve access to food.

Individuals or countries that cannot afford these and other IoT-related technologies may feel a negative impact as others take advantage of the effects brought by these technologies. Students without access to these technologies could be at a disadvantage. Workers with shorter travel times may enjoy a better quality of life. Those who cannot afford health-related devices may be at higher risk for illnesses or medical complications. Homeowners without IoT-enabled homes may be more prone to dangers, such as fires. Countries involved in agricultural exporting may lose business as others are able to reduce costs.

As costs of these technologies decrease, it is likely that the divide between the more and less fortunate will decrease. Awareness of the impact of the inequalities also may give rise to nonprofits or organizations that focus on providing IoT technologies to a larger population.

Consider This: In what other ways will IoT affect individuals and countries who cannot afford these technologies? What responsibility exists to make IoT technologies available to all?

SECURE IT 6-3

Does the Internet of Things Encroach on Privacy?

Being digitally observed in the connected world is inescapable. Every day, smart electric meters, wearable technology, and vehicles' black boxes submit data about us as part of the Internet of Things (IoT). Researchers predict billions of devices will be part of the IoT by the end of this decade. With all these devices in nearly every facet of our daily lives, data is being accumulated and sold to health care providers, home security businesses, utility companies, and researchers.

Savvy consumers can take some steps to attempt to limit exposure to data collection. They can enable privacy settings, for example, but that does not guarantee that data is not being gathered, transmitted, and compiled. The report of Smart TVs secretly collecting data about audiences' viewing habits sparked privacy and security concerns. Consumers need to urge companies to design products with built-in privacy protections. These devices could have default settings that prevent the sharing of data until obtaining the consumer's consent. Companies should explain what data is being collected and whether it will be used to help people live more productive lives or to create personal profiles that predict behavior. In addition, companies bear the responsibility of ensuring sensitive data being collected is kept secure and confidential.

Privacy and security concerns abound with the Internet of Things, but most consumers and technology experts believe that the security, health, and productivity benefits of this technology outweigh the potential risks.

Consider This: Should companies inform consumers about the data being collected in homes, vehicles, schools, and workplaces? What role should governmental agencies, such as the Federal Trade Commission, play in overseeing companies' secure products and commercial data collection techniques?

NOW YOU SHOULD KNOW

Be sure you understand the material presented in the sections titled Inside the Case and Processors as it relates to the chapter objectives.

Now you should know . . .

- Why you should protect the contents of computers and mobile devices (Objective 1)
- How processors in computers and mobile devices operate (Objective 2)
- Which processors might be best suited to your needs, and how to keep processors and other components from overheating (Objective 3)
- How you might interact with the Internet of Things (Objective 4)

Discover More: Visit this chapter's premium content for practice quiz opportunities.

Cloud Computing

Recall that cloud computing refers to an environment of servers that house and provide access to resources users access via the Internet. Home and business users choose cloud computing for a variety of reasons:

- **Accessibility:** Data and/or applications are available worldwide from any computer or device with an Internet connection.
- **Cost savings:** The expense of software and high-end hardware, such as fast processors and high-capacity memory and storage devices, shifts away from the user.
- **Space savings:** Floor space required for servers, storages devices, and other hardware shifts away from the user.
- **Scalability:** Provides the flexibility to increase or decrease computing requirements as needed.

Cloud computing consists of a front end and a back end, connected to each other through a network. The front end includes the hardware and software with which a user interacts to access the cloud. For example, a user might access a resource on the cloud through a browser on a laptop. The back end consists of the servers and storage devices that manage and store the resources accessed by users.

BTW
Technology Innovator
Discover More: Visit this chapter's free resources to learn about VMware, a provider of virtualization software and cloud computing services.

Internet Research
Which companies offer cloud computing services?
Search for: cloud computing providers

Mini Feature 6-2: Cloud Computing Services

Cloud computing allows companies to outsource, or contract to third-party providers, elements of their information technology infrastructure. They pay only for the computing power, storage, bandwidth, and access to applications that they actually use. As a result, companies need not make large investments in equipment, or the staff to support it. Read Mini Feature 6-2 to learn about available types of cloud computing services.

MINI FEATURE 6-2

Cloud Computing Services

Consumers and organizations rely on cloud computing services to manage IT infrastructure (infrastructure as a service), provide applications (software as a service), access online data (data as a service), and create, test, and deploy applications using web-based development tools (platform as a service).

Infrastructure as a Service

IaaS (infrastructure as a service) uses software to emulate hardware capabilities, enabling companies to scale, or adjust up or down, storage, processing power, or bandwidth as needed. For example, retailers may need to increase these capabilities to accommodate additional traffic to their websites during busy holiday shopping seasons. When the season ends, retailers easily can reduce these settings.

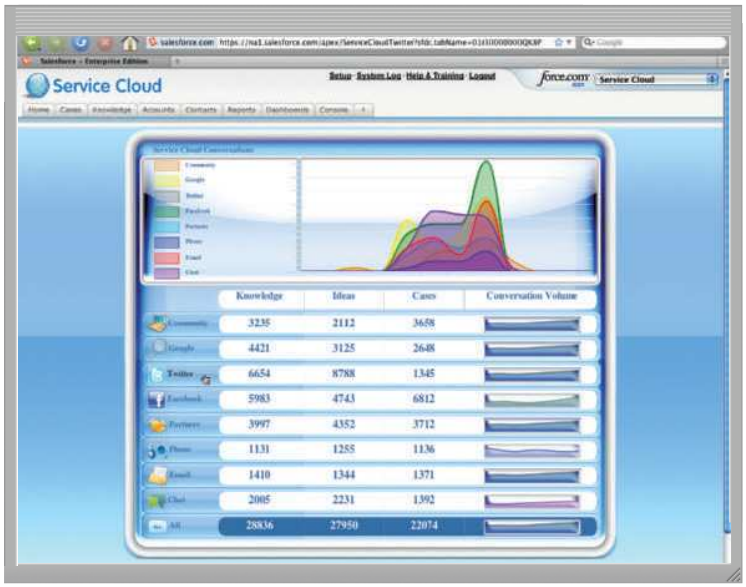
Two specific instances of IaaS are storage as a service and desktop as a service:

- **Storage as a Service:** Cloud storage providers offer file management services such as storing files online, system backup, and archiving earlier versions of files. Cloud storage is especially useful to tablet and smartphone users, because it enables them to access their files from all of their devices.
- **Desktop as a Service:** Some companies specify the applications, security settings, and computing resources available to employees on their desktop computers. These images, or configurations, provide a common desktop work environment available to employees across an entire organization. Because the desktop and its applications appear to be installed on the user's own computer, desktop as a service also is known as a *virtual desktop.*

Software as a Service

SaaS (software as a service) describes a computing environment where an Internet server hosts and deploys applications. Editing documents or photos, sending email messages, and managing finances are common consumer tasks of SaaS applications. A pioneering provider of SaaS applications for companies is Salesforce (shown in the figure in this mini feature), which offers customer relationship management (CRM) software. Salesforce users subscribe to modules to handle tasks such as sales and marketing campaigns and customer services.

(*continued*)



Source: Courtesy Salesforce.com

Data as a Service

Government agencies, companies, and social media sites make data available for developers to incorporate in applications or to use when making business decisions and plans. *DaaS (data as a service)* allows users and applications to access a company's data. *Mashups* are applications that incorporate data from multiple providers into a new application. Displaying homes or crime statistics on a map are examples of mashups that require data from real estate, police records, and mapping providers.

Platform as a Service

Application developers need to maintain computers running specific hardware, operating systems, development tools, databases, and other software. *PaaS (platform as a service)* allows developers to create, test, and run their solutions on a cloud platform without having to purchase or configure the underlying hardware and software.

Discover More: Visit this chapter's free resources to learn more about the various cloud services described in this mini feature.

Consider This: Cloud computing services are based on a "pay as you go" model. How are cloud services different from desktop or mobile applications? What services are customers paying for from an SaaS provider? Under what circumstances might it be advantageous to purchase an external hard drive to store your files, rather than storing them on a third-party server on the cloud?

Data Representation

To understand how a computer processes data, you should know how a computer represents data. People communicate through speech by combining words into sentences. Human speech is **analog** because it uses continuous (wave form) signals that vary in strength and quality. Most computers are **digital**. They recognize only two discrete states: on and off. This is because computers are electronic devices powered by electricity, which also has only two states: on and off.

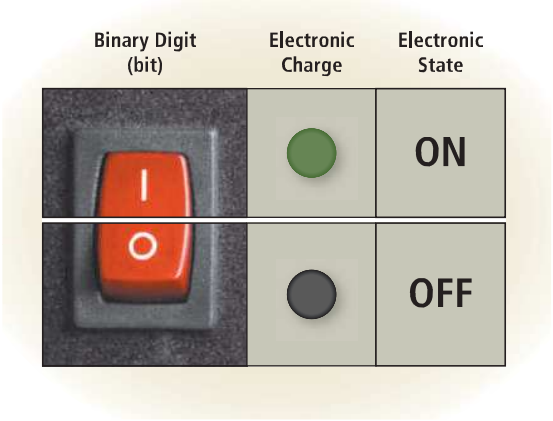


Figure 6-8 The circuitry in a computer or mobile device represents the on or the off states electronically by the presence or absence of an electronic charge.

Bits and Bytes

The two digits, 0 and 1, easily can represent these two states (Figure 6-8). The digit 0 represents the electronic state of off (absence of an electronic charge). The digit 1 represents the electronic state of on (presence of an electronic charge).

When people count, they use the 10 digits in the decimal system (0 through 9). The computer, by contrast, uses a binary system because it recognizes only two states. The **binary system** is a number system that has just two unique digits, 0 and 1, called bits. A **bit** (short for *binary digit*) is the smallest unit of data the computer can process. By itself, a bit is not very informative.

When 8 bits are grouped together as a unit, they form a **byte**. A byte provides enough different combinations of 0s and 1s to represent 256 different characters. These characters include numbers, uppercase and lowercase letters of the alphabet, punctuation marks, and other keyboard symbols, such as an asterisk (*), ampersand (&), and dollar sign ($).

Coding Schemes

The combinations of 0s and 1s that represent uppercase and lowercase letters, numbers, and special symbols are defined by patterns called a coding scheme. Coding schemes map a set of *alphanumeric characters* (letters and numbers) and special symbols to a sequence of numeric values that a computer can process. *ASCII* (pronounced ASK-ee), which stands for American Standard Code for Information Interchange, is the most widely used coding scheme to represent a set of characters. In the ASCII coding scheme, for example, the alphabetic character E is represented as 01000101; the symbolic character * is represented as 00101010; the numeric character 6 is represented as 00110110 (Figure 6-9).

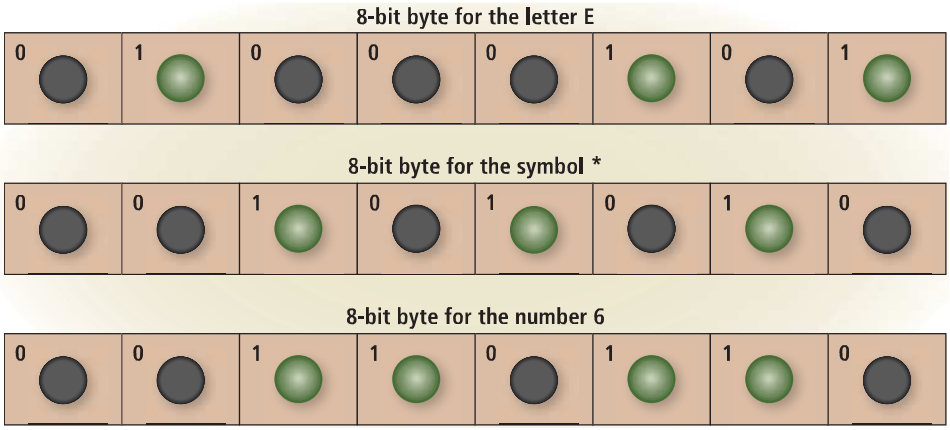


Figure 6-9 Eight bits grouped together as a unit are called a byte. A byte represents a single character in the computer or mobile device.

When you press a key on a keyboard, a chip in the keyboard converts the key's electronic signal into a special code, called a scan code, that is sent to the electronic circuitry in the computer. Then, the electronic circuitry in the computer converts the scan code into its ASCII binary form and stores it as a byte value in its memory for processing. When processing is finished, the computer converts the byte into a human-recognizable number, letter of the alphabet, or special character that is displayed on a screen or is printed (Figure 6-10). All of these conversions take place so quickly that you do not realize they are occurring.

BTW
High-Tech Talk
Discover More: Visit this chapter's free resources to learn more about coding schemes and number systems.

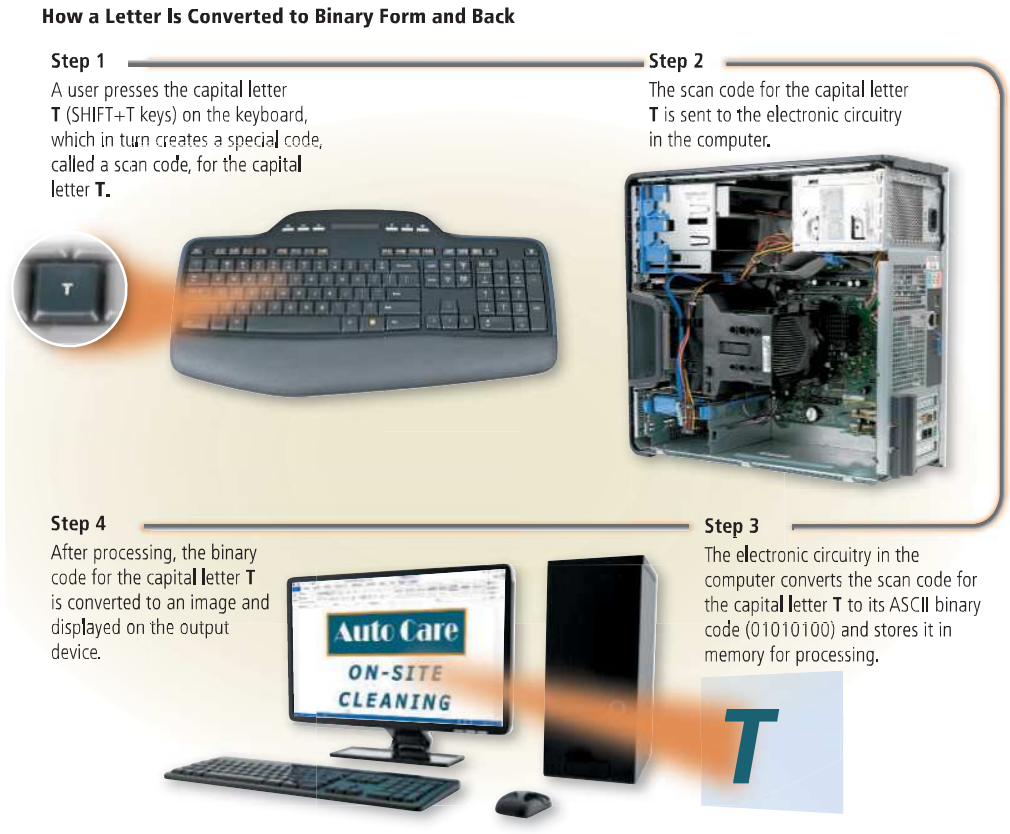


Figure 6-10 This figure shows how a letter is converted to binary form and back.

CONSIDER THIS

Why are coding schemes necessary?

Computers rely on logic circuits, which are controlled by electronic switches whose state can be either on or off. Each switch's on/off state is represented by one bit, whose value is either 0 or 1. Coding schemes translate real-world data into a form that computers can process easily.

Memory

Memory consists of electronic components that store instructions waiting to be executed by the processor, data needed by those instructions, and the results of processing the data (information). Memory usually consists of one or more chips on the motherboard or some other circuit board in the computer. Memory stores three basic categories of items:

1. The operating system and other programs that control or maintain the computer and its devices
2. Applications that carry out a specific task, such as word processing
3. The data being processed by the applications and the resulting information

This role of memory to store both data and programs is known as the *stored program concept*.

Bytes and Addressable Memory

A byte (character) is the basic storage unit in memory. When an application's instructions and data are transferred to memory from storage devices, the instructions and data exist as bytes. Each byte resides temporarily in a location in memory that has an address. Simply put, an *address* is a unique number that identifies the location of a byte in memory. To access data or instructions in memory, the computer references the addresses that contain bytes of data. The photo in Figure 6-11 shows how seats in a stadium are similar to addresses in memory: (1) a seat, which is identified by a unique seat number, holds one person at a time, and a location in memory, which is identified by a unique address, holds a single byte; and (2) both a seat, identified by a seat number, and a byte, identified by an address, can be empty.

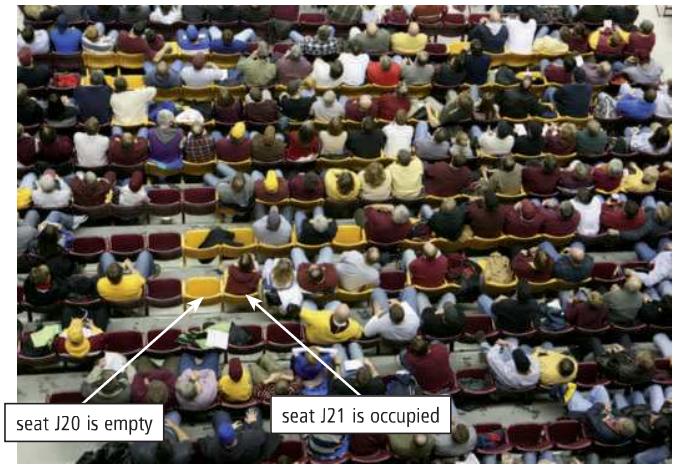


Figure 6-11 Seats in a stadium are similar to addresses in memory: a seat holds one person at a time, and a location in memory holds a single byte; and both a seat and a byte can be empty.

Manufacturers state the size of memory in terms of the number of bytes it has available for storage. Common sizes for memory are in the gigabyte and terabyte range. A *gigabyte* (*GB*) equals approximately 1 billion bytes. A *terabyte* (*TB*) is equal to approximately 1 trillion bytes.

Types of Memory

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

RAM

Users typically are referring to RAM when discussing computer and mobile device memory. **RAM** *(random access memory)*, also called *main memory*, consists of memory chips that can be read from and written to by the processor and other devices. When you turn on power to a computer or mobile device, certain operating system files (such as the files that determine how the desktop

or home screen appears) load into RAM from a storage device such as a hard drive. These files remain in RAM as long as the computer or mobile device has continuous power. As additional applications and data are requested, they also load into RAM from storage.

The processor interprets and executes a program or application's instructions while the program or application is in RAM. During this time, the contents of RAM may change (Figure 6-12). RAM can accommodate multiple programs and applications simultaneously.

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

How Program Instructions Transfer in and out of RAM

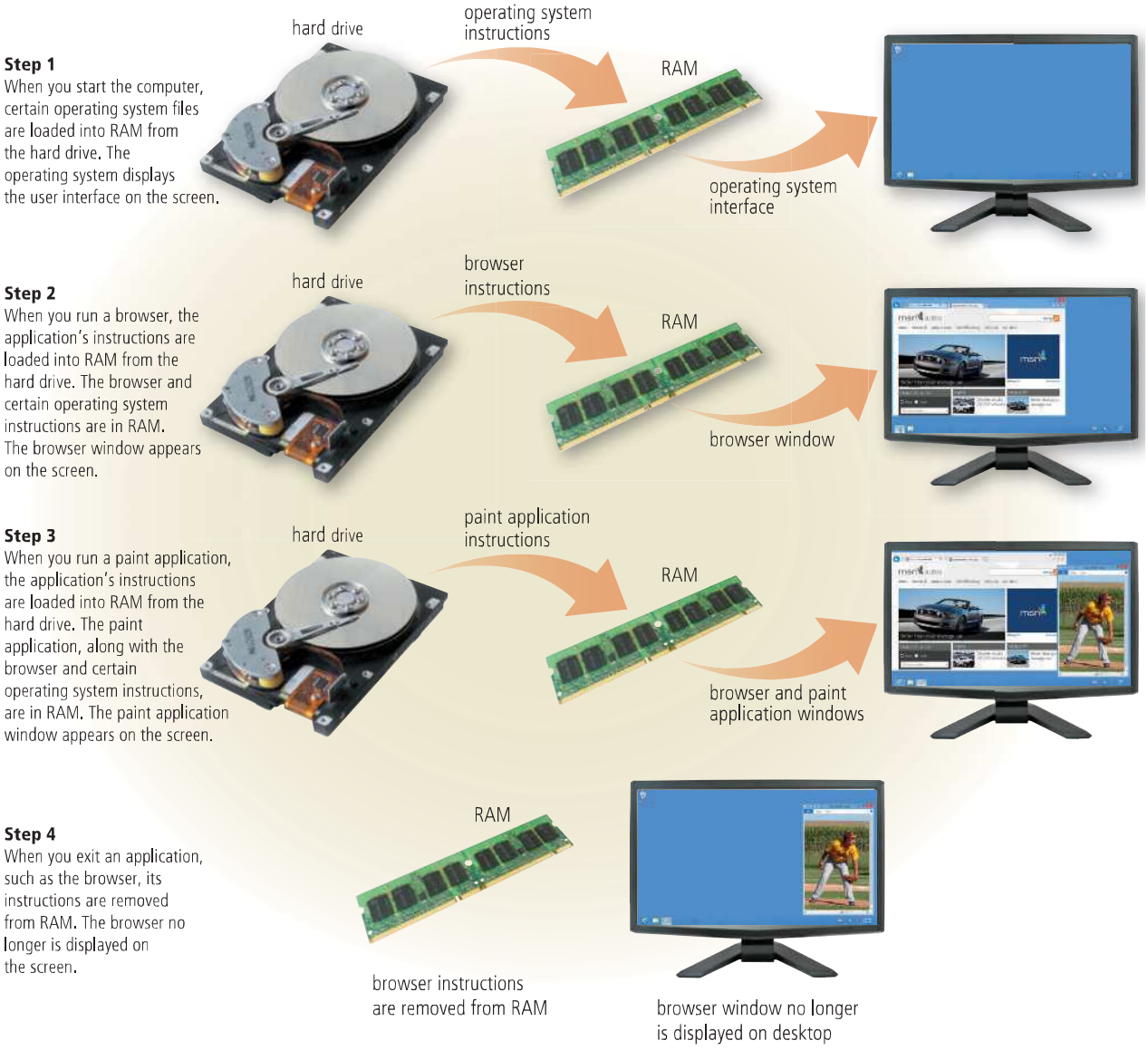


Figure 6-12 This figure shows how program and application instructions transfer in and out of RAM.

Types of RAM Two common types of RAM are dynamic RAM and static RAM:

- *Dynamic RAM* (*DRAM* pronounced DEE-ram) chips must be reenergized constantly or they lose their contents. Many variations of DRAM chips exist, most of which are faster than the basic DRAM (Table 6-1).
- *Static RAM* (*SRAM* pronounced ESS-ram) chips are faster and more reliable than any variation of DRAM chips. These chips do not have to be reenergized as often as DRAM chips; hence, the term, static. SRAM chips, however, are much more expensive than DRAM chips. Special applications, such as cache, use SRAM chips. A later section in this chapter discusses cache.

Read How To 6-2 for instructions about determining memory requirements.

Table 6-1 Common DRAM Variations

Name	Comments
SDRAM (Synchronous DRAM)	• Synchronized to the system clock • Much faster than DRAM
DDR SDRAM (Double Data Rate SDRAM)	• Transfers data twice, instead of once, for each clock cycle • Faster than SDRAM
DDR2	• Second generation of DDR • Faster than DDR
DDR3	• Third generation of DDR • Designed for computers with multi-core processors • Faster than DDR2
DDR4	• Fourth generation of DDR • Faster than DDR3
RDRAM (Rambus DRAM)	• Much faster than SDRAM

Discover More: Visit this chapter's free resources to learn about additional DRAM variations.

HOW TO 6-2

Determine Memory Requirements

If you are shopping for a new computer or looking to upgrade your existing computer, be sure that it will have sufficient memory. When a computer has insufficient memory, its performance can slow significantly. On the other hand, it would be an unnecessary expense to purchase a computer with more memory than you will ever use. The following steps describe how to determine memory requirements.

1. If you are upgrading the memory in your existing computer, determine the following:
   a. Amount of memory currently installed
   b. Amount of memory the computer can support
   c. Type of memory modules currently installed
   d. Whether memory modules must be installed in pairs
   e. Number of available slots for memory modules
2. Determine the amount of memory your computer requires by checking the memory requirements for the operating system and programs and applications you plan to run. You can find the system requirements, which will specify the memory requirements, on product packaging or on a software manufacturer's website. If you are planning to upgrade your computer and the amount of memory you require exceeds the amount of memory your computer currently can support, you may need to purchase a new computer. If you are purchasing a new computer, view the computer's specifications to make sure it has sufficient memory. Some online vendors offer a web app that will check the configuration on your computer to determine the memory modules that are compatible and offer options to you for purchase.
3. Once you have determined your memory requirements, you are ready to purchase the memory modules. Memory modules are available for purchase in many computer and electronic stores, directly from computer manufacturers, and on various websites. When you are purchasing memory modules, keep the following in mind:
   a. Many types of memory modules are available. Purchase a type, size, and speed that is compatible with your computer.
   b. If your computer requires that you install memory in pairs, be sure to purchase two memory modules that are the same type, size, and speed.
   c. Do not purchase more memory modules than you have slots available. You may need to remove existing memory modules to make room for new memory modules.

Consider This: How much memory would be appropriate for your computer based on your current computing needs?

Memory Modules RAM chips usually reside on a memory module, which is a small circuit board. Memory slots on the motherboard hold memory modules.

Two types of memory modules are SIMMs and DIMMs (Figure 6-13). A *SIMM* (single inline memory module) has pins on opposite sides of the circuit board that connect together to form a single set of contacts. With a *DIMM* (dual inline memory module), by contrast, the pins on opposite sides of the circuit board do not connect and, thus, form two sets of contacts. Read How To 6-3 for instructions about installing memory modules.

BTW
High-Tech Talk
Discover More: Visit this chapter's free resources to learn how data is written to RAM.

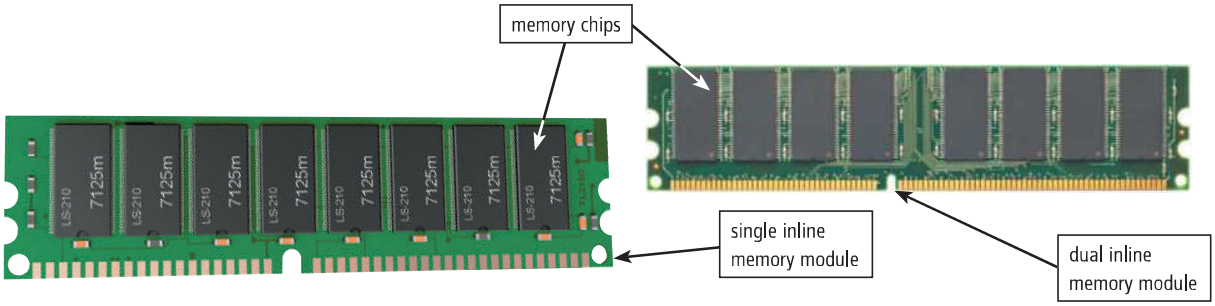


Figure 6-13 Memory modules contain memory chips.

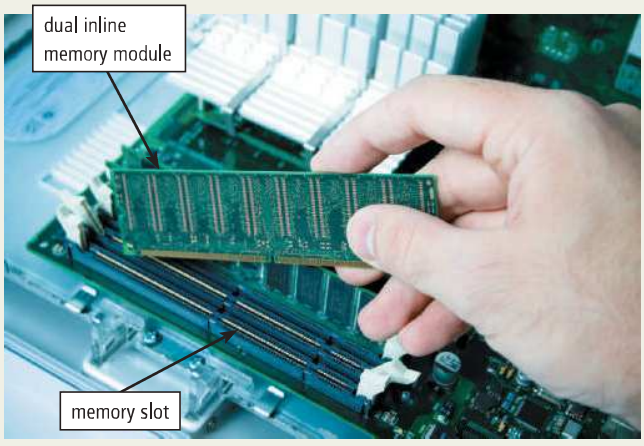
HOW TO 6-3

Install Memory Modules

Installing additional memory modules in a desktop or laptop can be a relatively easy process. The following steps describe how to install new memory modules.

1. Turn off and unplug your computer from the power source. If you are using a laptop, remove its battery.
2. Wear an antistatic wristband to protect the computer from static electricity.
3. Remove or open the computer case. If you are upgrading a laptop, you may be able to locate the slots for the memory modules through an access panel.
4. If necessary, remove any existing memory modules you no longer need. If clips are holding the memory module in place, you may need to pull the clips away from the memory module before removing it. Remove the memory modules by lifting them out by the side edges.
5. Remove the new memory modules from the packaging.
6. Slowly and carefully insert the memory modules into the slots on your computer's motherboard. Be sure they are facing the correct way as you insert them. The memory modules should "click" in place once they are inserted completely.
7. Close the computer case or any access panel you have opened.
8. Plug in the computer and turn it on.
9. Check the system information in the operating system to make sure it is recognizing the new amount of memory installed.

Consider This: Why might it not be possible to install memory modules in some types of computers?



Cache

Most of today's computers improve their processing times with **cache** (pronounced cash), which is a temporary storage area. Two common types of cache are memory cache and disk cache. This chapter discusses memory cache. Chapter 8 discusses disk cache.

Memory cache helps speed the processes of the computer because it stores frequently used instructions and data. Most personal computers today have two types of memory cache: Level 1 (L1) cache and Level 2 (L2) cache. Some also have Level 3 (L3) cache.

BTW
L2 Cache
When discussing cache, most users are referring to L2 cache.

- *L1 cache* is built directly on the processor chip. L1 cache usually has a very small capacity.
- *L2 cache* is slightly slower than L1 cache but has a much larger capacity. Current processors include *advanced transfer cache* (*ATC*), a type of L2 cache built directly on the processor chip. Processors that use ATC perform at much faster rates than those that do not use it.
- *L3 cache* is a cache on the motherboard that is separate from the processor chip. L3 cache exists only on computers that use L2 advanced transfer cache.

When the processor needs an instruction or data, it searches memory in this order: L1 cache, then L2 cache, then L3 cache (if it exists), then RAM — with a greater delay in processing for each level of memory it must search (Figure 6-14). If the instruction or data is not found in memory, then it must search a slower speed storage medium, such as a hard drive or optical disc.

Discover More: Visit this chapter's free resources to learn more about memory cache.

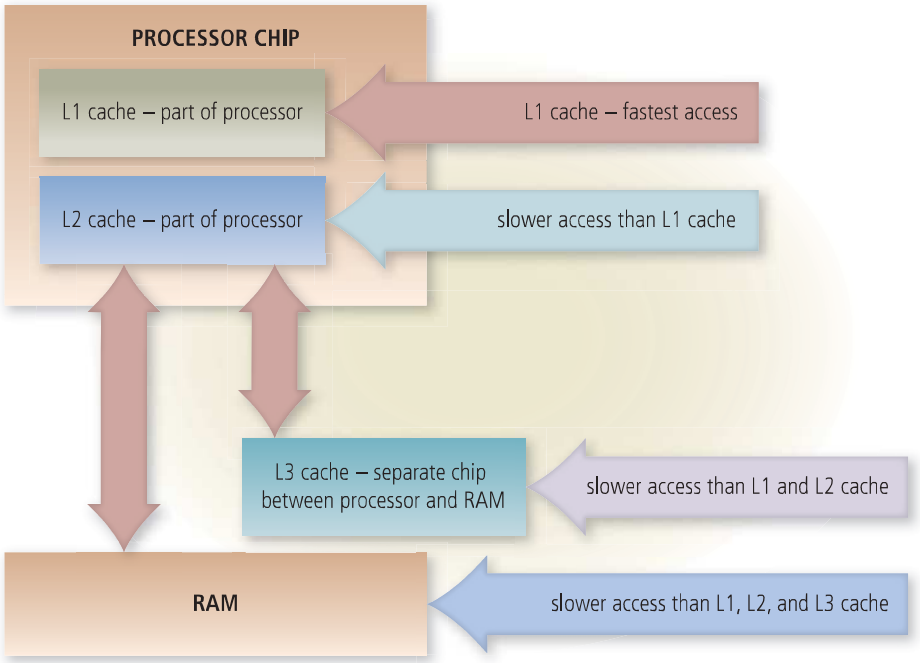


Figure 6-14 Memory cache helps speed processing times when the processor requests data, instructions, or information.

ROM

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

Manufacturers of ROM chips often record data, instructions, or information on the chips when they manufacture the chips. These ROM chips, called **firmware**, contain permanently written data, instructions, or information, such as a computer or mobile device's start-up instructions. Read Ethics & Issues 6-2 to consider issues related to the manufacture of computer and mobile device components.

ETHICS & ISSUES 6-2

Should Companies Reveal Which Products They Manufacture Using Fair Trade Practices?

Despite the increased cost, many coffee and tea drinkers gladly purchase fair trade products. Fair trade labels indicate that the workers who pick the coffee beans or tea leaves work in humane conditions and receive fair pay for their labor.

With respect to technology, several cases of unfair labor practices exist. Some technology manufacturers use products or components made in areas of extreme poverty. In these cases, factory owners coerce workers, including children, to work long hours in unsafe or unsanitary conditions for little pay and without breaks. In another example, mining for the raw materials needed to manufacture technology components may occur in areas where military conflict exists. Those involved in the military conflict may use the revenue from mining this material, sometimes called conflict minerals, to fund the soldiers and continue the discord.

Under a rule recently adopted by the U.S. Securities and Exchange Committee (SEC), manufacturers must review their supply sources and file a form disclosing any materials mined in areas of conflict. Failure to disclose may have legal consequences, as well as attract the attention of human rights and environmental activists. Critics of this rule state that it does not address methods to ease situations of conflict, and may take jobs away from the workers. In addition, the rule applies only to manufacturers, not to retailers or distributors.

The Fair Labor Association (FLA) provides workplace standards for the environment and treatment of workers at all stages of product development. Many technology companies are making efforts to comply with the SEC ruling, as well as FLA guidelines. Providing a living wage, ensuring worker safety, and mandating that workers receive breaks are some of the guidelines.

Consider This: Would you pay more for a fair trade smartphone or laptop? Why or why not? Are retailers responsible for the source of the materials used in products they sell? Why or why not? Should the government require companies to comply with fair trade policies? Why or why not?

Flash Memory

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

Flash memory chips also store data and programs on many mobile devices and peripheral devices, such as smartphones, portable media players, printers, digital cameras, automotive devices, and digital voice recorders. When you enter names and addresses in a smartphone, for example, a flash memory chip stores the data. Some portable media players store music on flash memory chips; others store music on tiny hard drives or memory cards. Memory cards contain flash memory on a removable device instead of a chip. Read Secure IT 6-4 for tips about deleting data on a smartphone.

SECURE IT 6-4

Wiping Mobile Phone Memory

If you ever have lent your smartphone to someone, left it sitting on your desk at school or work, or placed it in your car's center console at valet parking, you might have provided someone access without your consent to all your personal data stored on that device. A thief can plug a small device, called a *Cellular Seizure Investigation (CSI) stick*, into the phone and then download sensitive data in seconds.

While this unscrupulous activity seems alarming, a similar action occurs every day when smartphone users recycle or sell their devices without wiping all their personal records from memory. A person buying or acquiring the phone then can access the sensitive data left in memory. Some recyclers claim that 95 percent of the mobile phones they receive are not completely cleaned.

A kill switch allows smartphone owners to delete all data or to disable their devices remotely in the event of theft or loss. Since 2015, all smartphones sold in California must include this device, and federal and other state lawmakers have proposed requiring all manufacturers to include this switch in their products.

Deleting all data from a mobile phone's memory is a relatively simple process, but it is not a universal procedure. Each device has its own set of steps described in the owner's manual or online. In general, users must locate their device's settings area on a menu and then look for a reset command. Most electronics manufacturers post instructions for this process on their websites. Mobile phone retailers often can offer help in clearing personal data; if you resort to this measure, be certain to watch the sales associate perform this action. If your mobile phone has a SIM or memory card, remove and destroy it if you are not going to transfer it to another phone. Employees who use their phone to access email messages on corporate servers sometimes are required to enter a passcode on the phone so that if it is lost or stolen, the data can be wiped remotely.

Consider This: Have you ever wiped the memory of your mobile phone? What action would you take if you received or bought a used mobile phone and then discovered the previous owner's personal information stored in memory? Should lawmakers require smartphone manufacturers to include a kill switch in their products? Why or why not?

CMOS

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

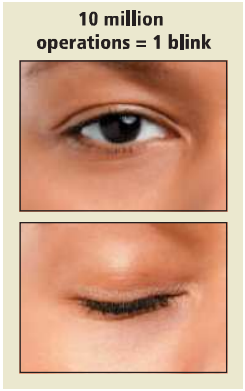


Figure 6-15 It takes about one-tenth of a second to blink your eye, in which time a computer can perform some operations 10 million times.

Memory Access Times

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

Today's manufacturers use a variety of terminology to state access times (Table 6-2). Some use fractions of a second, which for memory occurs in nanoseconds. A *nanosecond* (abbreviated *ns*) is one billionth of a second. A nanosecond is extremely fast (Figure 6-15). In fact, electricity travels about one foot in a nanosecond.

Table 6-2 Access Time Terminology

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

CONSIDER THIS

What if a manufacturer states access times in megahertz instead of fractions of a second?

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

While access times of memory greatly affect overall computer performance, manufacturers and retailers often list a computer's memory in terms of its size, not its access time. For example, an advertisement might describe a computer as having 8 GB of RAM.

NOW YOU SHOULD KNOW

Be sure you understand the material presented in the sections titled Cloud Computing, Data Representation, and Memory, as it relates to the chapter objectives.

Now you should know . . .

- Which cloud computing service is best suited to your needs (Objective 5)
- How your computers and mobile devices represent data (Objective 6)
- How memory on your computer or mobile device works with your programs and applications (Objective 7)
- When you are using RAM, cache, ROM, flash memory, and CMOS (Objective 8)

Discover More: Visit this chapter's premium content for practice quiz opportunities.

Adapters

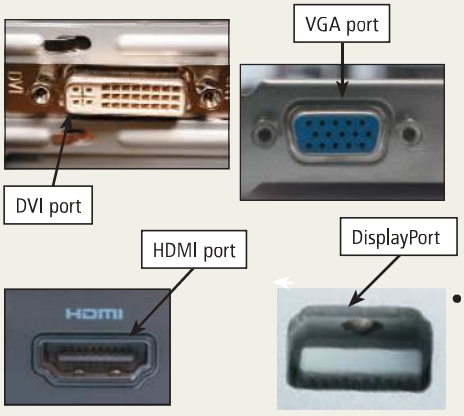
Although the circuitry in many of today's computers integrates all the necessary functionality, some require additional capabilities in the form of adapters. Desktops and servers use adapter cards; mobile computers use USB adapters. Read How To 6-4 to learn about ports you might consider including in a computer or mobile device that can eliminate the need for adapters.

HOW TO 6-4

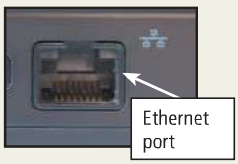
Determine Which Ports You Need on a Computer or Mobile Device

When purchasing a computer or mobile device, it is important to make sure it has the correct ports so that you can connect your peripheral devices. The following list will help identify the ports you need on a computer or mobile device.

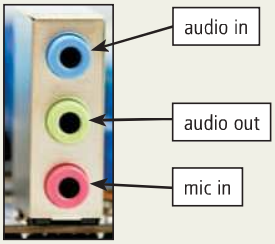
- **Displays:** If you plan to connect your computer or mobile device to a display such as a monitor or projector, make sure your computer or mobile device has a port that is compatible with the display. For example, if you plan to connect a laptop to a monitor that has an HDMI port, your computer or mobile device should have a port capable of HDMI output.



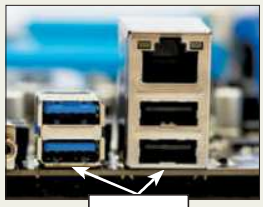
- **Networking:** If you plan to connect your computer or mobile device to a wired computer network, it should have an Ethernet port to which you can connect network cables.



- **Audio:** If you plan to connect your computer or mobile device to an audio output device, such as speakers, headphones, or earbuds, your computer or mobile device should have a port for audio output. If you are connecting an external microphone or other device that provides audio, your computer or mobile device should have a port for audio input.



- **Other Input, Output, and Storage Devices:** If you plan to connect other devices, such as a keyboard, mouse, external hard drive, or printer, look at the cable that connects this device to the computer, and make sure your computer has a port that will accept the connector on the cable. In many cases, these devices will connect to your computer using a USB connection. Make sure your computer has a sufficient number of USB ports to support the devices you want to connect. If you are unable to connect a computer with enough USB ports, you can purchase a USB hub.



If your computer or mobile device does not have the ports you need, you may be able to purchase an adapter that converts an existing port to one that can connect to the desired device.

Consider This: In addition to the devices discussed in this box, what other devices might you connect to your computer or mobile device?

Adapter Cards

An **adapter card**, sometimes called an *expansion card* or *adapter board*, is a circuit board that enhances the functions of a component of a desktop or server system unit and/or provides connections to peripheral devices. An **expansion slot** is a socket on a desktop or server motherboard that can hold an adapter card. Figure 6-16 shows some adapter cards in expansion slots on a desktop motherboard.

Two popular adapter cards are sound cards and video cards. A *sound card* enhances the sound-generating capabilities of a personal computer by allowing sound to be input through a

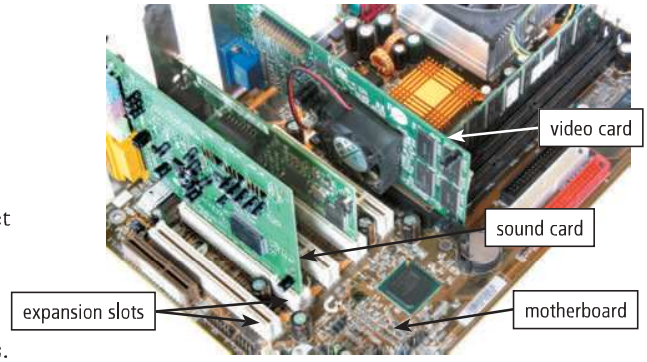


Figure 6-16 Cards inserted in expansion slots on a desktop motherboard.

microphone and output through external speakers or headphones. A *video card*, also called a *graphics card*, converts computer output into a video signal that travels through a cable to the monitor, which displays an image on the screen. Table 6-3 identifies the purpose of some adapter cards. Sometimes, all functionality is built in the adapter card. With others, a cable connects the adapter card to a device, such as a digital video camera, outside the computer.

Today's computers support **Plug and Play** technology, which means the computer automatically can recognize peripheral devices as you install them. Plug and Play support means you can plug in a device and then immediately begin using it. Read Secure IT 6-5 for issues related to Plug and Play technology.

Table 6-3 Adapter Cards

Type	Purpose
Bluetooth	Enables Bluetooth connectivity
MIDI	Connects to musical instruments
Modem	Connects to transmission media, such as cable television lines or phone lines
Network	Provides network connections, such as to an Ethernet port
Sound	Connects to speakers or a microphone
TV tuner	Allows viewing of digital television broadcasts on a monitor
USB	Connects to high-speed USB ports
Video	Provides enhanced graphics capabilities, such as accelerated processing or the ability to connect a second monitor
Video capture	Connects to a video camera

SECURE IT 6-5

Plug and Play Security Flaws

Plug and Play technology allows your computer to recognize peripheral devices and begin using them immediately after they are installed. This support permits computers to connect and communicate with devices easily, but it also creates security flaws that allow hackers to take control of security systems, routers, Smart TVs, printers, webcams, and other devices connected to the Internet.

According to Rapid7, a security firm that uncovered these defects, between 40 and 50 million devices are susceptible to remote attacks. Rapid7 has developed a scanner tool to check vulnerabilities and identify affected hardware. Security experts recommend turning off or disabling any Plug and Play device not being used on a network that accesses the Internet.

Consider This: Would you consider checking your home network to discover Plug and Play security weaknesses or disabling devices? What steps can manufacturers take to minimize these vulnerabilities?

USB Adapters

Because of their smaller size, mobile computers typically do not have expansion slots. Instead, users can purchase a **USB adapter**, which is a dongle that plugs into a USB port, enhances functions of a mobile computer, and/or provides connections to peripheral devices (Figure 6-17). USB adapters can be used to add memory, communications, multimedia, security, and storage capabilities to mobile computers. A USB flash drive is a common USB adapter that provides computers and mobile devices with additional storage capability as long as it is plugged in. Read Ethics & Issues 6-3 to consider whether manufacturers should eliminate proprietary connectors.

Unlike adapter cards that require you to open the system unit and install the card on the motherboard, you can change a removable flash memory device without having to open the system unit or restart the computer. This feature, called *hot plugging*, allows you to insert and remove a device while the computer is running (be sure, though, to stop or eject the device before removing it).

ETHICS & ISSUES 6-3

Should Manufacturers Eliminate Proprietary Connectors?

If you need to replace the cable that connects your mobile device to a USB port, you might have a choice of many makes, models, and prices. Some devices, however, require the use of proprietary connectors, limiting your options to those manufacturers who make connectors that match the port on your mobile device.

When Apple released the iPhone 5 in 2012, for example, it required the use of a proprietary connector that was incompatible with connectors used with prior iPhone models and other Apple devices. Apple developed the connector, called Lightning, in part to eliminate problems caused by attempts to attach the cord the wrong way. With Lightning, users can attach the cord in either direction without causing damage to the port or device. Critics argue that requiring customers to purchase proprietary connectors increases the cost of purchasing or upgrading a mobile device.

The International Electronics Commission (IEC) is working with major technology providers to make micro USB the universal connector standard used to charge mobile devices. This type of universal standard has several advantages. It will save customers money because they will not have to purchase a new connector with their new device, even if it is a different brand. A universal standard connector also will enable users with different device models to share connectors. The environment will benefit because fewer outdated or incompatible cords will find their way into landfills. Further, the manufacturing process will generate less waste because fewer cords will be required.

Consider This: Should customers pressure manufacturers to use a universal connector standard? Why or why not? Would you consider the connector type when purchasing a new phone? Why or why not?

Figure 6-17 A USB adapter inserts into a USB port on a computer or mobile device.

Buses

As explained earlier in this chapter, a computer processes and stores data as a series of electronic bits. These bits transfer internally within the circuitry of the computer along electrical channels. Each channel, called a **bus**, allows the various devices both inside and attached to the system unit to communicate with one another. Just as vehicles travel on a highway to move from one destination to another, bits travel on a bus (Figure 6-18).

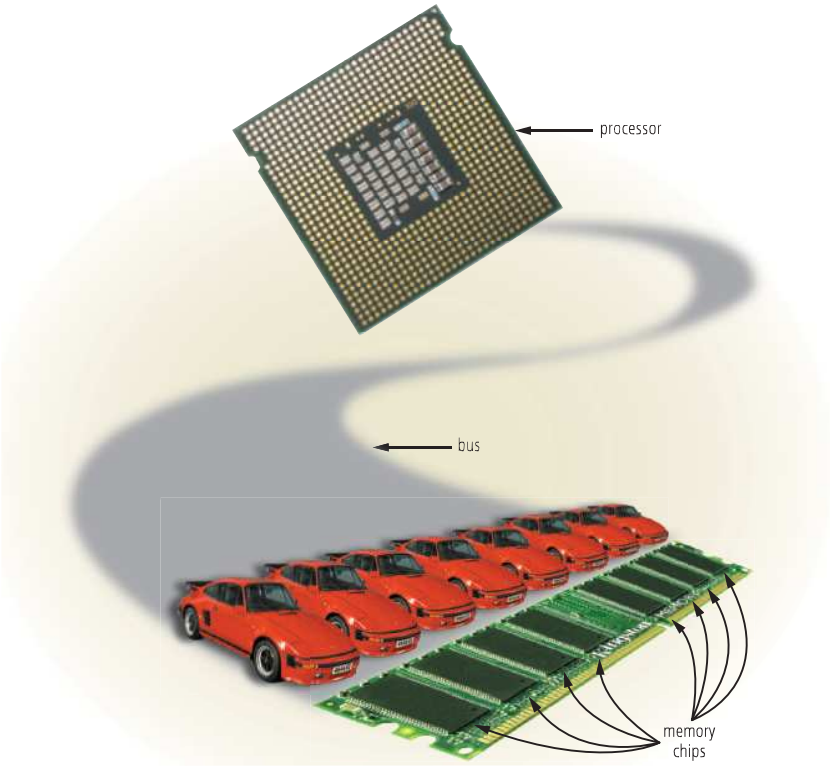


Figure 6-18 Just as vehicles travel on a highway, bits travel on a bus. Buses are used to transfer bits from input devices to memory, from memory to the processor, from the processor to memory, and from memory to output or storage devices.

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

Bus Width

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

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

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

CONSIDER THIS

How is bus speed measured?

Every bus also has a clock speed. Just like the processor, manufacturers state the clock speed for a bus in hertz. The higher the bus clock speed, the faster the transmission of data, which results in programs running faster.

Types of Buses

A computer has a system bus, possibly a backside bus, and an expansion bus.

- A *system bus*, also called the *front side bus* (*FSB*), is part of the motherboard and connects the processor to main memory.
- A *backside bus* (*BSB*) connects the processor to cache.
- An *expansion bus* allows the processor to communicate with peripheral devices.

When computer professionals use the term, bus, by itself, they usually are referring to the system bus.

Power Supply and Batteries

Many personal computers plug in standard wall outlets, which supply an alternating current (AC) of 115 to 120 volts. This type of power is unsuitable for use with a computer or mobile device, which requires a direct current (DC) ranging from 5 to more than 15 volts. The **power supply** or laptop AC adapter converts the wall outlet AC power into DC power (Figure 6-19). Different motherboards and computers require different wattages on the power supply. If a power supply is not providing the necessary power, the computer will not function properly.

Figure 6-19 Examples of desktop power supply and laptop AC adapter.
© robootb / Shutterstock.com; © iStockphoto / Freer Law

Built into the power supply is a fan that keeps the power supply cool. Some have variable speed fans that change speed or stop running, depending on temperature in the case. Many newer computers have additional fans near certain components in the system unit, such as the processor, hard drive, and ports. Some users install more fans to help dissipate heat generated by the components of the computer.

CONSIDER THIS

How many fans are in a desktop case?

Most have at least three fans: one in the power supply, one in the case, and one on the processor heat sink. In addition, you also might find a fan on a video card or other adapter card. While some computers contain fans that are designed to be quiet or operate in quiet mode, others allow you to turn off noisy fans until they are needed. You also can purchase programs that slow or stop the fan until the temperature reaches a certain level.

Some external peripheral devices, such as a cable modem, speakers, or a printer, have an AC adapter, which is an external power supply. One end of the AC adapter plugs in the wall outlet and the other end attaches to the peripheral. The AC adapter converts the AC power into the DC power that the peripheral requires, and also often charges the battery in a mobile computer or device.

Mobile computers and devices can run using either a power supply or batteries. The batteries typically are rechargeable lithium-ion batteries (Figure 6-20). Some mobile devices and computers, such as some ultrathin laptops, do not have removable batteries.

Internet Research

How effective are solar chargers?

Search for: portable solar charger reviews

Figure 6-20 Rechargeable batteries for mobile computers and devices.

CONSIDER THIS

How often do batteries for mobile computers and devices need to be replaced?
Battery life depends on usage. While some may last several years, you may need to replace a battery much sooner than that. When the battery no longer can hold a charge, you should replace it with a battery made by, or recommended by, the manufacturer of the computer or device. Read Ethics & Issues 6-4 to consider issues surrounding mobile phone policies.

ETHICS & ISSUES 6-4

Should Businesses Be Allowed to Make Policies Regarding Customer Mobile Phone Use?

Diners who use mobile devices while at a restaurant or moviegoers whose devices make noise or light up an otherwise dark theater can cause distractions and frustrations for employees and other patrons. One deli counter posted a sign that said it would not serve customers until they put away their phone. Another similar business said it would levy an additional charge to anyone using a phone while ordering, stating that "It's rude."

Restaurant owners who want to ban mobile phones insist that "distracted dining" adds considerably to the time a customer spends occupying a table, which results in more time elapsing before the restaurant can seat new customers. Food service may be slower because customers are not promptly reading the menu and deciding on their order. This has prompted many owners to adopt a zero tolerance policy for mobile phone use. One movie theater escorted a patron from the theater for refusing to turn off her phone. The theater argued that the purchase of a ticket, which states that it can refuse service without a refund for anyone causing disturbances, is a contract.

You can expect to see more and more restaurants, movie theaters, and other businesses posting or stating guidelines for use of mobile devices beyond asking customers to silence their devices. Some businesses institute rules that state acceptable use for mobile phones, rather than an outright ban. Many businesses designate mobile phone areas. Others give a discount for patrons who leave devices with the host or front desk. Still others allow use of photography, as long as no flash is involved. One etiquette blogger suggested that patrons dining in a group stack their phones in the middle of the table. Whoever first reaches for his or her phone must pay the entire bill.

Consider This: Do businesses have a right to refuse service or otherwise restrict phone usage by customers? Why or why not? Is it ever acceptable to use a mobile phone in a restaurant or theater? Under what circumstances? Have you ever been negatively affected by another person's inappropriate use of a mobile phone? How did you resolve the problem?

Mini Feature 6-3: Proper Care for Computers and Mobile Devices

Taking proper care of computers and mobile devices not only will help prolong their life, but also will keep them running optimally. Read Mini Feature 6-3 to learn about properly caring for computers and mobile devices.

MINI FEATURE 6-3

Proper Care for Computers and Mobile Devices

Caring for a computer or mobile device requires keeping hardware in good condition and maintaining programs and apps.

Hardware Maintenance

Before performing any of the following steps to care for your computer or mobile device, turn off and unplug the device from its power source. If the computer or mobile device has a removable battery, you also should remove the battery. All hardware maintenance should be performed in an area that is clean and free from clutter.

- Use a damp cloth to clean the screen gently. Do not use any special cleaners to clean the display, as they may damage the display. Water is sufficient to remove dust and most dirt. Read How To 6-5 for additional ways to protect screens and replace them if necessary.
- If the computer or mobile device has a keyboard, use a can of compressed air to free the keyboard from any dirt and debris that might interfere with the operation of the keys or pose a risk of getting inside the computer or mobile device. When using compressed air, hold the can upright, and not at an angle, when dispensing the air. Holding the can at an angle can cause the can to dispense a very cold liquid instead of air, which can damage components in your computer or mobile device.

© iStockphoto / jfmdesign

- If you are transporting a laptop, be sure to store it in a case with plenty of padding. If you are using a mobile device, protect it with a case. A case will protect the device better in the event you drop it and may make it easier for you to grip the device while using it.
- If the computer or mobile device has an air vent where a fan removes heat, make sure the vent is free of dust and debris. A blocked vent can prohibit heat from escaping, which ultimately can cause the computer or mobile device to overheat. If the air vent is dirty, contact a trained professional to have it cleaned properly. Improperly cleaning an air vent can result in more debris entering the computer or mobile device.


© Raw Group / Shutterstock.com

- When you insert media such as an optical disc, be sure the media is clean. Inserting dirty media can damage a computer or mobile device's internal components.

Software Maintenance

Maintaining the software on your computers and mobile devices can help them run optimally. While no specific recommendation exists for the frequency with which you should perform the following actions, you should do so if you begin to notice a decline in your computer or mobile device's performance.

- Uninstall programs and remove apps you no longer need on your computer or mobile device. These programs and apps may consume a significant amount of space on your storage medium and decrease the performance of your computer or mobile device. More information about uninstalling programs and removing apps can be found in How To 4-4 in Chapter 4.
- If you are using a desktop or laptop, defragment the computer's hard disk if you notice a decline in the computer's performance. More information about defragmenting can be found in the Disk Defragmenter section in Chapter 4.
- Install programs and apps only from reputable software manufacturers. In addition, make sure you are installing the program or app from the original installation media, the software manufacturer's website, or from your mobile device's app store or marketplace. You also should read reviews for programs and apps before you download and/or install them to make sure the program or app will meet your needs.

Discover More: Visit this chapter's free resources to learn about additional ways to care for your hardware.

Consider This: In addition to the methods mentioned in this mini feature, what other ways can you care for your computer or mobile device?

CONSIDER THIS

How does an antistatic wristband work?

When working with electronic components, such as a motherboard, you should wear an antistatic wristband. An *antistatic wristband* is a bracelet designed to protect electronics from an electrostatic discharge by preventing a buildup of static electricity on a user. The wristband has an attached clip that you connect to any bare metal surface, which acts as a ground.

HOW TO 6-5

Protect and Replace Screens

One way to protect the screen on your mobile device is to use a screen protector. A *screen protector* is a thin plastic film that adheres to the screen of your device. While screen protectors may not protect the screen if you drop your device or an object impacts it with excessive force, it will protect the screen from minor scratches obtained through normal use. Screen protectors often can be purchased from the same place you bought your mobile device and also are available online. If you cannot find a screen protector that is the exact same size as the screen on your mobile device, you can purchase a larger one and then trim it to fit your screen.

In the event the screen on your mobile device breaks, the following steps will guide you through the process of replacing it. Even if your device continues to work with a broken screen, you still should replace it as soon as possible to avoid injury. **NOTE: Screen replacement should be attempted only by advanced users. If you are uncomfortable following these steps, seek help from a trained professional. In addition, the exact steps to replace a broken screen can vary with each device. If the steps for your device vary from the steps listed below, follow the instructions from your device's manufacturer.**

1. Back up the data on your mobile device before starting a screen replacement. While a successful screen replacement should not threaten the data, it is a good idea to keep a backup in case a problem arises unexpectedly.
2. Turn off the mobile device and disconnect it from all power sources. If the device uses a removable battery, remove it.
3. Protect your hands and eyes before beginning glass replacement.
4. If possible, carefully remove all pieces of broken glass. Consider using compressed air to remove any dust.
5. Remove the display assembly. Refer to your device's documentation for information about removing the display. You may need a small, nonmagnetic screwdriver and/or metal or plastic tool to remove the assembly. If the display assembly is connected to the mobile device with a cable, carefully disconnect the cable.
6. Unpack the new screen and connect it to the mobile device, connecting any necessary cables.
7. Reassemble the mobile device, reconnect the power source and/or the battery, and turn on the device.

Consider This: Why might you replace a cracked screen instead of replacing the entire mobile device?

iStockPhoto / deepblue4you

NOW YOU SHOULD KNOW

Be sure you understand the material presented in the sections titled Adapters, Buses, and Power Supply and Batteries, as it relates to the chapter objectives.

Now you should know . . .

- When you would use an adapter card and a USB adapter (Objective 9)
- How your computer uses buses (Objective 10)
- Why your computers and mobile devices need power supplies or batteries (Objective 11)
- How to care for your computers and mobile devices (Objective 12)

Discover More: Visit this chapter's premium content for practice quiz opportunities.

Chapter Summary

This chapter presented the various components inside computers and mobile devices. It discussed types of processors, steps in a machine cycle, and processor cooling methods. You learned about advantages and services of cloud computing. The chapter discussed how memory stores data and described various types of memory. You learned about adapters, buses, power supplies and batteries, and ways to care for computers and mobile devices.

Discover More: Visit this chapter's free resources for additional content that accompanies this chapter and also includes these features: Technology Innovators: Intel and Gordon Moore, AMD, Nvidia, and VMware; Technology Trends: Medical Robotics and Self-Driving Cars; and High-Tech Talks: How Data is Written to RAM and Coding Schemes and Number Systems.

Test your knowledge of chapter material by accessing the Study Guide, Flash Cards, and Practice Test resources from your smartphone, tablet, laptop, or desktop.

TECHNOLOGY @ WORK

Publishing

Today, virtually any printed material that you read exists additionally in electronic form. In publishing's early years, and before computers existed, authors and writers recorded content using a typewriter, which then would be duplicated and bound into a publication. When word processors were introduced, writers not only could type their work, but also were able to apply basic formatting and check their spelling. While typewriters and word processors performed their tasks adequately, they pale in comparison to the extent to which today's computers and mobile devices have improved the publishing process.

Before computers and other related technological advances, publishing a book would be a very long process. After the authors wrote a manuscript, it was converted into a form that was ready to print; the printing process then could take several weeks to complete. Today, authors can use programs and apps to write material in a format that will require minimal, if any, conversion before it is ready to print.

Many book, magazine, and newspaper publishers are turning away from the print medium and encouraging consumers to read content electronically. In fact, some publishers are turning exclusively to publishing in electronic form and abandoning the print medium altogether. As mentioned previously in this book, you can read book content or magazine and newspaper articles either on the web or using an e-book reader. Content on the web usually is available free or for a fee. For example, some newspapers allow people to read articles for free, while others may charge a digital subscription fee. If you are using an e-book reader, you often have to pay to download and read content, although some items are available for free.

Programs and apps, including web apps, also are enabling individuals to publish content themselves. Individuals easily can publish content to a blog on the web, or they can use an app to create and publish an e-book for others to purchase and download.

Many libraries also are taking advantage of advances in technology by enabling users to check out books electronically. Similar to a print book, library patrons can reserve an e-book on their computer or mobile device. When the e-book is available, it will download to the user's computer or mobile device automatically. When the e-book is due or when the user decides to return the book, it will remove itself from the user's computer or mobile device. While many people believe that libraries can check out unlimited copies of the same e-book simultaneously, this is not true. Libraries are able to check out simultaneously only the number of copies, or licenses, of the e-book they purchase. For example, if a library purchases two licenses of an e-book, only two copies of that e-book can be checked out simultaneously. If a third user wants to check out this e-book, he or she must wait for one copy to be returned.

Technology has greatly improved the publishing industry. Not only is content published more quickly and in an easily accessible form, but it also now is less prone to errors because the development process is much more streamlined.

Consider This: In what other ways do computers and technology play a role in the publishing industry?

iStockPhoto / StudioThreeDots

STUDENT ASSIGNMENTS

Study Guide

The Study Guide exercise reinforces material you should know for the chapter exam.

Discover More: Visit this chapter's premium content to **test your knowledge of digital content** associated with this chapter and **access the Study Guide resource** from your smartphone, tablet, laptop, or desktop.

Instructions: Answer the questions below using the format that helps you remember best or that is required by your instructor. Possible formats may include one or more of these options: write the answers; create a document that contains the answers; record answers as audio or video using a webcam, smartphone, or portable media player; post answers on a blog, wiki, or website; or highlight answers in the book/e-book.

1. Describe the hardware referred to by the terms, system unit and chassis.
2. Name the typical location of the case for a laptop, slate tablet, convertible tablet, smartphone, game console, wearable device, portable media player, digital camera, and handheld game device.
3. List products for securing and tracking hardware and how each is used.
4. Define the terms, motherboard, chip, integrated circuit, and transistor.
5. Describe the purpose of the processor and how multi- and single-core processors differ.
6. Describe how a chip can be used to locate a lost animal.
7. Explain the role of the control unit and ALU in performing computer operations.
8. Describe what happens during each step in the machine cycle.
9. Define these terms: registers, system clock, and superscalar. Describe how clock speed is measured.
10. List two leading manufacturers of personal computer processor chips. List considerations when choosing a processor.
11. List technologies that processor chips often include.
12. List options for cooling a processor, and describe how each works.
13. Define the term, Internet of Things (IoT). List IoT-enabled devices and technologies.
14. Describe issues related to access and privacy regarding IoT.
15. Explain why a home or business user might choose cloud computing. Describe services offered with cloud computing.
16. Human speech is ___ because it uses continuous (wave form) signals that vary in strength and quality. Most computers are ____, meaning that they recognize only two discrete states: on and off.
17. Define the terms, bit and byte. Describe the binary system and the ASCII coding scheme.
18. List categories of items stored in memory. Explain how manufacturers state memory size.
19. Differentiate between volatile and nonvolatile memory. List an example of each.
20. Describe how RAM works. List two types of RAM.
21. Explain how to determine memory requirements.
22. Describe the function of a memory module. List two types of memory modules.
23. List the steps to install memory modules.
24. Describe how a computer uses cache. Differentiate among L1, L2, and L3 cache.
25. Describe what is stored in ROM. ____ are ROM chips that contain permanently written data, instructions, or information.
26. Explain if a company is responsible for using components manufactured using fair trade practices.
27. Identify uses for flash memory.
28. List methods to wipe the memory of a mobile device when recycling or selling.
29. Describe CMOS technology and its possible uses.
30. Define the term, access time. List different methods used to state access time.
31. Identify the port options for computers and mobile devices. Explain the function of each type.
32. Describe the purpose of an adapter card and the role of an expansion slot. List types of adapter cards.
33. Explain Plug and Play technology.
34. List security concerns regarding Plug and Play technology.
35. Describe the functions of USB adapters.
36. Explain the advantages of using a universal standard connector.
37. Define the term, hot plugging.
38. Identify the role of a bus. Differentiate between a data bus and an address bus.
39. Describe how bus width and word size affect and are used to measure computer speed.
40. List types of buses and describe the purpose of each.
41. Explain how a power supply converts AC current into DC current.
42. Explain the purpose of and roles of fans in power supplies.
43. Describe issues surrounding use of mobile devices in restaurants or movie theatres.
44. Explain how to maintain hardware and software on your computer or mobile device.
45. A(n) ____ wristband is a bracelet designed to protect electronics from an electrostatic discharge by preventing a buildup of static electricity on a user.
46. List steps and precautions to take when replacing the screen on a mobile device.
47. Identify how technology is used in the publishing industry.

Key Terms

You should be able to define the Primary Terms and be familiar with the Secondary Terms listed below.

Discover More: Visit this chapter's premium content to **view definitions for each term** and to **access the Flash Cards resource** from your smartphone, tablet, laptop, or desktop.

Primary Terms

(shown in **bold-black** characters in the chapter)

access time (296)
adapter card (297)
analog (288)
arithmetic logic unit (281)
binary system (288)
bit (288)
bus (299)
byte (288)
cache (293)
central processing unit (CPU) (280)
chip (278)
clock speed (283)
control unit (281)
digital (283)
eCycling (297)
expansion slot (297)
firmware (294)
flash memory (295)
gigahertz (GHz) (283)
memory (290)
memory cache (294)
motherboard (278)
multi-core processor (280)
Plug and Play (298)
power supply (301)
processor (280)
RAM (290)
read-only memory (ROM) (294)
system clock (282)
USB adapter (298)
word size (300)

Secondary Terms

(shown in *italic* characters in the chapter)

adapter board (297)
address (290)
address bus (300)
advanced transfer cache (ATC) (294)
alphanumeric characters (289)
ALU (281)
antistatic wristband (304)
arithmetic operations (281)
ASCII (289)
backside bus (BSB) (300)
binary digit (288)
bus width (300)
Cellular Seizure Investigation (CSI) stick (295)
chassis (276)
clock cycle (283)
CMOS (296)
comparison operations (281)
cooling pad (284)
DaaS (data as a service) (288)
data bus (300)
DDR SDRAM (292)
DDR2 (292)
DDR3 (292)
DDR4 (292)
decoding (281)
DIMM (dual inline memory module) (293)
dynamic RAM (DRAM) (292)
executing (281)
expansion bus (300)
expansion card (297)
fetching (281)
front side bus (FSB) (300)
gigabyte (GB) (290)
graphics card (298)
heat sink (284)
hertz (283)
hot plugging (298)
IaaS (infrastructure as a service) (287)
integrated circuit (278)
Intel-compatible processors (283)
Internet of Things (IoT) (284)
L1 cache (294)
L2 cache (294)
L3 cache (294)
liquid cooling technology (284)
machine cycle (281)
main memory (290)
mashups (288)
microprocessor (280)
nanosecond (ns) (296)
nonvolatile memory (290)
PaaS (platform as a service) (288)
random access memory (290)
RDRAM (292)
real-time clock (283)
registers (282)
screen protector (304)
SDRAM (292)
SIMM (single inline memory module) (293)
software as a service (SaaS) (287)
sound card (297)
static RAM (SRAM) (292)
stored program concept (290)
storing (281)
superscalar (283)
system board (278)
system bus (300)
system unit (276)
terabyte (TB) (290)
transistor (278)
video card (298)
virtual desktop (287)
volatile memory (290)

power supply (301)

STUDENT ASSIGNMENTS

Checkpoint

The Checkpoint exercises test your knowledge of the chapter concepts. The page number containing the answer appears in parentheses after each exercise. The Consider This exercises challenge your understanding of chapter concepts.

Discover More: Visit this chapter's premium content to **complete the Checkpoint exercises** interactively; complete the **self-assessment in the Test Prep resource** from your smartphone, tablet, laptop, or desktop; and then **take the Practice Test.**

True/False

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

_____ 1. The motherboard also is called a system board. (278)

_____ 2. On a personal computer, all functions of the processor usually are on a single chip. (280)

_____ 3. A dual-core processor doubles the processing speed of a single-core processor. (280)

_____ 4. In general, multi-core processors are less energy efficient than separate multiple processors. (280)

_____ 5. The system clock keeps track of the date and time in a computer. (283)

_____ 6. In cloud computing, the back end consists of the servers and storage devices that manage and store the resources accessed by users. (287)

_____ 7. In the binary system, the digit 1 represents the absence of an electronic charge. (288)

_____ 8. Most RAM is nonvolatile. (291)

_____ 9. The processor interprets and executes a program or application's instructions while the program or application is in nonvolatile memory. (291)

_____ 10. ROM chips also are called firmware. (294)

_____ 11. As with processors, manufacturers state the clock speed for a bus in hertz. (300)

_____ 12. The power supply converts the wall outlet AC power into DC power. (301)

Multiple Choice

Select the best answer.

1. The _____ is the main circuit board of the computer. (278)
   a. ALU
   b. CPU
   c. motherboard
   d. system chassis

2. A _____ is a single chip with two or more separate processor cores. (280)
   a. transistor
   b. multi-core processor
   c. resistor
   d. capacitor

3. _____ include basic calculations such as addition, subtraction, multiplication, and division. (281)
   a. Arithmetic operations
   b. Comparison operations
   c. Machine cycles
   d. Transistors

4. In the machine cycle, the _____ operation obtains a program or application instruction or data item from memory. (281)
   a. fetching
   b. decoding
   c. executing
   d. storing

5. The term, _____, describes a computing environment where everyday objects are connected to the Internet. (284)
   a. IoT
   b. DaaS
   c. IaaS
   d. ASCII

6. An aspect of cloud computing that allows developers to create, test, and run their solutions on a cloud platform without having to purchase or configure the underlying hardware and software is known as _____. (288)
   a. DaaS
   b. IaaS
   c. SaaS
   d. PaaS

7. _____ are applications that incorporate data from multiple providers into a new application. (288)
   a. Plug and Play apps
   b. Firmware
   c. Mashups
   d. DDR2s

8. A(n) _____ is a circuit board that enhances the functions of a component of a desktop or server system unit and/or provides connections to peripheral devices. (297)
   a. expansion slot
   b. USB adapter
   c. front side bus
   d. adapter card

Checkpoint

STUDENT ASSIGNMENTS

Matching

Match the terms with their definitions.

_____ 1. motherboard (278)
_____ 2. chip (278)
_____ 3. transistor (278)
_____ 4. control unit (281)
_____ 5. registers (282)
_____ 6. IaaS (287)
_____ 7. ASCII (289)
_____ 8. firmware (294)
_____ 9. bus width (300)
_____ 10. word size (300)

a. small, high-speed storage locations contained in a processor
b. component of the computer that directs and coordinates most of the operations in the computer
c. widely used coding scheme to represent a set of characters
d. the main circuit board of the computer
e. integrated circuit component that acts as an electronic switch that opens or closes the circuit for electrical charges
f. ROM chips that contain permanently written data, instructions, or information
g. determines the number of bits that the computer can transmit at one time
h. the use of software to emulate hardware capabilities, enabling computers to scale, or adjust up or down, storage, processing power, or bandwidth as needed
i. small piece of semiconducting materials, usually silicon, on which integrated circuits are etched
j. number of bits the processor can interpret and execute at a given time

Consider This

Answer the following questions in the format specified by your instructor.

1. Answer the critical thinking questions posed at the end of these elements in this chapter: Ethics & Issues (286, 295, 299, 302), How To (283, 292, 293, 297, 304), Mini Features (285, 287, 303), Secure IT (279, 280, 286, 295, 298), and Technology @ Work (305).
2. Where is the typical location of the case on a laptop, tablet, smartphone, game console, wearable device, portable media player, digital camera, and handheld game device? (276)
3. How does tracking software help secure hardware? (279)
4. What is meant by the term, microprocessor? (280)
5. What are the two components contained in the processor? (281)
6. How do arithmetic operations and comparison operations differ? (281)
7. What are the four operations performed during the machine cycle? (281)
8. What are registers? (282)
9. In addition to the clock speed, what other factors influence the computer's performance? (283)
10. What does the term superscalar mean, with regard to the clock cycle? (283)
11. What is clock speed? (283)
12. What is a heat sink? (284)
13. How does a cooling pad reduce the heat generated by a computer? (284)
14. How might the Internet of Things (IoT) invade privacy? (286)
15. In reference to cloud computing, what do the front end and back end include, respectively? (287)
16. What is the binary system? (289)
17. How do volatile and nonvolatile memory differ? (290)
18. Which type of memory is RAM? (291)
19. How do DRAM and SRAM chips differ? (292)
20. What are the two types of memory modules? (293)
21. How do L1, L2, and L3 cache differ? (294)
22. What is the function of an adapter card? (297)
23. What does Plug and Play allow you to do? (298)
24. Should a universal connector standard be adopted? Why or why not? (299)
25. How does bus width measure a computer's processing speed? (300)
26. How does the data bus differ from the address bus? (300)
27. What are three types of buses? (300)

STUDENT ASSIGNMENTS

Problem Solving

The Problem Solving exercises extend your knowledge of chapter concepts by seeking solutions to practical problems with technology that you may encounter at home, school, work, or with nonprofit organizations. The Collaboration exercise should be completed with a team.

Instructions: You often can solve problems with technology in multiple ways. Determine a solution to the problems in these exercises by using one or more resources available to you (such as a computer or mobile device, articles on the web or in print, blogs, podcasts, videos, television, user guides, other individuals, electronics or computer stores, etc.). Describe your solution, along with the resource(s) used, in the format requested by your instructor (brief report, presentation, discussion, blog post, video, or other means).

Personal

1. **No Matching Port** Your uncle has given you a new monitor for your computer. When you attempt to connect it, you notice that none of the ports on the back of your computer is able to accept the connector at the end of the monitor's cable. What are your next steps?
2. **Incompatible Power Adapter** While using your laptop, you notice the battery life is running low. When you plug in the AC adapter that was included with the laptop, an error message is displayed stating that the AC adapter is incompatible. You unplug the AC adapter and plug it back in, but the same message keeps appearing. Why might this be happening?

© iStockphoto / Freer Law

3. **Nonworking Fan** Each time you turn on your computer, you hear the noise generated by the fans in the system unit. Recently, however, you turned on the computer and noticed that the noise was not as loud and that the fan in the back of the system unit was not spinning. What are your next steps?
4. **Missing Smartphone** You have just returned from the mall and seem to have forgotten your smartphone. You checked all over your house and your car, and it is nowhere to be found. What are your next steps?
5. **Low Battery Life** You have had your laptop for more than one year and notice that your battery is losing its charge more quickly than normal. What are some ways you can conserve battery life so that your smartphone does not lose its charge as quickly?

Professional

6. **Determining Memory Requirements** Your computer has been running slowly and you suspect it is because it is low on memory. You review the computer's hardware configuration and find that the computer has only 4 GB of RAM. How can you determine how much memory your computer should have to run properly?
7. **Selecting the Right Processor** Your boss has given you permission to purchase a new processor for your aging desktop computer, but many models are available. What steps will you take to make sure you purchase the processor that is best for you?
8. **Plug and Play Error** You have connected an external hard drive to your computer so that you can back up your important files, but the computer is not recognizing the external hard drive when it is connected. What might be wrong?
9. **Internet Access Unavailable** You are using a cloud storage provider to save files you want to use both at work and at home, so that you do not have to carry a USB flash drive back and forth with your files. When you arrive at work, you notice that your Internet connection is unavailable and you are unable to access the files stored on the cloud. What steps can you take to prevent this in the future?
10. **System Password** You started working at a company to replace someone who has just been terminated. When you turn on your computer, which previously was used by the terminated employee, the computer immediately asks for a system password. You do not know the password but need to access the computer so that you can start working. What are your next steps?

Collaboration

11. **Technology in Publishing** You have been hired to select employees for the IT (information technology) department in a start-up publishing company. Before you can begin hiring employees, you must familiarize yourself with the technology requirements in the publishing industry. Form a team of three people to compose a plan for creating the IT department. One team member should research the hardware requirements for people working in the publishing industry. Another team member should research the types of software used in this industry, and the third team member should compile a list of interview questions to ask each candidate.

STUDENT ASSIGNMENTS

How To: Your Turn

The How To: Your Turn exercises present general guidelines for fundamental skills when using a computer or mobile device and then require that you determine how to apply these general guidelines to a specific program or situation.

Discover More: Visit this chapter's premium content to **challenge yourself with additional How To: Your Turn exercises**, such as App Adventure.

Instructions: You often can complete tasks using technology in multiple ways. Figure out how to perform the tasks described in these exercises by using one or more resources available to you (such as a computer or mobile device, articles on the web or in print, online or program help, user guides, blogs, podcasts, videos, other individuals, trial and error, etc.). Summarize your 'how to' steps, along with the resource(s) used, in the format requested by your instructor (brief report, presentation, discussion, blog post, video, or other means).

1 Conserve Battery Life of Mobile Computers and Devices

As consumers rely on mobile computers and devices more and more every day, it is increasingly important for the battery life on these devices to support high usage demands. Unfortunately, battery life on these devices often is not sufficient for many users to make it throughout the day with moderate activity on their devices. For this reason, it is important to conserve battery life so that a mobile computer or device can remain functional until it is possible to connect it to a battery charger. The following steps guide you through the process of conserving battery life on mobile computers and devices:

a. When you first obtain a new mobile computer or device or purchase a new battery for your computer or mobile device, charge the battery completely. Most new mobile computers and devices will indicate how long to charge the battery before its first use. Refrain from using the device before the battery is fully charged.
b. Charge the battery only when it is drained completely. Many batteries on computers and mobile devices can be charged only a certain number of times before they fail completely. For this reason, you should charge batteries only when absolutely necessary.
c. When you charge your mobile computer or device, try not to unplug the battery charger until the battery is charged completely.
d. Use the battery charger supplied with the mobile computer or device. Connecting inexpensive battery chargers from other vendors may damage the battery.
e. If you want to use the mobile computer or device while it is plugged in to an external power source, remove the battery, if possible, if it is fully charged. Leaving the mobile computer or device connected to an external power source while the battery has a full charge can shorten the life of the battery.
f. If you are using a laptop or tablet, disable Wi-Fi and Bluetooth unless you are using them.
g. Adjust the display's brightness. Brighter displays consume more battery life, so keep the display as dim as you can without having to strain your eyes.
h. Download and install an app that will inform you which other apps are running and consuming battery life. If an app does not need to run, you should exit it so that the app does not consume your battery.
i. Avoid turning your mobile computer or device on and off multiple times per day. The power-saving features on mobile computers and devices often require less power than turning on your computer or mobile device from a powered-off state.
j. Turn off automatic app update capabilities on your phone or mobile device, so that your device is not constantly checking for new apps and downloading them to your device.

Exercises

1. What other ways can you think of to conserve the battery life on your mobile computer or device?
2. Approximately how long do batteries on your mobile computers and devices last before they no longer are able to hold a charge?
3. What else can shorten the battery life on a mobile computer or device?


2 Locate a Lost Mobile Computer or Device

Mobile computers and devices sometimes contain a feature that can help you locate it in the event you lose it. If the device does not contain this feature, you may be able to download and install an app that can help you track its location. The following steps guide you through the process of locating a lost mobile computer or device.

STUDENT ASSIGNMENTS

How To: Your Turn

a. Before you lose or misplace a mobile computer or device, enable the feature that allows you to track its location remotely.
b. Make sure the GPS feature on your device is enabled. If GPS is not enabled, the device might be more difficult to locate.
c. If you lose your smartphone, try calling it to see if someone answers. He or she may have located your misplaced phone. If nobody answers, send it a text message inquiring about the phone's location.
d. If you lose a device, you can run an app or navigate to a website that will enable you to track the device's location. The device's location typically will be displayed on a map and include the approximate address.
e. If the device is in an unfamiliar location, use a service such as Google Maps to obtain driving directions to the location.
f. If the device is in a location other than where you originally lost it, exercise extreme caution while trying to retrieve your device. You might consider contacting a local law enforcement agency to accompany you while trying to retrieve your device.
g. If you are unable to track your device using the above suggestions, consider contacting your mobile service provider to see if they have a way to locate the device.

© iStockPhoto / Krystian Nawrocki

Exercises

1. What privacy concerns might arise as a result of keeping the GPS feature on a device enabled?
2. What are names of some apps that can help you track your device's location in the event it is lost or stolen?
3. In addition to GPS, what other ways might you be able to determine your device's location?

3 Run Diagnostic Tools and Check for Computer Hardware Errors

If your computer is not functioning properly and you believe the problem is related to the computer's hardware, you can run diagnostic tools to check for hardware errors. If the diagnostic tool identifies a hardware error, you then can communicate information about the error to technical support personnel so that they either can correct the problem or suggest replacing the problematic hardware. The following steps guide you through the process of running diagnostic tools and checking for hardware errors.

Obtain Diagnostic Tools

Your computer may have included diagnostic tools you can use to check for hardware errors. If it did not include diagnostic tools, follow these steps to download diagnostic tools from the computer manufacturer's website:

a. Navigate to the computer manufacturer's website.
b. Tap or click the necessary links to display information about the computer.
c. Tap or click the link to display a page containing drivers and/or downloads for the computer's model.
d. Browse for a diagnostic tool that you can download to your computer.
e. Some diagnostic tools can run within the operating system, and some require that you copy them to an optical disc or USB flash drive so that you can start the computer from this media and run the diagnostic tools. If necessary, copy the diagnostic tools to an optical disc or USB flash drive.

Run Diagnostic Tools

a. Run the program containing the diagnostic tools. If you copied the diagnostic tools to an optical disc or USB flash drive, restart the computer with the optical disc or USB flash drive inserted, and be sure to select the option to boot (start) from that device.
b. Select the option to scan all computer hardware for errors.
c. Begin the scan. Please note that because the program is scanning all hardware, it may take some time to complete. Some specific tests during the scan will require input from you, so watch the computer closely while the scan is in progress.
d. When the scan is complete, note any errors and, if desired, report them to the computer manufacturer's technical support team.
e. When the scan is complete, if necessary, restart the computer.

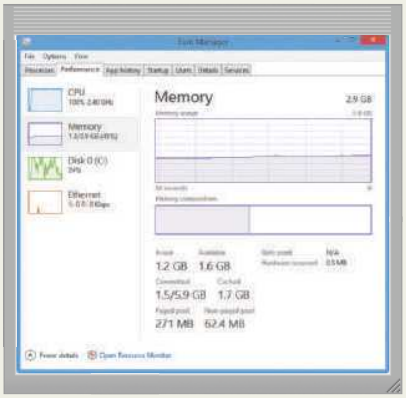
Exercises

1. What might cause you to use diagnostic tools to scan a computer for hardware errors?
2. After scanning your computer for hardware errors, were any found?
3. In addition to downloading drivers from the computer manufacturer's website, are there any other websites offering tools to help you diagnose your computer hardware problems? If so, what are some?

4 Determine How Much Memory Is Being Used on Your Computer or Mobile Device

If your computer or mobile device is running slowly, it could be running low on memory. A number of factors can contribute to the slow performance, but checking the memory usage is fast and easy. If the computer or mobile device's memory is almost all used, you may be able to determine which programs and apps are using the most memory. Exiting these programs and apps may make more memory available and increase a computer or mobile device's performance. The following steps guide you through the process of determining how much memory is being used on a computer or mobile device.

a. Restart the computer or mobile device.
b. If necessary, sign in to the operating system.
c. Navigate to the window or screen showing a list of running tasks. On a computer, you may be able to search for the Task Manager or Activity Monitor. On a mobile device, a list of running processes may be found in the system settings.
d. Tap or click the option to show the list of running processes. This list will show you how much memory each process is using. This list also includes the programs and apps currently running. If you notice that a program or app is consuming a high amount of memory, consider exiting the program or app to make the memory available.
e. When you are finished, return to the desktop or home screen.



Source: Microsoft

Exercises

1. How much memory is installed on your computer or mobile device? How much currently is being used?
2. Which three processes are using the largest amount of memory on your computer or mobile device?
3. If the programs and apps you run consume nearly all available memory on your computer or mobile device, what additional steps might you be able to take?

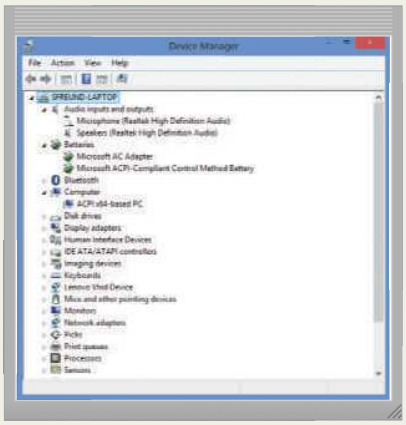
5 Check Your Computer's Hardware Configuration

If you are experiencing a problem with a hardware component on your computer, you can check the computer's hardware configuration to determine the manufacturer's name and model number for the hardware in question. With this information, you then can search for ways to correct the problem. Alternatively, if you reinstall the operating system on the computer, you may check the computer's hardware configuration to make sure the operating system is recognizing correctly all hardware connected to the computer. The following steps guide you through the process of checking a computer's hardware configuration.

a. If you are using a Mac, display the Apple menu and then select the option to display information about the computer. If you are running Windows, display the Control Panel.
b. Navigate to the area that displays information about the hardware and devices currently connected to the computer. (*Hint:* In Windows, display the Device Manager. On a Mac, display the System Report.)
c. Tap or click the categories of hardware devices to see details related to those types of devices.
d. If you are familiar with the hardware devices on the computer, verify that the operating system is recognizing these devices correctly.
e. If you notice a problem with the operating system detecting any of these devices, you might need to run the installation software and/or install the drivers for the hardware device so that the operating system can communicate with the device. If necessary, contact the computer manufacturer's technical support for assistance.

Exercises

1. List at least three hardware devices listed in the System Report or in the Device Manager.
2. In addition to the reasons mentioned above, what are some other reasons why you might want to check the hardware configuration on a computer?
3. What steps can you take if one or more hardware devices are not identified by your computer?



Source: Microsoft

STUDENT ASSIGNMENTS

Internet Research

The Internet Research exercises broaden your understanding of chapter concepts by requiring that you search for information on the web.

Discover More: Visit this chapter's premium content to **challenge yourself with additional Internet Research exercises**, which include Search Sleuth, Green Computing, Ethics in Action, You Review It, and Exploring Technology Careers.

Instructions: Use a search engine or another search tool to locate the information requested or answers to questions presented in the exercises. Describe your findings, along with the search term(s) you used and your web source(s), in the format requested by your instructor (brief report, presentation, discussion, blog post, video, or other means).

1 Making Use of the Web

Content Aggregation and Curation

Locating valuable information to read on particular topics or to share with your online social network may take some effort. To help find material, you may want to use content aggregation, an automated process that uses keywords to gather and filter materials someone else has written or produced on the Internet. Another option is content curation, which is a manual process of acquiring this information and then expanding the content into original and useful material to post. A good content curator can edit the content to share, add annotations and notes, give attributions to the original source, and provide additional viewpoints. As a starting point, Twitter and blog feeds, bookmarking tools such as StumbleUpon, and services that provide email notifications, such as Google Alerts, provide the opportunity to view webpages, photos, videos, and additional material about celebrities, sports, politics, businesses, and other people and subjects.

Research This: (a) Visit StumbleUpon and two other bookmarking services. If necessary, sign in to these services and compare the features. How do users select the categories to view? What information is required to create a profile? What opportunities for feedback are provided? What procedure would users follow to delete their profiles and terminate their accounts?

(b) Visit Google Alerts and two other email alerting services. If necessary, create an alert for at least two words for which you would want to receive email notifications. What options are available to customize these alerts? For example, can you specify the frequency of the alerts, the types of websites to search, the geographical region, or the number of messages sent?

Source: StumbleUpon

2 Social Media

Companies review the conversations, comments, complaints, and feedback written on online social networks to obtain valuable information that ultimately enhances developing or improving products and services. In some cases, companies have asked consumers to view videos of product demonstrations, Tweet their immediate impressions, and suggest improvements. Small companies with limited marketing and advertising budgets, in particular, increasingly view social media as an inexpensive means of building relationships with and among customers. Social media users interact with others who have similar interests and exchange information about their experiences. In general, companies have found that customers are eager to provide feedback and recommend improvements.

Research This: View at least two automotive websites and describe the social media that are featured. Choose one of the websites and review the content. What topics are being discussed? In which ways is the company encouraging participation, such as by sponsoring contests or providing opportunities for consumers to upload photos and videos? Can consumers create an account to share advice, rate and review vehicles, and discuss mechanical issues?

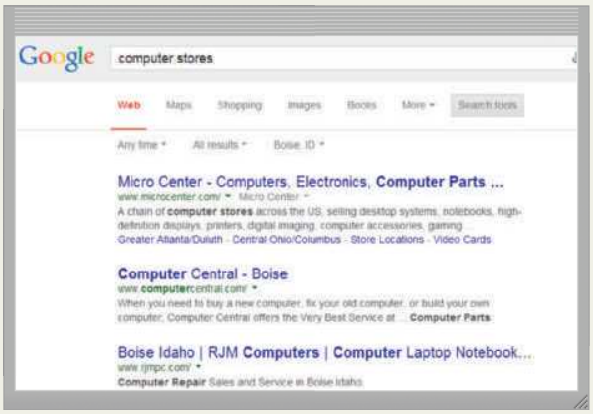
3 Search Skills

Limiting Search Results by Website, Date, and Location

You can instruct a search engine to look for results on a specific website that match your search text. To do so, in your search text include the operator site: followed by a domain name you would like to search, with no spaces between the colon and the domain name. For example, to read articles from the Cnet website about solid state drives, type the search text, site:cnet.com "solid state drives".

Some search engines provide additional search tools to specify a date range such as the past day, week, or month, to limit your results. Limiting search results by date can help you to find current information because the search engine will return results published during

a specified period. Providing a location or ZIP code as search options (beneath the search box) will limit search results to the geographic area you specify. Location search can help you find results for a specific area, such as computer stores in Boise, Idaho.



Source: Google

Research This: Create search text using the techniques described above or in previous Search Skills exercises, and type it in a search engine to answer these questions. (1) Find information on Intel's website about core I7 processors that was posted within the past month. (2) Where in your local area can you recycle used computer equipment and electronics? (3) Find reviews of digital cameras posted within the past week. (4) Which laptops reviewed during the past six months have the longest battery life?

4 Security

More than 3 million smartphones are stolen each year, according to a *Consumer Reports* survey. In addition, 1.4 million smartphone users never have recovered a lost phone. Secure IT 6-1 in this chapter describes categories of products that can help secure and track hardware that has been stolen or lost.

Research This: Which apps are available for your smartphone to erase data remotely? Which location-tracking apps allow you to take a photo of the thief and then send an email message that contains the image to you automatically? If your device is lost and you file a police report, you will need the device's serial number. Locate that number now and write it on a piece of paper. Also, locate the phone's 15-digit International Mobile Equipment Identity (IMEI) number and record that number. Store the document with these two numbers in a secure location. In addition, research the efforts by the U.S. Federal Communications Commission (FCC) and the Cellular Telecommunications Industry Association (CTIA) to create a centralized database of lost and stolen mobile phones. What is the status of this database? What legislation has been proposed or passed that requires wireless carriers and phone manufacturers to develop technological solutions that can curb the growing problem of violent smartphone theft?

5 Cloud Services

Public, Private, Hybrid, and Personal Clouds (IaaS)

When deciding how to host data and apps on the cloud, companies often choose between sharing a server on the cloud with other organizations, configuring a dedicated server on the cloud, or using both options. Companies must consider the type of data involved and the level of security required to keep it safe. Public, private, and hybrid clouds are examples of IaaS (infrastructure as a service), a service of cloud computing that uses a provider's hardware to manage, store and access files and apps over the Internet. On a public cloud, several companies store data or apps on the same physical server on the cloud. On a private cloud, a company has its own servers in the cloud to host its apps and data. On a hybrid cloud, organizations may host confidential data on a private cloud and rely on a public cloud for information that does not require such a high degree of security.

Individual users may set up a personal cloud by purchasing a networked hard drive. A networked hard drive connects directly to a router, providing access to its files over the Internet. This is a useful solution for having access to files from several devices.

Research This: (1) Use a search engine to find IaaS providers that offer public, private, and hybrid cloud solutions. Summarize the different solutions they provide. (2) Under what circumstances might an individual or enterprise set up a public, private, or hybrid cloud? (3) Research networked hard drive models from different manufacturers. Compare their costs, storage sizes, and additional features to consider when creating a personal cloud. (4) When might you create a personal cloud instead of using a cloud storage provider?

STUDENT ASSIGNMENTS

Critical Thinking

The Critical Thinking exercises challenge your assessment and decision-making skills by presenting real-world situations associated with chapter concepts. The Collaboration exercise should be completed with a team.

Instructions: Evaluate the situations below, using personal experiences and one or more resources available to you (such as articles on the web or in print, blogs, podcasts, videos, television, user guides, other individuals, electronics or computer stores, etc.). Perform the tasks requested in each exercise and share your deliverables in the format requested by your instructor (brief report, presentation, discussion, blog post, video, or other means).

1. Cloud Storage

The owner of the motorcycle repair shop where you work as a part-time office manager is seeking alternatives to using a network server to store and back up files. She asks you to investigate the feasibility of using cloud storage, rather than purchasing additional storage media for the company's computers, mobile devices, and network servers.

Do This: Analyze the advantages and disadvantages of using cloud storage. Include in your discussion security concerns, costs, and a comparison between two different cloud storage offerings. Which company offers the better arrangement? Why? Explore one other area of cloud computing, such as SaaS (software as a service), and determine how the service might benefit the shop. Find three providers of the cloud service and compare prices, user reviews, and features. List the risks and benefits of using the cloud for storage and other services.

2. Upgrading Memory

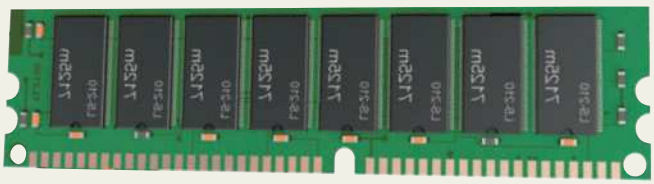
You are an IT consultant at a bank. An analyst at the bank is complaining that her laptop is performing slowly. You determine that the laptop's memory is insufficient for the complex calculations and reports the analyst is running.

Do This: Search the web to learn more about current memory modules available to increase memory capacity. Evaluate the differences among various options, including type, size, speed, and price. Find articles from industry experts that list methods and recommendations for upgrading a laptop's memory. Also determine how to add memory to a laptop, obtaining answers to the following questions: How can you determine the type and correct amount of memory to add? Why should you not purchase more memory than your computer can support? How do you determine the available slots for memory modules? What safety measures should you take when upgrading memory? Is it better to upgrade the memory or purchase a new laptop?

3. Case Study

Amateur Sports League You are the new manager for a nonprofit amateur soccer league. You recently purchased replacement smartphones for yourself and another employee, along with an upgraded tablet that the staff can use. Because you are discarding the outdated devices, the league's board of directors is concerned about how to secure and protect data when selling, donating, or recycling the devices. The board asked you to prepare information it can use in a press release to educate the league's customers about keeping data secure when discarding a device.

Do This: Determine the possible steps needed to wipe the memory and storage media in the devices. What kind of data is important to delete? Why? What are the risks of not wiping the memory and storage media in a device before you discard it? What responsibility does the league have to protect members' personal data? Why? Does choosing whether to sell, donate, or recycle the devices change your approach and need to wipe the devices' memory? Why or why not?



© mycola / Shutterstock.com

Collaboration

4. Mobile Device Batteries

You work in the IT department for a large publishing company that just purchased new tablets for all employees. The department manager asked you to prepare information about how to conserve the battery life of the tablets.

Do This: Form a three-member team. Each member of your team should choose a different type of tablet. Find information about the battery life for each device type, including recommendations for use by the manufacturer and user reviews of the device and its chargers. Research apps that track battery life. Search for articles by industry experts that give tips on conserving the battery life of a tablet. Meet with your team, and discuss and compile your findings. Which tablet would you recommend? Why? How does the charger affect the battery life? What did you learn about battery conservation? Which apps would you recommend? Why?