

OPERATING SYSTEMS: Managing, Coordinating, and Monitoring Resources

9



Operating systems provide a variety of functions to users.

“My laptop is running slower than when I bought it, but it seems to be working properly. I install operating system updates regularly on my computer and smartphone. I added a printer using my operating system’s configuration options. Aside from knowing where my files are stored, what more could I learn about operating systems?”

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

- Remove a program or app?
- Prevent a computer from thrashing?
- Resolve a low memory issue with a mobile device?
- Locate and install a driver for a device connected to your computer?
- Identify bloatware?
- Evaluate an operating system’s built-in security tools?
- Use the Windows interface?
- Use the Mac OS interface?
- Determine whether to use an open or closed source operating system?
- Set up a virtual machine?
- Use the Windows operating system on a Mac computer?
- Recognize BYOD security issues?

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.

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 Objectives**After completing this chapter, you will be able to:**

- 1 Explain the purpose of an operating system
- 2 Describe the start-up process and shutdown options on computers and mobile devices
- 3 Explain how an operating system provides a user interface, manages programs, manages memory, and coordinates tasks
- 4 Describe how an operating system enables users to configure devices, establish an Internet connection, and monitor performance
- 5 Identify file management and other tools included with an operating system, along with ways to update operating system software
- 6 Explain how an operating system enables users to control a network or administer security
- 7 Summarize the features of several desktop operating systems: Windows, OS X, UNIX, Linux, and Chrome OS
- 8 Briefly describe various server operating systems: Windows Server, OS X Server, UNIX, and Linux
- 9 Summarize the features and uses of several mobile operating systems: Google Android, Apple iOS, and Windows Phone

Operating Systems

When you purchase a computer or mobile device, it usually has an operating system and other tools installed. As previously discussed, the operating system and related tools collectively are known as system software because they consist of the programs that control or maintain the operations of the computer and its devices. An **operating system (OS)** is a set of programs that coordinate all the activities among computer or mobile device hardware. Other tools, which were discussed in Chapter 4, enable you to perform maintenance-type tasks usually related to managing devices, media, and programs used by computers and mobile devices.

Most operating systems perform similar functions that include starting and shutting down a computer or mobile device, providing a user interface, managing programs, managing memory, coordinating tasks, configuring devices, monitoring performance, establishing an Internet connection, providing file management and other device or media-related tasks, and updating operating system software. Some operating systems also allow users to control a network and administer security (Figure 9-1).

Although an operating system often can run from a USB flash drive, media in an optical drive, or an external drive, in most cases, an operating system resides inside a computer or mobile device. For example, it is installed on a hard drive in a laptop or desktop. On mobile devices, the operating system may reside on firmware in the device. *Firmware* consists of ROM chips or flash memory chips that store permanent instructions.

Operating systems often are written to run on specific types of computers, based on their computing needs and capabilities. That is, servers do not run the same operating system as tablets or laptops because these computers perform different computing tasks. For example, a tablet or laptop operating system might have a feature to turn the device off after a few minutes of inactivity in order to conserve battery power. A server, by contrast, always is plugged in and generally remains on all of the time, which means its operating system would not need this power-saving feature. The same types of computers, such as laptops, may run different operating systems. It also is possible to run more than one operating system on the same computer.

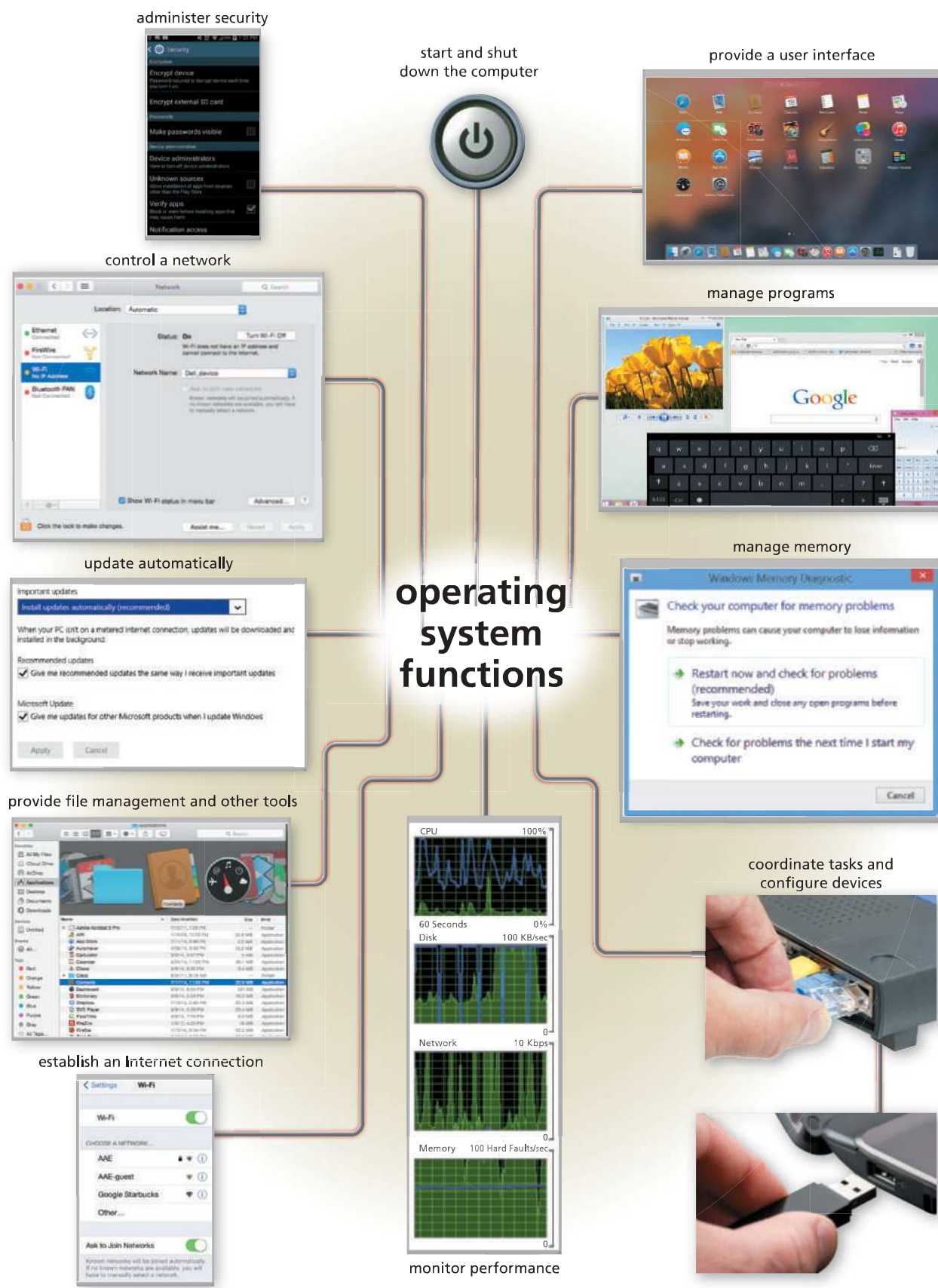


Figure 9-1 Most operating systems perform similar functions, a variety of which are illustrated above.

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When purchasing a program or an application, you must ensure that it works with the operating system installed on your computer or mobile device. The operating system that a computer uses sometimes is called the *platform* because applications are said to run “on top of” it, or because the platform supports the applications. With purchased applications, their specifications will identify the required platform(s), or the operating system(s), on which they will run. A *cross-platform application* is an application that runs the same way on multiple operating systems.

Operating System Functions

Every computer and mobile device has an operating system. Regardless of the type of the computer or device, however, their operating systems provide many similar functions. The following sections discuss functions common to most operating systems. These functions include starting and shutting down computers and mobile devices, providing a user interface, managing programs, managing memory, coordinating tasks, configuring devices, monitoring performance, establishing an Internet connection, updating operating system software, providing file and disk management tools, controlling a network, and administering security.



Figure 9-2 Examples of power buttons on computers and mobile devices.

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Starting Computers and Mobile Devices

If a computer or mobile device is off, you press a power button to turn it on (Figure 9-2). If it is on, you may need to restart (also called reboot) the computer or mobile device for a variety of reasons. For example, you might install a new program or app, update existing software, or experience network or Internet connectivity problems. Alternatively, you might notice that the performance of the computer or device is sluggish, or it may stop responding altogether. The method you use to restart a computer or device differs, depending on the situation and also the hardware. You may be able to use operating system instructions or press keys on the keyboard to restart the computer or device. Or, you might be required to respond to on-screen prompts. Sometimes, the computer or device restarts automatically.

When you start or restart a computer or mobile device, a series of messages may appear on the screen. The actual information displayed varies depending on the make and type of the computer or mobile device and the equip-

ment installed. The start-up process, however, is similar for large and small computers and mobile devices, as described in the following steps.

- Step 1:** When you turn on the computer or mobile device, the power supply or battery sends an electrical current to circuitry in the computer or mobile device.
- Step 2:** The charge of electricity causes the processor chip to reset itself and finds the firmware that contains start-up instructions.
- Step 3:** The start-up process executes a series of tests to check the various components. These tests vary depending on the type of computer or devices and can include checking the buses, system clock, adapter cards, RAM chips, mouse, keyboard, and drives. It also includes making sure that any peripheral devices are connected properly and operating correctly. If any problems are identified, the computer or device may beep, display error messages, or cease operating — depending on the severity of the problem.
- Step 4:** If the tests are successful, the kernel of the operating system and other frequently used instructions load from the computer or mobile device’s internal storage media to its memory (RAM). The *kernel* is the core of an operating system that manages memory and devices, maintains the internal clock, runs programs, and assigns the resources, such

as devices, programs, apps, data, and information. The kernel is *memory resident*, which means it remains in memory while the computer or mobile device is running. Other parts of the operating system are *nonresident*; that is, nonresident instructions remain on a storage medium until they are needed, at which time they transfer into memory (RAM).

Step 5: The operating system in memory takes control of the computer or mobile device and loads system configuration information. The operating system may verify that the person attempting to use the computer or mobile device is a legitimate user. Finally, the user interface appears on the screen, and any start-up applications, such as antivirus software, run.

CONSIDER THIS

What is meant by the phrase, booting a computer?

The process of starting or restarting a computer or mobile device is called *booting*. Some people use the term *cold boot* to refer to the process of starting a computer or mobile device from a state when it is powered off completely. Similarly, *warm boot* refers to the process of restarting a computer or mobile device while it remains powered on.

A warm boot generally is faster than a cold boot because it skips some of the operating system start-up instructions that are included as part of a cold boot. If you suspect a hardware problem, it is recommended that you use a cold boot to start a computer or device because this process detects and checks connected hardware devices. If a program or app stops working, a warm boot often is sufficient to restart the device because this process clears memory.

A **boot drive** is the drive from which your personal computer starts, which typically is an internal hard drive, such as a hard disk or SSD. Sometimes, an internal hard drive becomes damaged and the computer cannot boot from it, or you may want to preview another operating system without installing it. In these cases, you can start the computer from a *boot disk*, which is removable media, such as a CD or USB flash drive, that contains only the necessary operating system files required to start the computer.

When you purchase a computer, it may include recovery media in the form of a CD. If it does not, the operating system usually provides a means to create one. When the word, *live*, is used with a type of media, such as *Live USB* or *Live CD*, this usually means the media can be used to start the computer.

Discover More: Visit this chapter's free resources to learn more about restarting computers and mobile devices.

Shutting Down Computers and Mobile Devices

Some users choose to leave their computers or mobile devices running continually and rarely turn them off. Computers and devices that are left on always are available, and users often run back up or other similar programs while the computer or device is not being used. These users also do not need to wait for the boot process, which can be time consuming on older computers. Other users choose to shut down their computers and mobile devices regularly. These users might be concerned with security, want to reduce energy costs, or prefer to clear memory often. To turn off a computer or mobile device, you may be required to use operating system commands, press keyboard key(s), push a power button, or a combination of these methods. Read Secure IT 8-2 in Chapter 8 for tips on safely removing media before shutting down a computer or mobile device.

Power options include shutting down (powering off) the computer or mobile device, placing it in sleep mode, or placing it in hibernate mode. Both sleep mode and hibernate mode are designed to save time when you resume work on the computer or device. *Sleep mode* saves any open documents and running programs or apps to RAM, turns off all unneeded functions, and then places the computer in a low-power state. If, for some reason, power is removed from a computer or device that is in sleep mode, any unsaved work could be lost. *Hibernate mode*, by contrast, saves any open documents and running programs or apps to an internal hard drive before removing power from the computer or device.

The function of the power button on a computer or mobile device varies, and users typically are able to configure its default behavior. For example, you typically can place a computer or mobile device in sleep mode by quickly pressing its power button or closing its lid or cover (for example, on a laptop or a tablet). Pressing and holding down the power button may remove all power from the computer or mobile device.

BTW

Recovery Media

In situations when a boot disk is required to restart a computer or device that will not start from its boot drive, the boot disk often is referred to as *recovery media*.

Internet Research

When should I turn off a computer, and when should I use sleep mode?

Search for: shut down or sleep computer

Providing a User Interface

You interact with an operating system through its user interface. That is, a **user interface (UI)** controls how you enter data and instructions and how information is displayed on the screen. Two types of operating system user interfaces are graphical and command line. Operating system user interfaces often use a combination of these techniques to define how a user interacts with a computer or mobile device.

Graphical User Interface Most users today work with a graphical user interface. With a *graphical user interface (GUI)*, you interact with menus and visual images by touching, pointing, tapping, or clicking buttons and other objects to issue commands (Figure 9-3). Many current GUI operating systems incorporate features similar to those of a browser, such as links and navigation buttons (i.e., Back button and Forward button) when navigating the computer or mobile device's storage media to locate files.

A graphical user interface designed for touch input sometimes is called a *touch user interface*. Some operating systems for desktops and laptops and many operating systems for mobile devices have a touch user interface.

Internet Research

Which operating systems have a touch user interface?

Search for: touch operating systems

CONSIDER THIS

What is a natural user interface?

With a **natural user interface (NUI)**, users interact with the software through ordinary, intuitive behavior. NUIs are implemented in a variety of ways: touch screens (touch input), gesture recognition (motion input), speech recognition (voice input), and virtual reality (simulations).



Figure 9-3 Examples of operating system graphical user interfaces on a variety of computers and mobile devices. Courtesy of Apple Inc.; Courtesy of SAMSUNG; Courtesy of Microsoft; Courtesy of SAMSUNG; Courtesy of Apple Inc.

Command-Line Interface To configure devices, manage system resources, automate system management tasks, and troubleshoot network connections, network administrators and other technical users work with a command-line interface. In a *command-line interface*, a user types commands represented by short keywords or abbreviations (such as `dir` to view a directory, or list of files) or presses special keys on the keyboard (such as function keys or key combinations) to enter data and instructions (Figure 9-4).

Some people consider command-line interfaces difficult to use because they require exact spelling, form, and punctuation. Minor errors, such as a missing period, generate an error message. Command-line interfaces, however, give a user more control to manage detailed settings. When working with a command-line interface, the set of commands used to control actions is called the *command language*.

Managing Programs

How an operating system handles programs directly affects your productivity. An operating system can be single tasking or multitasking:

- A single tasking operating system allows only one program or app to run at a time. For example, if you are using a browser and want to check email messages, you must exit the browser before you can run the email program. Operating systems on embedded computers and some mobile devices use a single tasking operating system.
- Most operating systems today are multitasking. A *multitasking* operating system allows two or more programs or apps to reside in memory at the same time. Using the example just cited, if you are working with a multitasking operating system, you do not have to exit the browser to run the email program. Both programs can run concurrently.

When a computer is running multiple programs concurrently, one program is in the foreground and the others are in the background (Figure 9-5). The one in the *foreground* is the active program, that is, the one you currently are using. The other programs running but not in use are in the *background*. The foreground program typically is displayed on the screen, and the background programs are hidden partially or completely behind the foreground program. A multitasking operating system's user interface easily allows you to switch between foreground and background programs.

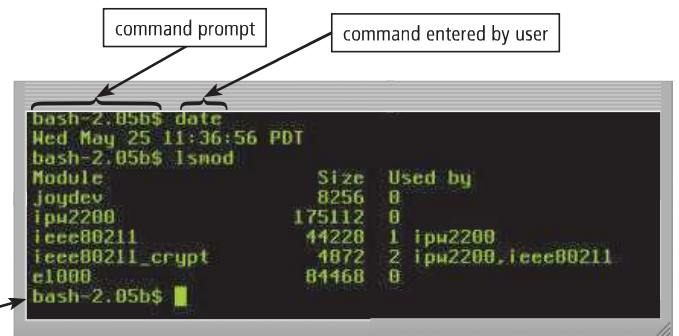


Figure 9-4 A command-line interface requires you to enter exact spelling, form, and punctuation.
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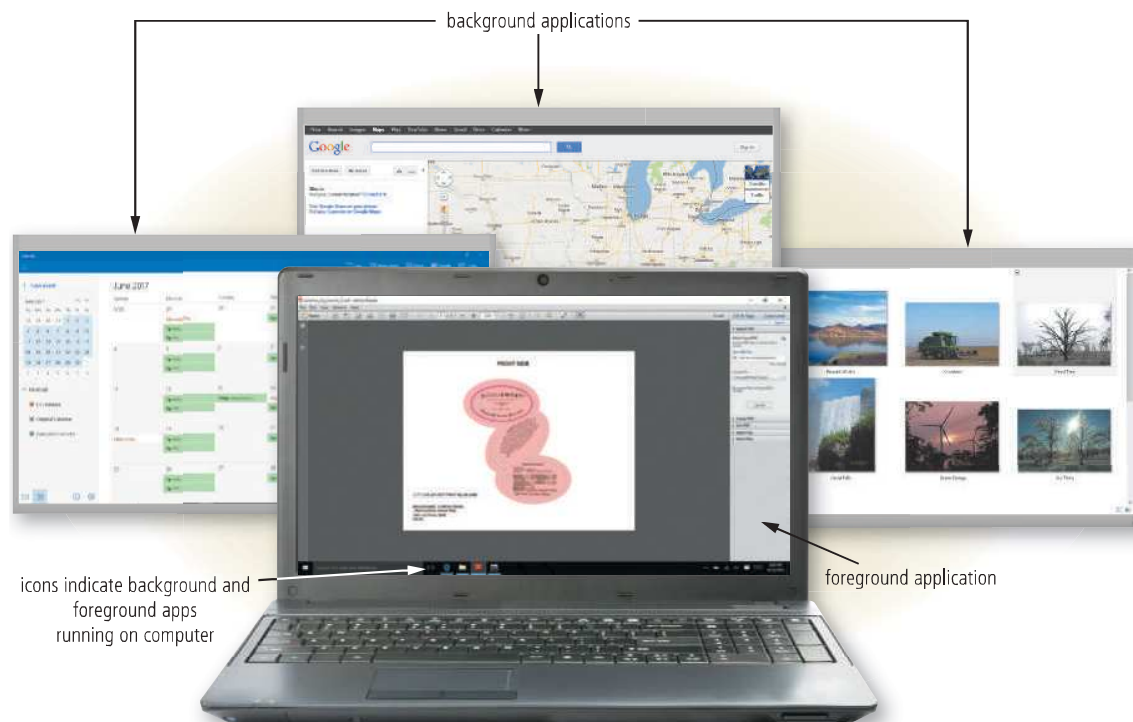


Figure 9-5 The foreground application, Adobe Acrobat reader, is displayed on the screen. The other applications (Calendar, Google Maps in Edge, and File Explorer) are in the background.

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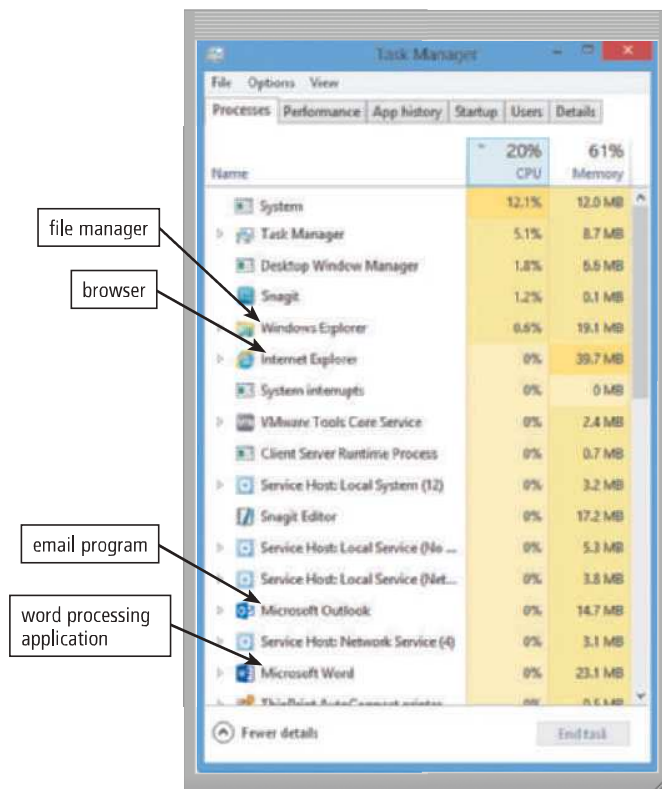


Figure 9-6 An operating system manages multiple programs and processes while you use a computer or mobile device.

Source: Microsoft

In addition to managing applications, an operating system manages other processes. These processes include programs or routines that provide support to other programs or hardware. Some are memory resident. Others run as they are required. Figure 9-6 shows a list of some processes running on a Windows computer; notice the list contains the applications running in Figure 9-5, as well as other programs and processes.

Some operating systems support a single user; others support thousands of users running multiple programs. A *multiuser* operating system enables two or more users to run programs simultaneously. Networks, servers, and supercomputers allow hundreds to thousands of users to connect at the same time and, thus, use multiuser operating systems.

Through the operating system, you also can install programs and apps, as well as remove them. For instructions on installing programs and apps, refer to How To 1-4 in Chapter 1. Read How To 9-1 for instructions on removing a program or app.

Discover More: Visit this chapter's free resources to learn more about single tasking, multitasking, and multiuser operating systems.

HOW TO 9-1

Remove a Program or App

If you are running low on space on your computer or mobile device, you may want to remove programs and apps you no longer use. The following steps describe how to remove a program or app from your computer or mobile device:

1. Sign in to a user account that has administrative privileges; that is, the user account should have the capability

to perform functions such as removing programs or apps.

2. Make sure the program or app you want to remove is not running.
3. Display the list of programs or apps installed on your computer or mobile device.
4. Select the program or app you wish to remove.
5. Tap or click the button to remove the program or app.

6. If necessary, when the installation is complete, restart your computer or device.
7. Verify the program or app you removed no longer is on your computer or mobile device.

Consider This: What are some other reasons why you might want to remove a program or app from your computer or mobile device?

Managing Memory

The purpose of memory management is to optimize the use of a computer or device's internal memory, i.e., RAM. As Chapter 6 discussed, RAM (random access memory) consists of one or more chips on the motherboard that hold items such as data and instructions while the processor interprets and executes them. The operating system allocates, or assigns, data and instructions to an area of memory while they are being processed. Then, it carefully monitors the contents of memory. Finally, the operating system releases these items from being monitored in memory when the processor no longer requires them.

If several programs or apps are running simultaneously, your computer or mobile device may use up its available RAM. For example, assume an operating system requires 2 GB of RAM to run, an antivirus program — 256 MB, a browser — 512 MB, a productivity software suite — 1 GB, and a photo editing program — 512 MB. With all these programs running simultaneously, the total RAM required would be 4.352 GB (2048 MB + 256 MB + 512 MB + 1024 MB + 512 MB) (Figure 9-7). If the computer has only 4 GB of RAM, the operating system may have to use virtual memory in order to run all of the applications at the same time. When a computer or mobile device runs low on available RAM, this often results in the computer or mobile device running sluggishly.

Applications Using RAM

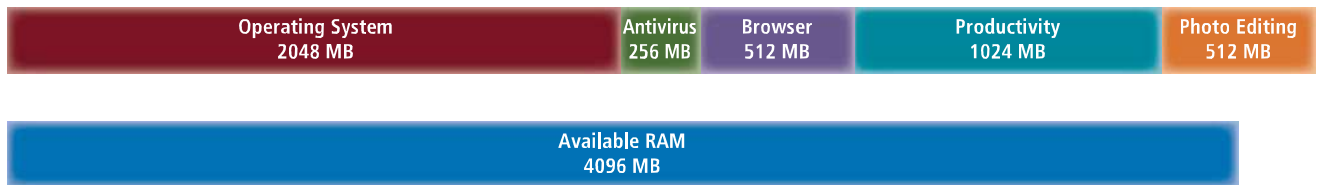


Figure 9-7 Many applications running at the same time may deplete a computer's or device's available RAM.
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With **virtual memory**, the operating system allocates a portion of a storage medium, such as a hard drive or a USB flash drive, to function as additional RAM (Figure 9-8). As you interact with a program, part of it may be in physical RAM, while the rest of the program is on the hard drive as virtual memory. Because virtual memory is slower than RAM, users may notice the computer slowing down while it uses virtual memory.

How a Computer Might Use Virtual Memory

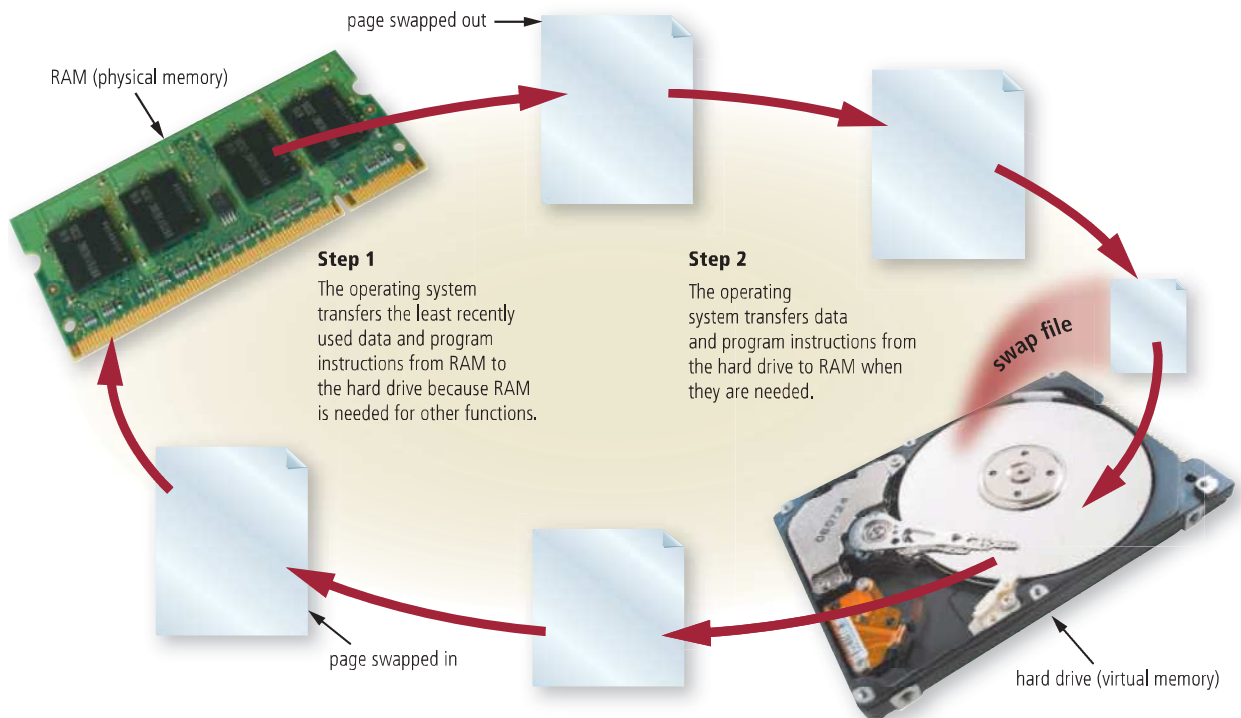


Figure 9-8 This figure shows how a computer might use virtual memory.
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The area of the hard drive used for virtual memory is called a *swap file* because it swaps (exchanges) data, information, and instructions between memory and storage. A *page* is the amount of data and program instructions that can swap at a given time. The technique of swapping items between memory and storage, called *paging*, is a time-consuming process for the computer. When an operating system spends much of its time paging, instead of executing application software, it is said to be *thrashing*.



CONSIDER THIS

What happens if an application stops responding or the computer appears to run sluggishly?

If an application, such as a browser, has stopped responding, the operating system may be thrashing. When this occurs, try to exit the program. If that does not work, try a warm boot and then a cold boot. To help prevent future occurrences of thrashing, you might consider the following:

1. Remove unnecessary files and uninstall seldom used programs and apps. (Read How To 9-1 earlier in this chapter for instructions about removing programs and apps.)
2. If your computer has a hard disk (instead of an SSD), try defragmenting the hard disk. (Read How To 8-1 in Chapter 8 for instructions about defragmenting a hard disk.)
3. Purchase and install additional RAM. (Read How To 6-3 in Chapter 6 for instructions about installing memory modules.)



CONSIDER THIS

What if my smartphone runs out of memory?

If your smartphone or other mobile device displays a message that it is running low on memory, try the following:

1. Exit unnecessary applications that are running.
2. Restart the smartphone or mobile device.
3. Uninstall seldom used applications. (Read How To 9-1 earlier in this chapter for instructions about removing programs and apps.)
4. Remove unnecessary files, including photos and videos (you may want to copy them to cloud storage, a computer, or a memory card first).
5. If your smartphone supports the use of a memory card, specify that applications, photos, videos, or downloaded files should be saved on a memory card instead of the smartphone's internal memory.



BTW

Higher-Priority Tasks

A multiuser operating system does not always process tasks on a first-come, first-served basis. If a user or task has been assigned a higher priority than others by the network administrator, the operating system performs higher-priority tasks first. For example, an operating system on a corporate server may process tasks to check for incoming email more frequently than it processes tasks to access archived documents.

Coordinating Tasks

The operating system determines the order in which tasks are processed. A task, or job, is an operation the processor manages. Tasks include receiving data from an input device, processing instructions, sending information to an output device, and transferring items from storage to memory and from memory to storage.

Sometimes, a device already may be busy processing one task when it receives a request to perform a second task. For example, if a printer is printing a document when the operating system sends it a request to print another document, the printer must store the second document in memory until the first document has completed printing.

While waiting for devices to become idle, the operating system places items in buffers. A *buffer* is a segment of memory or storage in which items are placed while waiting to be transferred from an input device or to an output device.

An operating system commonly uses buffers with printed documents. This process, called *spooling*, sends documents to be printed to a buffer instead of sending them immediately to the printer. If a printer does not have its own internal memory or if its memory is full, the operating system's buffer holds the documents waiting to print while the printer prints from the buffer at its own rate of speed. By spooling documents to a buffer, the computer or mobile device's processor can continue interpreting and executing instructions while the printer prints. This allows users to perform other activities on the computer while a printer is printing. Multiple documents line up in a **queue** (pronounced Q) in the buffer. A program, called a *print spooler*, intercepts documents to be printed from the operating system and places them in the queue (Figure 9-9).

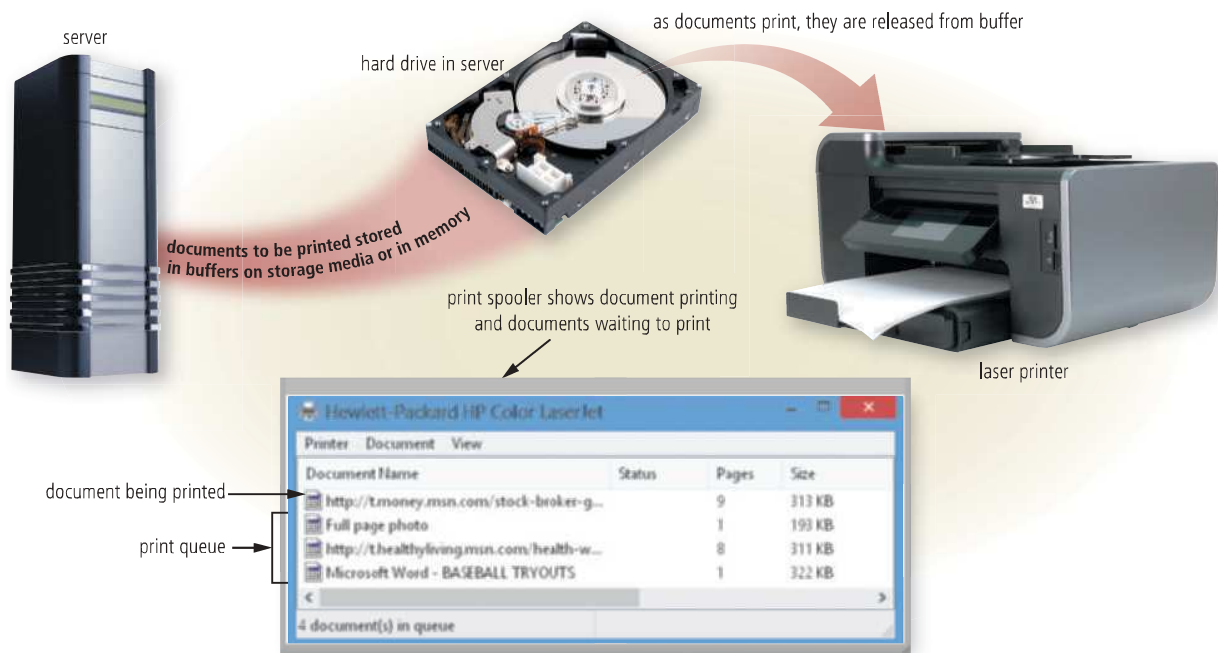


Figure 9-9 Spooling increases both processor and printer efficiency by placing documents to be printed in a buffer or on storage media before they are printed. This figure shows three documents in the queue with one document printing.

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Configuring Devices

A **driver**, short for *device driver*, is a small program that tells the operating system how to communicate with a specific device. Each device connected to a computer, such as a mouse, keyboard, monitor, printer, card reader/writer, digital camera, webcam, portable media player, or smartphone, has its own specialized set of commands and, thus, requires its own specific driver. When you start a computer or connect a device via a USB port, the operating system loads the device's driver. Drivers must be installed for each connected device in order for the device to function properly. Read How To 9-2 for instructions about finding the latest drivers for devices.

If you attach a new device, such as a portable media player or smartphone, to a computer, its driver must be installed before you can use the device. Today, most devices and operating systems support Plug and Play. As discussed in Chapter 6, *Plug and Play* means the operating system automatically configures new devices as you install or connect them. Specifically, it assists you in the device's installation by loading the necessary drivers automatically from the device and checking for conflicts with other devices. With Plug and Play, a user plugs in a device and then immediately can begin using the device without having to configure it manually.

HOW TO 9-2

Find the Latest Drivers for Devices

Device manufacturers sometimes release updated driver versions either to correct problems with previous drivers, enhance a device's functionality, or increase compatibility with new operating system versions. The following steps describe how to find the latest drivers for devices:

1. Search for and navigate to the device manufacturer's website.

2. Tap or click the link on the website to display the webpage containing technical support information.

3. Select or enter the device's model number to display support information for the device.

4. Browse the device's support information and then tap or click the link or button to download the most current driver. Manufacturers often create different versions of drivers for different operating

systems, so make sure you download the driver that is compatible with the operating system you currently are using.

5. When the download is complete, follow the instructions that accompanied the driver to install it.

Consider This: What might you do if you are unable to locate your device's driver on the manufacturer's website?



High-Tech Talk

Discover More: Visit this chapter's free resources to learn about benchmarking.

Monitoring Performance

Operating systems typically include a performance monitor. A **performance monitor** is a program that assesses and reports information about various computer resources and devices (Figure 9-10). For example, users can monitor the processor, drives, network, and memory usage.

The information in performance reports helps users and administrators identify a problem with resources so that they can try to resolve any issues. If a computer is running extremely slow, for example, the performance monitor may determine that the computer's memory is being used to its maximum. Thus, you might consider installing additional memory in the computer.

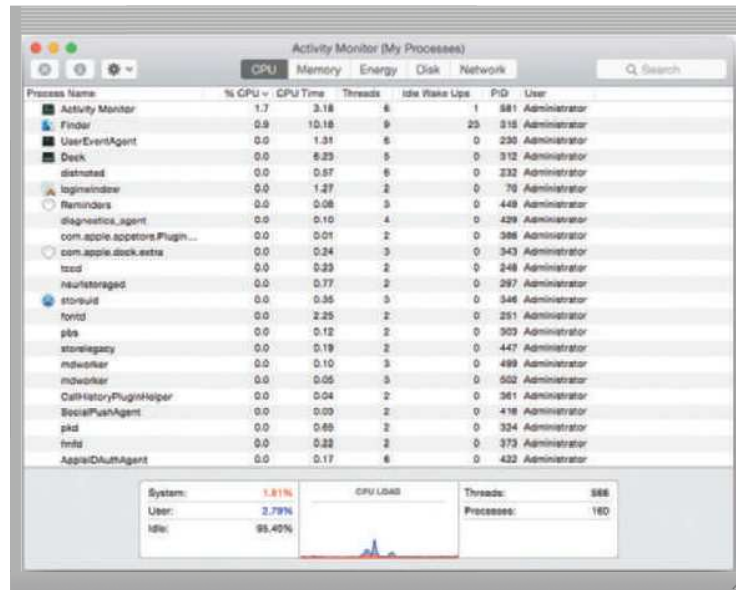


Figure 9-10 The Activity Monitor in this figure is tracking CPU (processor) usage. Source: Apple Inc.

Establishing an Internet Connection

Operating systems typically provide a means to establish Internet connections. You can establish wired connections, such as cable and DSL, or wireless connections, such as Wi-Fi, mobile broadband, and satellite. Some connections are configured automatically as soon as you connect to the Internet. With others, you may need to set up a connection manually (Figure 9-11).

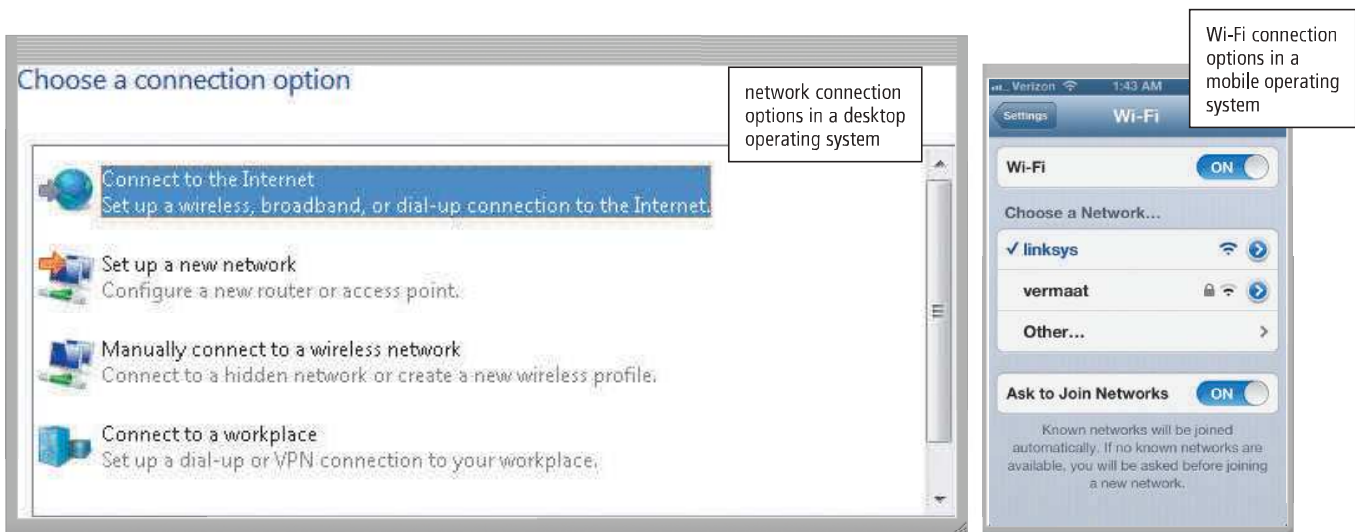


Figure 9-11 Shown here are Internet connection options for desktop and mobile operating systems. Source: Microsoft; Source: Apple Inc.

Some operating systems also include a browser and an email program, enabling you to begin using the web and communicating with others as soon as you set up an Internet connection. Operating systems also sometimes include firewalls and other tools to protect computers and mobile devices from unauthorized intrusions and unwanted software. Read Ethics & Issues 9-1 to consider whether operating systems should include antivirus and other programs.

ETHICS & ISSUES 9-1

Should Manufacturers Include Extra Programs in Operating Systems for Computers and Mobile Devices?

OEMs (original equipment manufacturers) often include and profit from including extra programs installed with a computer or device's operating system. These additional programs and apps, often called *bloatware*, mostly are harmless. Users object to their inclusion, however, because these programs and apps take up space, may slow start-up time, and can decrease the computer or device's overall efficiency.

Bloatware can come in many forms: antivirus programs, games, productivity apps, and more. Some programs or apps cause nuisances for the user, such as those that display alarming messages about a computer's virus protection and then

offer more protection for additional costs. Programs that run when the operating system starts or run in the background cause unnecessary slowdowns. Websites exist that you can use to check your installed programs or apps against a list of those other users commonly have uninstalled, as well as the reasons for uninstalling. Independent computer programmers post fixes to remove bloatware. These fixes may or may not be legal, depending on your license agreement, and could violate any warranties for which you may be eligible.

Critics of this practice state that OEMs and operating system manufacturers should offer users the option to purchase a computer or device with a clean installation (without bloatware) of the operating system. A clean install may lead to an increased

cost to make up for the lost revenue the manufacturer receives by including the extra programs or apps. Many say that charging more for a clean installation is unethical. Some recommend giving users the option to install the programs or apps that provide additional functionality as plug-ins or add-ons. Open source software advocates state that these versions offer more options to avoid bloatware.

Consider This: Should OEMs be able to install programs and apps to run alongside capabilities built into a computer or mobile device's operating system? Why or why not? Would you pay more for a clean installation of your operating system? Why or why not?

NOW YOU SHOULD KNOW

Be sure you understand the material presented in the section titled Operating Systems and the first nine sections in Operating System Functions, as it relates to the chapter objectives.

Now you should know...

- The purpose of an operating system (Objective 1)
- What processes are occurring when you start up or shut down your computers or mobile devices (Objective 2)
- How an operating system enables you to interact with the user interface, manage programs, manage memory, coordinate tasks, configure devices, monitor performance, and establish an Internet connection (Objectives 3 and 4)

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Updating Operating System Software

Many programs, including operating systems, include an **automatic update** feature that regularly provides new features or corrections to the program. That is, the operating system automatically checks to see if new updates are available, and if so, downloads them from the Internet and installs them on your computer. With an operating system, these updates can include fixing program errors, improving program functionality, expanding program features, enhancing security, and modifying device drivers (Figure 9-12).

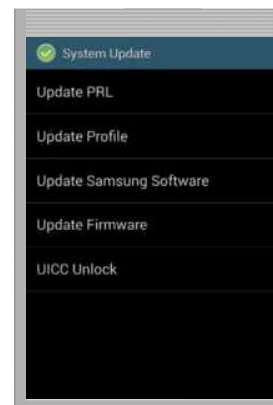


Figure 9-12 An operating system usually includes a means to download and install important updates.

Source: Google Inc.

**Bugs**

An error in a program sometimes is called a *bug*.

Many software makers provide free downloadable updates, sometimes called a *service pack*, to users who have registered and/or activated their software. With operating systems, the automatic update feature can be configured to alert users when an update is available or to download and install the update automatically. Users without an Internet connection usually can order the updates on an optical disc for a minimal shipping fee. Read Secure IT 9-1 for issues related to automatic updates.

SECURE IT 9-1**Automatic Updates — Safe or Not?**

Software updates often improve security and reliability, and they also may add significant features that optimize the computer's performance. In most cases, you have the choice either to allow the software to update automatically or to assess and then decide whether to install each update individually. Software manufacturers often recommend you download and install all available updates when they become available.

The automatic update option occasionally has caused problems. In one case, people

preparing their income tax returns were unable to print forms when a leading software company issued an automatic update one week before the filing deadline. In another situation, an automatic update was installed on all computers — even those with this feature disabled. The company claimed that the update was harmless and was for the benefit of its customers. Only later did some users realize that this secret update caused serious problems. One problem, ironically, was that updates no longer could be installed on the affected

computers. Customers were furious about the issues, especially because the company made the changes without informing the computer owners. One consequence of the ensuing outrage was that many people turned off the automatic update feature, fearing that future updates might cause even more damage.

Consider This: Is the automatic update feature enabled or disabled on your computer? Why? Should software companies be able to send automatic updates to your computer without your knowledge? Why or why not?

Providing File, Disk, and System Management Tools

Operating systems often provide users with a variety of tools related to managing a computer, its devices, or its programs. These file, disk, and system management tools were discussed in Chapter 4 and are summarized in Table 9-1. Read Secure IT 9-2 to learn more about an operating system's built-in security tools.

Table 9-1 File, Disk, and System Management Tools

Tool	Function
<i>File Manager</i>	Performs functions related to displaying files; organizing files in folders; and copying, renaming, deleting, moving, and sorting files
<i>Search</i>	Attempts to locate files on your computer or mobile device based on specified criteria
<i>Image Viewer</i>	Displays, copies, and prints the contents of graphics files
<i>Uninstaller</i>	Removes a program or app, as well as any associated entries in the system files
<i>Disk Cleanup</i>	Searches for and removes unnecessary files
<i>Disk Defragmenter</i>	Reorganizes the files and unused space on a computer's hard disk so that the operating system accesses data more quickly and programs and apps run faster
<i>Screen Saver</i>	Causes a display's screen to show a moving image or blank screen if no keyboard or mouse activity occurs for a specified time
<i>File Compression</i>	Shrinks the size of a file(s)
<i>PC Maintenance</i>	Identifies and fixes operating system problems, detects and repairs drive problems, and includes the capability of improving a computer's performance
<i>Backup and Restore</i>	Copies selected files or the contents of an entire storage medium to another storage location

SECURE IT 9-2

Using and Evaluating an Operating System's Built-In Security Tools

Security software must run constantly to protect against new viruses and malware and spyware attacks. Operating systems can include the following security tools:

- **Firewall:** Security experts recommend using a firewall and configuring it to turn on or off automatically.
- **Automatic updating:** Security updates are issued at least once daily, and other updates are generated on an as-needed basis. Many people enjoy the convenience offered by allowing these fixes to install automatically instead of continually checking for new files to download. Users can view the update history to see

when specific updates were installed. If an update caused a problem to occur, a user can uninstall these new files.

- **Antivirus software:** Many operating systems include antivirus programs that are updated regularly. Some users mistakenly think they should install and run another antivirus program simultaneously for more protection. They should not run more than one antivirus program on a computer because multiple programs might conflict with one another and slow overall performance.
- **Spyware and malware detection software:** Sophisticated malware and spyware threats are emerging at an unparalleled rate, so comprehensive

spyware and malware detection software is mandatory to fend off attacks on the computer or device.

The operating system generally is scheduled to scan and update when the computer is idle, such as in the middle of the night. Overall, the security tools should run constantly and quietly in the background to ensure a safe computing experience.

Consider This: Does your operating system have a firewall and protection against spyware and malware? Do updates occur automatically or manually? Which operating systems are more susceptible to malware attacks? Why?

Controlling a Network

Some operating systems are designed to work with a server on a network. These multiuser operating systems allow multiple users to share a printer, Internet access, files, and programs.

Some operating systems have network features built into them. In other cases, the operating system for the network is a set of programs that are separate from the operating system on the client computers or mobile devices that access the network. When not connected to the network, the client computers use their own operating system. When connected to the network, the operating system on the network may assume some of the operating system functions on the client computers or mobile devices.

The *network administrator*, the person overseeing network operations, uses the server operating system to add and remove users, computers, and other devices to and from the network. The network administrator also uses the operating system on the network to configure the network, install software, and administer network security.

Administering Security

Network administrators, as well as owners of computers, typically have an *administrator account* that enables them to access all files and programs, install programs, and specify settings that affect all users on a computer, mobile device, or network. Settings include creating user accounts and establishing permissions. These *permissions* define who can access certain resources and when they can access those resources.

For each user, the network administrator or computer owner establishes a user account. A user account enables a user to **sign in** to, or access resources on, a network or computer (Figure 9-13). Each user account typically consists of a user name and password. Recall that a **user name**, or user ID, is a unique combination of characters, such as letters of the alphabet and/or numbers, that identifies a specific user.



BTW Guest Account

If you want to provide someone temporary access to your computer, you can create a secure guest account that provides access to basic functions.

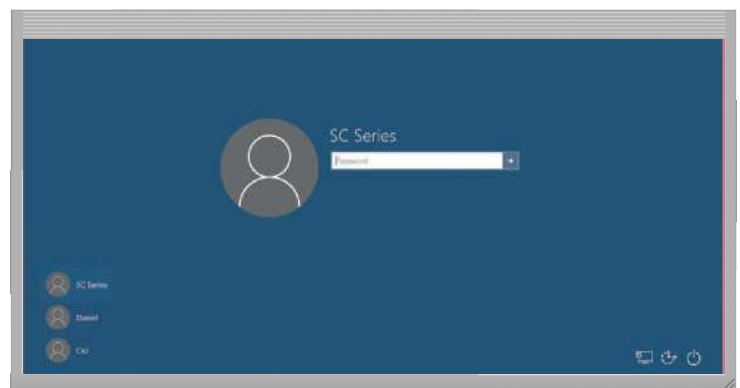


Figure 9-13 Most multiuser operating systems allow each user to sign in, which is the process of entering a user name and a password into the computer. Single-user operating systems often use a password to lock an entire device or computer.

Source: Microsoft



BTW Passwords

While users type a password, most computers and mobile devices hide the actual password characters by displaying some other characters, such as asterisks (*) or dots.

A **password** is a private combination of characters associated with the user name that allows access to certain computer, mobile device, or network resources. Some operating systems allow the network administrator to assign passwords to files and commands, restricting access to only authorized users. Mobile device owners often assign a password to the entire device, restricting all access until the correct password is entered. Read Secure IT 1-3 in Chapter 1 for tips on creating strong passwords.

To prevent unauthorized users from accessing computer resources, keep your password confidential. After entering a user name and/or password, the operating system compares the user's entry with the authorized user name(s) and password(s). If the entry matches the user name and/or password stored in a file, the operating system grants the user access. If the entry does not match, the operating system denies access to the user.

The operating system on a network records successful and unsuccessful sign-in attempts in a file. This allows the network administrator to review who is using or attempting to use the computer. The administrators also use these files to monitor computer usage. Read Ethics & Issues 9-2 to consider who is responsible for operating system security flaws.

ETHICS & ISSUES 9-2

Should Operating System Manufacturers Be Liable for Breaches Due to Security Flaws?

If you purchase a household device with a warranty, you can hold the manufacturer responsible for replacing and fixing it. Some argue that the same product liability laws that protect consumers in other industries should apply to software. Users' devices and data are vulnerable when security flaws exist in operating systems for computers and mobile devices. A flaw in an operating system can affect the performance of the computer or mobile device and subject data to corruption or unauthorized use. A user may not even be aware when a computer or mobile device is corrupted.

Hackers look for ways to break into a computer or mobile device using flaws in the operating system. An operating system is complex software that includes millions of lines of code. Developers write code as securely as possible, but with the volume of code, mistakes are bound to occur. Users sometimes are unaware of their own role in infecting their own computer or mobile device. Perhaps a hacker took advantage of a user with an unsecured Wi-Fi connection, or the user did not install or enable the latest updates to the operating system.

Some argue that making software manufacturers responsible for flaws will inhibit innovation. If a company spends

more time looking for potential security flaws, it has less time to spend enhancing the software. In addition, some of the same features that enhance an operating system, such as web integration, increase the software's vulnerability.

Consider This: Has your computer or mobile device become infected with malware due to a flaw in the operating system? How did you know? What responsibility does a software manufacturer have for preventing and fixing operating system flaws? Should users expect their software to be perfect? Why or why not?

CONSIDER THIS

What are some alternatives to passwords?

Many computers and mobile devices offer alternatives to setting and entering a password in order to gain access. Alternatives to passwords include specifying passcodes containing only numeric characters, swiping or touching areas of the screen in a specified order or pattern, or fingerprint or facial recognition.

CONSIDER THIS

Do operating systems encrypt data and files?

To protect sensitive data and information further as it travels over a network, the operating system may encrypt it. Recall that *encryption* is the process of encoding data and information into an unreadable form. Administrators can specify that data be encrypted as it travels over a network to prevent unauthorized users from reading the data. When an authorized user attempts to read the data, it is automatically decrypted, or converted back into a readable form.

Types of Operating Systems

Many of the first operating systems were device dependent and proprietary. A *device-dependent* program is one that runs only on a specific type or make of computer or mobile device. *Proprietary software* is privately owned and limited to a specific vendor or computer or device model.

Some operating systems still are device dependent. The trend today, however, is toward *device-independent* operating systems that run on computers and mobile devices provided by a variety of manufacturers. The advantage of device-independent operating systems is you can retain existing applications and data files even if you change computer or mobile device models or vendors.

When you purchase a new computer or mobile device, it typically has an operating system preinstalled. As new versions of the operating system are released, users often upgrade their existing computers and mobile devices to incorporate features of the new versions. Some upgrades are free; some offer an upgrade price that is less than the cost of purchasing the entire operating system. Read Ethics & Issues 9-3 to consider when you should upgrade.

Discover More: Visit this chapter's free resources to learn more about device-independent operating systems.

ETHICS & ISSUES 9-3



Should You Be an Early Adopter of a New Technology?

Consumers' reactions to the release of a new device, program or app, or operating system fall into two camps: those who cannot wait, and those who exercise caution. Early adopters is the term given to users who sleep in line on the street outside a store in order to be one of the first to own a new device, or those who stay up until midnight to start the download of a program or app the moment it is released.

Some early adopters of new technology do so for the same reasons one might purchase a new item of clothing — to make a statement. Others do so out of

curiosity, or for a desire to Tweet, blog, or post on social media his or her experiences. Manufacturers and developers rely on early adopters to provide valuable feedback and insight into the user experience, as well as to help generate excitement. In some cases, early adopters receive additional customer assistance in exchange for feedback. As one manufacturer said, the more people who initially use the product, the better the resulting product will be.

Critics of early adoption cite security risks and usability issues that may be uncovered. Many feel that waiting until the initial reviews, and subsequent patches or updated releases,

are available is prudent. Others are concerned with compatibility issues between syncing the new technology with the user's current devices, data, or apps. Another factor in waiting is that the price of the new technology often drops within a few months of its release. Early adopters may have paid more for a less satisfying experience than those who wait.

Consider This: Have you ever been an early adopter of a new technology? What was your experience? Will you be an early adopter in the future? Why or why not? Should manufacturers give benefits to early adopters? Why or why not?

New versions of an operating system usually are *backward compatible*, which means they recognize and work with applications written for an earlier version of the operating system (or platform). The application, by contrast, may or may not be *upward compatible*, meaning it may or may not run on new versions of the operating system.

The three basic categories of operating systems on computers and mobile devices are desktop, server, and mobile. Table 9-2 lists examples in each of these categories, which are discussed on the following pages.



Table 9-2 Examples of Operating Systems by Category

Category	Name
Desktop	Windows
	OS X
	UNIX
	Linux
	Chrome OS
Server	Windows Server
	Mac OS X Server
	UNIX
	Linux
Mobile	Google Android
	Apple iOS
	Windows Phone

Desktop Operating Systems

Internet Research

What is the most widely used desktop operating system?

Search for: desktop os market share

A **desktop operating system**, sometimes called a *stand-alone operating system*, is a complete operating system that works on desktops, laptops, and some tablets. Desktop operating systems sometimes are called *client operating systems* because they also work in conjunction with a server operating system. Client operating systems can operate with or without a network.

Examples of the more widely used desktop operating systems are Windows, Mac OS, UNIX, Linux, and Chrome OS.

Windows/Mini Feature 9-1

In the mid-1980s, Microsoft developed its first version of Windows, which provided a graphical user interface. Since then, Microsoft continually has updated its Windows operating system, incorporating innovative features and functions with each subsequent version. In addition to basic capabilities, the latest versions of Windows offer these features:

- Uses tiles to access apps
- Includes the desktop interface
- Support for input via touch, mouse, and keyboard
- Email app, calendar app, and browser (*Internet Explorer*) included
- Photos, files, and settings can sync with *OneDrive*, Microsoft's cloud server
- Enhanced security through an antivirus program, firewall, and automatic updates
- Windows Store offers additional applications for purchase

Discover More: Visit this chapter's free resources to learn more about the Windows Store. Read Mini Feature 9-1 to learn more about the interface of the Windows operating system.

BTW

Networking

Some desktop operating systems include networking capabilities, allowing the home and small business user to set up a small network.

BTW

PC

The term, PC, sometimes is used to describe a computer that runs a Windows operating system.

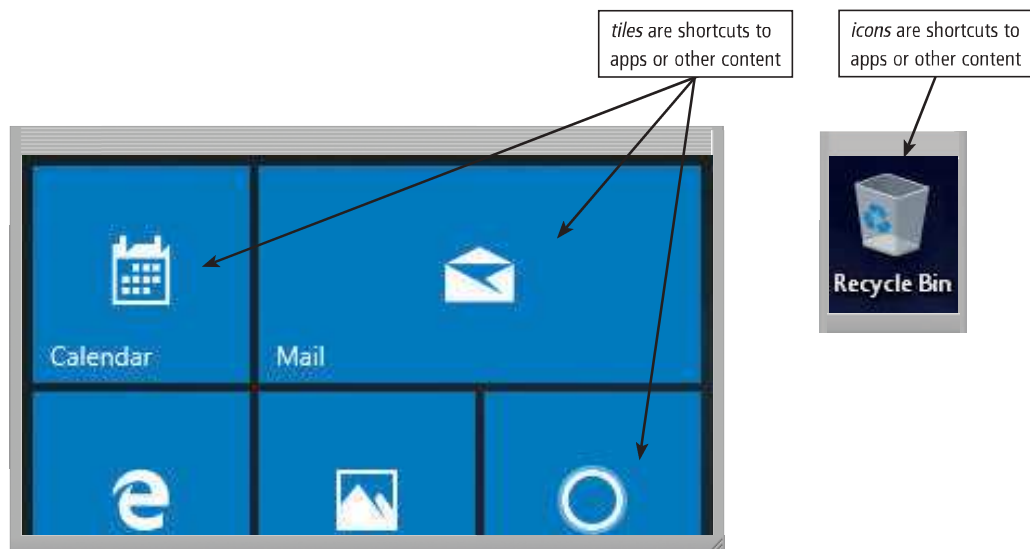
MINI FEATURE 9-1

Windows User Interface

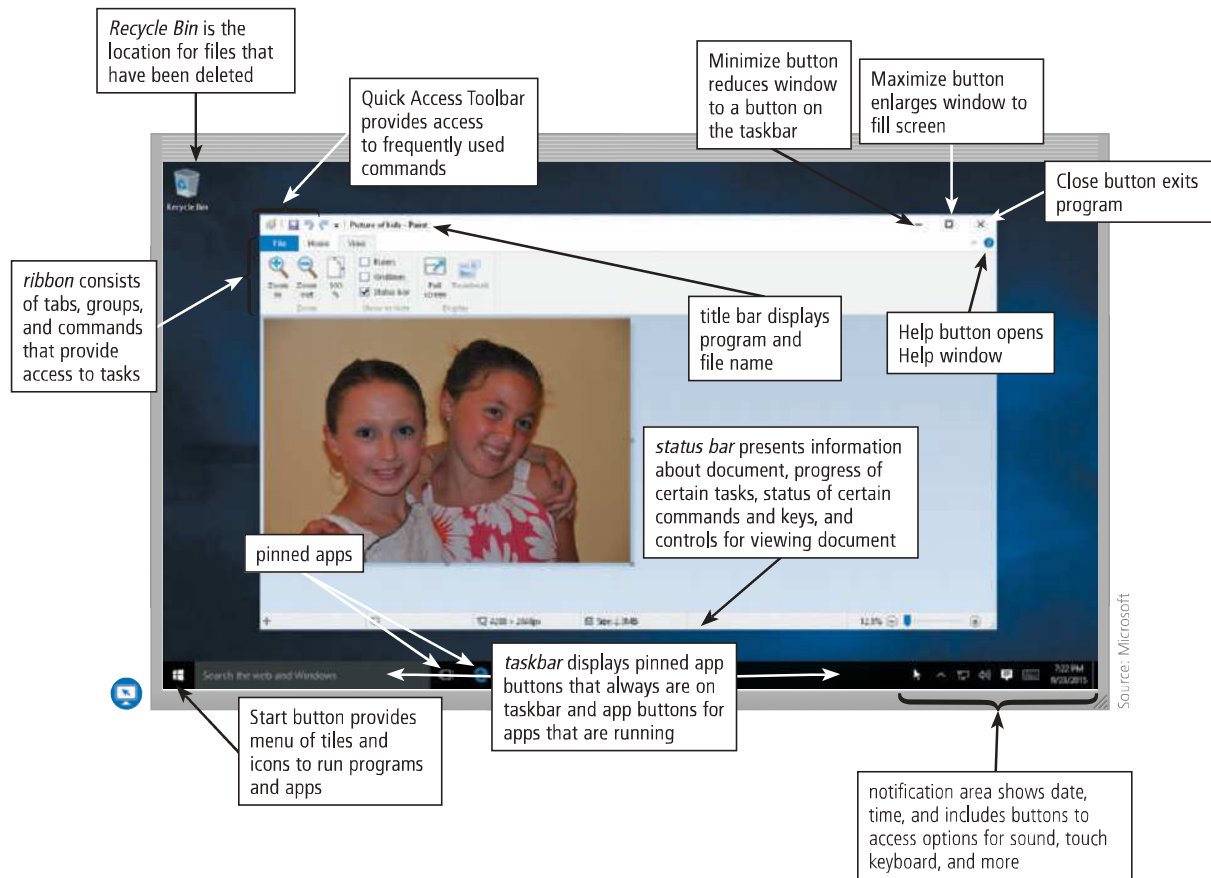
The following screens show the components of the Windows interface. The Windows operating system simplifies the process of working with documents and apps by organizing the manner in which you interact with the computer.

The Windows interface includes tiles and icons, as shown in the figure below. You tap or click tiles to run apps, and double-tap or double-click icons to run apps.

When you run an app in Windows, it may appear in an on-screen work area app, called the desktop, shown in the second figure in this mini feature. Many Office and Windows programs, such as Paint, contain common elements.



Source: Microsoft



Discover More: Visit this chapter's free resources to learn about the current Windows version.

Consider This: Have you used Windows? If so, which version? What was your experience? What

features of the Windows interface make it easy to run apps and open documents? Why? How does the ribbon help make learning a new program easier?

Mac OS/Mini Feature 9-2

Since it was released in 1984 with Macintosh computers, Apple's *Macintosh operating system* (*Mac OS*) has earned a reputation for its ease of use and has been the model for most of the new GUIs developed for non-Macintosh systems. The latest version, **OS X**, is a multitasking operating system available for computers manufactured by Apple. Features of the latest version of OS X include the following:

- Mail, calendars, contacts, and other items sync with *iCloud*, Apple's cloud server
- Communicate and play games with users of mobile devices running Apple's mobile operating system (*iOS*)
- Built-in Facebook and Twitter support allows you to post a status, comments, or files from any app
- Browser (*Safari*)
- Open multiple desktops at once
- Dictated words convert to text
- Support for Braille displays
- Mac App Store provides access to additional apps and software updates

Discover More: Visit this chapter's free resources to learn more about the Mac App Store. Read Mini Feature 9-2 to learn more about the interface of the Mac operating system.

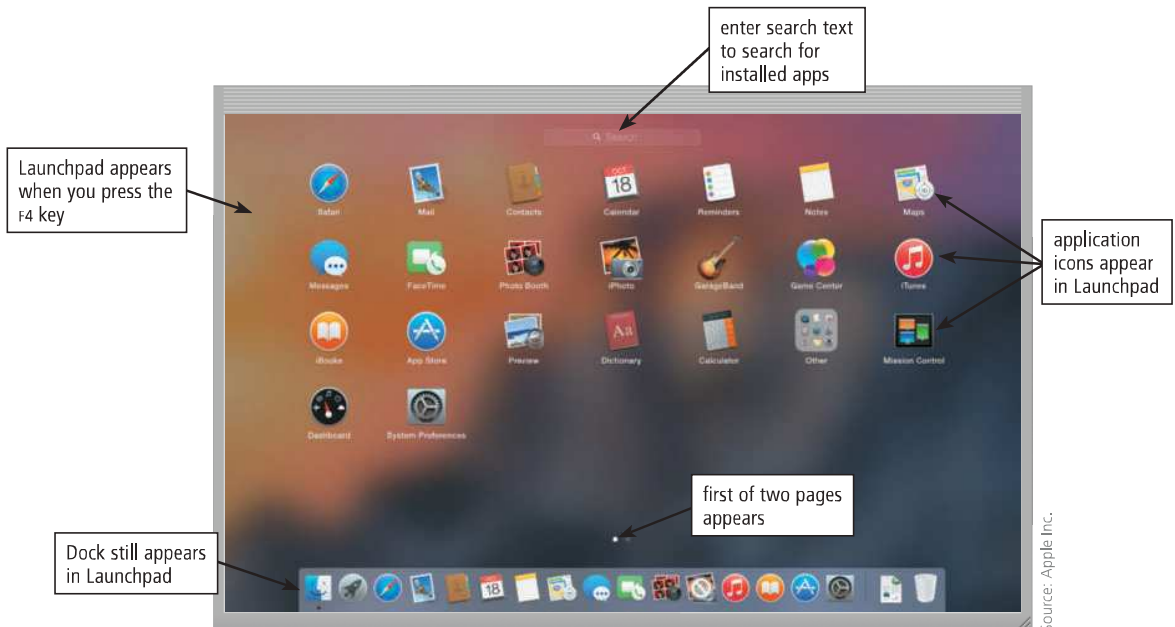
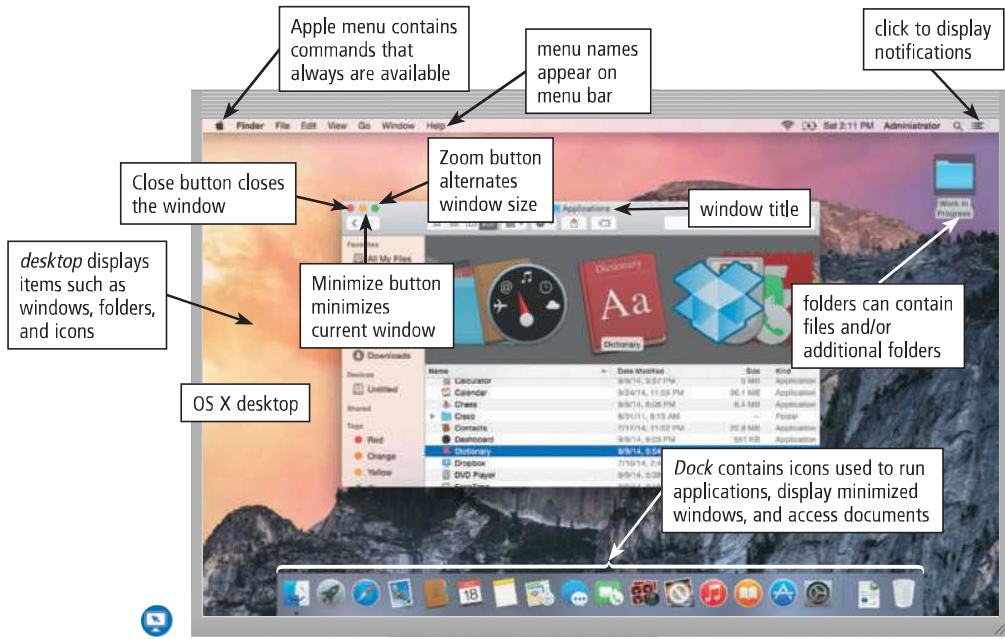
MINI FEATURE 9-2

Mac OS User Interface

The following screens show the components of the OS X user interface. Mac OS is installed on Apple computers, such as iMacs, MacBook Pros, MacBook Airs, Mac Pros, and Mac minis. The user interface contains components such as the Dock, icons, and windows.

The OS X user interface begins with the desktop. Many OS X programs and apps contain common elements, as shown in the desktop figure below.

You can use the Launchpad to view, organize, and run apps, as shown in the second figure below.



Discover More: Visit this chapter's free resources to learn more about the latest version of Mac OS.

Consider This: How is the user interface in OS X similar to the Windows user interface? How is it different?

UNIX

UNIX (pronounced YOU-nix) is a multitasking operating system developed in the early 1970s by scientists at Bell Laboratories. Bell Labs (a subsidiary of AT&T) was prohibited from actively promoting UNIX in the commercial marketplace because of federal regulations. Bell Labs instead licensed UNIX for a low fee to numerous colleges and universities, where UNIX obtained a wide following. UNIX was implemented on many different types of computers. In the 1980s, the source code for UNIX was licensed to many hardware and software companies to customize for their devices and applications. As a result, several versions of this operating system exist, each with slightly different features or capabilities.

Today, a version of UNIX is available for most computers of all sizes. Although some versions of UNIX have a command-line interface, most versions of UNIX offer a graphical user interface (Figure 9-14). Power users often work with UNIX because of its flexibility and capabilities. An industry standards organization, *The Open Group*, now owns UNIX as a trademark.

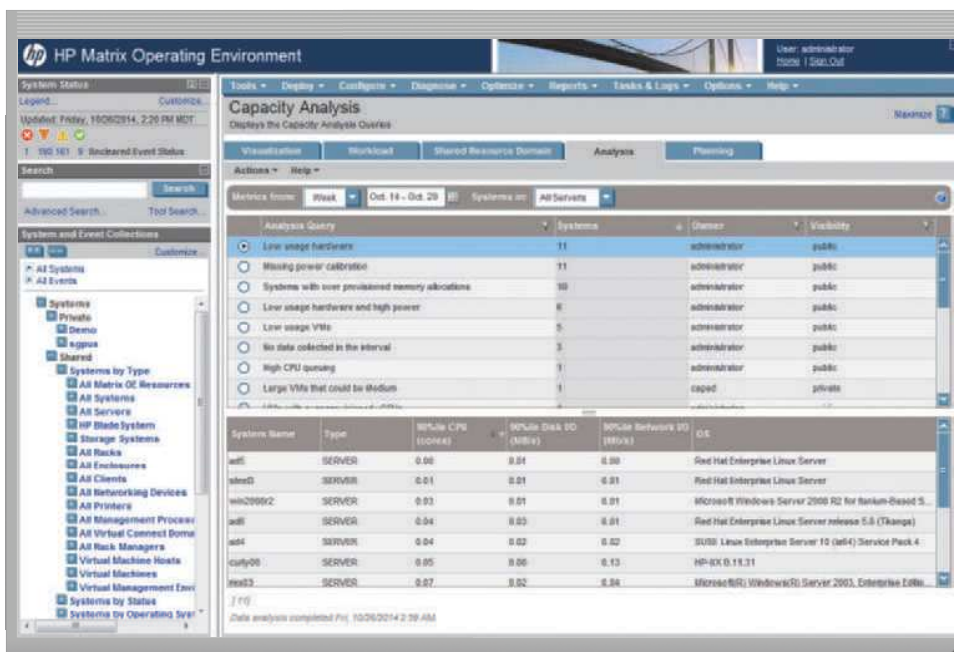


Figure 9-14 One version of the UNIX operating system.

Courtesy of Hewlett-Packard Company

Linux

Linux (pronounced LINN-uks), introduced in 1991, is a popular, multitasking UNIX-based operating system that runs on a variety of personal computers, servers, and devices. In addition to the basic operating system, Linux also includes many free tools and programming languages.

Linux is not proprietary software like the operating systems discussed thus far. Instead, Linux is *open source software*, which means its code is provided for use, modification, and redistribution. Many programmers have donated time to modify and redistribute Linux to make it the most popular UNIX-based operating system.

CONSIDER THIS

Why use open source software?

Open source software has no restrictions from the copyright holder regarding modification of the software's internal instructions and redistribution of the software. Promoters of open source software state two main advantages: users who modify the software share their improvements with others, and customers can personalize the software to meet their needs. Read Secure IT 9-3 to consider security issues associated with open and closed source programs.



OS X

OS X is a UNIX-based operating system.




Technology Innovator

Discover More: Visit this chapter's free resources to learn about Linus Torvalds, the creator of Linux.



Technology Trend

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

 **SECURE IT 9-3**
 **Open Source or Closed Source — Which Is More Secure?**

Supporters of open source software maintain that this operating system enables developers to create high-quality programs. Source code, along with any changes, remains public, so communities of open source programmers can examine, correct, and enhance programs. They also can make changes immediately when security issues arise.


Many proponents of open source software use Linux, which is known for its speed and stability. Of the 500 fastest supercomputers, more than 90 percent use variants of Linux. Many of these computers perform high-performance tasks, including detecting and preventing fraud. Companies and nonprofit

organizations can distribute and sell their versions of Linux, which enables those without the expertise to modify open source software and to benefit from the creative efforts of the Linux community.

Developers of closed source operating systems, on the other hand, refuse to share some or all of the code. They believe that companies and developers should be able to control, and profit from, the operating systems they create. Their philosophy may hinder third-party software developers who create programs and apps for the operating system.

Fear of viruses and other security concerns can lead some to question about whether open source software is worthwhile. While

dishonest and anonymous developers can use open source software to create programs that may be or may include malware, cryptography experts emphasize that Linux systems have fewer reported security exposures than Windows-based systems. In general, Linux systems do not run antivirus software, but they do use detection programs that check for signs of attacks and probes.

 **Consider This:** Are the security concerns about open source software legitimate? Why or why not? Why is antivirus software not needed on Linux-based systems? Does the open source model lead to higher-quality software? Why or why not?

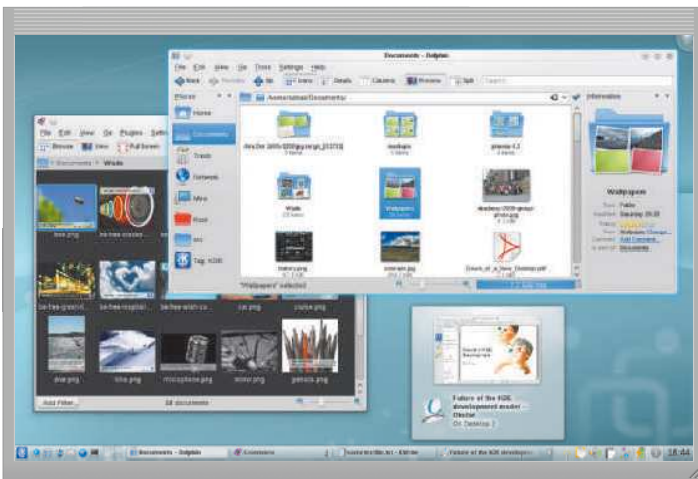


Figure 9-15 A GUI distribution of Linux.
Courtesy of KDE

 **BTW**
Technology Innovator

Discover More: Visit this chapter's free resources to learn about Red Hat, a distributor of Linux.

Chrome OS

Chrome OS, introduced by Google, is a Linux-based operating system designed to work primarily with web apps (Figure 9-16). Apps are available through the Chrome Web Store, and data is stored on Google Drive. The only apps typically installed on the computer are the Chrome browser, a media player, and a file manager. A specialized laptop that runs Chrome OS is called a *Chromebook*, and a specialized desktop that runs Chrome OS is called a *Chromebox*. Chromebooks and Chromeboxes typically use SSDs for internal storage. Users also can run Chrome OS as a virtual machine (which is discussed in the next section).

Because computers running Chrome OS work mostly with web apps, they do not require as much internal storage capacity as other desktop operating systems discussed in this section. Their start-up and shutdown time also is considerably less than other desktop operating systems because Chrome OS uses a streamlined start-up procedure.

Discover More: Visit this chapter's free resources to learn more about Chromebooks and Chromeboxes.

Linux is available in a variety of forms, known as distributions. Some distributions of Linux are command line. Others are GUI (Figure 9-15). Some companies market software that runs on their own distribution of Linux. Many application programs, tools, and plug-ins have Linux distributions.

Users obtain versions of Linux in a variety of ways. Some download it free from a provider's website and create media to install it on a computer, or they create a Live CD or Live USB from which to preview it. Others purchase optical discs from vendors who may bundle their own software with the operating system or download it from their websites. Some retailers will preinstall Linux on a new computer on request.

Discover More: Visit this chapter's free resources to learn more about Linux distributions and Live CDs/Live USBs.

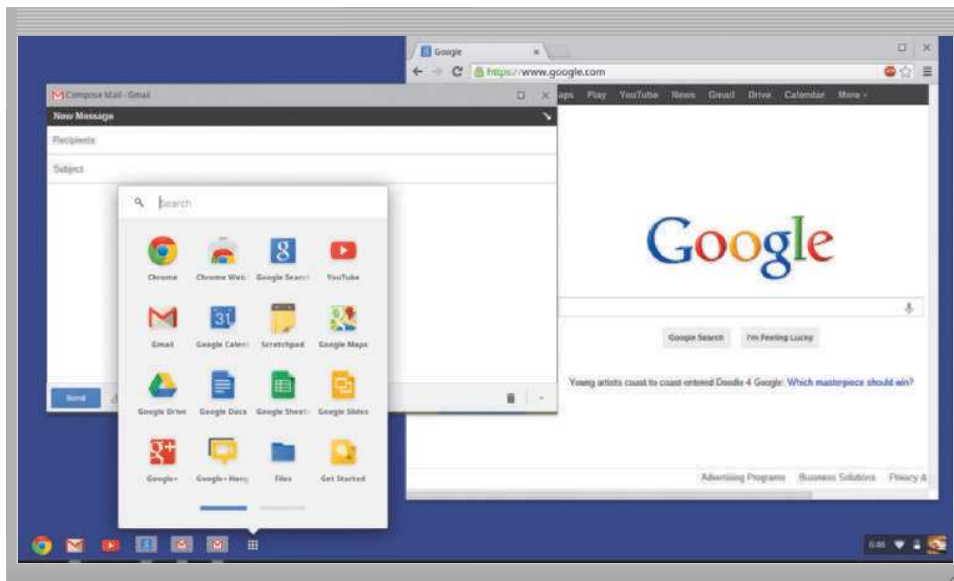


Figure 9-16 Chrome OS is a Linux-based operating system by Google.

Courtesy of Volha Kryvets; Source: Google Inc.

Running Multiple Desktop Operating Systems

If you want to run multiple operating systems on the same computer, you could partition the hard drive or you could create a virtual machine. *Partitioning* divides a hard drive in separate logical storage areas (partitions) that appear as distinct drives. When you partition a drive, you can install a separate operating system in each partition, sometimes called a dual boot. Because partitioning requires advanced skills, users often opt to create a virtual machine instead. A *virtual machine (VM)* is an environment on a computer in which you can install and run an operating system and programs. VMs enable you to install a second operating system on a computer. Read How To 9-3 for instructions about creating a virtual machine. Another option for Mac users who want to run Windows programs is a program called Boot Camp. Read How To 9-4 for instructions about installing the Windows operating system on a Mac computer.

HOW TO 9-3

Set Up and Use a Virtual Machine

A virtual machine enables a computer to run another operating system in addition to the one installed. Various reasons exist for using a virtual machine. For example, if you are running the latest version of Windows on a computer but require an app that runs only in a previous version of Windows, you might set up a virtual machine running the previous version of Windows so that you can run the desired app. The computer still will have the latest version of Windows installed, but you easily will be able to switch to the previous version when necessary.

To set up a virtual machine, you will need the required software, as well as installation media for the operating system you want to install in the virtual machine. The following steps describe how to set up a virtual machine:

1. Obtain and install an app that creates and runs virtual machines.

2. Run the app and select the option to create a new virtual machine.
3. Specify the settings for the new virtual machine.
4. If necessary, insert the installation media for the operating system you want to run in the virtual machine.
5. Run the virtual machine. Follow the steps to install the operating system in the virtual machine.
6. When the operating system has finished installing, remove the installation media.
7. While the virtual machine is running, if desired, install any apps you want to run.
8. When you are finished using the virtual machine, shut down the operating system in the same manner you would shut down your computer.
9. Exit the virtual machine software.

After you set up the virtual machine, you can use the virtual machine any time by performing the following steps:

1. Run the virtual machine software.
2. Select the virtual machine you want to run.
3. Tap or click the button to run the virtual machine.
4. When you are finished using the virtual machine, shut down the operating system similar to how you would shut down your computer.
5. Exit the virtual machine software.


Consider This: What are some other reasons that might require you to set up and use a virtual machine on a computer?

 HOW TO 9-4**Use Boot Camp to Install the Windows Operating System on a Mac**

If you are using an Apple computer, such as an iMac or MacBook Pro, you may encounter instances where you need to run apps in the Windows operating system. Newer versions of Mac OS enable you to install Windows on a computer using a program called *Boot Camp*. The following steps describe how to use Boot Camp to install the Windows operating system on a Mac:

1. Obtain the installation media for the version of Windows you want to install.
2. Use the operating system's search feature to locate the Boot Camp Assistant application. (*Hint: Use the search text, boot camp.*)
3. Click the search result for the Boot Camp Assistant application.
4. When the Boot Camp Assistant runs, read the introduction and then click the Continue button.
5. Next, you create a partition, which is a section of storage or memory reserved for a specific program or application. Partitions enable a single drive to be treated as multiple drives. Follow the remaining steps to create a Windows partition and install Windows:
 - a. Specify the amount of disk space to use for the Windows partition. The partition should be large enough to store all operating system files, apps you want to run in Windows, and any files you want to store using Windows.
 - b. Complete the steps described in the Windows installation process.
6. When the installation is complete and Windows starts, if necessary, enter your user name and password to sign in to Windows.

If you want to switch between Mac OS and Windows, press and hold the option key on the keyboard while turning on or restarting the computer. When the list of operating systems is displayed, select the operating system you want to run.

 **Consider This:** What apps might someone want to run in Windows that are unavailable in Mac OS? How does Boot Camp differ from a virtual machine?

 NOW YOU SHOULD KNOW

Be sure you understand the material presented in the last four sections in Operating System Functions and the sections titled Types of Operating Systems and Desktop Operating Systems, as it relates to the chapter objectives. *Now you should know ...*

- How to update your operating system and tools (Objective 5)
- How you can use an operating system to control a network or administer security (Objective 6)
- Which desktop operating system is best suited to your needs (Objective 7)

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

Server Operating Systems

 BTW**Multipurpose OS**

Operating systems, such as UNIX and Linux, that function as both desktop and server operating systems sometimes are called *multipurpose operating systems*.

 BTW**High-Tech Talk**

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

A **server operating system** is a multiuser operating system that organizes and coordinates how multiple users access and share resources on a network. Client computers on a network rely on server(s) for access to resources.

Many of the desktop operating systems discussed in the previous section function as clients and work in conjunction with a server operating system. Although desktop operating systems may include networking capability, server operating systems are designed specifically to support all sizes of networks, including medium- to large-sized businesses and web servers. Server operating systems can handle high numbers of transactions, support large-scale messaging and communications, and have enhanced security and backup capabilities.

Many also support virtualization. Recall that *virtualization* is the practice of sharing or pooling computing resources, such as servers or storage devices. Through virtualization, for example, server operating systems can separate a physical server into several virtual servers. Each virtual server then can perform independent, separate functions.

Examples of server operating systems include the following:

- **Windows Server:** Developed by Microsoft, Windows Server enables organizations to manage applications and websites on-site and/or on the cloud.
- **OS X Server:** Developed by Apple, OS X Server enables organizations to collaborate, share files, host websites and mail servers, and more on Mac computers and iOS devices.

- **UNIX:** Capable of handling a high volume of transactions in a multiuser environment and working with multiple processors, UNIX often is used on web servers.
- **Linux:** Because it provides a secure, stable multiuser environment, Linux often is used on web servers and on supercomputers.

Discover More: Visit this chapter's free resources to learn more about the latest versions of Windows Server and OS X Server.

Mobile Operating Systems

The operating system on mobile devices and many consumer electronics is called a **mobile operating system** and resides on firmware. Mobile operating systems typically include or support the following: calendar and contact management, text messaging, email, touch screens, accelerometer (so that you can rotate the display), digital cameras, media players, speech recognition, GPS navigation, a variety of third-party apps, a browser, and wireless connectivity, such as cellular, Wi-Fi, and Bluetooth. Read Ethics & Issues 9-4 to consider the privacy of text messages.

Internet Research

What is the most widely used server operating system?

Search for: server os market share

BTW

Technology Innovators

Discover More: Visit this chapter's free resources to learn about the products and services of Sun and IBM.

ETHICS & ISSUES 9-4

Should Text Messages Sent by Employees Be Private?

When an employer asks a worker to disclose work-related text messages, is the employee legally required to reveal all messages, even personal ones? Is the employer liable for damages caused by inappropriate messages sent by an employee?

Many companies provide employees with mobile devices, such as smartphones, for work communications. Employers typically create acceptable use policies. These policies address ownership of electronic communications, including email messages, voice mail messages, and text messages. Regardless of the policy,

employees may believe they have the rights of privacy and self-expression when they use a company-issued mobile device for personal use. The issue is complicated further when companies employ BYOD (bring your own device) policies. When an employee uses a personal device for business-related communications, it is unclear who owns the communications, and who takes responsibility for any misuse. Read Secure IT 9-4 for security issues associated with BYOD.

The U.S. Supreme Court ruled that an employer can read workers' text messages on company-owned devices if the employer has reason to believe the text messages violate workplace rules. The Court held that employees

can purchase their own mobile devices for personal use. Critics state that employees have a reasonable expectation of privacy. Supporters of the decision argue that employers own the devices because they provide the devices and pay for the service for the employee. They claim, therefore, that employers have a right to view the content of all text messages.

Consider This: Should text messages sent by employees be private? Why or why not? How can employers impose policies regarding text messages sent on company-issued mobile devices? Should employers be able to access work-related communications on an employee-owned device? Why or why not?

SECURE IT 9-4

BYOD Security Issues

Effective BYOD (bring your own device) policies can lead to many benefits for businesses, but they also give rise to many issues that affect information security and data protection. When employees bring their smartphones, tablets, and laptops into the workplaces, the companies surrender much control over this hardware compared to devices they own.

One of the biggest problems is that employees can carry their devices everywhere outside of work. If these devices are lost or stolen, the company's sensitive information can land in the hands of criminals. Many of these allegedly lost devices are sold on online auctions and other services websites, even if the original owners have wiped their devices remotely.

Companies need to educate employees on *mobile device management (MDM)*. One point they need employees to know is that phishing scams abound in email messages, text messages, Facebook posts, and Tweets. Other security measures to emphasize are the need to use strong passwords, to not reveal these passwords to other employees, and to avoid apps that collect information about the user, especially those that monitor the employee's location and shopping habits.

BYOD policies should be developed that address technical, legal, and human resources issues. The language in these policies should cover these topics:

- Ensuring that work data will not be merged with the employee's personal data

- Requiring that nonemployees, such as family members who use the device, will not access work data
- Following procedures when an employee resigns or is terminated
- Alerting management immediately when the device is lost or stolen

Consider This: Do you or people you know work at a business that allow employees to bring their own devices to work? If so, do these businesses have a BYOD policy? If so, how were the policy's terms communicated? For example, were they explained verbally and available in written form?

Internet Research

What is the most widely used mobile operating system?

Search for: mobile os market share

BTW

Android Releases

Google names its Android releases alphabetically after sweet treats, such as Gingerbread, Honeycomb, Ice Cream Sandwich, Jelly Bean, Key Lime Pie, KitKat, and Lollipop.

Popular mobile operating systems include Android, iOS, and Windows Phone. The following sections discuss each of these operating systems.

CONSIDER THIS

Do other mobile operating systems exist?

Yes. Several other mobile operating systems exist, although they are not as widely used as Android, iOS, and Windows Phone. For example, the *Blackberry operating system* is a proprietary mobile operating system that runs on Blackberry smartphones and Blackberry tablets. *Firefox OS* is a Linux-based open source operating system that runs on smartphones and tablets developed by Mozilla. *Fire OS* is a Linux-based operating system for Amazon Kindle tablets and Amazon Fire Phones. Several phones also run a version of Linux.



Figure 9-17 An Android phone and tablet.
© iStockPhoto / deepblue4you; Courtesy of Sony Corporation

Android

Android is an open source, Linux-based mobile operating system designed by Google for smartphones and tablets (Figure 9-17). A variety of manufacturers produce devices that run the Android operating system, adding their own interface elements and bundled software. As a result, an Android smartphone manufactured by Samsung may have different user interface features from one manufactured by Google.

Features unique to recent versions of the Android operating system include the following:

- *Google Play* app store provides access to apps, songs, books, and movies.
- *Google Drive* provides access to email, contacts, calendar, photos, files, and more.
- Face recognition or fingerprint scanner can unlock the device.
- Share contacts and other information by touching two devices together (using NFC technology).
- Speech output assists users with vision impairments.
- Voice recognition capability enables users to speak instructions.
- Built-in heart rate monitor works with phone apps.

Discover More: Visit this chapter's free resources to learn more about the Android operating system.



Figure 9-18 An iOS phone and tablet.
© iStockPhoto / cotesebastien

iOS

iOS (originally called iPhone OS), developed by Apple, is a proprietary mobile operating system specifically made for Apple's mobile devices (Figure 9-18). Supported devices include the iPhone, iPod Touch, and iPad. Features unique to recent versions of the iOS operating system include the following:

- *Siri*, a voice recognition app, enables you to speak instructions or questions to which it takes actions or responds with speech output.
- *Apple Pay* provides a centralized, secure location for credit and debit cards, coupons, boarding passes, loyalty cards, and mobile payment accounts.
- *iCloud* enables you to sync mail, calendars, contacts, and other items.
- *iTunes Store* provides access to music, books, podcasts, ringtones, and movies.
- Integrates with iPod to play music, video, and other media.
- Improves connectivity with other devices running the Mac operating system.
- *Mac App Store* provides access to additional apps and software updates.

Discover More: Visit this chapter's free resources to learn more about the iOS operating system.

Windows Phone

Windows Phone, developed by Microsoft, is a proprietary mobile operating system that runs on some smartphones (Figure 9-19). Features unique to recent versions of the Windows Phone operating system include the following:

- Sync photos, files, and settings with OneDrive.
- Use your phone as a remote control for your television.
- Access a global catalog of music, videos, or podcasts, or listen to iTunes music.
- Geofencing enables your phone to send or receive notification when you enter or exit a geographic location. (Read Ethics & Issues 8-2 in Chapter 8 for other uses of geofencing.)
- *Windows Phone Store* provides access to additional apps and software updates.
- *Wallet* app provides a centralized location for coupons, credit cards, loyalty cards, and memberships in a single, easily accessible location.

Discover More: Visit this chapter's free resources to learn more about the Windows Phone operating system.



Figure 9-19 A Windows Phone.
Courtesy of Microsoft

Mini Feature 9-3: Mobile versus Desktop Operating Systems

While mobile and desktop operating systems share many similarities, they also have differences designed for their operating environment. Read Mini Feature 9-3 for a comparison of mobile and desktop operating systems.

MINI FEATURE 9-3

Mobile versus Desktop Operating Systems

An operating system has the same role, whether for a desktop or mobile device. It manages operations and provides a user interface. Because of this shared role, many similarities exist between the functions of desktop and mobile operating systems. From a user's perspective, operating systems enable you to work with apps and to monitor and maintain the functions of the computer or device. Typical functions included in mobile operating systems include the following:

- Main areas, such as a desktop or home screen, enable you to access and organize apps
- Methods to return to the main area quickly
- The ability to organize the app icons or tiles in the main areas easily by moving them to pages or folders or by adding them to menus
- System tools, such as to manage battery power and Internet connections
- Options for security settings

Whether you are purchasing a computer or mobile device, the choice of an operating system plays an important role.

Historically, the two types of operating systems have had different uses and capabilities. The differences are due in part to the disparity in screen size, keyboards, and processing power. Because of convergence, as well as the increased reliance on mobile devices for communications and productivity, the use and function of mobile and desktop operating systems are becoming more similar. The prevalence of web apps and cloud storage services enables users to access the same programs and files they work with on their desktop from a mobile device. Some developers now create operating systems that share code and have common features, regardless of whether they are installed on a computer or mobile device. Features, such as tiles and icons (typically used in mobile devices), make the transition between using a mobile device and computer easier. For example, mobile device operating systems include capabilities that allow users to take advantage of the touch screen displays. As more computer desktop monitors today are touch enabled, computer users can take advantage of this feature.

Many differences exist in the way a user interacts with a mobile operating system.



BTW

Technology Trend

Discover More: Visit this chapter's free resources to learn more about mobile versus desktop operating system usage.



Source: SAMSUNG



Source: Google Inc.



Source: SAMSUNG



Source: Google Inc.

- A desktop operating system may use menus, windows, and bars to run apps and to access features within apps. On a desktop, you can run multiple programs simultaneously and seamlessly due to the large screen and the use of pointing devices. This feature makes desktops more relevant than mobile operating systems to productivity and multitasking.
- A mobile operating system typically has one program running at a time, although others may be running in the background. Quick movements and gestures are often all that you need to perform tasks on a mobile device. Mobile operating systems use technologies such as cellular, Bluetooth, Wi-Fi, GPS, and NFC to communicate with other devices and to connect to the Internet. Mobile devices also typically include cameras, video cameras, voice recorders, and sometimes speech recognition.

Discover More: Visit this chapter's free resources to learn more about mobile and desktop operating systems.

- ☀ **Consider This:** What similarities have you noticed between mobile and desktop operating systems? What differences have you noticed between mobile and desktop operating systems? What features work better with a mobile versus a desktop operating system? Why? Is the convergence trend beneficial or should each device type take advantage of its strengths? Why?

☀ CONSIDER THIS

Do embedded computers use mobile operating systems?

Typically, an embedded computer uses an embedded operating system, sometimes called a *real-time operating system (RTOS)*. Examples of products that use embedded operating systems include digital cameras, ATMs, digital photo frames, HDTV receivers, fuel pumps, ticket machines, process controllers, robotics, and automobile components. Embedded operating systems often perform a single task, usually without requiring input from a user. Several embedded operating systems are available, each intended for various uses.

✓ NOW YOU SHOULD KNOW

Be sure you understand the material presented in the sections titled Server Operating Systems and Mobile Operating Systems, as it relates to the chapter objectives.

Now you should know ...

- When you might use a server operating system (Objective 8)
- Which mobile operating system you would prefer to use (Objective 9)

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

Chapter Summary

This chapter discussed the functions common to most operating systems: starting and shutting down computers and mobile devices, providing a user interface, managing programs, managing memory, coordinating tasks, configuring devices, monitoring performance, establishing an Internet connection, updating operating system software, providing file, system, and disk management tools, controlling a network, and administering security. It also presented a variety of desktop operating systems, server operating systems, and mobile operating systems.

Discover More: Visit this chapter's free resources for additional content that accompanies this chapter and also includes these features: Technology Innovators: Linus Torvalds, Red Hat, Sun, and IBM; Technology Trends: Linux Powering the Internet of Things and Mobile versus Desktop Operating System Usage; and High-Tech Talks: Benchmarking and Virtualization.

- Test your knowledge of chapter material by accessing the Study Guide, Flash Cards, and Practice Test apps that run on your smartphone, tablet, laptop, or desktop.

TECHNOLOGY @ WORK

Meteorology

With the television tuned to the local weather station, you anxiously are awaiting to see the projected path of a hurricane in the tropics. Having experienced hurricanes in the past, you rely heavily on the accuracy of weather forecasts so that you can prepare adequately if a storm travels through the area. Technology allows meteorologists to better estimate the severity and path of storms, enabling people to make potentially life-saving preparations.

The National Hurricane Center uses powerful computers to generate multiple computer models to determine a storm's path. These models consider factors such as the storm's current strength, the effects of nearby weather systems, the storm's central pressure, and whether the storm may travel over land. These models also may consider previous storms that traveled a similar path. While these models are not 100 percent accurate, they do ensure that everyone who may be affected by the storm has enough time to prepare.

Violent, rotating thunderstorms potentially can spawn tornadoes, which sometimes cause catastrophic damage. For this reason, it is important for everyone to watch or listen closely to the weather during the storm. Meteorologists can monitor weather systems on multiple radars and send additional severe weather warnings automatically to weather radios and apps. Technology enables these messages to be

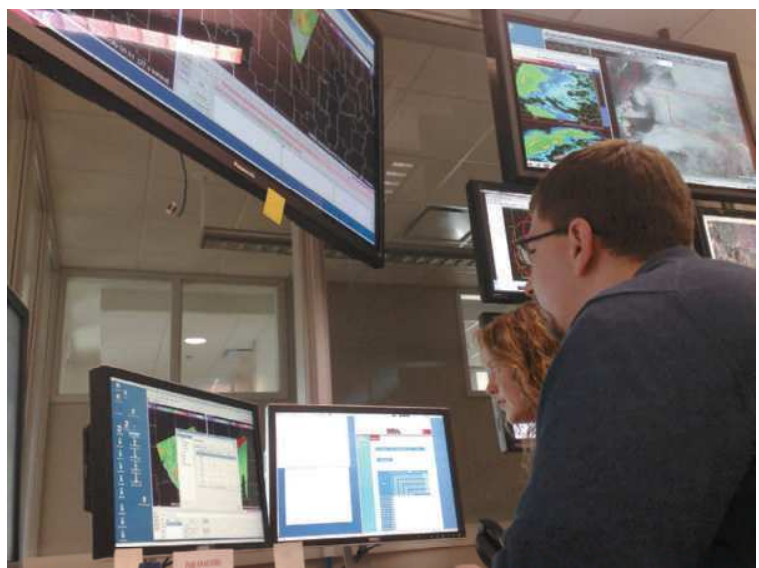
broadcast automatically to weather radios and apps only in areas that may be affected.

In addition to computers helping us stay safe during severe storms, they also assist with day-to-day weather forecasting. Several years ago, meteorologists could predict the weather for only a few days into the future. Beyond that point, the forecast was very uncertain. Meteorologists presently are able to predict the weather, including temperature and chance of precipitation, one week or more into the future with much greater accuracy because computers create models using historical weather data and behavior to predict the future path of various weather systems.

News and weather stations have weather apps and also post their weather forecasts online. In fact, several websites have interactive radars that allow visitors to zoom in and view how weather is affecting their immediate neighborhood.

The meteorology field has made significant advancements because of computer technologies. Weather forecasts are more accurate, which not only helps us prepare on land, but also helps to protect those traveling by air or by sea.

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



National Oceanographic and Atmospheric Administration

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. Define the term, operating system. List the functions of an operating system.
2. Define the term, firmware. Name another term for an operating system.
3. List methods to start a computer or device.
4. Identify the five steps in the start-up process.
5. The _____ is the core of an operating system. Differentiate between resident and nonresident, with respect to memory.
6. Explain the role of a boot drive.
7. List reasons why users might shut down computers or mobile devices regularly. Differentiate between sleep mode and hibernate mode.
8. Define the term, user interface. Distinguish between GUI, natural-user, and command-line interfaces.
9. Define the terms, foreground and background, in a multitasking operating system.
10. List steps for removing a program or app.
11. Describe how a computer manages memory. Define the term, virtual memory.
12. The technique of swapping items between memory and storage is called _____.
13. Explain what occurs during thrashing, and list steps to prevent it.
14. List actions you should take if a mobile device displays a message that it is running low on memory.
15. Explain how a computer coordinates tasks. Define these terms: buffer, spooling, and queue.
16. Describe the role of a driver. Explain how to find the latest drivers for a device.
17. Describe the role of a performance monitor.
18. Explain how an operating system establishes an Internet connection.
19. Explain the issues surrounding an operating system's inclusion of additional software.
20. Identify changes that may be made to an operating system during an automatic update. List security concerns regarding automatic updates.
21. List file and disk management tools, and describe the function of each.
22. List and describe security tools used by operating systems.
23. Describe the role of a network administrator.
24. Explain the capabilities of administrator and user accounts on a network.
25. Explain the use of permissions on a network.
26. Explain issues surrounding responsibility for operating system security flaws.
27. List alternatives to using passwords.
28. Explain how an operating system uses encryption.
29. Differentiate between device-dependent and device-independent programs.
30. Define these terms: proprietary software, backward compatible, and upward compatible.
31. Explain issues surrounding being an early adopter of a new technology.
32. List two other names for a desktop operating system.
33. Identify features of Windows. Define the term, desktop, with respect to Windows and Mac OS.
34. The term, _____, sometimes is used to describe a computer that runs a Windows operating system.
35. Identify features of OS. You can use the _____ to view, organize, and run apps.
36. Describe uses and features of the UNIX operating system.
37. Define the term, open source software. _____ is an example of an open source operating system.
38. Explain the issues surrounding open source versus closed source operating systems.
39. Identify features of Chrome OS.
40. Identify reasons to use a virtual machine. List steps for setting up a virtual machine.
41. List steps for using Boot Camp to install the Windows operating system on a Mac computer.
42. Describe a server operating system. List examples of server operating systems.
43. Identify common features of mobile operating systems.
44. Explain issues surrounding ownership of text messages sent using company-issued devices.
45. Explain security concerns regarding BYOD policies.
46. Differentiate among the features of the Android, iOS, and Windows Phone mobile operating systems.
47. List differences and similarities between how a user interacts with mobile versus desktop operating systems.
48. Describe how embedded computers use operating systems.
49. Explain how the meteorology industry uses technology.

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.

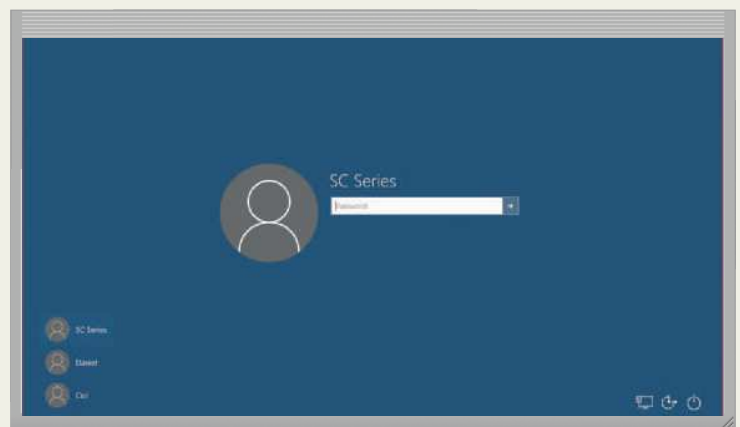
Key Terms

Primary Terms (shown in bold-black characters in the chapter)

Android (434)	iOS (434)	OS X (427)	UNIX (429)
automatic update (421)	Linux (429)	password (424)	user interface (UI) (414)
boot drive (413)	mobile operating system (433)	performance monitor (420)	user name (423)
Chrome OS (430)	natural user interface (NUI) (414)	queue (418)	virtual memory (417)
desktop operating system (426)	operating system (OS) (410)	server operating system (432)	Windows Phone (435)
driver (419)		sign in (423)	

Secondary Terms (shown in *italic* characters in the chapter)

<i>administrator account (423)</i>	<i>foreground (415)</i>	<i>permissions (423)</i>	<i>sleep mode (413)</i>
<i>background (415)</i>	<i>Google Drive (434)</i>	<i>platform (412)</i>	<i>spooling (418)</i>
<i>backup and restore (422)</i>	<i>Google Play (434)</i>	<i>Plug and Play (419)</i>	<i>stand-alone operating system (426)</i>
<i>backward compatible (425)</i>	<i>graphical user interface (GUI) (414)</i>	<i>print spooler (418)</i>	<i>status bar (427)</i>
<i>Blackberry operating system (434)</i>	<i>hibernate mode (413)</i>	<i>proprietary software (425)</i>	<i>swap file (418)</i>
<i>bloatware (421)</i>	<i>iCloud (427)</i>	<i>real-time operating system (RTOS) (436)</i>	<i>taskbar (427)</i>
<i>Boot Camp (432)</i>	<i>icons (426)</i>	<i>recovery media (413)</i>	<i>The Open Group (429)</i>
<i>boot disk (413)</i>	<i>image viewer (422)</i>	<i>Recycle Bin (427)</i>	<i>thrashing (418)</i>
<i>booting (413)</i>	<i>Internet Explorer (426)</i>	<i>ribbon (427)</i>	<i>tiles (426)</i>
<i>buffer (418)</i>	<i>iTunes Store (434)</i>	<i>Safari (427)</i>	<i>touch user interface (414)</i>
<i>bug (422)</i>	<i>kernel (412)</i>	<i>screen saver (422)</i>	<i>uninstaller (422)</i>
<i>Chromebook (430)</i>	<i>Live CD (413)</i>	<i>scroll bars (427)</i>	<i>upward compatible (425)</i>
<i>Chromebox (430)</i>	<i>Live USB (413)</i>	<i>search (422)</i>	<i>virtual machine (VM) (431)</i>
<i>client operating systems (426)</i>	<i>Macintosh operating system (MAC OS) (427)</i>	<i>service pack (422)</i>	<i>virtualization (432)</i>
<i>cold boot (413)</i>	<i>memory resident (413)</i>	<i>sign in (423)</i>	<i>Wallet (435)</i>
<i>command language (415)</i>	<i>mobile device management (MDM) (433)</i>	<i>Siri (434)</i>	<i>warm boot (413)</i>
<i>command-line interface (414)</i>	<i>multipurpose operating systems (432)</i>		<i>Windows Phone Store (435)</i>
<i>cross-platform application (412)</i>	<i>multitasking (415)</i>		
<i>desktop (428)</i>	<i>multiuser (416)</i>		
<i>device driver (419)</i>	<i>network administrator (423)</i>		
<i>device-dependent (425)</i>	<i>nonresident (413)</i>		
<i>device-independent (425)</i>	<i>OneDrive (426)</i>		
<i>disk cleanup (422)</i>	<i>open source software (429)</i>		
<i>disk defragmenter (422)</i>	<i>page (418)</i>		
<i>Dock (428)</i>	<i>paging (418)</i>		
<i>Edge (415)</i>	<i>partitioning (431)</i>		
<i>encryption (424)</i>	<i>PC maintenance (422)</i>		
<i>file compression (422)</i>			
<i>file manager (422)</i>			
<i>Fire OS (434)</i>			
<i>Firefox OS (434)</i>			
<i>firmware (410)</i>			



Source: Microsoft

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

Mark T for True and F for False.

- _____ 1. An operating system must reside inside a computer or mobile device; that is, it cannot run from a USB flash drive or other external drives. (410)
- _____ 2. The kernel is nonresident, which means it remains in memory while the computer or mobile device is running. (413)
- _____ 3. A user interface controls how you enter data and instructions and how information is displayed on the screen. (414)
- _____ 4. Most users today work with a command-line interface. (414)
- _____ 5. Most operating systems today are multitasking. (415)
- _____ 6. The area of the hard drive used for virtual memory is called a swap file. (418)
- _____ 7. Each device connected to a computer requires its own specific driver. (419)
- _____ 8. Hackers often look for ways to break into a computer or device using flaws in the operating system. (424)
- _____ 9. Many of the first operating systems were device dependent and proprietary. (425)
- _____ 10. An upward compatible application means it can recognize and work with applications written for an earlier version of the operating system. (425)
- _____ 11. Linux is proprietary software. (429)
- _____ 12. Operating systems that function as both desktop and server operating systems sometimes are called multipurpose operating systems. (432)

Multiple Choice


Select the best answer.

- 1. A _____ application is an application that runs the same on multiple operating systems. (412)
 - a. cross-platform
 - b. stand-alone
 - c. device driver
 - d. multitasking
- 2. Placing a computer in _____ mode saves any open documents and running programs or apps to an internal hard drive before power is removed from the computer or device. (413)
 - a. sleep
 - b. hibernate
 - c. kernel
 - d. NUI
- 3. With a _____ interface, users interact with the software through ordinary, intuitive behavior. (414)
 - a. command-line interface
 - b. proprietary software
 - c. natural user interface
 - d. graphical user interface
- 4. A _____ operating system allows two or more programs or apps to reside in memory at the same time. (415)
 - a. foreground
 - b. background
 - c. multiuser
 - d. multitasking
- 5. With _____, the operating system allocates a portion of a storage medium to function as additional RAM. (417)
 - a. Live USB
 - b. a natural user interface
 - c. virtual memory
 - d. spooling
- 6. The technique of swapping items between memory and storage is called _____. (418)
 - a. thrashing
 - b. paging
 - c. spooling
 - d. buffering
- 7. In Windows, a _____ is a shortcut to apps or other content. (426)
 - a. tile
 - b. Launchpad
 - c. ribbon
 - d. Recycle Bin
- 8. A _____ is a multiuser operating system that organizes and coordinates how multiple users access and share resources on a network. (432)
 - a. stand-alone operating system
 - b. server operating system
 - c. virtual machine
 - d. multipurpose operating system

Checkpoint

Matching Match the terms with their definitions.

- | | |
|--------------------------------------|---|
| _____ 1. firmware (410) | a. operating system problem that occurs when it spends much of its time paging, instead of executing application software |
| _____ 2. command language (415) | b. small program that tells the operating system how to communicate with a specific device |
| _____ 3. thrashing (418) | c. Windows term for a shortcut to an app or other content |
| _____ 4. buffer (418) | d. software that is privately owned and limited to a specific vendor or computer or device model |
| _____ 5. driver (419) | e. ROM chips or flash memory chips that store permanent instructions |
| _____ 6. bloatware (421) | f. operating system that runs on computers and mobile devices provided by a variety of manufacturers |
| _____ 7. proprietary software (425) | g. software whose code is provided for use, modification, and redistribution |
| _____ 8. device-independent (425) | h. additional programs and apps included with operating systems, usually for profit |
| _____ 9. icons (426) | i. segment of memory or storage in which items are placed while waiting to be transferred from an input device or to an output device |
| _____ 10. open source software (429) | j. set of commands used to control actions performed in a command-line interface |

 **Consider This** Answer the following questions in the format specified by your instructor.

- Answer the critical thinking questions posed at the end of these elements in this chapter: Ethics & Issues (421, 424, 425, 433), How To (416, 419, 431, 432), Mini Features (426, 428, 435), Secure IT (422, 423, 430, 433), and Technology @ Work (437).
- What is the role of the operating system? (410)
- What does firmware do? (410)
- What is a platform? (412)
- What is a cross-platform application? (412)
- What does the kernel do? (412)
- How do resident and nonresident memory differ? (413)
- What does the word, live, signify when used to describe a type of media (i.e., Live USB or Live CD)? (413)
- What is the difference between a cold and warm boot? (413)
- How does sleep mode differ from hibernate mode? (413)
- Why do some users find command-line interfaces difficult to use? (415)
- What is the role of virtual memory? (417)
- In terms of speed, how does virtual memory compare with RAM? (417)
- What does it mean when an operating system is thrashing? (418)
- What is meant by the term, swap file? (418)
- What remedies can you try if your computer or application runs sluggishly? (418)
- What is a buffer? (418)
- In a multiuser operating system, are tasks processed on a first-come, first-served basis? Why or why not? (418)
- Why do some users object to bloatware? (421)
- What is a service pack? (422)
- How do users without an Internet connection obtain updates? (422)
- What built-in security tools are included in most operating systems? (422)
- What duties does a network administrator perform? (423)
- What is the advantage of device-independent operating systems? (425)
- What are some widely used desktop operating systems? (426)
- How are tiles used in the Windows user interface? (426)
- What elements are contained in the OS Dock? (428)
- Why do computers running Chrome OS require less internal storage capacity than those running other desktop operating systems? (430)
- What are some popular mobile operating systems? (434)

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, or work. 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. Difficulty Signing In to Operating System** You are attempting to sign in to your operating system, but you receive an error message stating that you have entered an invalid password. What are your next steps?
- 2. Missing Customization Settings** When you sign in to your operating system, your customized desktop background does not appear. Instead, the operating system displays the default desktop background. What might have happened?
- 3. Incompatible Program** You have upgraded to the latest version of an operating system on your computer. After the upgrade, you realize that programs that used to run without issue now do not run. What are your next steps?
- 4. Insufficient Access** You are attempting to install a program on your computer and a dialog box appears informing you that you have insufficient privileges to install the program. What might be wrong?



Source: Google Inc.

- 5. Software Update Issues** You have heard that new software updates are available for your operating system, but when the operating system checks for updates, it shows that no updates are available. Why might this be the case?

Professional

- 6. Virtual Machine Error** You use virtual machines on your office computer so that you can run and test software in multiple operating system versions. When you attempt to run one of the virtual machines, you receive an error message that the virtual machine already is running. You are certain that the virtual machine is not running. What steps can you take to correct the problem?
- 7. Missing Files and Settings** When you sign in to various computers at work with the credentials assigned by your IT department, you typically see all your files. When you recently signed in to the computer in your office, however, you were unable to view your files. What are your next steps?
- 8. Faulty Update** Your computer is set to install updates for the operating system, programs, and apps automatically. You have learned through your company's IT department that a recent operating system update causes a problem to occur with a program you use regularly. What are your next steps?
- 9. Mobile Device Operating System Upgrade** A notification appears on your mobile phone stating that an operating system upgrade has been downloaded and is ready to install. Your company has provided the mobile phone to you for work-related business, and you are hesitant to install the upgrade. What are your next steps?
- 10. Slow System Performance** Your office computer has been running slow lately, and you are attempting to determine the cause. What steps can you take to determine what might be slowing your computer's performance?

Collaboration

- 11. Technology in Meteorology** Your environmental sciences instructor is teaching a lesson about how technology has advanced the meteorology field. Form a team of three people to prepare a brief report about how technology and meteorology are connected. One team member should research how meteorologists predicted weather patterns before computer use became mainstream. Another team member should create a timeline illustrating when and how technology was introduced to the meteorology field, and the third team member should research the technology required for a typical news station to forecast and present the weather.

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**, which include 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 Determine Your Operating System Version

Companies such as Microsoft, Apple, and Google release new versions of operating systems periodically. Software and drivers sometimes are designed for specific operating system versions, which means you may need to determine your operating system version so that you can obtain the proper software. The following steps describe how to determine your operating system version.

- If necessary, turn on your computer or mobile device and, if necessary, sign in to the operating system. Some operating systems will display the version when they run. If the operating system version is not displayed, continue following these steps.
- If you are using a Mac computer, click the command on the Apple menu to display information about the computer to determine the operating system version. If you are running an operating system other than Mac OS, continue following these steps.
- Display the control panel or settings for your computer or mobile device.
- Navigate to and then tap or click the command to display system information about the computer or device, and then locate the operating system version.



Source: Google, Inc.

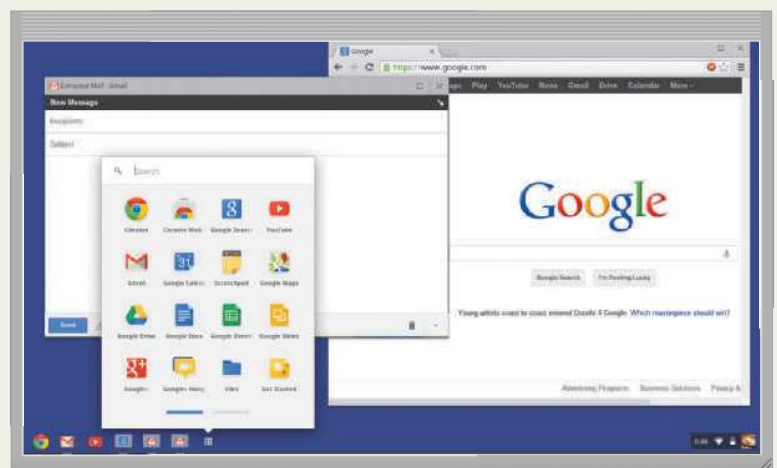
Exercises

- What operating system are you running?
- What are some other reasons why you might need to know the operating system version on your computer or mobile device?
- What might happen if you attempt to install a program or app that is not designed for your operating system version?

2 Search for Files on a Computer

Advances in technology enable users to store a large number of files, such as documents, photos, videos, and music, on their computers. Users store contacts, appointments, email messages, and other information on mobile devices to retrieve at a later time. With all the information you can store on computers and mobile devices, it sometimes can be difficult to locate an item you need to access. Today's operating systems contain a search tool that provides an easy way to locate files stored on a computer or mobile device. To search for an item on a computer or mobile device, you should know information about the item for which you are searching. The following steps guide you through the process of searching a computer or mobile device.

- If necessary, run the search tool on your computer or mobile device. If you are using a mobile device, such as a smartphone or tablet, you may be able to access the search tool by pressing a search button on the phone or tablet.



Courtesy of Volha Kryvets; Source: Google Inc.

How To: Your Turn

How To: Your Turn

- If you remember all or part of the name of the file for which you are searching, enter all or part of the file name in the search box.
- Tap or click the search button to display the search results. Depending upon the number of files and folders on your computer or mobile device, it may take several minutes for search results to appear.
- If no search results are displayed, consider searching again and entering less information in the search box.
- When you locate the file for which you are searching, you can open it either by tapping, double-tapping, or double-clicking the file. The method you should use to open the file will depend on the operating system you are using.

Exercises

- Have you used the search tool on your computer? If so, what files were you attempting to locate? If not, do you think the search tool will be helpful to you?
- Have you used the search tool on a mobile device? What were you attempting to locate?
- In addition to searching for files, what other items might the search tool locate?

3 Personalize Your Operating Environment

When you purchase a new computer or mobile device, the first task you might want to complete is to personalize the operating environment to suit your tastes. For example, you might want to have your favorite sports team's logo as your desktop background, a screen saver consisting of a slide show containing photos of your recent vacation, or specific sounds that play when certain events occur. The following steps guide you through the process of personalizing your operating environment.

- If necessary, sign in to your operating system.
- Display your operating system's control panel, settings, or system preferences.
- Tap or click the option to modify the display settings and then navigate to the specific setting to change the desktop background (the desktop background also may be referred to as wallpaper).
- Tap or click the option to locate the image to use as your desktop background. If you are planning to download an image from the web, you should do

so before completing this step. Download only an image that is not protected by copyright.

- Navigate to the location of the image to use as the desktop background and then select the image to set it as your desktop background.
- Navigate to the screen saver settings and then select the desired screen saver. If necessary, set the desired preferences for the screen saver.
- Navigate to the sound settings.
- Select the event for which you want to assign or change the sound.
- Select the sound you want to play. If you are not using one of the operating system's prerecorded sounds, navigate to the location of the sound you want to use and then select the sound.
- If necessary, save the changes and close the control panel, settings, or system preferences.

Exercises

- What image are you currently using as your desktop background or wallpaper?
- Do you have a screen saver configured on your computer or mobile device? If so, what does it look like?
- What other personalization settings do you customize?



Courtesy of KDE

4 Configure Accessibility Settings

Many modern operating systems allow users to configure accessibility settings to make it easier for some individuals to interact with them. Accessibility features can perform functions such as enhancing the contrast between colors on the display device, narrating text that is displayed on the screen, and allowing the user to control the pointer using keys on

How To: Your Turn

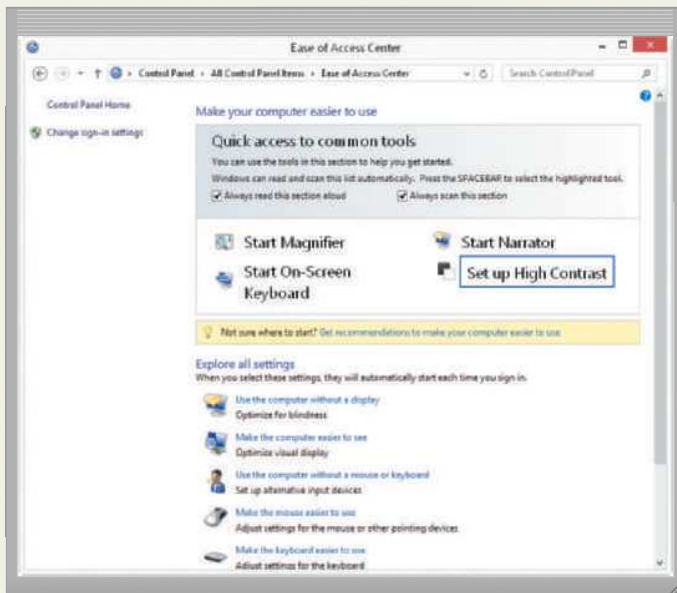
5 Add Users to an Operating System

If you share your computer with others, you can add more user accounts to the operating system. When users sign in to their accounts, they can customize their settings and store files in locations that may not be accessible to other users on the computer. The following steps guide you through the process of adding users to an operating system.

- Sign in to a user account that has administrative privileges; that is the user account should have the capability to perform functions such as adding users.
- Display the operating system settings.
- Tap or click the option to display user accounts.
- Tap or click the option to add a new user account.
- Specify the options for the new user account:
 - Enter a name to identify the user account.
 - Specify a default password for the user account.
 - Select the type of user account (administrative, standard, etc.). You should create user accounts with administrative access only if you want the user to be able to perform tasks such as change computer settings; add or remove programs and apps; and add, modify, or remove a user account.
 - If necessary, set parental controls for the user account.
- Save the settings for the new user account.
- Sign out of the existing user account.
- Sign in to the newly created user account and make sure everything works as intended.

Exercises

- Do you have multiple user accounts on your computer? Why or why not?
- Do you think it is a good idea for students in a school computer lab to have administrative access to the computers? Why or why not?
- What types of parental controls can you enable using your operating system? Do you think these controls are relevant only to parents, or can you determine other people who might benefit from using parental controls? What parental controls might those other people use, and why?



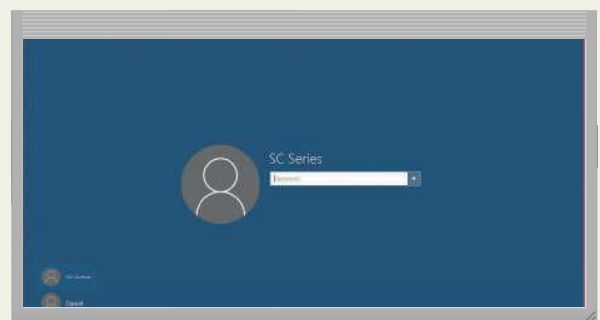
Source: Microsoft

the keyboard. The following steps guide you through the process of configuring accessibility settings.

- If necessary, sign in to the operating system.
- Display your operating system's control panel, settings, or system preferences.
- Tap or click the command to display accessibility settings.
- Select the accessibility setting you want to configure, and specify your desired settings.
- Repeat the previous step for all remaining accessibility settings you want to configure.
- When you have finished configuring the accessibility settings, save your changes and then close the window containing the control panel, settings, or system preferences.
- If you no longer require the accessibility settings, display your operating system's control panel, settings, or system preferences, display the setting you want to disable, and then disable the setting.

Exercises

- Accessibility settings are not only for people with impairments; these settings can make it easier for anyone to use a computer. Can you think of any accessibility settings that you might consider using to make it easier to interact with the computer?
- Which third-party programs can provide additional features for accessibility?
- Do you feel that the accessibility features in your computer or mobile device's operating system are sufficient? Why or why not?



Source: Microsoft

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 Banking and Finance

Managing money and making wise investments and are among the most important skills consumers need to master. Abundant advice is available on a variety of banking and financial websites. More than 80 percent of Americans who manage household finances have enrolled in online banking programs, and 20 percent have used a banking app on their smartphones or mobile devices. Whether their financial institutions are a retail bank, a virtual bank, or a credit union, they enjoy the convenience of monitoring account balances, depositing checks, transferring funds, receiving text message alerts, and paying bills.

Personal finance websites provide information on portfolio management, tax preparation, real estate investing, mortgage rates, retirement planning, credit card and student loan advice, and a host of other lifestyle and educational topics. Also available are calculators to help make saving, spending, and real estate decisions. Business finance websites include market data, company earnings, interest rates, and corporate news.

Research This: (a) Visit two online banking websites: one for a financial institution that has a physical presence in your community and another that is virtual. Compare the services and featured products. For example, do they offer bill payment,

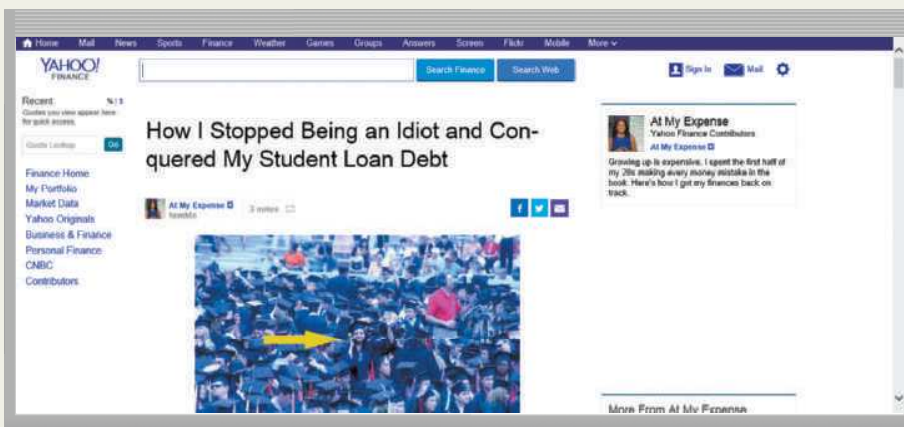
retirement accounts, and mobile banking apps? What fees are charged for these services? Which bank has the highest money market and certificate of deposit rates?

(b) Visit two financial websites, such as Yahoo! Finance, that feature information about managing personal credit and debt. Read two stories discussing student loans, credit card debt, overspending, or retirement planning. According to these articles, what mistakes do people make managing their money? Who are the economic professionals writing or being quoted in the articles? What advice is given that can help you handle your expenses?

2 Social Media

Operating systems constantly evolve as developers add new features, fix security issues, and modify functions. Computer and mobile device users need to stay abreast of these changes, especially when the updates affect performance and safety. Many blogs feature content about operating systems. Their posts cover industry news, photos, product reviews, previews of forthcoming software and hardware, and management changes. Most of these blogs are unofficial, meaning that the writers are not necessarily employees of the companies that develop the operating systems. The bloggers generally have extensive experience in the technology field and desire to share their expertise with others.

Research This: Search online for a blog that tracks features or updates to a mobile, desktop, or other operating system that you use or about which you would like more information. Report the web address of the blog, along with a summary of the most recent blog post.



Source: Yahoo

Internet Research

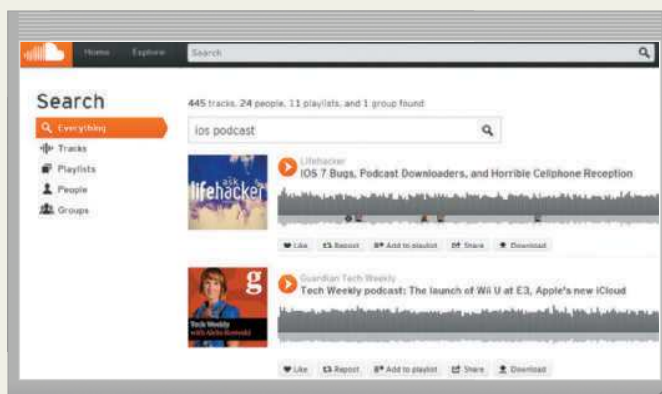
3 Search Skills

Video, Audio, and Voice Search

A video search allows you to locate video files posted or shared online. Tap or click the Videos link on a search engine's home page and then type the search text. For example, type the search text, linux tutorial, in the search box to find videos for learning about Linux. You can narrow your results by specifying additional conditions. These may include length (in minutes), time taken (such as past day, week, or month), quality, popularity (based on number of views), and source (YouTube or other websites).

To search for audio files, type the search text, audio search, in a search engine's search box and look for a search engine that specializes in finding audio clips, streaming audio, and other audio files. Alternatively, visit a website for sharing audio and music files, and search that site directly. For example, type the search text, ios podcast, in an audio sharing site's search box to find podcasts about Apple's mobile operating system.

Some search apps allow you to speak your search text. For example, using Google, tap or click the microphone button in the search box or say the phrase, "ok google" to activate voice search and then speak your question. The app will convert your speech to text and provide the search results.



Source: SoundCloud

Research This: Using a search app that accepts voice input, either speak the search text or find an audio sharing site in which to type search text to find podcasts, audio files, or videos about these topics: (1) a video about how to manage security settings on your computer posted within the past month; (2) a video tutorial about how to use the Mac Finder, shorter than four minutes in length; (3) a video that was not posted on YouTube, describing how to partition a hard

drive; and (4) audio files of Windows operating system start-up sounds.

Create a document containing the web address of each audio or video clip and the name or web address of the website on which it appears. Watch or listen to comments on how accurately they reflect your search text.

4 Security

An operating system should include antivirus and spyware and malware detection software to fend off intrusions. The use of this security software is discussed in Secure IT 9-2 in this chapter. Major companies that provide this software often include information on their websites about recently discovered virus threats and hoaxes. They also track scheduled virus payload strikes and map global and regional virus attacks.

Research This: Visit at least two virus protection websites to obtain virus information. When were the latest active threats discovered and updated? What are their names and risk levels? When is the next virus payload strike scheduled? What type of malware is spreading via mobile device use? Which virus removal tools and resources are available?

5 Cloud Services

Cloud Development Platforms (PaaS)

Developers have many choices for the programming languages, operating systems, databases, and tools they use to create apps hosted on the cloud. Microsoft Azure, Amazon Web Services, and Google App Engine are providers of platform as a service (PaaS), a service of cloud computing that delivers tools for developing, testing, and deploying apps on the cloud.

A PaaS provider manages the computing resources required to run apps on the cloud so that developers can concentrate on writing the code, logic, interfaces, and operations of the software.

Research This: (1) Read a customer case study about Microsoft Azure, Amazon Web Services, or Google App Engine. In what industry is the customer involved? What was the challenge for which the customer was seeking a PaaS solution? How did this solution meet their needs? (2) Research one of these PaaS providers. Which operating systems and development tools does it support? How does it support scalability when additional computing resources are required? What pricing model is in place?

Critical Thinking

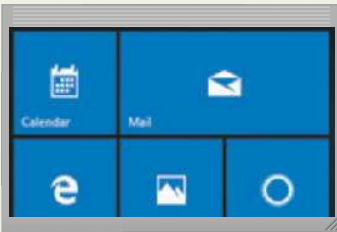
The Critical Thinking exercises challenge your assessment and decision-making skills by presenting real-world situations associated with chapter concepts. The Collaboration exercise should be completed with a team.

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. Using Operating System Tools

You are the office manager at a social media consulting business. The office recently upgraded and replaced several computers. You now are running the latest version of Windows on all of your computers. Your boss asks you to explore the various tools that are included with the operating system and to evaluate any additional needs you might have.

Do This: Use the web to learn more about the following Windows operating system tools: firewalls, automatic updates, and software that scans for viruses, spyware, and other malware. Read reviews by industry experts and users. Analyze the advantages and disadvantages of using built-in operating system tools. Do any built-in operating system tools present security concerns? If so, what would you recommend? Explore alternatives for each of the tools, and determine whether you should disable the Windows tool and if any risks exist. Compile your findings.



Source: Microsoft

2. Complete Security Solutions

Your neighbor started a new construction business. He would like to hire you to set up his new computers. His business will use the Internet to communicate with clients via email, store backups of data, and access cloud-based accounting software. The office will include two networked computers, which will share a printer and an Internet connection. In addition, he will use a tablet so that he can access the cloud-based accounting software using Wi-Fi. Because of security concerns with

using the Internet, he first would like you to install a program(s) designed to protect his computers from various security threats.

Do This: Use the web to find answers to the following questions. What types of security threats exist on the Internet that could impact his business? What types of security measures should he use? Evaluate two programs that provide a comprehensive security solution. What are the programs' functions? What are their costs? Do the services charge subscription fees in order to receive automatic updates? Which would you recommend? Why?

3. Case Study

Amateur Sports League You are the new manager for a nonprofit amateur soccer league. The board of directors has asked you to recommend options for mobile operating systems for the new smartphones they would like to purchase.

Do This: Select two mobile operating systems to explore (such as Android, iOS, and Windows Phone). Use the web to find industry experts' recommendations and user reviews for each operating system. Include the different device types for which each is available. Examine differences in security, features, speed, and reliability. What security concerns exist? What security features enable you to protect the smartphone and its data? Which mobile operating system offers the best features? Which is considered faster and/or more reliable? Your office computers run the Mac OS operating system. Do compatibility issues exist with any of the mobile operating systems? If so, what are the issues? Can you find solutions that would enable you to sync data? Compile your findings.

Collaboration

4. Desktop Operating Systems You are an analyst for a large manufacturer of laundry soaps. The company currently uses an early version of the Windows operating system on its 5,000 desktops. This year, the company plans to upgrade the operating system and, if necessary, its desktops. The company asks your team to compare the latest versions of the Windows, Mac OS, and Linux operating systems.

Do This: Form a three-member team and assign each member an operating system. Each member should use the web to develop a feature/benefit analysis and answer the following questions. What is the initial cost of the operating system per computer? What are the memory and storage requirements? Will the operating system require the company to purchase new computers? Which is best at protecting against viruses, spam, and spyware? Which support touch input? As a team, compile your findings and share your recommendation with the class.