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CHAPTER 1

Personal Computer Hardware

Objectives

Upon completion of this chapter, you will be able to answer the following questions:

- Where are personal computers found and what use do they serve?
- What is the difference between a local application and a network application?
- What are some types of computing devices and what are their main applications?
- How is data represented and manipulated in a computer system?
- What is the role of the various computer components and peripherals?
- What is the proper way to install and test computer components and peripherals?

Key Terms

This chapter uses the following key terms. You can find the definitions in the Glossary.

hardware *page 3*

operating system *page 3*

application software *page 3*

basic input output system (BIOS) *page 4*

firmware *page 4*

local application *page 4*

network application *page 4*

Internet *page 4*

mainframe *page 6*

server *page 6*

services *page 6*

client *page 6*

personal computer (PC) *page 7*

workstation *page 7*

laptop *page 8*

notebook *page 8*

Tablet PC *page 9*

Pocket PC *page 9*

personal digital assistant (PDA) *page 9*

cellular phone *page 9*

binary *page 10*

bit *page 10*

American Standard Code for Information Interchange (ASCII) *page 10*

byte *page 10*

modem *page 11*

pixel *page 13*

hertz *page 14*

motherboard *page 15*

central processing unit (CPU) *page 16*

random-access memory (RAM) *page 17*

adapter cards *page 18*

Accelerated Graphic Port (AGP) *page 19*

hard disk drive (HDD) *page 20*

floppy disk drive (FDD) *page 20*

tape drive *page 21*

Blu-ray *page 21*

static memory *page 21*

continued

USB memory keys *page 21*

flash drives *page 21*

peripheral *page 22*

case *page 24*

power supply *page 24*

surge suppressor *page 24*

uninterruptible power supply (UPS) *page 25*

hot-swappable *page 26*

Electrostatic Discharge (ESD) *page 26*

catastrophic failures *page 26*

grounding strap *page 26*

driver *page 28*

system resources *page 29*

Universal Serial Bus (USB) *page 31*

Plug-and-Play (PnP) *page 31*

Computers provide us with a gateway to a world of information. They allow us to connect from anywhere at any time to share information and collaborate with others in the human network. This chapter introduces the different types of computers and the applications that make them useful. Part II of this book includes the corresponding labs for this chapter.

Personal Computers and Applications

Computers have become an almost indispensable part of everyday life. They help control power grids, telecommunications and financial networks, and even traffic-flow patterns in most major cities. We interact with these systems every day without even considering the role that computers are playing. In addition to these major systems we interact with many other types of computers on a regular basis, as described in this section.

How and Where Computers Are Used

Computers are used all over the world and in all types of environments. They are used in businesses, manufacturing environments, homes, government offices, and non-profit organizations. Schools use computers for instruction and for maintaining student records. Hospitals use computers to maintain patient records and to provide medical care.

In addition to these types of computers, there are also many customized computers designed for specific purposes. These computers can be integrated into devices such as televisions, cash registers, sound systems, and other electronic devices. They can even be found embedded in appliances such as stoves and refrigerators and used in automobiles and aircraft. Think about being able to call your home refrigerator to see whether you have the ingredients for your favorite dinner or being able to adjust the temperature in your house before you come home from a day at school or work.

Computers are used for many reasons and in many different places. They may be of different sizes and processing power, but all computers have some features in common that allow them to do their job. For most computers to perform useful functions, three components have to work together:

- Hardware
- Operating system
- Application software

Hardware consists of the physical components, both internal and external, that make up a computer. Some common examples of computer hardware include disk drives, memory, monitors, and motherboards.

The ***operating system*** is a set of computer programs that manages the hardware of a computer. An operating system controls the resources on a computer, including memory and disk storage, and provides a mechanism for the application software to make use of the underlying hardware. Examples of common operating systems include Windows XP, Windows Vista, and Linux.

Application software is any program loaded on the computer to perform a specific function. These programs work between the operating system and the user. The user interacts with the application software, which in turn communicates with the underlying operating system to gain access to the hardware resources. An example of application software is a word processor or a computer game.

Without software, the computer is merely a collection of hardware components. The software must direct the hardware in order for the computer to be of any use. Both operating system and application software programs are large in size and normally stored on a physical media such as a hard disk.

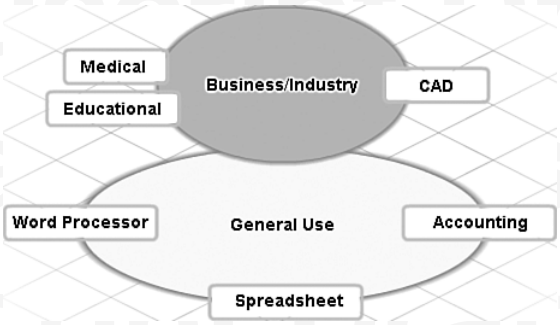
Before the computer can make use of the software the information must be moved from the physical storage medium into the machine's electronic memory. This requires that a basic set of instructions be available to perform hardware functionality tests and then find and load the operating system. These instructions are known as the ***basic input output system (BIOS)*** and are stored in a memory chip in the computer. BIOS instructions run automatically whenever the computer is started. Because these instructions (software) are permanently stored in a memory chip (hardware) they are often referred to as ***firmware***.

Types of Computer Applications

The computer is only as useful as the program or application running on it. Applications can be divided into two general categories, as shown in Figure 1-1:

- **Business/industry software**: Software that is designed for use by a specific industry or market. Examples include medical practice management tools, educational tools, and programs designed for use by the law profession.
- **General-use software**: Software that has been designed for use by a wide range of organizations and home users for various purposes. These applications can be used by any business or individual.

Figure 1-1 Industry-Specific and General-Use Applications



One of the most common general-use application software packages encountered is known as an *office suite*. This software includes such applications as word processing, spreadsheet, database, presentation, and contact management software all integrated into a single application package. All of these applications are designed to work together and allow information to be quickly moved from one application to another. For example, financial information from a spreadsheet program can be quickly converted into a graphical representation and then inserted into a word processing document.

Other popular applications include graphics editing software and multimedia authoring applications. These tools allow users to manipulate photos as well as create rich media presentations that use voice, video, and graphics.

In addition to business/industry and general-use software, an application can be classified as either local or network, as shown in Figure 1-2. A ***local application*** is a program, such as a word processor, that is stored on the hard disk of the computer. The application runs only on that computer. A ***network application*** is one that is designed to run over a network, such as the ***Internet***. A network application has two components, one that runs on the local computer and one that runs on a remote computer. E-mail is a common example of a network application.

Figure 1-2 Local and Network-Based Applications

Most computers have a combination of local and network applications installed. For example, consider the use of a home computer system. It is commonly used for local applications such as word processing and maintaining spreadsheets but may also be used to surf the Internet and exchange e-mail, which are activities that use network applications.

Interactive Activity 1-1: Classification of Applications (1.1.2.3)

In this activity you will classify applications as either business/industry or general use and also either local or network.

Types of Computers

With all the different tasks that computers are designed to do, it is understandable that no one type of computer can handle all applications and roles efficiently. Many different types of computers have been designed, each with a specific role or application in mind.

Classes of Computers

Some of the different classes of computers include the following:

- Mainframes
- Servers
- Desktops
- Workstations
- Laptops
- Hand-held portable devices

The icons used to represent these types of computers are shown in Figure 1-3.

Figure 1-3 Icons for Various Types of Computers

Each type of computer has been designed with a particular purpose in mind, such as portable access to information, processing of detailed graphics, and so on. The most common types of computers used in homes and businesses are servers, workstations, desktops, laptops, and other portable devices. ***Mainframes***, on the other hand, are large centralized computers found in sizeable enterprises and purchased through specialized resellers.

Servers, Desktops, and Workstations

Servers, desktops, and workstations are all similar in size and appearance but each has specific features that make it more suited to a specific task or environment. For example, it is not uncommon for a desktop computer to be used as a server for less demanding applications. This practice is very dangerous because desktop computers lack many of the features built into servers that are designed to protect data from loss or corruption.

Servers

Servers are high-performance computers used in businesses and other organizations to provide ***services*** to many end users or ***clients***. Server hardware is optimized for quick response time to multiple network requests. They often have multiple central processing units (CPU), large amounts of random-access memory (RAM), and multiple high-capacity disk drives that provide very fast information retrieval. More recently servers are being equipped with multi-core processors and are running advanced software that allows the resources to be shared efficiently between multiple applications.

Servers are designed to provide services to end users and devices. Common services found on a server include file and e-mail storage, web pages, and print sharing. In addition they normally provide services, such as name resolution and addressing, that are critical to the efficient operation of a network.

The services provided by a server are often important and might need to be available to users at all times. This type of service is referred to as *business critical* and depending on the business, the cost associated with the loss of these services can be enormous. Servers, therefore, often contain duplicate, or redundant, parts to prevent them from failing. They are often configured in such a way that if one hardware component fails another will automatically take over, giving the technician time to make repairs without encountering any downtime. Servers are usually kept in secure areas where access is controlled and are administered by knowledgeable individuals. Because servers can often contain large amounts of user data, automatic and manual backups are usually done on a regular basis.

Servers can be one of three types, as shown in Figure 1-4:

- **Standalone**: Standalone servers offer great flexibility in selection of internal components but take up quite bit of floor space.
- **Rack-mounted**: Rack-mounted servers save floor space when racks are available.
- **Blade**: Blade servers provide the highest concentration of computing power in the smallest amount of space.

Figure 1-4 Types of Servers

Blade Server | Rack Mount Server | Standalone Server

Because a server is typically used as a storage point and not a day-to-day end-user device, it may not have a monitor or keyboard, or it may share a monitor and keyboard with other devices.

Desktops

Desktop computers, also commonly termed ***personal computers (PC)*** or simply PCs, are designed as end-user devices. They support many options and capabilities and can be customized depending on the requirements of the user. A wide variety of cases, power supplies, hard drives, video cards, monitors, and other components are available. Desktop computers can have many different connection types, video options, and a wide array of supported peripherals.

Desktop computers are commonly used to run applications such as word processors, spreadsheets, and network applications such as e-mail and web browsing. They do not normally have redundant components as are found in servers. They are housed in the normal work environment and normally only support a single individual at any one time. This is shown in Figure 1-5.

Figure 1-5 Desktop Computers

Workstations

Another end-user computing device that is very similar to the desktop computer is the ***workstation***. Though similar to a desktop computer in appearance, workstations are usually high-powered machines designed for specialized, high-end applications. Some of the application programs that normally run on workstations include various engineering programs such as CAD (Computer-Aided Design), 3-D modeling and graphics design, video animation, and virtual reality simulation.

Workstations can also be used as management stations for telecommunications or medical equipment. As with servers, workstations typically have multiple CPUs, large amounts of RAM, and multiple high-capacity disk drives that are very fast. Workstations usually have very powerful graphics capabilities and a large monitor or multiple monitors, as shown in Figure 1-6.

Figure 1-6 Computer Workstation with Multiple Monitors

Interactive Activity 1-2: Function of a Computer (1.2.2.4)

In this activity you will determine whether a computer is acting as a server, workstation, or desktop in a given scenario.

Portable Devices

Servers, desktops, and workstations are all designed as stationary devices. In addition to these various types of stationary computers, many different portable electronic devices are available.

Portable computing devices allow an individual to have access to high-power computing wherever and whenever necessary. These devices vary in size, power, and graphics capability and include the following:

- Laptop or notebook PC
- Tablet PC
- Pocket PC
- Personal Digital Assistant (PDA)
- Gaming device
- Cell phones

Figure 1-7 shows examples of each device.

Figure 1-7 Portable Devices

The key advantage of portable computers is that they allow information and services to be accessed immediately from almost anywhere. For example, most mobile phones have built-in address books for contact names and telephone numbers. PDAs are available with built-in telephone, web browser, e-mail, and other software. This section introduces the features of each type of portable device.

Laptops

Laptops, also called ***notebooks***, are comparable to desktops in usage and processing capability; however, they are portable devices built to be lightweight and use less power. These computers often come with a built-in mouse, monitor, and keyboard. Laptops can also be attached to a docking station that

allows the user to utilize a larger monitor, mouse, full-sized keyboard, and other external devices when at home or in the office. Laptop computers normally have a limited number of configurations available and are not as easily upgradeable as desktop computers.

Tablet PC

A specialized form of the notebook computer is known as a ***Tablet PC***. It is typically a wireless device with an LCD touch screen that allows a user to write on it using a special stylus-type pen. The notes or handwritten text can be digitized using built-in handwriting recognition software. Tablet PCs can have comparable power and functionality to desktops and laptops. A Tablet PC can have a convertible screen that allows it to function like a laptop or the screen can be rotated and folded down over the integrated keyboard. The "slate" type of Tablet PC is a one-piece design that uses a stylus and on-screen keyboard. Tablet PCs run a special OS such as Microsoft's Windows XP Tablet Edition.

Pocket PC

Other portable devices, such as Pocket PCs, Personal Digital Assistants (PDAs), game devices, and cell phones usually have less powerful CPUs and less RAM than a conventional notebook computer. They have small screens with limited display capabilities and may either have a small input keyboard or no keyboard at all.

A ***Pocket PC*** is a scaled-down version of a laptop, with a less powerful CPU, less RAM, and no hard disk. Most Pocket PCs have small QWERTY-style keyboards and color display screens with fairly good resolution. They use memory cards to store user documents and photographs and run a special OS such as Microsoft Mobile. They are typically about the size of a candy bar and weigh less than 7 ounces. Features can include mini-applications such as PowerPoint viewer and Mobile Excel, cellular phone, wireless networking, non-volatile storage, memory card storage, touch screen, mega-pixel camera, camcorder, voice recorder, and high-speed Internet capability.

PDA

Personal digital assistants (PDAs) are also known as handhelds or Palmtops. These generic terms are applied to any small portable device that provides storage for personal information, such as calendars and contacts. They use primarily touch screen technology although some also have a small keyboard. The distinction between these devices and the Pocket PC is blurred. PDAs are increasingly being combined with cell phones and PC-like functionality. Some PDAs use Microsoft Windows CE and others use a proprietary OS such as Palm OS or Blackberry OS.

Game Device

Portable gaming devices are small computers that are dedicated to playing various computer games. They have good quality displays and are increasing more powerful. Some include wireless capabilities to allow multiperson gaming. Examples include Sony Play Station Portable (PSP) and Nintendo DS (dual screen). Gaming devices run a proprietary OS and games are written to run on a specific OS or device. Many of these gaming devices also allow the user to connect to the Internet to browse online content, read e-mail, and download files.

Cell Phone

Cellular phones (commonly called cell phones or mobile phones) are pervasive and are replacing regular land-line phones in some areas. Newer cell phones have many features of handheld PDAs and pocket PCs, including calendars, contact information, memory card storage, digital camera, camcorder, MP3 player, games, wireless networking capabilities, and Internet access.

Binary Representation of Data

Humans have the ability to interpret a wide variety of inputs by internally processing the input as electrical impulses in the nerves and brain. Similarly, computers process inputs as electrical signals; however, computers represent that information digitally. This section describes how computers represent information using binary format and also describes how to measure data capacity, speed, resolution, and frequency.

Representing Information Digitally

Within a computer, information is represented, stored, and processed in ***binary*** format. In the binary system only two values exist: a binary zero and a binary one. The term ***bit*** is an abbreviation of binary digit and represents the smallest piece of data that can be manipulated. Humans interpret words and pictures; computers interpret only patterns of bits.

Because a bit can have only two possible values, a one digit (1) or a zero digit (0), it can only be used to represent one of two states. For example, a light switch can be either on or off; in binary representation, these states would correspond to 1 and 0, respectively.

Computers use bit patterns to represent and interpret letters, numbers, and special characters. Bit patterns or codes can be used to represent almost any type of information digitally: computer data, graphics, photos, voice, video, and music. A commonly used code is the ***American Standard Code for Information Interchange (ASCII)***. With ASCII, each character is represented by a string of seven bits. This allows for a total of 128 different characters to be represented. Extended ASCII uses eight bits per character allowing representation of 256 different characters. Each group of eight bits is referred to as a ***byte*** and each byte is used to represent a single character using extended ASCII. For example, the uppercase letter *A* is represented by the bit pattern 0100 0001, the number 9 is represented by the pattern 0011 1001, and the # symbol is represented by 0010 0011. These strings of bits can be stored and manipulated by the computer at great speeds.

Interactive Activity 1-3: ASCII Digital Translator (1.3.1.1)

In this activity you will use a translator to convert ASCII characters into their digital representation.

Measuring Storage Capacity

Although a bit is the smallest representation of data, the most basic unit of digital storage is the byte. As previously stated, a byte is a collection of 8 bits and is the smallest unit of measure (UOM) used to represent digital data storage capacity.

Because a single byte can only be used to represent a single character it is necessary to collect multiple bytes together to allow storage of large amounts of information. When referring to storage space, we use the terms bytes (B), kilobytes (KB), megabytes (MB), gigabytes (GB), and terabytes (TB). Examples of components and devices that use byte storage include RAM, hard disk drive space, CDs, DVDs, and MP3 players.

One kilobyte is a little more than 1000 bytes, specifically 1024. A megabyte represents more than a million bytes, or 1,048,576 to be exact. A gigabyte is 1,073,741,824 bytes and a terabyte is 1,099,511,627,776 bytes. The exact number is gained by taking 2^n power, for example, KB = 2^10; MB = 2^20; GB = 2^30; TB = 2^40. Note that these values are all multiples of 2 unlike in the International System of Units (SI) where the units are multiples of 10. This is because every bit can

only have one of two values in the binary number system (base 2) whereas SI uses the decimal (base 10) numbering system.

Tip

The difference between the meaning of the prefixes in the binary and decimal numbering systems is often an area of confusion. The unit "kilo" if represented with a lowercase k refers to the base 10 system and means times 1000. The same term, if represented by an uppercase K implies the binary number system and means times 1024. For example, 64 kbytes implies 64 x 1000 or 64,000 bytes whereas 64 Kbytes implies 64 x 1024 or 65,536 bytes. For units of measure greater than kilo, usually no distinction is made between the binary and decimal prefixes. It is important to understand the context of the term to know which should be used.

In general, when information is represented digitally, the greater the detail, the greater the number of bits needed to represent it. A low-resolution picture from a digital camera might only use around 360 KB to store the image whereas a high-resolution picture of the same scene could use 2 MB or more, as shown in Figure 1-18.

Figure 1-8 High- and Low-Resolution Images

High Resolution Low Resolution

Lab 1-1: Determining Data Storage Capacity (1.3.2.2)

In this lab you will determine the amount of RAM available in a PC as well as the total size of the hard disk and how much space is remaining. You will also explore other storage devices on the PC.

Interactive Activity 1-4: Byte Conversion Calculator (1.3.2.3)

In this activity you will convert between common units of measure for digital storage capacity.

Measuring Speed, Resolution, and Frequency

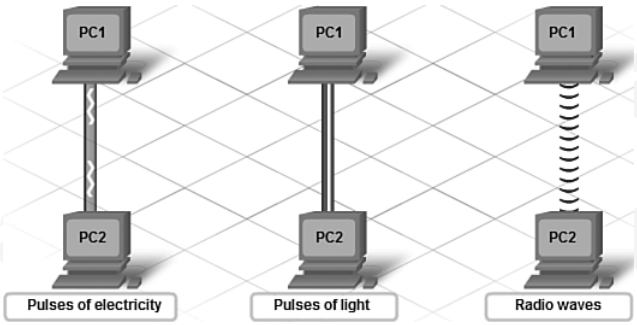
One of the advantages of digital information is that it can be transmitted over long distances without its quality becoming degraded. A ***modem*** is commonly used to convert the binary information into a form suitable for transmitting through the medium. At the source, modems encode digital information onto an analog carrier signal for transfer across the media. They also decode the binary information from the analog carrier signal at the destination. Many different types of media are available to carry this digital information. A description of some of the more commonly employed media is given in Table 1-1.

Table 1-1 Commonly Employed Networking Media

Media	Description
Metallic cables	Usually made out of copper but aluminum cables are also used in some instances. Metallic cables carry digital information in the form of electromagnetic waves.
Fiber-optic cables	Can be made from either glass or plastic and carry the digital information in the form of light pulses.
Wireless	Uses pulses of low-power radio waves or infrared (IR) light to carry the information between source and destination.

Metallic cables carry information in the form of electromagnetic waves that travel through the wire. Fiber-optic cable carry the same information using pulses of light. Wireless communication normally relies on radio waves or infrared light to carry the information. Figure 1-9 illustrates how information can be transferred between source and destination.

Figure 1-9 Transmission of Digital Data



There are two measures for the size of a file: bits (b) and bytes (B). Communication engineers think in terms of transferring bits, whereas computer users think in terms of file sizes, which are usually measured in bytes (such as kilobytes, megabytes, and so on). There are eight bits to one byte.

Computer systems are compared based on many different criteria. Among these are the length of time that it takes to transfer a file; the screen resolution; and the speed of various system components. Generally, the faster the files transfer, the higher the resolution, and the faster the component speed, the better the computer system.

File Transfer Time

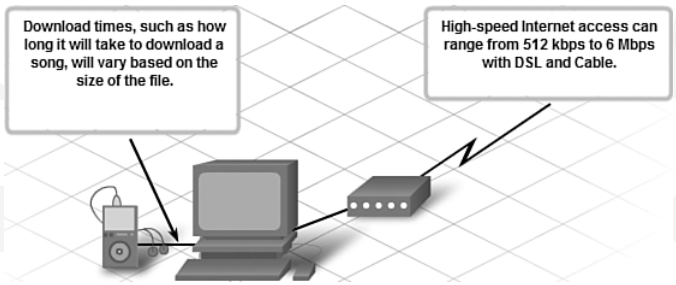
The data rate determines how long it takes to transfer a file between source and destination. Large files contain more information than small files and therefore take longer to transfer. Data transfer rates are measured in thousands of bits per second (kbps) or millions of bits per second (Mbps). Notice that in the kbps acronym, a lowercase *k* is used instead of the uppercase *K*. This is because when talking about the transfer of data, most engineers round the number down. So a kbps actually refers to the transfer of 1000 bits of information in 1 second, whereas a Kbps refers to the transfer of 1024 bits of information in 1 second. A DSL or a cable modem can operate in ranges of 512 kbps, 2 Mbps, or higher depending on the technology being used.

Tip

Be careful about the units used to represent data transfer rate. A lowercase *b* represents a single bit of information but an uppercase *B* represents a byte or collection of 8 bits. When calculating download time it is important to work with the same unit.

Calculated download times are theoretical and depend on cable connection (see Figure 1-10), computer processor speed, and other overheads. To obtain an estimate of the length of time it takes to download a file, divide the file size by the data rate.

Figure 1-10 Download Times



For example, to determine how long it will take to transfer a low-resolution digital photo of 256 KB via a 512 kbps cable connection, follow these steps:

How To

Step 1. Convert the file size into bits. Because the size of the file is represented in KB and the transfer speed is given in kbps, you must convert the size of the file to bits. In this case 256 KB equals 2,097,152 bits (256 KB x 1024 bytes/Kbyte x 8 bits/byte).

Step 2. Convert the file size in bits to kilobits. To convert the file size in bits to kilobits, simply divide by 1000. In this example 2,097,152 bits would equal approximately 2097 kb (2,097,152 bits / 1000).

Step 3. Divide the file size in kilobits by the transfer rate in kilobits per second. In this example 2097 kb divided by 512 kbps equates to approximately 4 seconds. It would take approximately 4 seconds to download a 256 KB file at a speed of 512 kbps.

In addition to storage capacity and data transfer speed, there are other units of measure when working with computers.

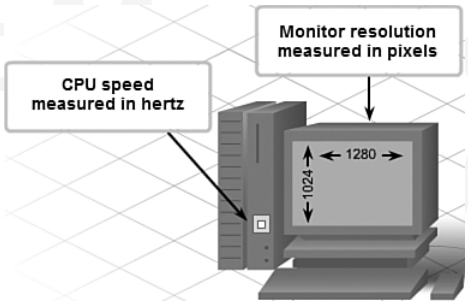
Computer Screen Resolution

Graphics resolution is measured in pixels. A ***pixel*** is a distinct point of light displayed on a monitor or captured by a digital camera. The quality of a computer screen is defined by the number of horizontal and vertical pixels that can be displayed. For example a widescreen monitor may be able to display 1280 x 1024 pixels with millions of colors, as shown in Figure 1-11. In digital cameras, image resolution is measured by the number of pixels that can be captured in a photograph. Because this number is usually very high it is represented as millions of pixels, or megapixels.

note

The term *pixel* is derived from the words *pic*ture *el*ement. The more elements that make up a picture, the higher the resolution, and the better the image quality will be.

Figure 1-11 Computer Screen Resolution



Lab 1-2: Determining the Screen Resolution of a Computer (1.3.3.4)

In this lab you will identify the graphics card and monitor installed on a PC. You will also determine both the current and maximum possible resolution supported by the card and monitor.

Analog Frequencies

Hertz is a measurement of how fast something cycles or refreshes. One ***hertz*** represents one cycle per second. In computers, the speed of the computer processor is measured by how fast it can cycle in order to execute instructions, measured in hertz. For example, a processor that runs at 1.8 GHz (gigahertz) executes 1800 million cycles per second. The radio frequencies used in wireless communications are also measured in hertz.

Computer Components and Peripherals

Many types of computers exist. What makes one computer better suited to play a new game or play a new audio file over another? The answer is the components and peripherals that make up the computer system. The requirements for a machine dedicated mainly to word processing are very different than one designed mainly for graphics applications or gaming. It is important to determine the intended uses for a computer system before deciding on the type of computer and components to purchase.

Computer Systems

Many manufacturers mass-produce computer systems and sell them either through direct marketing or retail chains. These computer systems are designed to function well for a variety of tasks but are not optimized for a single one.

In addition to mass-produced systems, a number of vendors can custom-assemble computer systems to the end user's specifications. The advantages and disadvantages for both are shown in Table 1–2.

Table 1-2 Advantages and Disadvantages of Computer Purchase Options

	Advantages	Disadvantages
Preassembled computer	Lower cost	Often lack the performance level that can be obtained from custom-built computers
	Adequate to perform most applications	
	No waiting period for assembly	
	Typically used by less-knowledgeable consumers who do not require special needs	
Custom-built computer	The end user can specify exact components that meet user needs	Generally more costly than a preassembled device
	Generally support higher performance applications such as graphics, gaming, and server applications	Longer waiting periods for assembly

Purchasing the individual parts and components of a computer and building it yourself is also possible. Regardless of the decision to buy a preassembled or custom-built system or build it yourself, the final product must match the requirements of the end user. When purchasing a computer system, you must consider the motherboard, processor, RAM, storage, adapter cards, and the case and power supply.

Motherboard, CPU, and RAM

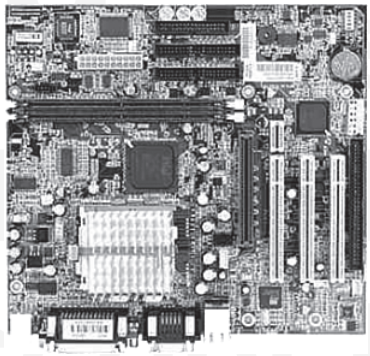
Regardless of whether you decide to purchase a pre-built system, have one built to match a specific application, or build your own, you must pay attention to the choice of the motherboard, CPU, and system RAM.

Motherboard

The ***motherboard*** is a large circuit board used to connect the electronics and circuitry required for the computer to function. Motherboards contain much of the electronics used to interconnect various components and also contain connectors that allow major system components such as the CPU and RAM to attach to the board. The motherboard moves data between the various connections and system components. A typical motherboard is shown in Figure 1-12.

A motherboard can also contain connector slots for network, video, and sound cards. However, many motherboards now come equipped with these features as integrated components. The difference between the two is how they are upgraded. When using connectors on the motherboard, system components are easily unplugged and changed or upgraded as technology advances. When upgrading or replacing an on-board feature, you cannot remove it from the motherboard. Therefore, disabling the on-board functionality and adding an additional dedicated card using a connector is often necessary.

Figure 1-12 A Typical Motherboard



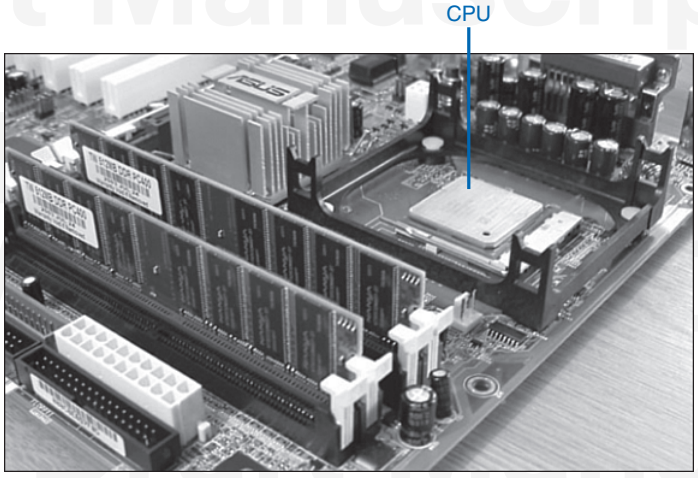
Remember that the motherboard not only controls the flow of information between the various system components but also provides the connection point for these components. Not paying attention to the selection of the motherboard can have a serious negative impact on the performance of the final computer system. The motherboard must meet the following criteria:

- Support the selected CPU type and speed
- Support the amount and type of system RAM required by the applications
- Have sufficient slots of the correct type to accept all required interface cards
- Have sufficient interfaces of the correct type

Central Processing Unit (CPU)

The ***central processing unit (CPU)***, or processor, is the nerve center of the computer system. It is the component that processes all the data within the machine. The type of CPU should be the first decision made when building or updating a computer system. Important factors when selecting a CPU include the processor and bus speed as well as the number of cores. Many modern CPUs have multiple cores, or processing entities, on a single chip. This setup is similar to having multiple CPUs in the machine. Figure 1-13 shows a CPU attached to a motherboard.

Figure 1-13 CPU on a Motherboard



Processor speed measures how fast a CPU cycles information. It is normally measured in MHz or GHz. In general terms, the higher the CPU speed the better the performance. Faster processors consume more power and create more heat than their slower counterparts. For this reason, mobile devices, such as laptop computers, typically use processors that are slower and have been specifically designed to consume less power in order to extend the time they can operate using batteries.

A CPU must transfer data between various types of memory on the system board during its operation. The pathway for this movement of data is called the *bus*. In general, the faster the bus, the faster the computer will be. There are many different types of busses in a computer system. When selecting a CPU you may encounter the terms front-side bus (FSB) and back-side bus (BSB). The FSB is also known as the system bus and is used to carry data between the CPU, the system RAM, and the various other secondary data busses. The BSB is used to move data between the CPU and high-speed cache memory.

A recent trend in CPUs is to include more than one processing core in a single processor. The terms *dual-core* and *quad-core* are now quite common. Essentially this setup is the same as running multiple CPUs in a single machine. Most modern operating systems support these newer CPUs and massive improvements in system performance can be obtained with very little additional cost.

Note

A multicore processor is different from a multiprocessor system. In a multiprocessor system, there are separate CPUs each with its own resources. In a multicore processor, resources are shared and the cores reside on the same chip. A multiprocessor system is generally faster than a system with a multicore processor, while a multicore system is normally faster than a single-core system.

When selecting a CPU, keep in mind that applications continue to evolve. Purchasing a CPU of moderate speed may satisfy current requirements. Future applications, however, may be more complicated and require more resources. If the purchased CPU is not sufficiently fast, the overall performance, measured in terms of response time, will be reduced. Thorough research must be conducted before purchasing a CPU to ensure that it will function reliably with the desired applications.

The CPU is mounted through a socket on the motherboard and is normally the largest component on the board. The motherboard must be equipped with a compatible socket to accept the selected CPU. In addition the chipset on the motherboard must be able to support the processor and all of its capabilities.

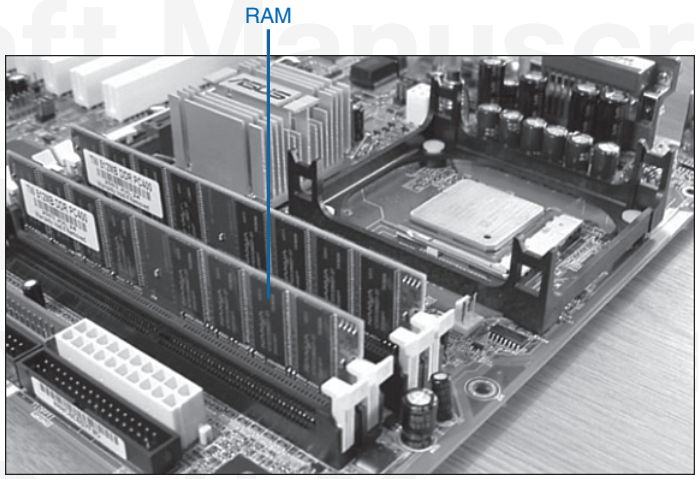
Random-Access Memory (RAM)

Random-access memory (RAM) is a type of data storage medium used in computers. It is used to store programs and data while they are being processed by the CPU. The information stored in RAM is accessed in any order, or at random, as needed. All computer programs run from RAM. Many different types of RAM are available and it must be matched to both the CPU and the capabilities of the motherboard. Besides the CPU, the amount and type of RAM is the most important factor in computer performance. Figure 1-14 shows RAM attached to a motherboard.

Every operating system requires a minimal amount of RAM in order for the OS to function. Most modern computers are often used to run multiple applications simultaneously, or to multitask. For example, many users run e-mail programs and Instant Messenger clients as well as anti-virus tools or firewall software. All of these applications require memory. The more applications that need to run simultaneously, the more RAM is required.

More RAM is also recommended for computer systems with multiple processors or multicore processors. Additionally, as the speed of the CPU and the bus increase, so must the speed of the memory it accesses. The amount and type of RAM that can be installed on a system is dictated by the motherboard.

Figure 1-14 RAM on a Motherboard



caution

System RAM is connected to the FSB of the CPU. As CPU speeds continue to increase, so must the speed that the data can be written to and read from the connected memory. If the RAM is of the wrong type or speed the CPU will not be able to use it and the computer will be rendered non-operational. Because of this, it is advisable to buy as much RAM as possible when purchasing or building the computer. Doing so helps ensure that the memory chips are compatible. Memory from different manufacturers or even different batches from the same manufacturer may not function together.

Adapter Cards

Adapter cards add enhanced functionality to a computer system. They are designed to be plugged into a connector or slot on the motherboard and, once this is done, become part of the system. Many modern motherboards are designed to incorporate the functionality of many of the basic adapter cards on the motherboard itself thus removing the necessity to purchase and install separate cards. Although this does provide basic functionality, the addition of dedicated adapter cards can often provide an enhanced level of performance.

Some of the more common adapter cards include the following:

- Video cards
- Sound cards
- Network interface cards
- Modems
- Controller cards

Video Card

Video cards, also commonly referred to as graphic cards, accept information from the computer and translate it into a format that can be displayed on a monitor screen. Most current video cards contain large amounts of RAM and dedicated processor chips for manipulating video content. Figure 1-15 shows a video card.

Figure 1-15 Video Card

Most motherboards have a specialized, high-speed port that has been designed to allow the video card to exchange information with the system bus at extremely fast rates. This specialized bus is known as the ***Accelerated Graphic Port (AGP)***. The choice of video card is made based on the video speed, resolution, and price. Graphic artists and gamers require faster speed and higher-resolution cards than those individuals concerned mainly with text. The video card output must match the capabilities of the connected monitor both in resolution and signal type. Some video cards output a digital signal but others output an analog one. Some video cards are capable of running multiple monitors for specialized applications.

Sound Cards

A sound card, as shown in Figure 1-16, accepts digital information from the system and converts it into a signal that is transmitted to a speaker to produce an audio output. Some sound cards also accept analog input and sample the sound to produce a file that can be stored and manipulated digitally. Current sound cards can produce an audio output that rivals some of the best stereo equipment available.

Figure 1-16 Sound Card

Network Interface Cards (NICs)

A network interface card (NIC), as shown in Figure 1-17, enables a computer system to exchange information with other systems on a local network. The speed of the network and the type of technology help determine what type of NIC is required. The most common networking technology is currently Ethernet. This type of NIC normally has an RJ45 type connector to allow it to connect into the local network.

Figure 1-17 Network Interface Card

Modems

Modems enable computer systems to connect to remote networks such as the Internet. Figure 1-18 shows a modem. At the source, modems encode digital information onto an analog carrier signal that is carried across analog networks such as the public telephone network. At the receiving end, modems remove the encoded information from the carrier and pass the digital signal to the receiving device.

Modems allow digital devices to communicate over analog networks such as the public telephone network, as well as DSL and cable networks. Each type of network requires a different type of modem.

Figure 1-18 Modem

Controller Cards

Controller cards are a large group of adapter cards that add additional interfaces or act as controllers for specialized hardware devices such as an external hard disk drive or tape drive. These cards are usually specific to a single device or group of devices and format the information in a manner specific to the end device. Specialized controller cards are less common now that most devices use standard interfaces. The most common controller card encountered is the small computer systems interface (SCSI) card used to connect a wide range of devices from printers to hard drives and other storage devices. Figure 1-19 shows an example of a controller card.

Figure 1-19 Controller Card

Storage Devices

When power is removed from the computer, any data stored in RAM is lost. Programs and user data must be stored in a form that will not disappear when the power is removed. This is known as *non-volatile storage*. Many types of non-volatile storage are available for computer systems including the following:

- Magnetic storage devices
- Optical storage devices
- Static memory (flash) drives

Magnetic Storage

Magnetic storage devices are the most common form found in computers. These devices store information in the form of magnetic fields. The following three main types of magnetic storage, shown in Figure 1-20, are found in many computer systems:

- ***Hard disk drive (HDD)***: Also known simply as hard drives, HDDs are the main storage medium found in almost all computers including servers, desktops, and laptops. Hard drives are typically internal components attached to the motherboard, though external hard drives can be connected to the computer via a USB, firewire, or hard disk controller card. The cost of hard disk drives is rapidly falling and the available capacity is increasing. Hard disks of 500 GB or more are now common in most home computers.
- ***Floppy disk drive (FDD)*:** FDDs, or simply floppy drives, can store 1.44 MB of data on a removable plastic disk. Floppy disks are becoming quite rare, and are being replaced by static memory

devices, which offer higher storage capacities at lower prices. Most new computer systems do not include a FDD.

- ***Tape drive*:** Tape drives are used to back up information for archival or disaster recovery purposes. They are often found on file servers but are not normally found on home computers.

Figure 1-20 Common Magnetic Media Devices

Tip

All magnetic media can be affected by storage conditions such as humidity and stray magnetic fields. Data stored on tapes or floppy disks should not be considered permanent. This information should be refreshed on a regular basis to ensure that it is still readable. For critical data it is wise to keep multiple copies in different locations or to consider optical storage devices.

Optical Storage

Optical storage devices use laser beams to record information by creating differences in optical density. These devices include both compact discs (CD) and digital versatile/video discs (DVD). Both CDs and DVDs come in three different formats:

- **Read only**: CD, DVD
- **Write once**: CD-Recordable (CD-R), DVD-Recordable (DVD-R)
- **Write many**: CD-Read/Write (CD-RW), DVD-Read/Write (DVD-RW)

The prices of these devices continue to fall and most computers now incorporate DVD-RW drives that can store approximately 4.7 GB of data on a single disc. Compact disc (CD) devices have a much lower storage capacity than DVDs and are therefore becoming less common. Another form of DVD drive, called ***Blu-ray*** is also available. It uses a different type of laser to read and write data. The color of the laser used to store this information is blue-violet. For this reason, disks are called Blu-ray, to distinguish them from conventional DVDs, which use a red laser. Blu-ray disks have storage capacities of 25 GB and more. A typical optical drive and disc are shown in Figure 1-21.

Static Memory and Memory Sticks

Static memory devices use memory chips to store information. This information is retained even after the power is turned off. They connect to a USB port on the computer and offer capacities of 8 GB or more. Due to their size and shape, these devices are known as ***USB memory keys*** or ***flash drives*** and have widely replaced floppy disks for transportation of files between systems.

Figure 1-21 A Typical Optical Drive and Disk

The cost of these devices is rapidly decreasing as the maximum available capacity continues to increase. Larger capacity static memory storage units are available for use in portable devices where the weight and susceptibility to vibration of a conventional hard drive is a limiting factor. Many portable and hand-held devices rely entirely on static memory for storage. In addition, many networking devices rely on flash memory to store the operating system and retain user configurations.

Tip

When purchasing storage for a computer system, it is generally good practice to have a mix of magnetic storage, optical drives, and static memory available. When determining storage requirements, be sure to allow for growth. Anticipating just how much storage is enough is difficult but a good general rule is to purchase the largest storage devices that you can afford.

Peripheral Devices

A ***peripheral*** is a device that is added to the computer to expand its capabilities. These devices are optional in nature and are not required for the basic functioning of the computer. Instead they are used to increase the usefulness of the machine. Peripheral devices are connected externally to the computer using a specialized cable or wireless connection.

Peripheral devices can fit into one of four categories, as follows:

- **Input:** Trackball, joystick, scanner, digital camera, digitizer, barcode reader, microphone
- **Output:** Printer, plotter, speakers, headphones
- **Storage:** Secondary hard drive, external CD/DVD devices, flash drives
- **Network:** External modems, external NIC

Figure 1-22 shows examples of common peripherals, and Table 1–3 describes each device.

Figure 1-22 Common Peripheral Devices

Table 1-3 Common Peripherals

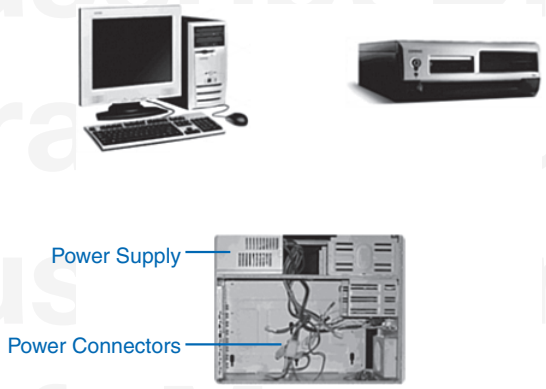
Device	Type	Description
Disk drive	Storage and input/output (I/O)	Allows a user to easily increase the available storage capacity of a computer and also move large amounts of data between different computers. A disk drive that is external to a computer and is not required for the computer to function is considered a peripheral device. Different types of disk drives exist including FDDs, HDDs, CD drives, and DVD drives.
Scanner	Input	Enables you to convert printed pages, handwriting, diagrams, and pictures into digital format for storage on a computer.
Mouse	Input	Enables the user to select items displayed on the monitor.
Flash drive	Storage and I/O	Connects to the USB interface and allows files to be saved and moved between computers. Functions similarly to an external floppy disk drive.
Network Interface Card (NIC)	Network and I/O	Allows communications between computers. Not required for the individual computer to function; therefore, it is considered a peripheral device.
Printer	Output	Converts the digital information stored in a computer to a printed page. Many different types of printers exist and can have either monochrome or color output.
Monitor	Output	Used to visually display output from the computer.
Keyboard	Input	Enables the end user to enter information into the computer.
Modem	Network and I/O	Allows communication between digital devices over an analog medium. At the source, modems encode digital information onto an analog carrier signal for transfer across the media. At the destination the digital information is removed from the analog carrier signal.

Cases and Power Supplies

Once all internal components and connections are determined, the case and power supply is the next consideration. The ***case*** holds and protects the internal computer components whereas the ***power supply*** converts the wall outlet power source to the low voltage required by the components.

Some cases are designed to sit on top of the user's desk whereas other cases sit below the desk. Computers designed to sit on the desk provide easy access to interfaces and drives but occupy valuable desk space. A tower or mini-tower type case can either be used on the desk or beneath the table. Whatever the case's style, select one that has enough space for all the components. Typical computer cases and power supply are shown in Figure 1-23.

Figure 1-23 Computer Cases and Power Supply



The case and power supply are usually sold together as a unit. The power supply must be sufficient to power the system. It is a good idea to always over–estimate the requirement for a computer power supply to allow for the later addition of larger or additional hard disk drives, DVD and tape drives, and additional system RAM.

Tip

Many power supplies that come shipped with computer cases are severely under-rated for today's powerful computer systems. If the computer behaves erratically, locks up unexpectedly, or fails to start reliably, it may be due to faulty power.

Computer systems require a steady supply of continuous power. The power from many electricity supply companies is subject to voltage reductions and cuts. A poor supply can affect the performance of computer hardware and possibly damage it. These power issues can also corrupt software and data. In order to help protect the computer system from these power problems, devices such as surge suppressors and uninterruptible power supplies (UPS) have been developed.

Surge Suppressor

A ***surge suppressor***, as shown in Figure 1-24, is designed to remove voltage spikes and surges from the power line and prevent them from damaging a computer system. They are relatively inexpensive and easy to install. Generally the surge suppressor is plugged into the power outlet and the computer system is plugged into the surge suppressor. Many surge suppressors also have connectors for phone lines to protect modems from damage due to voltage surges that may be carried through the telephone lines. It is important to purchase a surge suppressor with a sufficient rating to protect both the main computer system and any connected peripherals.

Figure 1-24 Surge Suppressor

Uninterruptible Power Supplies

An ***uninterruptible power supply (UPS)***, as shown in Figure 1-25, is a device that continually monitors the power to a computer system and maintains the charge on an internal battery. If the power is interrupted, the UPS provides backup power to the system without interruption. The backup power comes from a battery inside the UPS and can only power the computer system for a short period of time. A UPS is designed to provide the end user with sufficient time to properly shut down a computer system should the main power fail. An in-line UPS can provide an even flow of power to the computer and prevent damage caused by voltage surges. Some low-end UPSs act only as a backup power supply. These do not adequately protect the computer system and should be avoided if possible.

Figure 1-25 Uninterruptible Power Supply (UPS)

UPSs suitable for home and small business use are relatively inexpensive and often incorporate surge suppressors and other functionality to stabilize the power supplied by the utility company. It is highly recommended that all computers be protected by a UPS regardless of their functionality or location.

Computer System Components

Computers are a collection of very complex components and peripherals, all working together to accomplish a task. Occasionally one of these components fails or needs to be upgraded to improve the functionality of the system. Sometimes a new peripheral must be added to enhance the machine's functionality. When adding, upgrading, or replacing system components and peripherals, it is important to follow proper safety precautions and procedures to help ensure success.

Adherence to best practices and proper safety precautions when working on computer systems is extremely important. These practices and procedures are designed to help protect both the components and devices being installed and the technician doing the installation. Computer systems pose threats from high voltage, sharp edges, and small components. Great care must be taken when upgrading or repairing computer systems to avoid these dangers.

Safety and Best Practices

Computer systems and monitors can be very heavy and should be lifted with caution. Before opening a computer system, be sure to have a proper work area. The work area should be a clean flat surface, strong enough to support the weight of heavy equipment. It should be well organized, free from clutter and distractions, and adequately lit to prevent eye strain. Proper eye protection must be worn to prevent accumulated dust, small screws, and components from causing damage to the eyes.

Caution

Most computer systems accumulate dust. A technician encountering a significant amount of dust when opening a computer case is not uncommon. Stirring up old, stale dust can be a health concern for people with asthma-like symptoms. Proper use of a small vacuum for removal of this dust is more appropriate than the use of compressed gas, which simply redistributes the dust into the surrounding air.

Before the computer case is opened, make sure the computer is switched off and the power cable is unplugged. Most components function at only a few volts, but power supplies and monitors operate at dangerously high voltages and should only be opened by individuals with special training.

When working inside a computer case, it is important to keep precautions in mind to prevent damage to the system components as well as harm to the technician. When opening a computer case, be aware that there are sharp edges usually on the inside of the case that should be avoided.

Some computer systems are specially designed to enable components to be hot-swapped, meaning that turning off the computer before adding or removing components is not necessary. This feature allows the system to remain operational during repairs or upgrades and is usually found in high-performance servers. Unless you are sure that the system is hot-swappable, turn it off before opening the case or removing components. Inserting or removing components with the power on, in a system that is not ***hot-swappable***, can cause permanent and serious damage to the system and technician.

Internal system components are especially sensitive to static electricity. ***Electrostatic Discharge (ESD)*** is static electricity that can be transferred from your body to electronic components in the computer. The static electricity doesn't have to be felt by you in order to occur. If the discharge is felt more than 3000 volts has moved from your body to the object.

ESD can cause ***catastrophic failures*** in components, making them non-functional. ESD can also cause intermittent faults that are very difficult to isolate. For this reason, proper grounding is essential. A special wrist ***grounding strap***, shown in Figure 1-26, is used to connect the technician to the computer case. Grounding ensures that they both reach the same voltage potential and ESD is prevented.

Figure 1-26 Wrist Grounding Strap

Caution

ESD occurs when two objects at different voltages are connected together through a conductor. Electrons flow between the two objects in an attempt to balance out the difference in charge. Unfortunately computer components are easily damaged by this flow of electrons, and great care must be taken to prevent it from occurring. Never touch any internal computer components without first properly grounding yourself and the computer system.

Excessive force should never be used when installing components because it can damage both the motherboard and the component being installed and can prevent the system from functioning properly. Damage is not always visible. Force can also damage connectors which, in turn, can damage new system components.

To make certain that all safety precautions are followed, creating a safety checklist is a good idea. The following precautions should always be observed when working on a computer system:

- Use an antistatic mat and grounding wrist strap.
- Use antistatic bags to store and move computer components. Do not put more than one component in each bag, because stacking them can cause some of the components to break or become loose.
- Do not remove or install components while the computer is on.
- Ground often to prevent static charges from building up by touching a piece of bare metal on the chassis or power supply.
- Work on a bare floor because carpets can build up static charges.
- Hold cards by the edges to avoid touching chips or the edge connectors on the expansion cards.
- Do not touch chips or expansion boards with a screwdriver.
- Turn off the computer before moving it. This is to protect the hard drive, which is always spinning when the computer is turned on.
- Keep installation/maintenance CDs and disks away from heat and cold.
- Do not place a circuit board of any kind onto a conductive surface, especially a metal foil. The Lithium and Nickel Cadmium (Ni-Cad) batteries used on boards may short out.
- Do not use a pencil or metal-tipped instrument to change the settings on the small internal switches or to touch components. The graphite in the pencil is conductive and could easily cause damage.
- Do not allow anyone who is not properly grounded to touch or hand off computer components. This is true even when working with another individual. When passing components, always touch hands first to neutralize any charges.

Installing Components and Verifying Operation

When installing or upgrading components be certain to follow all safety precautions. The following procedures apply to most system components.

How To

Step 1. Determine whether the computer component is hot-swappable. If not, or if in doubt, unplug the system unit before opening the case.

Step 2. Attach a grounding strap from your body to the system framework, or chassis, to prevent any damage that could be caused by ESD.

Step 3. If replacing a component, remove the old component. Components are often held into the system with small screws or clips. When removing screws, do not let them drop on the system motherboard. Also, be careful not to break any plastic clips.

Step 4. Check the connection type on the new component. Each card is designed to work only with a certain type of connector and should not be forced when inserting or removing the card.

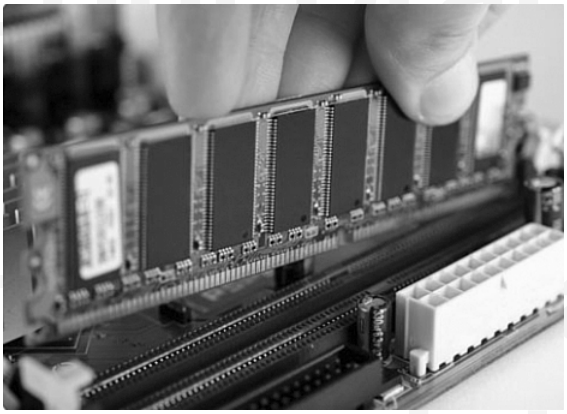
Step 5. Place the new component in the correct connection slot, with the correct orientation, carefully following all installation instructions that may have accompanied the component.

Step 6. Once the component has been added or upgraded, close the case and reconnect the power and other cables.

Step 7. Switch on the system and watch for any messages that may appear on the screen. If the system fails to start, disconnect all cables and verify that the component was properly installed.

If the system still will not start with the new component installed, remove it and try to start the system. If the system starts without the new component, the component may not be compatible with the current hardware and software and additional research into the problem is required. Figure 1-27 illustrates the process of installing a memory in a computer.

Figure 1-27 Installing Memory in a Computer System



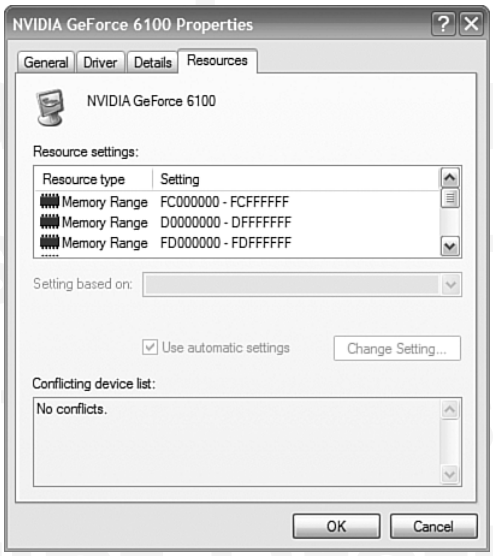
Certain components require the addition of a specialized piece of software, or ***driver***, to function. For commonly encountered components the drivers are usually contained in the operating system itself, but for more specialized components the driver must be added separately. Newer operating systems will usually prompt for the addition of any required drivers. Drivers are continually updated to improve efficiency and functionality. The most current driver can be obtained from the manufacturer's website and should normally be used. Always read any documentation that accompanies the driver software for potential problems and the proper installation procedure.

Tip

Always make certain that the driver installed is the correct one for the operating system. Using the wrong driver can cause unexpected results. The newest driver may not be the best. Problems with drivers often take some time to surface and using the newest release of a driver may cause unknown problems. If the component fails to function as expected after you upgrade the driver for a component, try rolling back the driver to a previous version.

Once installed, the component should be tested for complete functionality. Components are designed to make use of specific sets of ***system resources*** as shown in Figure 1-28. If two components try to use the same resources, one, or both, will fail. The solution is to change the resources used by one of the devices. Newer components and operating systems are able to dynamically assign system resources but older devices must have the resources set manually or through software configuration.

Figure 1-28 System Resource Utilization



If the device fails to function properly, verify that the correct and most recent driver is installed. Also check that the operating system has correctly detected and identified the device. If this fails to correct the problem, power down the system, carefully reseat the component, and verify that all connections are correct. Check the component documentation for the correct settings. If the device continues to be non-functional, it is possible that the component is defective and it should be returned to the vendor.

Installing Peripherals and Verifying Operation

Peripheral devices, unlike internal components, do not require the computer case to be opened for installation. Peripherals connect to an interface on the outside of the case with a wired or wireless link. Historically, peripherals were designed to function when connected to a specific type of port. For example, PC printers were designed to connect to a parallel port, which transferred data from the computer to the printer in a specific format. Figure 1-29 shows some of the more common ports available on a computer system, and Table 1-4 provides a brief description of these ports.

Figure 1-29 Common Ports on a Personal Computer

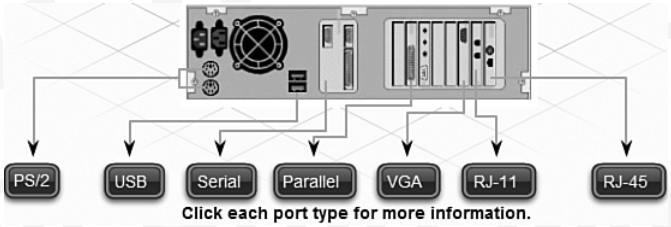


Table 1-4 Common Ports found on a PC

Port	Description
PS/2	These connectors are commonly used for both the keyboard and the mouse. They have a very compact design and are keyed to allow the plugs to be inserted in the correct orientation only. The functionality of these ports is replaced by USB on many new computer systems.
USB	The Universal Serial Bus allows the connection of many different devices and supports hot-swapping and Plug-and-Play (PnP) technology. PnP allows the operating system to automatically detect and configure devices plugged into the USB port. An increasing number of USB devices are becoming available. These devices now include mice, keyboards, sound cards, speakers, NICs, modems, and external storage devices.
Serial	Serial ports were originally designed as a 25-pin male connector (DB25) but only nine wires were actually used. The original DB25 connector took up quite a bit of space and has been widely replaced by a more compact 9-pin connector (DB9). Both DB25 and DB9 connectors can be found on modern computers and are used to connect devices such as modems. They may also be used to connect a printer or mouse but this is becoming less common. This port can also be used to connect two computers to transfer data between them. The functionality of these ports is replaced by USB on many new computer systems.
Parallel	The parallel port was designed to connect a printer to the PC. It is a 25-pin connector but has a female gender. Parallel ports are also commonly used to connect printers, external tape drives, and CD or DVD drives to the host computer. This port can also be used to connect two computers to transfer data between them. The functionality of these ports is replaced by USB on many new computer systems.
VGA	The 15-pin video connector is standard on most personal computers. It is designed to connect to either VGA or super-VGA monitors. Most PCs use a DB15HD connector, which has three rows of five pins.
RJ-11	The RJ-11 connector is the connector used by telephone companies in many areas of the world. This connector is usually found on a modem and is used to connect the computer to the telephone network.

Port	Description
RJ-45	The RJ-45 connector is the standard connector used for Ethernet networks. This connector is used to connect the computer into a local-area network (LAN) or to connect it to an external modem such as those provided by cable and DSL companies for high-speed Internet access.
Firewire (not pictured)	The firewire port provides a high-speed connection into the computer system. It can support up to 63 peripherals and allows them to communicate without the intervention of the CPU or system memory. Firewire supports PnP and hot-swapping. It is normally used to connect digital video devices to a computer.

More recently the development of the ***Universal Serial Bus (USB)*** interface has greatly simplified the connection of peripheral devices that use wires. USB devices require no complex configurations and can merely be plugged into an appropriate interface, assuming the proper driver has been installed. There have also been an increasing number of peripheral devices that connect to the host computer through wireless technology.

The installation of a peripheral device requires several steps. The order and detail of these steps varies depending on the type of physical connection and whether or not the peripheral is a ***Plug-and-Play (PnP)*** device. The steps include the following:

Step 1. Connect the peripheral to the host using the appropriate cable or wireless connection.

Step 2. Connect the peripheral to a power source.

Step 3. Install the appropriate driver.

Some old peripheral devices, called legacy devices, are not PnP enabled. For these, driver installation occurs after the device has been connected to the computer and powered up. For PnP-enabled USB devices, the driver is preinstalled on the system. In this case, when the PnP device is connected and powered on, the operating system recognizes the device and installs the appropriate driver. Installation of outdated or incorrect drivers can cause a peripheral device to behave unpredictably. For this reason, installing the most current drivers available is necessary.

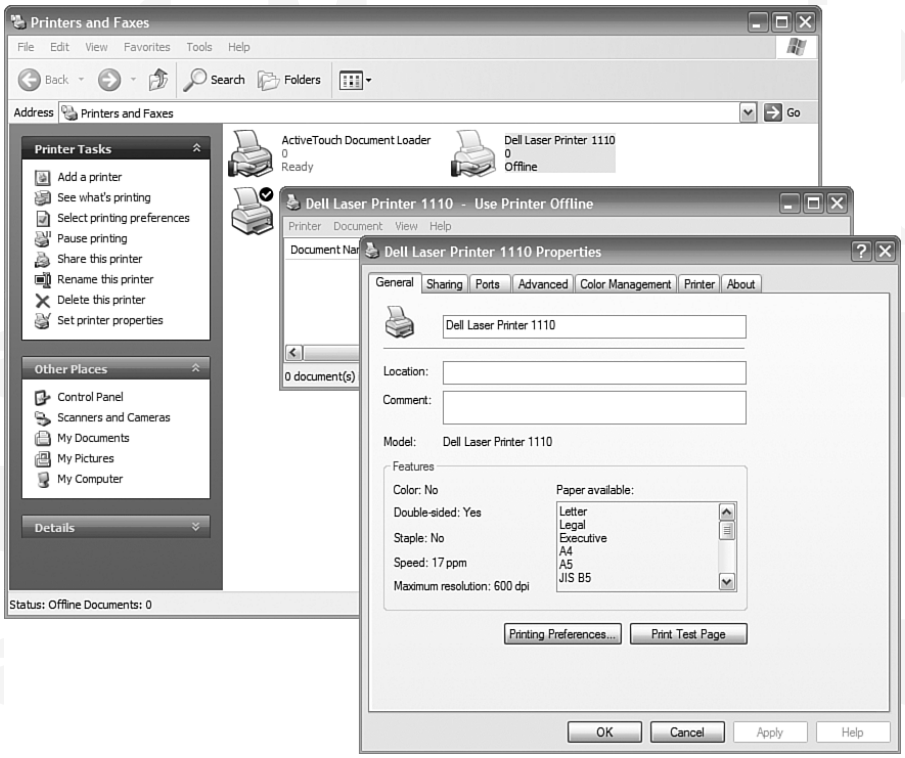
If the peripheral device does not function once connected and installed, verify that all cables have been properly connected and that the device is powered up. Many devices, such as printers, offer a testing functionality on the device directly, and not through the computer. This is shown in Figure 1-30. Use this feature to verify that the device itself is functioning properly.

If the device is operational, but not connecting to the computer system, the problem could be with the cable connection. If the cable is suspected, swap it with a known good one. If this fails to solve the problem the next step is to verify that the port the peripheral device is connected to is recognized by the operating system.

If everything appears to be functioning properly, the device may not be compatible with the current hardware or operating system and requires more research to solve the problem.

Once installed, the full functionality of the peripheral device must be tested. If only partial functionality is available, the most likely cause is an outdated driver. This is easily remedied by downloading and installing the most current driver from the manufacturer's website.

Figure 1-30 Printer Test Function



Lab 1-3: Installing a Printer and Verifying Its Operation (1.5.3.4)

In this lab you will manually install a printer using the default Windows XP driver and verify printer functionality. You will then download and install the latest printer driver from the manufacturer's web-site and compare functionality.

Summary

This chapter has introduced computers and their applications. Highly specialized computers are integrated into many common items, including automobiles, refrigerators, televisions, and other electronic devices. The hardware, operating system, and application program all work together to accomplish specific tasks.

Application programs may either be business/industry-specific such as software used to manage a medical office, or may be more generalized and designed to be used across many different industries. A common example of a generalized application is the office suite.

Applications may also be designed to run only on a local machine or may be designed to work in a network environment. Network-based applications require that client software be installed on the local machine and that the remote machine is running server software. The client software communicates with the server software to carry out a task. A common network application is e-mail.

Many different types of computers exist, each designed for a specific task or application. Mainframes and servers are designed to service multiple clients at the same time and have built-in redundancy to ensure their continued operation. PCs and laptops are designed to be used only by a single person at any one time and often lack the redundant hardware found in servers. Some computers are designed to remain stationary whereas others, such as laptops and PDAs, are powered by batteries and designed to be portable.

Computers may be highly specialized and designed to run only one or two applications or may be very generic in nature. Workstations are computers that have been optimized to run engineering and graphic-intensive programs such as CAD and virtual reality software. Portable gaming devices are smaller computers but have been optimized to play games that have been specially designed to run on the device. Many devices, such as cellular phones, are now integrating multiple functions into a small portable device. These often incorporate a digital camera, PDA, and audio/video player in addition to the basic phone capabilities.

All information within a computer system is represented digitally by a series of 1s and 0s known as bits. While the computer is processing data, these bits are stored in RAM, moved through the various computer buses, and manipulated by the CPU. In addition, this digital information can be stored on optical, magnetic, or solid-state memory chips for archival and transportation purposes. All of these devices are usually located inside the computer case and are known as components. Most components connect directly to the motherboard, which houses most of the electronics required to make the computer function.

Peripherals are devices located outside of the case and are designed to enhance system functionality. Peripherals are not required for the normal operation of the computer system but provide additional services. Printers and scanners are common examples of a computer peripheral.

Activities and Labs

This summary outlines the activities and labs you can perform to help reinforce important concepts described in this chapter. You can find the activity files on the CD-ROM accompanying this book. The complete hands-on labs appear in Part II.

Interactive activities on the CD-ROM:

Activity 1-1: Classification of Applications (1.1.2.3)

Activity 1-2: Function of a Computer (1.2.2.4)

Activity 1-3: ASCII Digital Translator (1.3.1.1)

Activity 1-4: Byte Conversion Calculator (1.3.2.3)

Hands-on Labs in Part II of this book:

Lab 1-1: Determining Data Storage Capacity (1.3.2.2)

Lab 1-2: Determining the Screen Resolution of a Computer (1.3.3.4)

Lab 1-3: Installing a Printer and Verifying Its Operation (1.5.3.4)

Check Your Understanding

Complete all the review questions listed here to test your understanding of the topics and concepts in this chapter. The section "Check Your Understanding and Challenge Questions Answer Key" at the end of this chapter lists the answers.

1. Which of the following would be classified as an application program? (Choose all that apply.)

   A. Spreadsheet
   B. Windows Vista
   C. Linux
   D. Word Processor
   E. Windows XP
   F. Database

2. What allows a computer to locate and load an operating system when it is first powered on?

   A. Application program
   B. Operating system
   C. Hard Disk Drive
   D. BIOS
   E. Hardware

3. Which of the following is considered a network application?

   A. E-mail
   B. Spreadsheet
   C. Word processor
   D. Database

4. Which type of computer is normally a large centralized computer found in enterprise environments?

   A. Mainframe
   B. Server
   C. Desktop
   D. Workstation
   E. Laptop

5. Which type of computer is normally designed to run high-end graphics and engineering applications such as CAD?

   A. Mainframe
   B. Server
   C. Desktop
   D. Workstation
   E. Laptop

6. Which types of computers are designed to be used by a single end user? (Choose two.)

   A. Mainframe
   B. Server
   C. Desktop
   D. Workstation

7. How long would it take to download a 600 KB file from the Internet with a 256 kbps connection?

   A. 2 seconds
   B. 19 seconds
   C. 2343 seconds
   D. 2400 seconds

8. What is the unit used to measure the resolution of a computer monitor?

   A. gigahertz
   B. KB
   C. pixel
   D. kbps

9. What are some advantages of purchasing a pre-built computer over having one custom built? (Choose two.)

   A. Ability to specify exactly which parts are used in the system
   B. Ability to optimize system performance for a specific application
   C. Less expensive than building your own computer with the same components
   D. No waiting period
   E. Better system performance

10. What should be the first step when upgrading a computer with an on-board NIC to one that plugs into an expansion slot?

A. Install the correct driver for the new NIC.
B. Disable the on-board NIC.
C. Update the operating system.
D. Upgrade the system BIOS.

11. When selecting a new motherboard, which of the following factors should you consider? (Choose all that apply.)

A. Support for the selected CPU type and speed
B. Support for the amount and type of system RAM required by the applications
C. Sufficient slots of the correct type to accept all required interface cards
D. Sufficient interfaces of the correct type

12. When building your own computer system, what is the first component that should be decided upon?

A. CPU
B. RAM
C. HDD
D. Motherboard

13. From where is an application program normally run?

A. HDD
B. FDD
C. RAM
D. BIOS

14. Which of the following peripherals are considered input devices? (Choose all that apply.)

A. Scanner
B. Digital camera
C. Mouse
D. Keyboard
E. Microphone

15. What is the first step when upgrading an internal video card in a computer system?

A. Reformat the hard disk drive.
B. Upgrade the system BIOS.
C. Unplug the computer.
D. Remove the old video card.

16. Before passing a CPU or a piece of memory to another individual, what should you do?

A. Touch hands first to equalize charges.
B. Place the component on a plastic table and then allow the other person to pick it up.
C. Touch the component to a grounding plate to remove any excess charge.
D. No precautions are necessary.

17. What is the sequence of steps required to install and verify a USB printer under Windows XP?

1. Physically connect the printer to the computer.
2. Power up the printer.
3. Install the driver.
4. Power up the computer.
5. Generate a test print.

A. 1,2,4,3,5
B. 4,3,1,2,5
C. 1,2,4,3,5
D. 4,1,2,3,5
E. 4,2,3,1,5
F. 4,2,1,3,5

Challenge Questions and Activities

These questions require a deeper application of the concepts covered in this chapter. You can find the answers at the end of this chapter.

1. Charlene must upgrade the memory in her new laptop computer by installing a single 2 GB stick. She quickly unscrews the door on the bottom of the computer and snaps the new stick into an empty connector. She then powers up the machine only to see that the new memory is not recognized by the computer. Checking the manual for the computer, she verifies that the memory type and capacity should be recognized. What is the problem and how would you correct it?

2. Juri has just installed a new PnP printer on his home computer system using the drivers on the Windows XP CD. The advertisement stated that the printer could print high-resolution pictures on various types of paper. Unfortunately Juri cannot see how to set this information. What advice would you give to Juri?

Check Your Understanding and Challenge Questions Answer Key

Check Your Understanding

1. A, D, F. Spreadsheet, word processing, and database programs are all application programs designed to accomplish a specific task. Windows XP, Windows Vista, and Linux are all operating systems.
2. D. Basic input output system (BIOS) is the instructions used to test the hardware and load the OS when the machine is first powered on. The BIOS code is stored in a memory chip and is therefore known as firmware. BIOS is only one type of firmware.
3. A. Network applications have two portions. One portion runs on the local machine while the other portion runs on a remote machine. Spreadsheet, word processing, and database software normally run on a local machine while e-mail runs as a client on the local machine and connects to a remote server, making it a network application.
4. A. The mainframe computer is normally a large centralized computer found in enterprise environments. Servers can also perform some of the same functions as mainframes but are normally not large and are often distributed around the enterprise.
5. D. Workstations are high-end machines designed to run graphics and engineering type applications.
6. C, D. Both workstations and desktop computers are normally used by a single individual. Mainframes and servers are designed to provide services to multiple individuals at any given time.
7. B. Estimated download time is calculated as follows: (600 KB*1024 B/KB*8 b/B)/(1000 b/kb*256 kbps)=19.2 seconds.
8. C. A pixel is the unit of measure for a computer monitor. It is an abbreviation of the term *pic*ture *el*ement and indicates the number of distinct points that make up the image. Gigahertz is a measure of analog frequency, KB is a measure of storage capacity, and kbps is a measure of data transfer rate.
9. C, D. Pre-built machines offer adequate performance at a reasonable price. The end user has no control over the components used to assemble the machine and cannot optimize its performance for any one application.
10. B. Before upgrading any components that are located on-board with expansion cards, it is necessary to disable the on-board component to avoid conflict.
11. A, B, C, D. All the stated factors are important criteria when selecting a motherboard.
12. A. The CPU should be the first component selected based on its speed and structure. Once the CPU is selected then the motherboard can be picked to support the CPU. RAM and HDD are secondary considerations once the motherboard and CPU are selected.
13. C. All programs must be run from system memory (RAM). The program may be stored on a HDD but it must first be moved from the HDD to RAM before the CPU can communicate with it.
14. A, B, C, D, E. All of these devices are considered input devices because they accept information and convert it into a form that can be used by the computer.
15. C. Before working on any system components always unplug the computer and properly ground it and yourself.

16. A. By touching hands the charges on both individuals become the same and no charge will pass through the component. All other mentioned techniques would be ineffective in equalizing the charges and allow a charge to move from one individual to the other through the component, possibly causing damage to it.

17. B. With PnP-compliant devices the driver is installed before the device is connected to the computer and powered on. When the printer is powered on the computer detects the device and finishes the installation.

Challenge Questions and Activities

1. In her haste Charlene did not take proper precautions against ESD. While inserting the memory, a static discharge could have occurred rendering the memory inoperable. The only recourse Charlene has is to replace the memory and adhere to best practices for the prevention of ESD when she installed the new memory.

2. These advanced features may only be available with the latest driver. You should advise Juri to go to the manufacture's website to download and install the latest driver. These features should then be available.

Part II of *Networking for Home and Small Businesses, CCNA Discovery Learning Guide* (ISBN-13: 9781587132094) includes the labs that correspond to this chapter. The labs are not included in this prepublication version.