CHAPTER 1

Introduction to the Personal Computer

Objectives

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

- What are IT industry certifications?
- What is a computer system?
- How can I identify the names, purposes, and characteristics of cases and power supplies?
- What are the names, purposes, and characteristics of internal components?
- What are the names, purposes, and characteristics of ports and cables?
- How can I identify the names, purposes, and characteristics of input devices?
- How can I identify the names, purposes, and characteristics of output devices?
- What are system resources and their purposes?

Key Terms

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

information technology (IT) page 3

certification page 3

hardware page 6

software page 6

Ohm's Law page 11

field replaceable unit (FRU) page 12

central processing unit (CPU) page 14

cache page 17

Reduced Instruction Set Computer (RISC) page 17

Complex Instruction Set Computer (CISC) page 17

hyperthreading page 18

overclocking page 18

single-core CPU page 18

dual-core CPU page 18

read-only memory (ROM) page 20

programmable read-only memory (PROM) page 20

erasable programmable read-only memory (EPROM) page 21

electronically erasable programmable read-only memory (EEPROM) page 21

random-access memory (RAM) page 21

dynamic RAM (DRAM) page 21

static RAM (SRAM) page 21

Fast Page Mode (FPM) page 21

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single in-line memory module (SIMM) *page 22*

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cache memory *page 22*

nonparity *page 22*

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network interface card (NIC)page *page 23*

Redundant Array of Independent Disks (RAID) *page 24*

parallel port *page 24*

serial port *page 24*

Small Computer System Interface (SCSI) *page 27*

FireWire *page 32*

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Video Graphics Array (VGA) *page 36*

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input/output (I/O) port address *page 44*

direct memory access (DMA) *page 45*

Information technology (IT) is the design, development, implementation, support, and management of computer hardware and software applications. An IT professional is knowledgeable about computer systems and operating systems. This chapter will review IT certifications and the components of a basic personal computer system.

After completing this chapter, you will meet these objectives:

- Explain IT industry certifications.
- Describe a computer system.
- Identify the names, purposes, and characteristics of cases and power supplies.
- Identify the names, purposes, and characteristics of internal components.
- Identify the names, purposes, and characteristics of ports and cables.
- Identify the names, purposes, and characteristics of input devices.
- Identify the names, purposes, and characteristics of output devices.
- Explain system resources and their purposes.

Explain IT Industry Certifications

This course will focus on desktop and laptop computers. It will also discuss electronic devices, such as personal digital assistants and cell phones.

Training and experience will qualify a technician to service these computers and personal electronic devices. You will gain the specialized technical skills needed to install, maintain, and repair computers. Earning an industry-standard ***certification*** will give you confidence and increase your opportunities in IT.

This course is focused on the following two industry-standard certifications:

- CompTIA A+
- European Certification of Informatics Professionals (EUCIP) IT Administrator certification (Modules 1 and 2)

After completing this section, you will meet these objectives:

- Identify education and certifications.
- Describe the A+ certification.
- Describe the EUCIP certification.

Identify Education and Certifications

Information technology (IT) is a term that encompasses the relationship between hardware, software, networks, and technical assistance provided to users. The IT Essentials: PC Hardware and Software course covers the information that a technician needs to understand to be successful in IT. This course covers the following topics:

- Personal computers
- Safe lab procedures
- Troubleshooting
- Operating systems
- Laptop computers
- Printers and scanners
- Networks
- Security
- Communication skills

The IT Essentials course focuses on two hardware and software skills-based industry certifications: CompTIA A+ and EUCIP. This course is only an introduction into the world of IT. A technician may continue to study and earn the following certifications:

- CCENT: Cisco Certified Entry Network Technician
- CCNA: Cisco Certified Network Associate
- CCNP: Cisco Certified Network Professional
- CCIE: Cisco Certified Internetwork Expert
- CISSP: $(ISC)^2$ Certified Information Systems Security Professional
- MCP: Microsoft Certified Professional
- MCSA: Microsoft Certified Systems Administrator
- MCSE: Microsoft Certified Systems Engineer
- Network+: CompTIA Network certification
- Linux+: CompTIA Linux certification
- EUCIP: European Certification of Informatics Professionals

In some cases, IT certifications can be used as credits for university and college toward degrees in areas such as computer science and telecommunications.

Describe the A+ Certification

Computing Technology Industry Association (CompTIA) developed the A+ certification program. A CompTIA A+ certification signifies that a candidate is a qualified PC hardware and software technician. CompTIA certifications are known throughout the IT community as one of the best ways to enter the IT field and build a solid career.

The latest version of CompTIA A+ is CompTIA A+ 2009 Edition. Two exams are necessary to be certified: CompTIA A+ Essentials, exam code 220-701; and CompTIA A+ Practical Application, exam code 220-702.

CompTIA A+ Essentials measures the necessary competencies of an entry-level IT professional with at least 500 hours of hands-on experience in the lab or field. It tests for the fundamentals of computer technology, networking and security, and the communication skills and professionalism now required of all entry-level IT professionals.

CompTIA A+ Practical Application is an extension of the knowledge and skills identified in CompTIA A+ Essentials, with more of a hands-on orientation focused on scenarios in which troubleshooting and tools must be applied to resolve problems.

Describe the EUCIP Certification

The EUCIP IT Administrator program offers a recognized certification of competence in IT. The certification covers the standards prescribed by the Council of European Professional Informatics Societies (CEPIS). The EUCIP IT Administrator certification consists of five modules, with a corresponding exam for each module. This course will prepare you for Modules 1 and 2.

Module 1: PC Hardware

The PC Hardware module requires that the candidate understand the basic makeup of a personal computer and the functions of the components. The candidate should be able to effectively diagnose and repair hardware problems. The candidate should be able to advise customers of the appropriate hardware to buy.

Module 2: Operating Systems

The Operating Systems module requires that the candidate be familiar with the procedures for installing and updating most common operating systems and applications. The candidate should know how to use system tools for troubleshooting and repairing operating systems.

Module 3: Local Area Network and Network Services

This module is beyond the scope of the IT Essentials course, although some of the topics are covered. The Local Area Network and Network Services module requires that the candidate be familiar with the procedure of installing, using, and managing LANs. The candidate should be able to add and remove users and shared resources. The candidate should know how to use system tools for troubleshooting and repairing networks.

Module 4: Expert Network Use

This module is beyond the scope of the IT Essentials course, although some of the topics are covered. The Expert Network Use module requires that the candidate understand LAN communication.

Module 5: IT Security

This module is beyond the scope of the IT Essentials course, although some of the topics are covered. The IT Security module requires that the candidate be familiar with security methods and features that are available for a standalone or networked computer.

Worksheet 1.1.2: Job Opportunities

In this activity, you use the Internet, magazines, or a local newspaper to gather information on jobs in the computer service and repair field. Be prepared to discuss your research with the class. Refer to the worksheet in *IT Essentials: PC Hardware and Software Lab Manual, Fourth Edition*. You may complete this worksheet now or wait to do so until the end of the chapter.

Describe a Computer System

A computer system consists of hardware and software components. ***Hardware*** is the physical equipment such as the case, storage drives, keyboards, monitors, cables, speakers, and printers. The term ***software*** includes the operating system and programs. The operating system instructs the computer how to operate. These operations may include identifying, accessing, and processing information. Programs or applications perform different functions. Programs vary widely depending on the type of information that will be accessed or generated. For example, instructions for balancing a checkbook are very different from instructions for simulating a virtual-reality world on the Internet.

The rest of this chapter discusses the hardware components found in a computer system.

Identify the Names, Purposes, and Characteristics of Cases and Power Supplies

The computer case provides protection and support for the internal components of the computer. All computers need a power supply to convert alternating-current (AC) power from the wall socket into direct-current (DC) power. The size and shape of the computer case is usually determined by the motherboard and other internal components.

You can select a large computer case to accommodate additional components that may be required in the future. Other users may select a smaller case that requires minimal space. In general, the computer case should be durable, be easy to service, and have enough room for expansion.

The power supply must provide enough power for the components that are currently installed and allow for additional components that may be added at a later time. If you choose a power supply that powers only the current components, it may be necessary to replace the power supply when other components are upgraded.

After completing this section, you will meet these objectives:

- Describe cases.
- Describe power supplies.

Describe Cases

A computer case contains the framework to support the internal components of a computer while providing an enclosure for added protection. Computer cases are typically made of plastic, steel, and aluminum and are available in a variety of styles.

The size and layout of a case is called a form factor. There are many types of cases, but the basic form factors for computer cases include desktop and tower. Desktop cases may be slimline or full-sized, and tower cases may be mini or full-sized, as shown in Figure 1-1.

Figure 1-1 Tower Cases

Computer cases are referred to in a number of ways:

- Computer chassis
- Cabinet
- Tower
- Box
- Housing

In addition to providing protection and support, cases also provide an environment designed to keep the internal components cool. Case fans are used to move air through the computer case. As the air passes warm components, it absorbs heat and then exits the case. This process keeps the components of the computer from overheating.

You must consider many factors when choosing a case:

- The size of the motherboard
- The number of external or internal drive locations, called bays
- Available space

In addition to providing protection from the environment, cases help to prevent damage from static electricity. Internal components of the computer are grounded by attachment to the case.

Note

You should select a case that matches the physical dimensions of the power supply and motherboard.

Describe Power Supplies

The power supply, an example of which is shown in Figure 1-2, converts AC power coming from a wall outlet into DC power, which is a lower voltage. DC power is required for all of the components inside the computer.

Figure 1-2 Power Supply

Connectors

Most connectors today are keyed connectors. Keyed connectors are designed to be inserted in only one direction. Each part of the connector has a colored wire with a different voltage running through it, as described in Table 1-1.

Table 1-1 Power Color Codes

Voltage	Wire Color	Use
+12 V	Yellow	Disk drive motors, fans, cooling devices, and system bus slots
+5 V	Red	Motherboard, early processors, many motherboard components
+3.3 V	Orange	Modern CPU and AGP video cards
0 V	Black	Ground, the return loop for circuits
–5 V	White	ISA expansion slots and early PROMs
–12 V	Blue	Some serial ports and early PROMs

Note

AT power supplies did not have 3.3 volts and used a mechanical switch. The BIOS and OS could not control the power supply through the Advanced Configuration and Power Interface (ACPI).

Caution

The black wires in the PC are the electrical ground. They are essentially harmless. Do not assume the black wires in AC electrical systems (in the walls and ceilings) are ground. They are not. The black wires in an AC system are normally the "hot" or energized wire and if mishandled could kill you.

Different connectors are used to connect specific components to various ports on the motherboard:

- A Molex connector is a keyed connector used to connect to an optical drive or a hard drive.
- A Berg connector is a keyed connector used to connect to a floppy drive. A Berg connector is smaller than a Molex connector.
- A 20-pin or 24-pin slotted connector is used to connect to the motherboard. The 24-pin slotted connector has two rows of 12 pins each, and the 20-pin slotted connector has two rows of 10 pins each.
- A 4-pin to 8-pin auxiliary power connector has two rows of two to four pins and supplies power to all areas of the motherboard. The 4-pin to 8-pin auxiliary power connector is the same shape as the main power connector, but smaller.
- Older standard power supplies used two connectors called P8 and P9 to connect to the motherboard. P8 and P9 were unkeyed connectors. They could be installed backward, potentially damaging the motherboard or power supply. The installation required the connectors to be lined up with the black wires together in the middle.

Note

If you have a difficult time inserting a connector, try a different way, or check to make sure that there are no bent pins or foreign objects in the way. Remember, if it seems difficult to plug in any cable or other part, something is wrong. Cables, connectors, and components are designed to fit together snugly. Never force any connector or component. The connectors that are plugged in incorrectly will damage the plug and the connector. Take your time and make sure that you are handling the hardware correctly.

Electricity and Ohm's Law

These are the four basic units of electricity:

- **Voltage (V)**: Voltage is a measure of the force required to push electrons through a circuit. Voltage is measured in volts (V). A computer power supply usually produces several different voltages.
- **Current (I)**: Current is a measure of the amount of electrons going through a circuit. Current is measured in amperes, or amps (A). Computer power supplies deliver different amperages for each output voltage.

- **Power (P)**: Power is a measure of the pressure required to push electrons through a circuit, called voltage, multiplied by the number of electrons going through that circuit, called current. The measurement is called watts (W). Computer power supplies are rated in watts.
- **Resistance (R):** Resistance is the opposition to the flow of current in a circuit. Resistance is measured in ohms. Lower resistance allows more current, and therefore more power, to flow through a circuit. A good fuse will have low resistance or a measurement of almost 0 ohms.

A basic equation expresses how three of the terms relate to each other. It states that voltage is equal to the current multiplied by the resistance. This is known as ***Ohm's Law***:

V = IR

In an electrical system, power (P) is equal to the voltage multiplied by the current:

P = VI

In an electrical circuit, increasing the current or the voltage will result in higher power.

As an example of how this works, imagine a simple circuit that has a 9-V light bulb hooked up to a 9-V battery. The power output of the light bulb is 100 W. Using the preceding equation, we can calculate how much current in amps would be required to get 100 W out of this 9-V light bulb.

To solve this equation, we know the following information:

P = 100 W

V = 9 V

I = 100 W / 9 V = 11.11 A

What happens if a 12-V battery and a 12-V light bulb are used to get 100 W of power?

100 W / 12 V = 8.33 A

This system produces the same power, but with less current.

Computers normally use power supplies ranging from 250-W to 650-W output capacity. However, some computers may need 850-W and higher-capacity power supplies. When building a computer, select a power supply with sufficient wattage to power all of the components. Each component inside the computer uses a certain amount of power. Obtain the wattage information for the components from the manufacturer's documentation. When deciding on a power supply, make sure to choose a power supply that has more than enough power for the current components. A power supply with a higher wattage rating has more capacity; therefore, it can handle more devices.

On the back of the power supply is a small switch called the voltage selector switch. This switch sets the input voltage to the power supply to either 110 V to 115 V or 220 V to 230 V. The correct voltage setting is determined by the country where the power supply will be

used. Setting the voltage switch to the incorrect input voltage could damage the power supply and other parts of your computer. If a power supply does not have the voltage selector switch, your power supply will automatically detect and set the correct voltage.

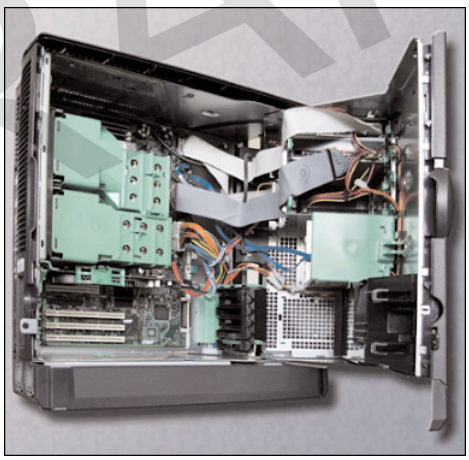
Caution

Do not open a power supply. Electronic capacitors located inside of a power supply can hold a charge for extended periods of time even when unplugged from the wall. The power supply is considered to be a ***field replaceable unit (FRU)***, which means that if it no longer works, don't fix it, but instead replace it.

Identify the Names, Purposes, and Characteristics of Internal Components

This section discusses the names, purposes, and characteristics of the internal components of a computer, as shown in Figure 1-3.

Figure 1-3 Computer Components



After completing this section, you will meet these objectives:

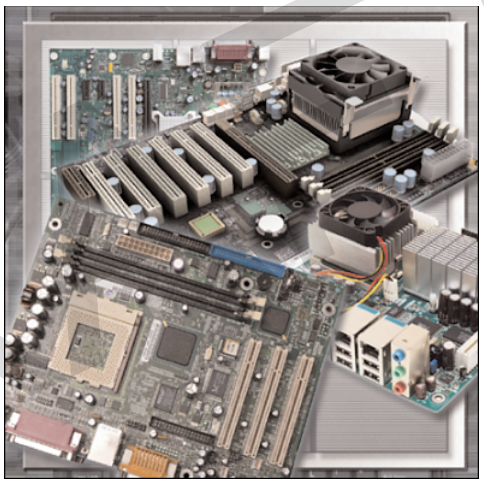
- Identify the names, purposes, and characteristics of motherboards.
- Explain the names, purposes, and characteristics of CPUs.
- Identify the names, purposes, and characteristics of cooling systems.
- Identify the names, purposes, and characteristics of ROM and RAM.
- Identify the names, purposes, and characteristics of adapter cards.

- Identify the names, purposes, and characteristics of storage drives.
- Identify the names, purposes, and characteristics of internal cables.

Identify the Names, Purposes, and Characteristics of Motherboards

The motherboard is the main printed circuit board and contains the buses, or electrical pathways, found in a computer. These buses allow data to travel between the various components that comprise a computer. Figure 1-4 shows a variety of motherboards. A motherboard is also known as the system board, the backplane, or the main board.

Figure 1-4 Motherboards



The motherboard accommodates the central processing unit (CPU), RAM, expansion slots, heat sink/fan assembly, BIOS chip, chipset, and the embedded wires that interconnect the motherboard components. Sockets, internal and external connectors, and various ports are also placed on the motherboard.

The form factor of motherboards pertains to the size and shape of the board. It also describes the physical layout of the different components and devices on the motherboard. The form factor determines how individual components attach to the motherboard and the shape of the computer case. Various form factors exist for motherboards, as shown in Figure 1-4.

The most common form factor in desktop computers was the AT, based on the IBM AT motherboard. The AT motherboard can be up to approximately one foot wide. This cumbersome size led to the development of smaller form factors. The placement of heat sinks and fans often interferes with the use of expansion slots in smaller form factors.

A newer motherboard form factor, ATX, improved on the AT design. The ATX case is designed to accommodate the integrated I/O ports on the ATX motherboard. The ATX power supply connects to the motherboard via a single 20-pin connector instead of the confusing P8 and P9 connectors used with some earlier form factors. Instead of using a physical toggle switch, the ATX power supply can be powered on and off using signaling from the motherboard.

Some manufacturers have proprietary form factors based on the ATX design. This causes some motherboards, power supplies, and other components to be incompatible with standard ATX cases.

An important set of components on the motherboard is the chipset. The chipset is composed of various integrated circuits attached to the motherboard that control how system hardware interacts with the CPU and motherboard. The CPU is installed into a slot or socket on the motherboard. The socket on the motherboard determines the type of CPU that can be installed.

The chipset of a motherboard allows the CPU to communicate and interact with the other components of the computer, and to exchange data with system memory, or RAM, hard disk drives, video cards, and other output devices. The chipset establishes how much memory can be added to a motherboard. The chipset also determines the type of connectors on the motherboard.

Most chipsets are divided into two distinct components; Northbridge and Southbridge. What each component does varies from manufacturer to manufacturer. In general, the Northbridge controls access to the RAM, video card, and the speeds at which the CPU can communicate with them. The video card is sometimes integrated into the Northbridge. AMD and Intel have chips that integrate the memory controller onto the CPU die, which improves performance and power consumption. The Southbridge, in most cases, allows the CPU to communicate with the hard drives, sound card, USB ports, and other I/O ports.

Identify the Names, Purposes, and Characteristics of CPUs

The ***central processing unit (CPU)*** is considered the brain of the computer. It is sometimes referred to as the processor. Most calculations take place in the CPU. In terms of computing power, the CPU is the most important element of a computer system. CPUs come in different form factors, each style requiring a particular slot or socket on the motherboard. Common CPU manufacturers include Intel and AMD.

The CPU socket or slot is the connector that interfaces between the motherboard and the processor. Most CPU sockets and processors in use today are built around the pin grid array (PGA) architecture, in which the pins on the underside of the processor are inserted into the socket, usually with Zero-Insertion Force (ZIF). ZIF refers to the amount of force needed to install a CPU into the motherboard socket or slot. Slot-based processors are

cartridge-shaped and fit into a slot that looks similar to an expansion slot. Table 1-2 is a list of 486-class sockets and CPUs.

The arrangement of the CPU pins is called a pin grid array (PGA). There are many variations of PGAs. Staggered Pin Grid Array (SPGA) shifts alternating rows to create a zig-zag pattern. To conserve space a mobile socket called mPGA was developed. An older name for these CPU sockets was Plastic PGA or PPGA, although that term is seldom used today. Some newer sockets do not use pins. A Land Grid Array (LGA) uses contacts instead of pins. Other terms used to describe CPUs include DX, which introduced the floating-point decimal capability, and Overdrive (OD), a marketing term used to describe a slightly faster version of CPU.

Table 1-2 CPU Socket Specifications: Intel/AMD 486 Class

Socket	Pins	Layout	Supported CPUs
Socket 1	169	17x17 PGA	486 SX/SX2, DX/DX2, DX4 OD
Socket 2	238	19x19 PGA	486 SX/SX2, DX/DX2, DX4 OD, 486 Pentium OD
Socket 3	237	19x19 PGA	486 SX/SX2, DX/DX2, DX4, 486 Pentium OD, AMD 5x86
Socket 6	235	19x19 PGA	486 DX4, 486 Pentium OD

Note

Sockets 1–4 used 5-V DC. As CPUs became more efficient, 3.3-V DC was used in Sockets 3–5. All other CPUs since around 1995 use Auto VRM, which allows the BIOS to control the voltage to the CPU.

Table 1-3 outlines the Intel Pentium and AMD class sockets and CPUs.

Table 1-3 CPU Socket Specifications: Intel/AMD 586 (Pentium), and Cyrix M1/11 Classes

Socket	Pins	Layout	Supported CPUs
Socket 4	273	21x21 PGA	Pentium 60/66, OD
Socket 5	320	37x37 SPGA	Pentium 75–133, OD
Socket 7	321	37x37 SPGA	Pentium 75–233+, MMX, OD, AMD K5/K6, Cyrix M1/ll

Table 1-4 is a list of 686-class sockets and CPUs.

Table 1-4 CPU Socket Specifications: Intel/AMD 686 (Pentium II/III) Class

Socket	Pins	Layout	Supported CPUs
Socket 8	387	Dual-pattern SPGA	Pentium Pro, OD
Slot 1 (SC242)	242	Slot	Pentium II/III, Celeron SECC
Socket 370	370	37x37 SPGA	Celeron/Pentium III PPGA/FC-PGA

Table 1-5 is a list of Pentium 4–class sockets and CPUs.

Table 1-5 CPU Socket Specifications: Pentium 4 Class

Socket	Pins	Layout	Supported CPUs
Socket 423	423	39x39 SPGA	Pentium 4 FC-PGA
Socket 478	478	26x26m PGA	Pentium 4/Celeron FC-PGA2
Socket T (LGA775)	775	30x33 LGA	Pentium 4/Celeron LGA775

Table 1-6 is a list of AMD K7–class sockets and CPUs.

Table 1-6 CPU Socket Specifications: AMD K7 Class

Socket	Pins	Layout	Supported CPUs
Slot A	242	Slot	AMD Athlon SECC
Socket A (462)	462	37x37 SPGA	AMD Athlon/Athlon XP/Duron PGA/FC-PGA

Table 1-7 is a list of AMD K8 sockets and CPUs.

Table 1-7 CPU Socket Specifications: AMD K8

Socket	Pins	Layout	Supported CPUs
Socket 754	754	29x29 mPGA	AMD Athlon 64
Socket 939	939	31x31 mPGA	AMD Athlon 64 v.2
Socket 940	940	31x31 mPGA	AMD Athlon 64FX, Opteron

Table 1-8 is a list of Intel/AMD server- and workstation-class sockets and CPUs.

Table 1-8 CPU Socket Specifications: Intel/AMD Server and Workstation Class

Socket	Pins	Layout	Supported CPUs
Slot 2	330	Slot	Pentium II/III Xeon
Socket 603	603	31x25 mPGA	Xeon (P4)
PAC 418 Socket	611	25x28 mPGA	Itanium 2
PAC 611 Socket 940	940	31x31 mPGA	AMD Athlon 64FX, Opteron
LGA 771 Socket J	771	LGA Extreme	Dual- and Quad-Core Xeon, Core
LGA 775 Socket T	775	LGA	Pentium 4, D Extreme Edition, and Dual-Core, Celeron, Core2 Duo, Extreme, and Quad, Xeon
LGA 1156 Socket H	1156	LGA	Pentium, Core i3, i5, i7, Xeon
LGA 1366 Socket B	1366	LGA	I7 and Xeon
Socket F	1207	LGA	Athlon 64, FX, and Opteron
AM2	940	31x31 PGA	Athlon 64, X2, FX, Opteron, Sempron, and Phenom
AM2+	940	31x31 PGA	Athlon 64, X2, Opteron, and Phenom
AM3	941	31x31 PGA	Athlon II, Phenom II, Opteron, and Sempron

The CPU executes a program, which is a sequence of stored instructions. Each model of processor has an instruction set, which it executes. The CPU executes the program by processing each piece of data as directed by the program and the instruction set. While the CPU is executing one step of the program, the remaining instructions and the data are stored nearby in a special memory called ***cache***. There are two major CPU architectures related to instruction sets:

- ***Reduced Instruction Set Computer (RISC)***: Architectures use a relatively small set of instructions, and RISC chips are designed to execute these instructions very rapidly.
- ***Complex Instruction Set Computer (CISC)***: Architectures use a broad set of instructions, resulting in fewer steps per operation.

Some CPUs incorporate ***hyperthreading*** to enhance the performance of the CPU. With hyperthreading, the CPU has multiple pieces of code being executed simultaneously on each pipeline. To an operating system, a single CPU with hyperthreading performs as though there are two CPUs.

The power of a CPU is measured by the speed and the amount of data that it can process. The speed of a CPU is rated in cycles per second. The speed of current CPUs is measured in millions of cycles per second, called megahertz (MHz), or billions of cycles per second, called gigahertz (GHz). The amount of data that a CPU can process at one time depends on the size of the processor data bus. This is also called the CPU bus or the front-side bus (FSB). The wider the processor data bus width, the more powerful the processor is. Current processors have a 32-bit or a 64-bit processor data bus. 32-bit processors as a group is often called x86. 64-bit processors are often called x64. The distinction is important because operating systems and applications are identified either x86 or x64.

Overclocking is a technique used to make a processor work at a faster speed than its original specification. Overclocking is not a reliable way to improve computer performance and can result in damage to the CPU. The opposite of overclocking is CPU throttling. CPU throttling is a technique used when the processor runs at less than the rated speed to conserve power or produce less heat. Throttling is commonly used on laptops and other mobile devices.

MMX is a set of multimedia instructions built into Intel processors. MMX-enabled microprocessors can handle many common multimedia operations that are normally handled by a separate sound or video card. However, only software specifically written to call MMX instructions can use the MMX instruction set. In Intel CPUs, MMX has been replaced by Streaming SIMD [single instruction, multiple data] Extensions (SSE), which is an enhancement to the instruction set. There are many versions of SSE, each of which includes additional instructions.

The latest processor technology has resulted in CPU manufacturers finding ways to incorporate more than one CPU core onto a single chip. These CPUs are capable of processing multiple instructions concurrently:

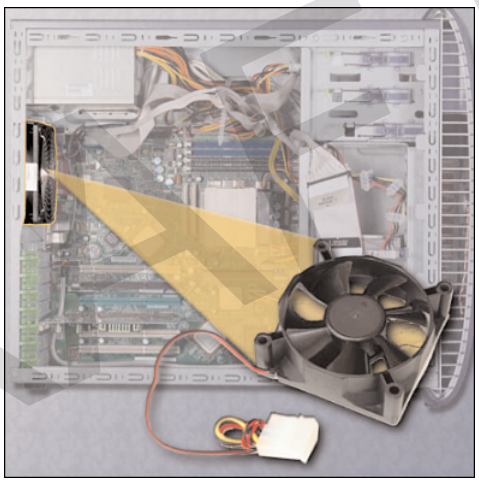
- ***Single-core CPU***: One core inside a single CPU that handles all of the processing capability. A motherboard manufacturer may provide sockets for more than one single processor, providing the ability to build a powerful, multiprocessor computer.
- ***Dual-core CPU***: Two cores inside a single CPU in which both cores can process information at the same time.
- **Triple-core CPU**: Three cores inside a single CPU that is actually a quad-core processor with one of the cores disabled.
- **Quad-core CPU**: Four cores inside a single CPU in which all cores can process information simultaneously for enhanced software applications.

Identify the Names, Purposes, and Characteristics of Cooling Systems

Electronic components generate heat. Heat is caused by the flow of current within the components. Computer components perform better when kept cool. If the heat is not removed, the computer may run slower. If too much heat builds up, computer components can be damaged.

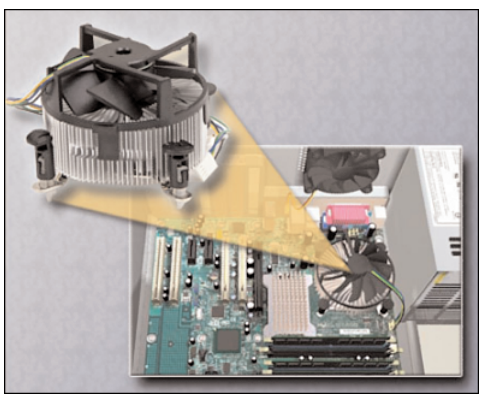
Increasing the air flow in the computer case allows more heat to be removed. A case fan, shown in Figure 1-5, is installed in the computer case to make the cooling process more efficient.

Figure 1-5 Case Fan



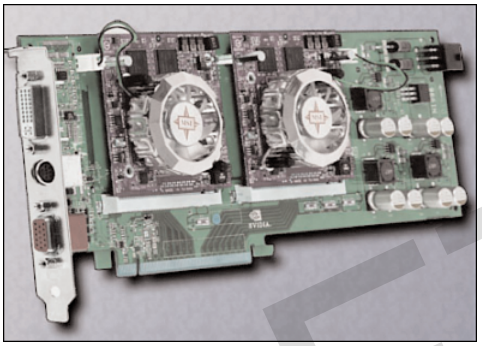
In addition to case fans, a heat sink draws heat away from the core of the CPU. A fan on top of the heat sink, shown in Figure 1-6, moves the heat away from the CPU.

Figure 1-6 CPU Fans



Other components are also susceptible to heat damage and are sometimes equipped with fans. Video adapter cards also produce a great deal of heat. Fans are dedicated to cool the graphics-processing unit (GPU), as shown in Figure 1-7.

Figure 1-7 Graphics Card Cooling System



Computers with extremely fast CPUs and GPUs may use a water-cooling system. A metal plate is placed over the processor and water is pumped over the top to collect the heat that the CPU creates. The water is pumped to a radiator to be cooled by the air, and then recirculated.

Identify the Names, Purposes, and Characteristics of ROM and RAM

ROM and RAM provide memory for a vast amount of computer equipment. They come in different memory sizes and module sizes and have different features. RAM chips are stored on memory modules that can easily be installed and removed to expedite upgrades. Some RAM uses parity to increase data integrity and reliability. Another kind of specialized memory is called cache. It stores frequently used data and commands. The following sections cover ROM, RAM, modules, parity, and cache in greater detail.

ROM

Read-only memory (ROM) chips are located on the motherboard. ROM chips contain instructions that the CPU can access directly. ROM stores basic instructions for booting the computer and loading the operating system. ROM chips retain their contents even when the computer is powered down. The contents cannot be erased, changed, or rewritten by normal means. ROM types include the following:

- ***Programmable read-only memory (PROM)***: Information is written to a PROM chip after it is manufactured. A PROM chip cannot be erased or rewritten.

- ***Erasable programmable read-only memory (EPROM)***: Information is written to an EPROM chip after it is manufactured. An EPROM chip can be erased with exposure to UV light. Special equipment is required.
- ***Electrically erasable programmable read-only memory (EEPROM)***: Information is written to an EEPROM chip after it is manufactured. EEPROM chips are also called flash ROMs. An EEPROM chip can be erased and rewritten without removing the chip from the computer.

Note

ROM is sometimes called firmware. This is misleading, because firmware is actually the software that is stored in a ROM chip.

RAM

Random-access memory (RAM) is the temporary storage for data and programs that are being accessed by the CPU. RAM is volatile memory, which means that the contents are erased when the computer is powered off. The more RAM in a computer, the more capacity the computer has to hold and process large programs and files. The different types of RAM are as follows:

- ***Dynamic RAM (DRAM)*** is a memory chip that is used as main memory. DRAM must be constantly refreshed with pulses of electricity to maintain the data stored in the chip.
- ***Static RAM (SRAM)*** is a memory chip that is used as cache memory. SRAM is much faster than DRAM and does not have to be refreshed as often.
- ***Fast Page Mode (FPM)*** DRAM is memory that supports paging. Paging enables faster access to the data than regular DRAM. Most 486 and Pentium systems from 1995 and earlier use FPM memory.
- ***Extended Data Out (EDO)*** RAM is memory that overlaps consecutive data accesses. This speeds up the access time to retrieve data from memory because the CPU does not have to wait for one data access cycle to end before another data access cycle begins.
- ***Synchronous DRAM (SDRAM)*** is DRAM that operates in synchronization with the memory bus. The memory bus is the data path between the CPU and the main memory.
- ***Double Data Rate (DDR)*** SDRAM is memory that transfers data twice as fast as SDRAM. DDR SDRAM increases performance by transferring data twice per cycle.
- ***Double Data Rate 2 (DDR2)*** SDRAM is faster than DDR-SDRAM memory. DDR2 SDRAM improves performance over DDR SDRAM by decreasing noise and crosstalk between the signal wires.
- ***Rambus DRAM (RDRAM)*** is a memory chip that was developed to communicate at very high rates of speed. RDRAM chips are not commonly used.

Memory Modules

Early computers had RAM installed on the motherboard as individual chips. These individual memory chips, called Dual Inline Package (DIP) chips, were difficult to install and often became loose on the motherboard. To solve this problem, designers soldered the memory chips on a special circuit board called a memory module. The different types of memory modules are as follows:

- ***Dual in-line package (DIP)*** is an individual memory chip. A DIP had dual rows of pins used to attach it to the motherboard.
- ***Single in-line memory module (SIMM)*** is a small circuit board that holds several memory chips. SIMMs have 30-pin and 72-pin configurations.
- ***Dual in-line memory module (DIMM)*** is a circuit board that holds SDRAM, DDR SDRAM, and DDR2 SDRAM chips. There are 168-pin SDRAM DIMMs, 184-pin DDR DIMMs, and 240-pin DDR2 DIMMs.
- ***Rambus in-line memory module (RIMM)*** is a circuit board that holds RDRAM chips. A typical RIMM has a 184-pin configuration.

Note

Memory modules can be single sided or double sided. Single-sided memory modules contain RAM on only one side of the module. Double-sided memory modules contain RAM on both sides of the module.

Cache Memory

SRAM is used as ***cache memory*** to store the most frequently used data. SRAM gives the processor faster access to the data than is possible by retrieving it from the slower DRAM, or main memory. The three types of cache memory are as follows:

- L1 is internal cache integrated into the CPU.
- L2 is external cache originally mounted on the motherboard near the CPU. L2 cache is now integrated into the CPU.
- L3 is used on some high-end workstations and server CPUs.

Error Checking

Memory errors occur when the data is stored incorrectly in the RAM chips. The computer uses different methods to detect and correct data errors in memory. Three different methods of memory error checking are as follows:

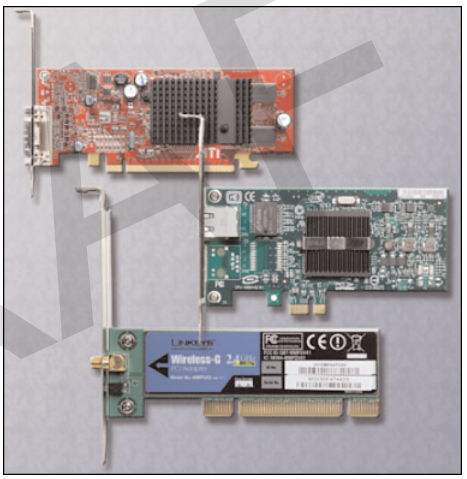
- ***Nonparity*** does not check for errors in memory.

- ***Parity*** contains 8 bits for data and 1 bit for error checking. The error-checking bit is called a parity bit.
- ***Error-correcting code (ECC)*** can detect multiple bit errors in memory and correct single bit errors in memory.

Identify the Names, Purposes, and Characteristics of Adapter Cards

Adapter cards increase the functionality of a computer by adding controllers for specific devices or by replacing malfunctioning ports. Figure 1-8 shows several types of adapter cards. Adapter cards are used to expand and customize the capability of the computer.

Figure 1-8 Adapter Cards



The following is a list of adapter cards and their uses:

- ***Network interface card (NIC)***: Connects a computer to a network using a network cable
- **Wireless NIC**: Connects a computer to a network using radio frequencies
- **Sound adapter**: Provides audio capability
- **Video adapter**: Provides graphic capability
- **Capture card**: Sends a video signal to a computer so that the signal can be recorded to the computer hard drive with video capture software
- **TV tuner**: Provides the ability to watch and record TV signals on a PC by connecting a TV source, such as cable TV, satellite, or an antenna, to the installed tuner card

- **Modem adapter**: Connects a computer to the Internet using a phone line
- **Small Computer System Interface (SCSI) adapter**: Connects SCSI (pronounced "scuzzy") devices, such as hard drives or tape drives, to a computer
- ***Redundant Array of Independent Disks (RAID)* adapter**: Connects multiple hard drives to a computer to provide redundancy and to improve performance
- **Universal Serial Bus (USB) port**: Connects a computer to peripheral devices
- ***Parallel port***: Connects a computer to peripheral devices
- ***Serial port***: Connects a computer to peripheral devices

Computers have expansion slots on the motherboard in which to install adapter cards. The type of adapter card connector must match the expansion slot. A riser card allows adapter cards to be installed horizontally. The riser card was mainly used in slimline desktop computers.

Identify the Names, Purposes, and Characteristics of Storage Drives

Storage drives, as shown in Figure 1-9, read or write information to magnetic or optical storage media. The drive can be used to store data permanently or to retrieve information from a media disk. Storage drives can be installed inside the computer case, such as a hard drive. For portability, some storage drives can connect to the computer using a USB port, a FireWire port, or a SCSI port. These portable storage drives are sometimes referred to as removable drives and can be used on multiple computers. Common types of storage drives include the following:

- Floppy drive
- Hard drive
- Optical drive
- External Flash drive

The following sections describe each type of drive in greater detail.

Figure 1-9 Storage Drives

Floppy Drive

A floppy drive, or floppy disk drive, is a storage device that uses removable 3.5-inch floppy disks. These magnetic floppy disks can store 720 KB or 1.44 MB of data. In a computer, the floppy drive is usually configured as the A: drive. The floppy drive can be used to boot the computer if it contains a bootable floppy disk. A 5.25-inch floppy drive is older technology and is seldom used.

Hard Drive

A hard drive, or hard disk drive, is a magnetic storage device that is installed inside the computer. The hard drive is used as permanent storage for data. In a Windows computer, the hard drive is usually configured as the C: drive and contains the operating system and applications. The hard drive is often configured as the first drive in the boot sequence. The storage capacity of a hard drive is measured in billions of bytes, or gigabytes (GB). The speed of a hard drive is measured in revolutions per minute (rpm). Multiple hard drives can be added to increase storage capacity.

Traditional hard drives are magnetic. Magnetic hard drives have drive motors designed to spin magnetic platters and the drive heads. In contrast, the newer solid state drives (SSD) do not have moving parts. Because there are no drive motors and moving parts, the SSD uses far less energy than the magnetic hard drive. Nonvolatile flash memory chips manage all storage on an SSD, which results in faster access to data, higher reliability, and reduced power usage. SSDs have the same form factor as magnetic hard drives and use ATA or SATA interfaces. SSDs can be installed as a replacement for magnetic drives.

Optical Drive

An optical drive is a storage device that uses lasers to read data on the optical media. There are three types of optical drives:

- Compact disc (CD)
- Digital versatile disc (DVD)
- Blu-ray Disc (BD)

CD, DVD, and BD media can be prerecorded (read-only), recordable (write once), or re-recordable (read and write multiple times). CDs have a data storage capacity of approximately 700 MB. DVDs have a data storage capacity of approximately 4.3 GB on a single-layer disc, and approximately 8.5 GB on a dual-layer disc. BDs have a storage capacity of 25 GB on a single-layer disc, and 50 GB on a dual-layer disc.

There are several types of optical media:

- **CD-ROM**: CD read-only memory media that is prerecorded
- **CD-R**: CD recordable media that can be recorded one time
- **CD-RW**: CD rewritable media that can be recorded, erased, and re-recorded
- **DVD-ROM**: DVD read-only memory media that is prerecorded
- **DVD-RAM**: DVD random-access memory media that can be recorded, erased, and re-recorded
- **DVD+/-R**: DVD recordable media that can be recorded one time
- **DVD+/-RW**: DVD rewritable media that can be recorded, erased, and re-recorded
- **BD-ROM**: BD read-only media that is prerecorded with movies, games, or software
- **BD-R**: BD recordable media that can record HD video and PC data storage one time
- **BD-RE**: BD rewritable format for HD video recording and PC data storage

External Flash Drive

An external flash drive, also known as a thumb drive, is a removable storage device that connects to a USB port. An external flash drive uses the same type of nonvolatile memory chips as solid state drives and does not require power to maintain the data. These drives can be accessed by the operating system in the same way that other types of drives are accessed.

Types of Drive Interfaces

Hard drives and optical drives are manufactured with different interfaces that are used to connect the drive to the computer. To install a storage drive in a computer, the connection interface on the drive must be the same as the controller on the motherboard. Here are some common drive interfaces:

- **IDE**: Integrated Drive Electronics, also called Advanced Technology Attachment (ATA), is an early drive controller interface that connects computers and hard disk drives. An IDE interface uses a 40-pin connector.
- **EIDE**: Enhanced Integrated Drive Electronics, also called ATA-2, is an updated version of the IDE drive controller interface. EIDE supports hard drives larger than 512 MB, enables direct memory access (DMA) for speed, and uses the AT Attachment Packet Interface (ATAPI) to accommodate optical drives and tape drives on the EIDE bus. An EIDE interface uses a 40-pin connector.
- **PATA**: Parallel ATA refers to the parallel version of the ATA drive controller interface. This is just another name for IDE and EIDE.
- **SATA**: Serial ATA refers to the serial version of the ATA drive controller interface. A SATA interface uses a 7-pin data connector.
- **eSATA**: External Serial ATA provides a hot-swappable, external interface for SATA drives. The eSATA interface connects an external SATA drive using a 7-pin connector. The cable can be up to two meters (6.56 feet) in length.
- ***Small Computer System Interface (SCSI)***: A drive controller interface that can connect up to 15 drives. SCSI can connect both internal and external drives. A SCSI interface uses a 50-pin, 68-pin, or 80-pin connector.

RAID provides a way to store data across multiple hard disks for redundancy. To the operating system, RAID appears as one logical disk. Table 1-9 compares the different RAID levels. The following terms describe how RAID stores data on the various disks:

- **Parity**: A method used to detect data errors
- **Striping**: A method used to write data across multiple drives
- **Mirroring**: A method of storing duplicate data to a second drive

Table 1-9 Raid Levels

Raid	Min. No. of Drives	Description	Advantages	Disadvantages
0	2	Data striping without redundancy	Highest performance.	No data protection, and failure of one drive results in loss of all data.
1	2	Disk mirroring	High-performance data protection because all data is duplicated.	High cost of implementation because an additional drive of equal or larger capacity is required.

continues

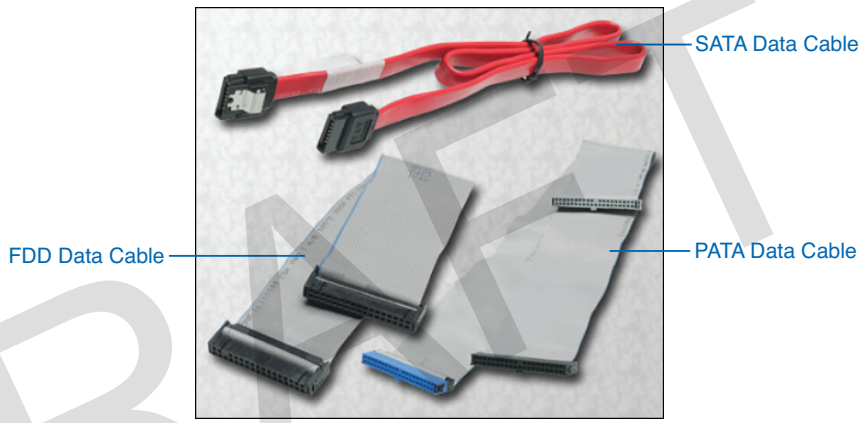
Table 1-9 Raid Levels *continued*

Raid	Min. No. of Drives	Description	Advantages	Disadvantages
2	2	Error-correcting code	This level is no longer used.	Same performance can be achieved at a lower cost using RAID 3.
3	3	Byte-level data striping with dedicated parity	For large sequential data requests.	Does not support multiple, simultaneous read and write requests.
4	3	Block-level data striping with dedicated parity	Supports multiple read requests, and if a disk fails, the dedicated parity is used to create a replacement disk.	Write requests are bottlenecked due to the dedicated parity.
5	3	Combination of data striping and parity	Supports multiple simultaneous reads and writes, data is written across all drives with parity, and data can be rebuilt from information found on the other drives.	Write performance is slower than RAID 0 and 1.
6	4	Independent data disks with double parity	Block-level striping with parity data distributed across all disks, and can handle two simultaneous drive failures.	Lower performance than RAID 5 and not supported on all RAID controllers.
1/0	4	Combination of data striping and disk mirroring	High performance and highest data protection.	High cost overhead because duplication of data requires twice the storage capacity.

Identify the Names, Purposes, and Characteristics of Internal Cables

Drives require both a power cable and a data cable. A power supply will have a SATA power connector for SATA drives, a Molex power connector for PATA drives, and a Berg 4-pin connector for floppy drives. The buttons and the light emitting diode (LED) lights on the front of the case connect to the motherboard with the front-panel cables. Figure 1-10 displays internal data cables.

Figure 1-10 Data Cables



Data cables connect drives to the drive controller, which is located on an adapter card or on the motherboard. Here are some common types of data cables:

- **Floppy disk drive (FDD) data cable**: Data cable has up to two 34-pin drive connectors and one 34-pin connector for the drive controller.
- **PATA (IDE/EIDE) 40-conductor data cable**: Originally, the IDE interface supported two devices on a single controller. With the introduction of Enhanced IDE, two controllers capable of supporting two devices each were introduced. The 40-conductor ribbon cable uses 40-pin connectors. The cable has two connectors for the drives and one connector for the controller.
- **PATA (EIDE) 80-conductor data cable**: As the data rates available over the EIDE interface increased, the chance of data corruption during transmission increased. An 80-conductor cable was introduced for devices transmitting at 33.3 MBps and over, allowing for a more reliable balanced data transmission. The 80-conductor cable uses 40-pin connectors.

- **SATA data cable**: This cable has seven conductors, one keyed connector for the drive, and one keyed connector the drive controller.
- **eSATA data cable**: The eSATA external disk connects to the eSATA interface using a 7-pin data cable. This cable does not supply any power to the eSATA external disk. A separate power cable provides power to the disk.
- **SCSI data cable**: There are three types of SCSI data cable:
  - **Narrow SCSI data cable:** Has 50 conductors, up to seven 50-pin connectors for drives, and one 50-pin connector for the drive controller, also called the host adapter.
  - **Wide SCSI data cable:** Has 68 conductors, up to 15 68-pin connectors for drives, and one 68-pin connector for the host adapter.
  - **Alt-4 SCSI connector:** Has 80 conductors, up to 15 80-pin connectors for drives, and one 80-pin connector for the host adapter.

Note

A colored stripe on a cable identifies Pin 1 on the cable. When installing a data cable, always ensure that Pin 1 on the cable aligns with Pin 1 on the drive or drive controller. Some cables may be keyed and therefore they can only be connected one way to the drive and drive controller.

Worksheet 1.4.7: Research Computer Components

In this worksheet, you use the Internet, a newspaper, or a local store to gather information about the components you need to complete your customer's computer from the scenario provided. Be prepared to discuss your selections. Refer to the worksheet in *IT Essentials: PC Hardware and Software Lab Manual, Fourth Edition*. You may complete this worksheet now or wait to do so until the end of the chapter.

Identify the Names, Purposes, and Characteristics of Ports and Cables

Input/output (I/O) ports on a computer connect peripheral devices, such as printers, scanners, and portable drives. The following ports and cables are commonly used:

- Serial
- Modem
- USB

- FireWire
- Parallel
- SCSI
- Network
- PS/2
- Audio
- Video

Serial Ports and Cables

A serial port can be either a D-shaped plug called DB-9, as shown in Figure 1-11, or a longer DB-25 male connector. Serial ports transmit one bit of data at a time. To connect a serial device, such as a modem or printer, a serial cable must be used. A serial cable has a maximum length of 50 feet (15.2 m).

Figure 1-11 Serial Ports and Cables

Modem Ports and Cables

In addition to the serial cable used to connect an external modem to a computer, a telephone cable is used to connect a modem to a telephone outlet. This cable uses an RJ-11 connector,. A traditional setup of an external modem using a serial cable and a telephone cable.

USB Ports and Cables

The Universal Serial Bus (USB) is a standard interface that connects peripheral devices to a computer. It was originally designed to replace serial and parallel connections. USB devices are hot-swappable, which means that users can connect and disconnect the devices while the computer is powered on. USB connections can be found on computers, cameras, printers, scanners, storage devices, and many other electronic devices. A USB hub is used to connect multiple USB devices. A single USB port in a computer can support up to 127 separate devices with the use of multiple USB hubs. Some devices can also be powered through the USB port, eliminating the need for an external power source. Figure 1-12 shows USB cables with connectors.

Figure 1-12 USB Connectors

USB 1.1 allowed transmission rates of up to 12 Mbps in full-speed mode and 1.5 Mbps in low-speed mode. USB 2.0 allows transmission speeds up to 480 Mbps. USB devices can only transfer data up to the maximum speed allowed by the specific port.

FireWire Ports and Cables

FireWire is a high-speed, hot-swappable interface that connects peripheral devices to a computer. A single FireWire port in a computer can support up to 63 devices. Some devices can also be powered through the FireWire port, eliminating the need for an external power source. FireWire uses the IEEE 1394 standard and is also known as i.Link.

The IEEE 1394a standard supports data rates up to 400 Mbps and cable lengths up to 15 feet (4.5 m). This standard uses a 6-pin connector or a 4-pin connector. The IEEE 1394b standard allows for a greater range of connections, including Category 5 UTP and optical

fiber. Depending on the media used, data rates are supported up to 3.2 Gbps over a 100-m distance. Figure 1-13 shows FireWire cables with connectors.

Figure 1-13 FireWire Connectors

Parallel Ports and Cables

A parallel port on a computer is a standard Type A DB-25 female connector. The parallel connector on a printer is a standard Type B 36-pin Centronics connector. Some newer printers may use a Type C high-density 36-pin connector. Parallel ports can transmit 8 bits of data at one time and use the IEEE 1284 standard. To connect a parallel device, such as a printer, a parallel cable must be used. A parallel cable, as shown in Figure 1-14, has a maximum length of 15 feet (4.5 m).

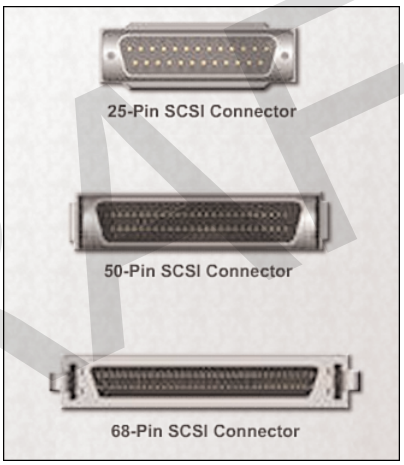
Figure 1-14 Parallel Printer Cable

SCSI Ports and Cables

A SCSI port can transmit parallel data at rates in excess of 320 MBps and can support up to 15 devices. If a single SCSI device is connected to a SCSI port, the cable can be up to 80 feet (24.4 m) in length. If multiple SCSI devices are connected to a SCSI port, the cable can be up to 40 feet (12.2 m) in length. A SCSI port on a computer can be one of three different types, as shown in Figure 1-15:

- DB-25 female connector
- High-density 50-pin female connector
- High-density 68-pin female connector

Figure 1-15 SCSI Connectors



Note

SCSI devices must be terminated at the endpoints of the SCSI chain. Check the device manual for termination procedures.

Caution

Some SCSI connectors resemble parallel connectors. Be careful not to connect the cable to the wrong port. The voltage used in the SCSI format may damage the parallel interface. SCSI connectors should be clearly labeled.

Network Ports and Cables

A network port, also known as an RJ-45 port, connects a computer to a network. The connection speed depends on the type of network port. Standard Ethernet can transmit

up to 10 Mbps, Fast Ethernet can transmit up to 100 Mbps, and Gigabit Ethernet can transmit up to 1000 Mbps. The maximum length of network cable is 328 feet (100 m). A network connector is shown in Figure 1-16.

Figure 1-16 Network Connector

PS/2 Ports

A ***PS/2 port*** connects a keyboard or a mouse to a computer. The PS/2 port is a 6-pin mini-DIN female connector. The connectors for the keyboard and mouse are often colored differently, as shown in Figure 1-17. If the ports are not color coded, look for a small figure of a mouse or keyboard next to each port.

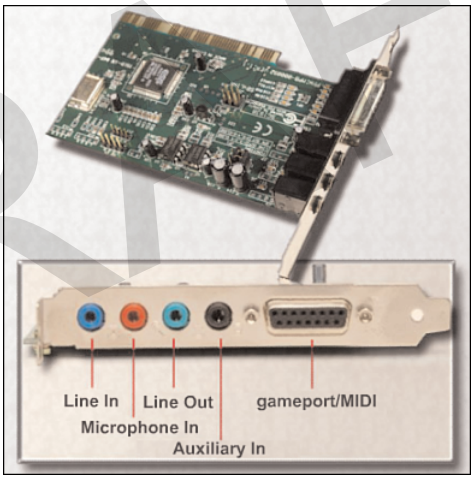
Figure 1-17 PS/2 Ports

Audio Ports

An audio port connects audio devices to the computer. Some of the following audio ports are commonly used, as shown in Figure 1-18:

- **Line In**: Connects to an external source, such as a stereo system
- **Microphone**: Connects to a microphone
- **Line Out**: Connects to speakers or headphones
- **Sony/Philips Digital Interface Format (S/PDIF)**: Connects to fiber-optic cable to support digital audio
- **TosLink**: Connects to fiber-optic cable to support digital audio
- **Gameport/MIDI**: Connects to a joystick or MIDI-interfaced device

Figure 1-18 Audio Ports



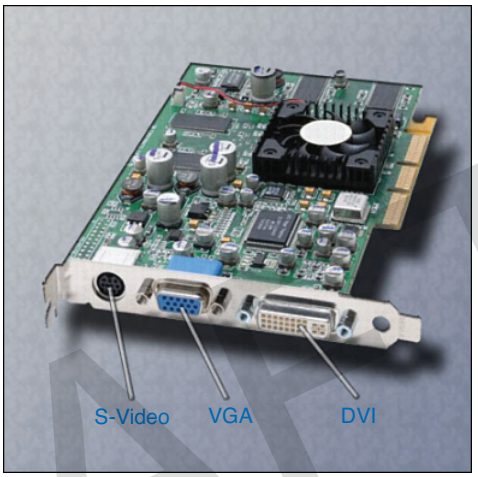
Video Ports and Connectors

A video port connects a monitor cable to a computer. Figure 1-19 shows three common video ports. There are several video port and connector types:

- ***Video Graphics Array (VGA)***: VGA has a three-row, 15-pin female connector and provides analog output to a monitor.
- ***Digital Visual Interface (DVI)***: DVI has a 24-pin female connector or a 29-pin female connector and provides an uncompressed digital output to a monitor. DVI-I provides both analog and digital signals. DVI-D provides digital signals only.
- ***High-Definition Multimedia Interface (HDMI)***: HDMI has a 19-pin connector and provides digital video and digital audio signals.

- ***S-Video***: S-Video has a 4-pin connector and provides analog video signals.
- ***Component/RGB***: RGB has three shielded cables (red, green, blue) with RCA jacks and provides analog video signals.

Figure 1-19 Video Ports



Identify the Names, Purposes, and Characteristics of Input Devices

An input device is used to enter data or instructions into a computer. Here are some examples of input devices:

- Mouse and keyboard
- Digital camera and digital video camera
- Biometric authentication device
- Touch screen
- Scanner

The mouse and keyboard are the two most commonly used input devices. The mouse is used to navigate the graphical user interface (GUI). The keyboard is used to enter text commands that control the computer.

Digital cameras and digital video cameras, shown in Figure 1-20, create images that can be stored on magnetic media. The image is stored as a file that can be displayed, printed, or altered.

Figure 1-20 Digital Camera

Biometric identification makes use of features that are unique to an individual user, such as fingerprints, voice recognition, or a retinal scan. When combined with ordinary usernames, biometric identification guarantees that the authorized person is accessing the data. Figure 1-21 shows a laptop that has a built-in fingerprint scanner. After measuring the physical characteristics of the fingerprint of the user, the scanner grants the user access if the fingerprint characteristics match the database and the user supplies the correct login information.

Figure 1-21 Fingerprint Scanner

A touch screen has a pressure-sensitive transparent panel. The computer receives instructions specific to the place on the screen that the user touches.

A scanner digitizes an image or document. The digitization of the image is stored as a file that can be displayed, printed, or altered. A bar code reader is a type of scanner that reads Universal Product Code (UPC) bar codes. It is widely used for pricing and inventory information.

Identify the Names, Purposes, and Characteristics of Output Devices

An output device is used to present information to the user from a computer. Here are some examples of output devices:

- Monitors and projectors
- All-in-one Printer
- Speakers and headphones

Monitors and Projectors

Monitors and projectors are primary output devices for a computer. There are different types of monitors, as shown in Figure 1-22. The most important difference between these monitor types is the technology used to create an image.

Figure 1-22 Types of Monitors

The following is an explanation of display technologies:

- ***CRT***: The cathode-ray tube (CRT) has three electron beams. Each beam directs colored phosphor on the screen that glows either red, blue, or green. Areas not struck by an electron beam do not glow. The combination of glowing and nonglowing areas creates the image on the screen. This technology is also used by most televisions. CRTs usually have a degauss button on the front that the user can press to remove discoloration caused by magnetic interference. CRT technology has largely been replaced with LCD.
- ***LCD***: Liquid crystal display is commonly used in flat panel monitors, laptops, and some projectors. It consists of two polarizing filters with a liquid crystal solution between them. An electronic current aligns the crystals so that light can either pass through or not pass through. The effect of light passing through in certain areas and not in others is what creates the image. LCD comes in two forms, active matrix and passive matrix. Active matrix is sometimes called thin film transistor (TFT). TFT allows each pixel to be controlled, which creates very sharp color images. Passive matrix is less expensive than active matrix but does not provide the same level of image control. Passive matrix is not commonly used in laptops.
- ***DLP***: Digital light processing is another technology used in projectors. DLP projectors use a spinning color wheel with a microprocessor-controlled array of mirrors called a digital micromirror device (DMD). Each mirror corresponds to a specific pixel. Each mirror reflects light toward or away from the projector optics. This creates a monochromatic image of up to 1024 shades of gray in between white and black. The color wheel then adds the color data to complete the projected color image.

Monitor resolution refers to the level of image detail that can be reproduced. Table 1-10 is a chart of common monitor resolutions. Higher resolution settings produce better image quality.

Table 1-10 Display Resolutions

Display Standard	Linear Pixels (Height x Vertical)	Aspect Ratio
CGA	320x200	16:10
EGA	640x350	11:6
VGA	640x480	4:3
WVGA	854x480	16:9
SVGA	800x600	4:3
XGA	1024x768	4:3
WXGA	1280x800	16:10
SXGA	1280x1024	5:4

Display Standard	Linear Pixels (Height x Vertical)	Aspect Ratio
WSXGA	1600x1024	25:16
UXGA	1600x1200	4:3
HDTV	1920x1080	16:9
WUXGA	1920x1200	16:10
QXGA	2048x1536	4:3
QSXGA	2560x2048	5:4
WQUXGA	3840x2400	16:10

Several factors are involved in monitor resolution:

- ***Pixel***: The term pixel is an abbreviation for picture element. Pixels are the tiny dots that comprise a screen. Each pixel consists of red, green, and blue.
- ***Dot pitch***: Dot pitch is the distance between pixels on the screen. A lower dot pitch number produces a better image.
- ***Contrast ratio***: The contrast ratio is a measurement of the difference in intensity of light between the brightest point (white) and the darkest point (black). A 10,000:1 contrast ratio shows dimmer whites and lighter blacks than a monitor with a contrast ratio of 1,000,000:1.
- ***Refresh rate***: The refresh rate is how often per second the image is rebuilt. A higher refresh rate produces a better image and reduces the level of flicker.
- ***Interlaced/noninterlaced***: Interlaced monitors create the image by scanning the screen two times. The first scan covers the odd lines, top to bottom, and the second scan covers the even lines. Noninterlaced monitors create the image by scanning the screen, one line at a time from top to bottom. Most CRT monitors today are noninterlaced.
- ***Horizontal vertical colors (HVC)***: The number of pixels in a line is the horizontal resolution. The number of lines in a screen is the vertical resolution. The number of colors that can be reproduced is the color resolution.
- ***Aspect ratio***: Aspect ratio is the horizontal to vertical measurement of the viewing area of a monitor. For example, a 4:3 aspect ratio would apply to a viewing area that is 16 inches wide by 12 inches high. A 4:3 aspect radio would also apply to a viewing area that is 24 inches wide by 18 inches high. A viewing area that is 22 inches wide by 12 inches high has an aspect ratio of 11:6.
- ***Native resolution***: Native resolution is the number of pixels that a monitor has. A monitor with a resolution of 1280x1024 has 1280 horizontal pixels and 1024 vertical pixels. Native mode is when the image sent to the monitor matches the native resolution of the monitor.

Monitors have controls for adjusting the quality of the image. Here are some common monitor settings:

- **Brightness**: Intensity of the image
- **Contrast**: Ratio of light to dark
- **Position**: Vertical and horizontal location of image on the screen
- **Reset**: Returns the monitor settings to factory settings

Adding additional monitors increases the number of windows that are visible on the desktop. Many computers have built-in support for multiple monitors.

All-in-One Printer

Printers are output devices that create hard copies of computer files. Some printers specialize in particular applications, such as printing color photographs. Other, all-in-one type printers, like the one shown in Figure 1-23, are designed to provide multiple services such as printing, scanning, faxing, and copying.

Figure 1-23 All-in-One Printer

Speakers and Headphones

Speakers and headphones are output devices for audio signals. Most computers have audio support either integrated into the motherboard or on an adapter card. Audio support includes ports that allow input and output of audio signals. The audio card has an amplifier to power headphones and external speakers, which are shown in Figure 1-24.

Figure 1-24 Speakers and Headphones

Explain System Resources and Their Purposes

System resources are used for communication purposes between the CPU and other components in a computer. There are three common system resources:

- Interrupt requests (IRQ)
- Input/output (I/O) port addresses
- Direct memory access (DMA)

Interrupt Requests

Interrupt requests (IRQ) are used by computer components to request information from the CPU. The IRQ travels along a wire on the motherboard to the CPU. When the CPU receives an IRQ, the CPU determines how to fulfill this request. The priority of the request is determined by the IRQ number assigned to that computer component. Older computers only had eight IRQs to assign to devices. Newer computers have 16 IRQs, which are numbered 0 to 15, as shown in Table 1-11. As a general rule, each component in the computer must be assigned a unique IRQ. IRQ conflicts can cause components to stop functioning and even cause the computer to crash. Today, most IRQ numbers are assigned automatically with "plug-and-play" (PnP) operating systems and the implementation of PCI slots, USB ports, and FireWire ports. With the numerous components that can be installed in a computer, it is difficult to assign a unique IRQ to every component. PCI devices can now share IRQs without conflict.

Table 1-11 Interrupt Requests (IRQ)

IRQ	Description
0	System timer. Reserved for the system. The user cannot change it.
1	Keyboard. Reserved for the system. Cannot be altered, even if no keyboard is present or needed.
2	Second IRQ controller.
3	COM 2 (default), COM 4 (user).
4	COM 1 (default), COM 3 (user).
5	Sound card (Sound Blaster Pro or later) or LPT2 (user).
6	Floppy disk controller.
7	LPT1 (parallel port) or sound card (8-bit Sound Blaster and compatible).
8	Real-time clock.
9	ACPI SCSI or ISA MPU-401.
10	Free/open interrupt/available/SCSI.
11	Free/open interrupt/available/SCSI.
12	PS/2 connector mouse. If no PS/2 connector mouse is used, this can be used for other peripherals.
13	Math coprocessor. Cannot be changed.
14	Primary IDE. If no primary IDE exists, this can be changed.
15	Secondary IDE.

Input/Output (I/O) Port Addresses

Input/output (I/O) port addresses are used to communicate between devices and software. The I/O port address is used to send and receive data for a component. As with IRQs, each component will have a unique I/O port assigned. There are 65,535 I/O ports in a computer, and they are referenced by a hexadecimal address in the range of 0000h to FFFFh. Table 1-12 shows a chart of common I/O ports.

Table 1-12 I/O Addresses

I/O Port Addresses (in Hex)	Typical Device or Port Assignment	I/O Port Addresses (in Hex)	Typical or Device Port Assignment	I/O Port Addresses (in Hex)	Typical Device or Port Assignment
000–00f, 081–09F	DMA controller	1F0–1F7	Primary hard disk controller	3E8–3EF	COM 3 serial port
010–01F, 0A0–0A1	Programmable interrupt controller	200–207	Game port joystick	3F0–3F7	Floppy disk controller
040–043	System timer	220–22F	Sound card	3F6–3F6	PCI primary IDE controller
060–060, 064–064	Keyboard	294–297	PCI bus (data comm)	3F8–3FF	COM 1 serial port
061–061	PC speaker	278–27F	LPT 2 or LPT 3	E000–E01F	USB host controller
070–071	CMOS/real-time clock	2E8–2EF	COM 4 serial port	E800–E87F	Fast Ethernet adapter
0F0–0FF	Math coprocessor	2F8–2FF	COM 2 serial port	F000–F00F	IDE controller
130–14F	SCSI host adapter	376–376	PCI IDE controller		
170–177	Secondary hard disk controller	378–37F	LPT1		

Direct Memory Access

Direct memory access (DMA) channels are used by high-speed devices to communicate directly with main memory. These channels allow the device to bypass interaction with the CPU and directly store and retrieve information from memory. Only certain devices can be assigned a DMA channel, such as SCSI host adapters and sound cards. Older computers only had four DMA channels to assign to components. Newer computers have eight DMA channels that are numbered 0 to 7, as shown in Table 1-13.

Table 1-13 DMA Channels

DMA Channel	Default Device	Can Also Be Used For
0	Dynamic RAM memory refresh	
1	Sound card (low DMA setting)	Network cards, SCSI adapters, parallel printing port, and voice modems
2	Floppy disk controller	
3	Available	Network cards, SCSI adapters, parallel printing port, voice modems, and sound card (low DMA setting)
4	Cascade for DMA 0–3	
5	Sound card (high DMA setting)	Network cards, SCSI adapters
6	Available	Network cards, sound card (high DMA setting)
7	Available	Network cards, sound card (high DMA setting)

Summary

This chapter introduced the IT industry, options for training and employment, and some of the industry-standard certifications. This chapter also covered the components that comprise a PC system. Much of the content in this chapter will help you throughout this course:

- Information technology encompasses the use of computers, network hardware, and software to process, store, transmit, and retrieve information.
- A PC system consists of hardware components and software applications.
- You must carefully choose the computer case and power supply to support the hardware inside the case and allow for the addition of components.
- A computer's internal components are selected for specific features and functions. All internal components must be compatible with the motherboard.
- You should use the correct type of ports and cables when connecting devices.
- Typical input devices include the keyboard, mouse, touch screen, and digital cameras.
- Typical output devices include monitors, printers, and speakers.
- System resources must be assigned to computer components. System resources include IRQs, I/O port addresses, and DMAs.

Summary of Exercises

This is a summary of the Labs, Worksheets, Remote Technician exercises, Class Discussions, Virtual Desktop activities, and Virtual Laptop activities associated with this chapter.

Worksheets

The following worksheets cover material from this chapter. Refer to the labs in *IT Essentials: PC Hardware and Software Lab Manual, Fourth Edition*.

Worksheet 1.1.2: Job Opportunities

Worksheet 1.4.7: Research Computer Components

Check Your Understanding

You can find the answers to these questions in the appendix, "Answers to Check Your Understanding Questions."

1. How many FireWire devices can a single FireWire port support?

   A. 12
   B. 25
   C. 32
   D. 54
   E. 63
   F. 127

2. Which type of memory transfers data twice as fast as SDRAM and increases performance by transferring data twice per cycle?

   A. DDR-SDRAM
   B. DRAM2
   C. D-SDRAM
   D. ROM

3. Which type of video connector has a 24-pin or 29-pin female connector and provides compressed digital output to a monitor?

   A. AAV
   B. DVI
   C. HDMI
   D. RCA
   E. VGA

4. How many USB devices can be connected to a USB port?

   A. 256
   B. 127
   C. 64
   D. 128

5. What is the maximum data speed of high-speed USB 2.0?

A. 1.5 Mbps
B. 12 Mbps
C. 380 Mbps
D. 480 Mbps
E. 480 Gbps
F. 840 Gbps

6. Which IEEE standard defines the FireWire technology?

A. 1284
B. 1394
C. 1451
D. 1539

7. What is the maximum data rate supported by the IEEE 1394a standard?

A. 200 Mbps
B. 380 Mbps
C. 400 Mbps
D. 800 Mbps
E. 900 Mbps

8. What is the purpose of a heat sink installed on a processor?

A. To set the processor voltage
B. To cool the processor
C. To set the processor speed
D. To ground the processor