Introduction to Information and Communication Technologies

Chapter 4

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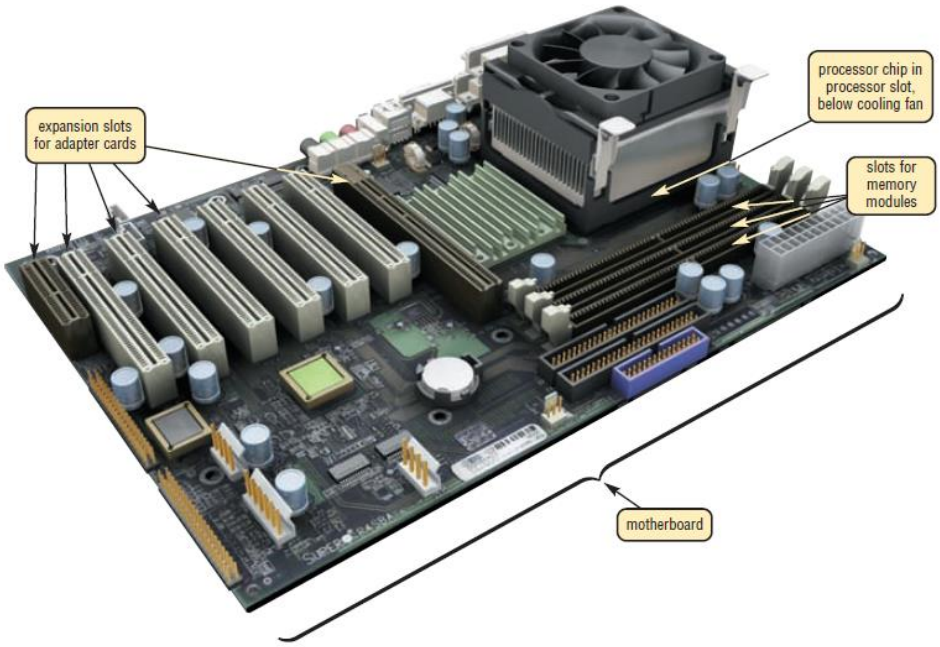
System Unit: Agenda

- Processor
- Data Representation
- Memory
- Expansion Slots and Adapter cards
- Ports and Connectors
- Buses
- Bays
- Power Supply



Processor

- The **processor**, also called the **central processing unit** (**CPU**), interprets and carries out the basic instructions that operate a computer.
- The processor significantly impacts overall computing power and manages most of a computer's operations. On a personal computer, all functions of the processor usually are on a single chip.
- Some computer and chip manufacturers use the term **microprocessor** to refer to a personal computer processor chip.
- Processors contain a control unit and an arithmetic logic unit (ALU). These two components work together to perform processing operations.
- Next Slide illustrates how other devices that are connected to the computer communicate with the processor to carry out a task.

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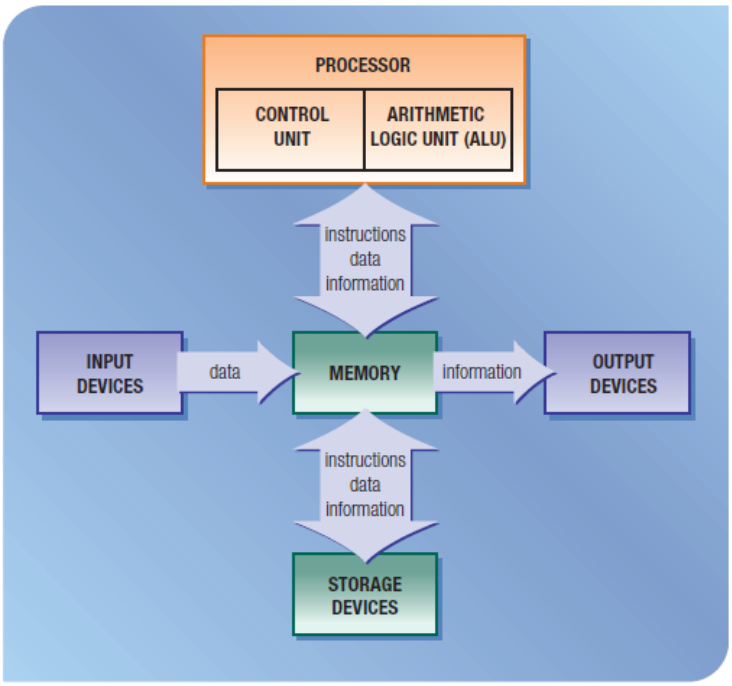

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Processor

- The **control unit** is the component of the processor that directs and coordinates most of the operations in the computer. The control unit has a role much like a traffic cop: it interprets each instruction issued by a program and then initiates the appropriate action to carry out the instruction. Types of internal components that the control unit directs include the arithmetic/logic unit and buses, each discussed in this chapter.
- The **arithmetic logic unit** (ALU), another component of the processor, performs arithmetic, comparison, and other operations. Arithmetic operations include basic calculations such as addition, subtraction, multiplication, and division. Comparison operations involve comparing one data item with another to determine whether the first item is greater than, equal to, or less than the other item. Depending on the result of the comparison, different actions may occur.

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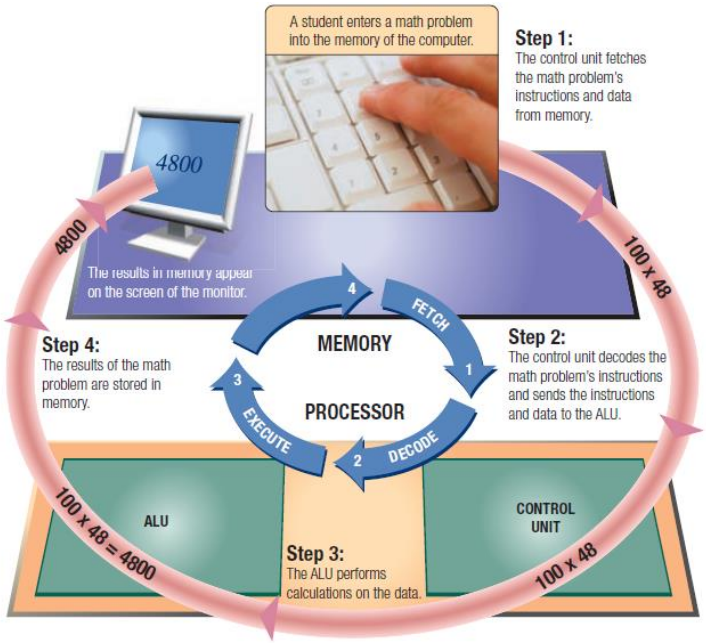
Machine Cycle



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System Clock

- The processor relies on a small quartz crystal circuit called the **system clock** to control the timing of all computer operations. Just as your heart beats at a regular rate to keep your body functioning, the system clock generates regular electronic pulses, or ticks, that set the operating pace of components of the system unit.
- The pace of the system clock, called the **clock speed**, is measured by the number of ticks per second.
- Current personal computer processors have clock speeds in the gigahertz range. Giga is a prefix that stands for billion, and a hertz is one cycle per second. Thus, one **gigahertz** (**GHz**) equals one billion ticks of the system clock per second. A computer that operates at 2.6 GHz has 2.6 billion (giga) clock cycles in one second (hertz). The faster the clock speed, the more instructions the processor can execute per second.
- The speed of the system clock is just one factor that influences a computer's performance. Other factors, such as the type of processor chip, amount of cache, memory access time, bus width, and bus clock speed, are discussed later in this chapter.

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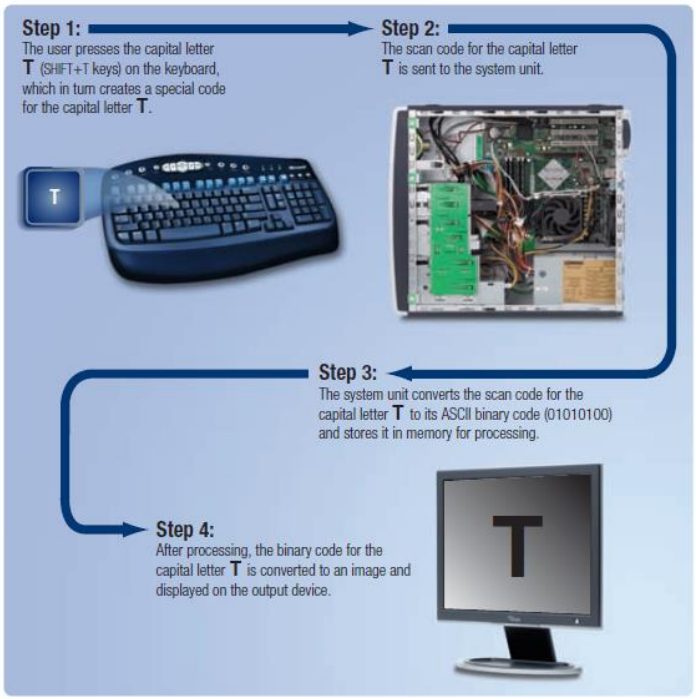
Dual Core and Multicore processors

- Several processor chip manufacturers now offer dual-core and multi-core processors.
- A **dual-core processor** is a single chip that contains two separate processors. Similarly, a **multi-core processor** is a chip with two or more separate processors.
- Each processor on a dual-core/multi-core chip generally runs at a slower clock speed than a single-core processor, but dual-core/multi-core chips typically increase overall performance.
- Although a dual-core processor does not double the processing speed of a single-core processor, it can approach those speeds.
- Dual-core and multi-core processors also are energy efficient, requiring lower levels of power consumption and emitting less heat in the system unit.

Data Representation

- Most computers are **digital**. They recognize only two discrete states: on and off. The two digits, 0 and 1, easily can represent these two states. The digit 0 represents the electronic state of off (absence of an electronic charge). The digit 1 represents the electronic state of on (presence of an electronic charge).
- The computer uses a binary system because it recognizes only two states. A **bit** (short for binary digit) is the smallest unit of data the computer can process. By itself, a bit is not very informative.
- When 8 bits are grouped together as a unit, they form a **byte**. The combinations of 0s and 1s that represent characters are defined by patterns called a coding scheme.
- In one coding scheme, the number 4 is represented as 00110100, the number 6 as 00110110, and the capital letter E as 01000101. Two popular coding schemes are ASCII and EBCDIC. The American Standard Code for Information Interchange scheme is the most widely used coding system to represent data.

FIGURE 4-9 HOW A LETTER IS CONVERTED TO BINARY FORM AND BACK



Memory

- **Memory** consists of electronic components that store instructions waiting to be executed by the processor, data needed by those instructions, and the results of processed data (information).
- Memory usually consists of one or more chips on the motherboard or some other circuit board in the computer.
- Memory stores three basic categories of items: (1) the operating system and other system software that control or maintain the computer and its devices; (2) application programs that carry out a specific task such as word processing; and (3) the data being processed by the application programs and resulting information.
- This role of memory to store both data and programs is known as the stored program concept.

Memory

- A **Byte** (character) is the basic storage unit in memory. When application program instructions and data are transferred to memory from storage devices, the instructions and data exist as bytes.
- Each byte resides temporarily in a location in memory that has an address. An address simply is a unique number that identifies the location of the byte in memory.
- To access data or instructions in memory, the computer references the addresses that contain bytes of data.
- Manufacturers state the size of memory chips and storage devices in terms of the number of bytes.

Memory

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

RAM

- **RAM** (random access memory), also called main memory, consists of memory chips that can be read from and written to by the processor and other devices.
- When you turn on power to a computer, certain operating system files (such as the files that determine how the Windows 7 desktop appears) load into RAM from a storage device such as a hard disk. These files remain in RAM as long as the computer has continuous power.
- As additional programs and data are requested, they also load into RAM from storage.
- The processor interprets and executes a program's instructions while the program is in RAM.
- During this time, the contents of RAM may change. RAM can hold multiple programs simultaneously, provided the computer has enough RAM to accommodate all the programs.
- Most RAM is volatile, which means it loses its contents when the power is removed from the computer. For this reason, you must save any items you may need in the future. Saving is the process of copying items from RAM to a storage device such as a hard disk.

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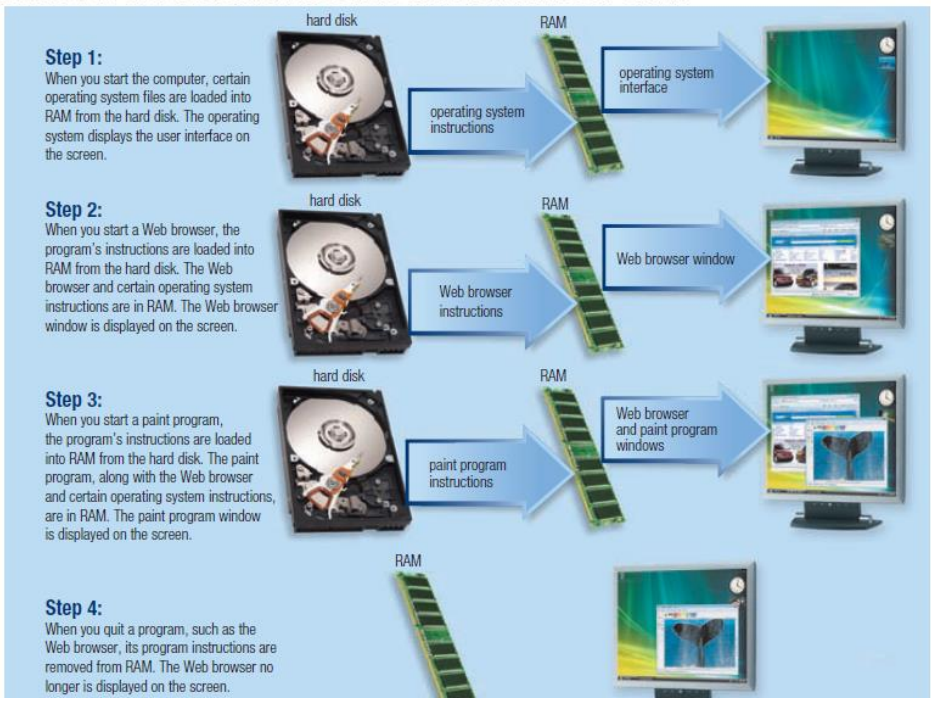
FIGURE 4-12 HOW PROGRAM INSTRUCTIONS TRANSFER IN AND OUT OF RAM



Types of RAM

- Three basic types of RAM chips exist: dynamic RAM, static RAM, and magnetoresistive RAM.
- **Dynamic RAM** (DRAM pronounced DEE-ram) chips must be re-energized constantly or they lose their contents.
- **Static RAM** (SRAM pronounced ESS-ram) chips are faster and more reliable than any variation of DRAM chips. These chips do not have to be re-energized as often as DRAM chips, thus, the term static.
- A newer type of RAM, called **Magnetoresistive RAM** (MRAM pronounced EM-ram), stores data using magnetic charges instead of electrical charges. Manufacturers claim that MRAM has greater storage capacity, consumes less power, and has faster access times than electronic RAM.

Cache

- Most of today's computers improve processing times with **cache** (pronounced cash). Two types of cache are memory cache and disk cache. This chapter discusses memory cache.
- **Memory cache** helps speed the processes of the computer because it stores frequently used instructions and data. Most personal computers today have at least two types of memory cache: L1 cache and L2 cache.
- **L1 cache** is built directly in the processor chip. L1 cache usually has a very small capacity, ranging from 8 KB to 128 KB.
- **L2 cache** is slightly slower than L1 cache but has a much larger capacity, ranging from 64 KB to 16 MB.
- Current processors include **advanced transfer cache**, a type of L2 cache built directly on the processor chip. Processors that use advanced transfer cache perform at much faster rates than those that do not use it. Personal computers today typically have from 512 KB to 4 MB of advanced transfer cache.

ROM

- **Read-only memory** (**ROM** pronounced rahm) refers to memory chips storing permanent data and
- instructions. The data on most ROM chips cannot be modified — hence, the name read-only. ROM is nonvolatile, which means its contents are not lost when power is removed from the computer.
- Manufacturers of ROM chips often record data, instructions, or information on the chips when they manufacture the chips.
- These ROM chips, called **firmware**, contain permanently written data, instructions, or information.

Expansion Slot and Adapter Card

- An **expansion slot** is a socket on the motherboard that can hold an adapter card.
- An **adapter card**, sometimes called an **expansion card**, is a circuit board that enhances functions of a component of the system unit and/or provides connections to peripherals.
- A **peripheral** is a device that connects to the system unit and is controlled by the processor in the computer. Examples of peripherals are modems, disk drives, printers, scanners, and keyboards.
- On next Page Figure 4-17 lists a variety of types of adapter cards. Sometimes, all functionality is built into the adapter card. With others, a cable connects the adapter card to a device, such as a digital video camera, outside the system unit. Figure 4-18 shows an adapter card being inserted in an expansion slot on a personal computer motherboard.

TYPES OF ADAPTER CARDS

Adapter Card	Purpose
Disk controller	Connects disk drives
FireWire	Connects to FireWire devices
MIDI	Connects musical instruments
Modem	Connects other computers through telephone or cable television lines
Network	Connects other computers and peripherals
PC-to-TV converter	Connects a television
Sound	Connects speakers or a microphone
TV tuner	Allows viewing of television channels on the monitor
USB 2.0	Connects to USB 2.0 devices
Video	Connects a monitor
Video capture	Connects a camcorder

FIGURE 4-17 Currently used adapter cards and their functions.

FIGURE 4-18 An adapter card being inserted in an expansion slot on the motherboard of a personal computer.

Expansion Slot and Adapter Card

- Some motherboards include all necessary capabilities and do not require adapter cards.
- Other motherboards may require adapter cards to provide capabilities such as sound and video.
- A **sound card** enhances the sound-generating capabilities of a personal computer by allowing sound to be input through a microphone and output through external speakers or headphones.
- A **video card**, also called a **graphics card**, converts computer output into a video signal that travels through a cable to the monitor, which displays an image on the screen.

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Ports and Connectors

- A **port** is the point at which a peripheral attaches to or communicates with a system unit so the peripheral can send data to or receive information from the computer.
- An external device, such as a keyboard, monitor, printer, mouse, and microphone, often attaches by a cable to a port on the system unit. Instead of port, the term jack sometimes is used to identify audio and video ports. The front and back of the system unit contain many ports (next page).
- Ports have different types of connectors. A **connector** joins a cable to a peripheral. One end of a cable attaches to the connector on the system unit, and the other end of the cable attaches to a connector on the peripheral.

Ports

- A **serial port** is a type of interface that connects a device to the system unit by transmitting data one bit at a time. Serial ports usually connect devices that do not require fast data transmission rates, such as a mouse, keyboard, or modem. The COM port (short for communications port) on the system unit is one type of serial port.
- A **parallel port** is an interface that connects devices by transferring more than one bit at a time (Figure 4-23). Parallel ports originally were developed as an alternative to the slower speed serial ports. Some printers can connect to the system unit using a parallel port. This parallel port can transfer eight bits of data (one byte) simultaneously through eight separate lines in a single cable.
- A **USB port**, short for universal serial bus port, can connect up to 127 different peripherals together with a single connector. Devices that connect to a USB port include the following: mouse, printer, digital camera, scanner, speakers, portable media player, CD, DVD, smart phone, PDA, game console, and removable hard disk. Personal computers typically have six to eight USB ports on the front and/or back of the system unit.
- The latest version of USB, called USB 3.0, is a more advanced and faster USB.

Ports

- A **FireWire port** is similar to a USB port in that it can connect multiple types of devices that require faster data transmission speeds, such as digital video cameras, digital VCRs, color printers, scanners, digital cameras, and DVD drives, to a single connector.
- Five special-purpose ports are MIDI, eSATA, SCSI, IrDA, and Bluetooth. These ports are not included in typical computers. For a computer to have these ports, you often must customize the computer purchase order.

Buses

- A computer processes and stores data as a series of electronic bits. These bits transfer internally within the circuitry of the computer along electrical channels.
- Each channel, called a **bus**, allows the various devices both inside and attached to the system unit to communicate with each other. Just as vehicles travel on a highway to move from one destination to another, bits travel on a bus.
- Buses transfer bits from input devices to memory, from memory to the processor, from the processor to memory, and from memory to output or storage devices. Buses consist of two parts: a data bus and an address bus. The data bus transfers actual data and the address bus transfers information about where the data should reside in memory.
- The size of a bus, called the bus width, determines the number of bits that the computer can transmit at one time.

Buses

- A computer has two basic types of buses: a system bus and an expansion bus.
- A **system bus** is part of the motherboard and connects the processor to main memory. When computer professionals use the term bus by itself, they usually are referring to the system bus.
- An **expansion bus** allows the processor to communicate with peripherals. Some peripherals outside the system unit connect to a port on an adapter card, which is inserted in an expansion slot on the motherboard. This expansion slot connects to the expansion bus, which allows the processor to communicate with the peripheral attached to the adapter card.

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Bays

- After you purchase a computer, you may want to install an additional storage device such as a disk drive in the system unit.
- A **bay** is an opening inside the system unit in which you can install additional equipment. A bay is different from a slot, which is used for the installation of adapter cards. Rectangular openings, called **drive bays**, typically hold disk drives.
- Two types of drive bays exist: external and internal.
- An external drive bay allows a user to access the drive from outside the system unit (Figure). CD drives, DVD drives, and tape drives are examples of devices installed in external drive bays.
- An internal drive bay is concealed entirely within the system unit. Hard disk drives are installed in internal bays.

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Power Supply

- Many personal computers plug in standard wall outlets, which supply an alternating current (AC) of 115 to 120 volts.
- This type of power is unsuitable for use with a computer, which requires a direct current (DC) ranging from 5 to 12 volts.
- The **power supply** is the component of the system unit that converts the wall outlet AC power into DC power.
- Some external peripherals such as an external modem, speakers, or a tape drive have an **AC adapter**, which is an external power supply.
- One end of the AC adapter plugs in the wall outlet and the other end attaches to the peripheral. The AC adapter converts the AC power into DC power that the peripheral requires.

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THE END