Chapter 4 Objectives

- Describe the components in the system unit
- Explain how the CPU uses the four steps of a machine cycle to process data
- Compare and contrast various personal computer processors on the market today
- Define a bit and describe how a series of bits represents data
- Differentiate between the various types of memory
- Explain the difference between a serial, a parallel port, and a USB port
- Describe how buses contribute to a computer’s processing speed
- Identify components in a notebook computer
- Identify components in a handheld computer

The Components of the System Unit

The System Unit

What is the system unit?
- Box-like case that houses the electronic components of the computer used to process data
- All computers have a system unit
- Sometimes called the chassis

What are common components inside the system unit?
- Processor
- Memory module
- Expansion cards
  - Sound card
  - Modem card
  - Video card
  - Network interface card
- Ports and Connectors

What is the motherboard?
- Also called the system board
- Main circuit board in the system unit
- Contains many electronic components

What electronic components are found on the motherboard?
- Chip: Small piece of semi-conducting material on which one or more integrated circuits are etched
- Integrated Circuit (IC): Microscopic pathway capable of carrying electrical current
- Transistor: Acts as an electronic switch, or gate, that opens or closes the circuit for electronic signals
What chip packages are available?
- Single edge contact (SEC) cartridge
- Dual inline package (DIP)
- Flip chip-PGA (FC-PGA) package
- Pin grid array (PGA)

What is the central processing unit (CPU)?
- Interprets and carries out the basic instructions that operate a computer
- Most devices communicate with the CPU in order to carry out a task
- Also called the processor

What are the components of the central processing unit (CPU)?
- CPU
- Arithmetic/Logic Unit (ALU)
- Control Unit

What is the control unit?
- A component of the CPU that directs and coordinates most of the operations in the computer
- The control unit repeats a set of four basic operations:
  - Fetch – obtain a program instruction or data item from memory
  - Decode - translate the instruction into commands
  - Execute - carry out the command
  - Store - write the result to memory

What is a machine cycle?
- Together the four operations of the CPU comprise a machine cycle
- Also called an instruction cycle
- Instruction time (i-time) - time it takes to fetch and decode
- Execution time (e-time) – time it takes to execute and store

A student enters a math problem into the memory of the computer.
Step 1: The control unit fetches the math problem from memory.
Step 2: The control unit decodes the math problem and sends it to the ALU.
Step 3: The ALU executes the math problem.
Step 4: The results of the math problem are stored in memory.
The result in memory displays on the screen of the monitor.
How is the speed of the CPU measured?
- According to how many millions of instructions per second (MIPS) it can process.

What are two designs used for the CPU?
- CISC (complex instruction set computing)
  - Supports a large number of instructions
  - CPU executes complex instructions more quickly
- RISC (reduced instruction set computing)
  - Reduces instructions to only those used more frequently
  - CPU executes simple instructions more quickly

What is the arithmetic/logic unit (ALU)?
- Component of the CPU
- Performs arithmetic, comparison, and logical operations
- Performs the execution part of the machine cycle

What is pipelining?
- CPU begins executing a second instruction before completing the first instruction
- Results in faster processing

What is a register?
- Temporary storage location used by the CPU
  - Stores location from where instruction was fetched
  - Stores an instruction while it is being decoded
  - Stores data while the ALU processes it
  - Stores the results of a calculation
What is the system clock?
- Synchronizes all computer operations.
- Each tick is a clock cycle.
- Faster clock speed means the CPU can execute more instructions each second.
- Clock speed (clock rate) measured in megahertz (MHz) and gigahertz (GHz).
- MHz - one million ticks of the system clock.
- GHz - one billion ticks of the system clock.

What is a personal computer processor?
- The single processor chip found in personal computers.
- Sometimes called a microprocessor.
- Processors identified by:
  - Manufacturer
  - Model name or model number

Who are the personal computer processor manufacturers?
- Intel
  - Pentium®, Pentium® II with MMX™
  - Celeron™
  - Xeon™
  - Used in PCs
  - AMD (Intel-compatible)
  - Athlon™
  - Used in PCs
  - Motorola
    - PowerPC
    - Used in workstations and high-end servers
  - Alpha
    - Used in workstations and high-end servers

How do personal computer processors compare?

Company on the Cutting Edge
- Intel
  - World’s largest chip maker
  - Chips power 85 percent of all desktop computers
  - Major producer of boards, systems, and software
  - Intel refined the process of placing thousands of tiny electronic devices on a silicon chip
  - Introduced the 1103 in 1970 which became the world’s best-selling semiconductor device
  - Developed the 4004, the world’s first processor in 1971

Company on the Cutting Edge
- AMD
  - Advanced Micro Devices
  - World’s second-largest manufacturer of processors for Microsoft Windows-compatible personal computers
  - Commitment to “parametric superiority”
  - Guarantees its microchips meet or exceed stringent standards
How are processors upgraded?
- Processors sometimes upgraded to increase a computer’s performance
- Three types of upgrades
  - Chip for chip: Replace existing processor chip with a new one
  - Piggyback: Stack the new processor chip on top of the old one
  - Daughterboard: Add a small circuit board to the motherboard

How do you install a processor?
- Installing a processor using a zero-insertion force (ZIF) socket
- Push lever down

How do heat sinks and heat pipes protect the processor?
- Heat sink: Small ceramic or metal component with fins on its surface that absorbs and ventilates heat produced by electrical components
- Heat pipe: A smaller device that cools processors in notebook computers

What is a coprocessor?
- A special processor chip or circuit board that assists the processor in performing specific tasks
- One type of coprocessor is a floating-point coprocessor, also known as a math or numeric coprocessor

What is parallel processing?
- Using multiple processors simultaneously to execute a program
- Speeds processing time
- Requires special software to divide up a problem and bring the results back together again

Andy Grove
- Intel Chairman
- Helped found Intel and named president in 1979
- From 1987 to 1998 served as chief executive officer
- Time magazine’s Man of the Year in 1997 for innovative work on microchips, entrepreneurial spirit, and sharp brilliant mind
How do computers represent data?

- Most computers are digital
  - Computers are electronic devices powered by electricity, which has only two states, on or off
  - Computers recognize only two discrete states: on or off

What is the binary system?

- A number system that has just two unique digits, 0 and 1
  - A single digit is called a bit (binary digit)
  - A bit is the smallest unit of data the computer can represent
  - By itself a bit is not very informative
  - The two digits represent the two off and on states

What is a byte?

- Eight bits are grouped together to form a byte
  - 0s and 1s in each byte are used to represent individual characters such as letters of the alphabet, numbers, and punctuation
- 8-bit byte for the number 3
- 8-bit byte for the number 5
- 8-bit byte for the capital letter T

What are two popular coding systems to represent data?

- American Standard Code for Information Interchange (ASCII)
- Extended Binary Coded Decimal Interchange Code (EBCDIC)
  - Sufficient for English and Western European languages
  - Unicode often used for other languages

How is a character sent from the keyboard to the computer?

Step 1: The user presses the letter T key on the keyboard
Step 2: An electronic signal for the letter T is sent to the system unit
Step 3: The signal for the letter T is converted to its ASCII binary code (01010100) and is stored in memory for processing
Step 4: After processing, the binary code for the letter T is converted to an image on the output device

What is the binary system?

- Binary Digits (bit) • Electronic Charge • Electronic State

Technology Trailblazer

Gordon Moore
- Co-founder of Intel
- Witnessed a consistent geometric growth in technology
- Developed principle called Moore’s Law in 1965
- Moore’s Law
  - The number of transistors and resistors placed on computer chips would double every year, with a proportional increase in computing power and decrease in cost. This principle held true until 1975, when he changed the prediction to doubling every two years.
Memory

What is memory?
- Temporary storage place for data, instructions, and information
- Consists of one or more chips on the motherboard or some other circuit board
- Three basic items stored in memory:
  - application programs that carry out a specific task
  - data being processed by application programs
  - operating system and other system software that control the usage of the computer equipment

How are bytes stored?
- Bytes are the basic storage unit in memory
- Each byte is stored at a specific location in memory called an address
- Each address has a unique identifying number, like the seats on an airplane
- Each address can hold only a single byte
- Each address can be full or empty

How is memory measured?
- Size of memory is measured by the number of bytes available
  - Kilobyte - 1,024 bytes
  - Megabyte - one million bytes

What are the two types of memory in the system unit?
- Volatile memory: Loses its contents when the computer’s power is turned off
- Nonvolatile memory: Does not lose its contents when the computer’s power is turned off

What is random access memory (RAM)?
- Memory chips that can be read from and written to by the processor and other devices
- When the computer starts, operating system files are loaded from a hard disk into RAM
- As additional programs and data are requested, they also load from storage into RAM
- Most RAM is volatile

How are applications transferred in and out of RAM?
- Step 1: When your computer is running, certain operating system files are in RAM.
- Step 2: When you start a word processing program such as Word, the program loads into RAM from a hard disk.
- As you create a document, it is in RAM and displays on your screen.
- Step 3: When you quit Word, RAM may be used to store another program or data. The program is removed from the screen and the operating system’s user interface redisplays.
- Step 4: When you start a spreadsheet program such as Excel, the program loads into RAM from a hard disk.
- As you create a spreadsheet, it is in RAM and displays on your screen.
- Step 5: When you quit Excel, RAM may be used to store another program or data. Excel is removed from your screen and the operating system’s user interface redisplays.
What are the two basic types of RAM chips?

- **Dynamic RAM (DRAM)**
  - Also called main memory
  - Most common type
  - Variations:
    - Synchronous DRAM (SDRAM)
    - Double data rate SDRAM (DDR SDRAM or SDRAM II)
    - Direct Rambus® DRAM (Direct RDRAM®)

- **Static RAM (SRAM)**
  - Used for special applications such as cache
  - Faster and more reliable than DRAM chips

**Variations:**

- Single inline memory modules (SIMMs)
- Dual inline memory modules (DIMMs)
- Rambus® inline memory module (RIMM)

What is a memory module?

- RAM chips usually reside on a small circuit board which inserts into motherboard
- Three types: SIMMS, DIMMS, and RIMMS

How much RAM is needed?

- Necessary RAM depends on what type of applications you intend to run on your computer

What is memory cache?

- Also called cache store or RAM cache
- Helps speed the processes of the computer by storing frequently used instructions and data
- When the processor needs an instruction or data, it first searches cache. If it cannot locate the item in cache, then it searches RAM.
What are the three types of cache?

- **Level 1 (L1)**: Primary or internal cache
  - Built directly into the processor chip
  - Small capacity
  - Not used on older computers

- **Level 2 (L2)**: External cache
  - Much larger capacity, but slower
  - On older computers:
    - High-speed SRAM chips on motherboard
  - On newer computers:
    - Advanced transfer cache
      - Built directly on the processor chip

- **Level 3 (L3)**: Not used on older computers
  - Only on newer computers with L2 advanced transfer cache
  - Cache on motherboard

What is read-only memory (ROM)?

- Memory chips that contain data, instructions, or information that is recorded permanently
  - Data can only be read; cannot be modified
  - Nonvolatile — Contents not lost when the computer is turned off
  - BIOS (basic input/output system)
    - Stored on ROM
    - Sequence of instructions the computer follows to load the operating system and other files when you first turn on the computer

What are types of ROM?

- **Firmware ROM chips**
  - ROM chips manufactured with permanently written data, instructions, or information

- **PROM**
  - Programmable read-only memory
  - Blank ROM on which you can place items permanently

- **EEPROM**
  - Electrically erasable programmable read-only memory
  - A type of PROM containing microcode that a programmer can erase

What is flash memory?

- Also called flash ROM or flash RAM
- Nonvolatile memory that can be erased electronically and reprogrammed
- Stores data and programs on many handheld computers and devices
- Flash memory cards store flash memory on removable devices instead of chips

What is CMOS?

- Complementary metal-oxide semiconductor memory
  - Stores configuration information about the computer
    - Type of disk drives
    - Keyboard
    - Monitor
    - Current time and date
  - Uses a battery to retain the information when the computer is turned off

What is memory access time?

- Speed at which the processor can access data from memory directly
  - Measured in fractions of a second
d  - One blink of the eye is 100 million ns; a computer performs some operations in 10 ns
What is an expansion slot?
- An opening, or socket, where a circuit board can be inserted into the motherboard
- Used to add new devices or capabilities to the computer
- Other terms for a circuit board include card, expansion card, expansion board, board, adapter card, adapter, interface card, add-in, and add-on

What are the uses of expansion cards?
- Modem card also called an internal modem
- Network interface card (NIC) also called a network card
- Sound card
- Video card also called video adapter or graphics card

What are four common types of expansion cards?
- Video card
- Sound card
- Network interface card (NIC)
- Modem card also called an internal modem

What is Plug and Play?
- The computer automatically can configure cards and other devices as you install them

What is a PC card?
- Used on notebook and other mobile computers
- Credit card-sized device used to add capabilities to mobile computer
- Standards developed by Personal Computer Memory Card International Association (PCMCIA)

What are the three types of PC Cards?
- Type I: add memory capabilities
- Type II: contain communication devices
- Type III: house devices such as hard disks
What is a flash memory card?

- Used to add memory to handheld computers and devices
- Can be added to a system without having to open the unit or restart the computer. This feature is known as hot plugging or hot swapping.

What is a port?

- Used to connect external devices to the system unit
- Port is the interface, or point of attachment, to the system unit
- Most located on the back of the system unit

What are the different types of connectors?

- Used to connect external devices to the system unit
- Port is the interface, or point of attachment, to the system unit
- Most located on the back of the system unit

What is a serial port?

- Transmits one bit of data at a time
- Used to connect devices that do not require fast transmission rates
- Two common types: 25-pin, 9-pin

What is a parallel port?

- Connects devices that can transfer more than one bit at a time
- Usually used for printers
- Two newer types: EPP (Enhanced Parallel Port), ECP (Extended Capabilities Port)
- IEEE 1284 is a standard that specifies how older and newer peripheral devices transfer data to and from a computer
What is a universal serial bus port (USB)?
- Can connect up to 127 different peripheral devices with a single connector type
- Supports newer peripherals
- Supports hot plugging and Plug and Play

How are multiple USB devices connected?
- Daisy Chain
  - Devices connected together outside the system unit in a chain
- USB hub
  - Plugs into the USB port on the computer
  - Contains multiple USB ports

What are other special-purpose ports?
- IrDA port on printer
- 1394 port (FireWire) – connect multiple devices
- MIDI port – musical instrument digital interface
- SCSI port – small computer system interface
- IrDA port – transmit data via infrared light waves
  - FIR (fast infrared)

What is a bus?
- Electrical channels that allow various devices inside the computer to communicate with each other
- Bus width determines the number of bits transmitted at one time
- Word size determines the number of bits the processor can interpret and execute at a given time

What are the two basic types of buses?
- System bus
  - Part of the motherboard that connects the processor to main memory
- Expansion bus
  - Allows the processor to communicate with peripheral devices

What are the types of expansion buses?
- Bus type determines type of expansion card you can add
  - ISA (Industry Standard Architecture)
- Local bus
  - VESA local bus
  - PCI (Peripheral Component Interconnect)
- Accelerated Graphics Port (AGP)
- Universal serial bus (USB)
- PC Card bus
**What is a bay?**

- An open area inside the system unit used to install additional equipment
- Drive bays
- Used for disk drives
- External drive bay
  - Also called exposed drive bay
  - Accessible from outside the system unit
- Internal drive bay
  - Also called hidden drive bay
  - Concealed entirely within the system unit

**Power Supply**

**What is a power supply?**

- Converts alternating current (AC, 115 to 120 volts) to direct current (DC, 5 to 12 volts)
- Some peripheral devices have an AC adapter

**Mobile Computers**

**What is a mobile computer?**

- Notebook or handheld
- Notebook computers typically weigh four to ten pounds
- Includes a system unit with many other devices built into it

**What is inside a mobile computer?**

- Inside of a notebook computer
- Inside of a handheld computer

**How is data transferred from a handheld computer?**

- An IrDA port allows the handheld computer to communicate wirelessly with other computers or devices
- Handheld computers also can rest in a cradle, so you can transfer data to your desktop computer
What are suggested processor, clock speed, and RAM requirements based on the needs of various types of users?

- **Home**: Pentium® III or AMD-K6® -2-P 500 MHz or higher, 64 MB RAM
- **Mobile**: Pentium® 4 or Athlon™ 800 MHz or higher, 128 MB RAM
- **Small Office/Home Office**: Pentium® 4 or Athlon™ 700 MHz or higher, 128 MB RAM
- **Large Business**: Pentium® 4 or Itanium™ or Athlon™ 1 GHz or higher, 256 MB RAM

**Summary of the Components of the System Unit**
- The system unit
- Central processing unit
- Data representation
- Memory
- Expansion slots and expansion cards
- Ports, buses, bays
- Power supply
- Mobile computers