COURSE TECHNOLOGY
CENGAGE Learning™

Principles of Information Systems, Ninth Edition

Chapter 3
Hardware: Input, Processing, and Output Devices

Principles and Learning Objectives

- Computer hardware must be carefully selected to meet the evolving needs of the organization and its supporting information systems
  - Describe the role of the central processing unit and main memory
  - State the advantages of multiprocessing and parallel computing systems, and provide examples of the types of problems they address

Principles and Learning Objectives (continued)

- Describe the access methods, capacity, and portability of various secondary storage devices
- Identify and discuss the speed, functionality, and importance of various input and output devices
- Identify the characteristics of and discuss the usage of various classes of single-user and multiuser computer systems

Principles and Learning Objectives (continued)

- The computer hardware industry is rapidly changing and highly competitive, creating an environment ripe for technological breakthroughs
  - Describe Moore's Law and discuss its implications for future computer hardware developments
  - Give an example of recent innovations in computer CPU chips, memory devices, and input/output devices

Why Learn About Hardware?

- Hardware
  - Any machinery that assists in the input, processing, storage, and output activities of an information system
- When making hardware decisions, businesses must consider how the hardware can support
  - Objectives of the information system
  - Goals of the organization

Computer Systems: Integrating The Power of Technology

- Hardware Components
  - Central processing unit (CPU)
    - Arithmetic/logic unit, the control unit, and the register areas
  - Arithmetic/logic unit (ALU)
    - Performs mathematical calculations and makes logical comparisons
  - Control unit
    - Sequentially accesses program instructions, decodes them, and coordinates the flow of data in and out of the ALU, registers, primary storage, and even secondary storage and various output devices

Computer Systems: Integrating The Power of Technology (continued)

- Registers
  - High-speed storage areas
- Primary storage
  - Closely associated with the CPU

Hardware Components in Action

- Step 1: Fetch instruction
- Step 2: Decode instruction
- Step 3: Execute instruction
- Step 4: Store results

Hardware Components in Action (continued)

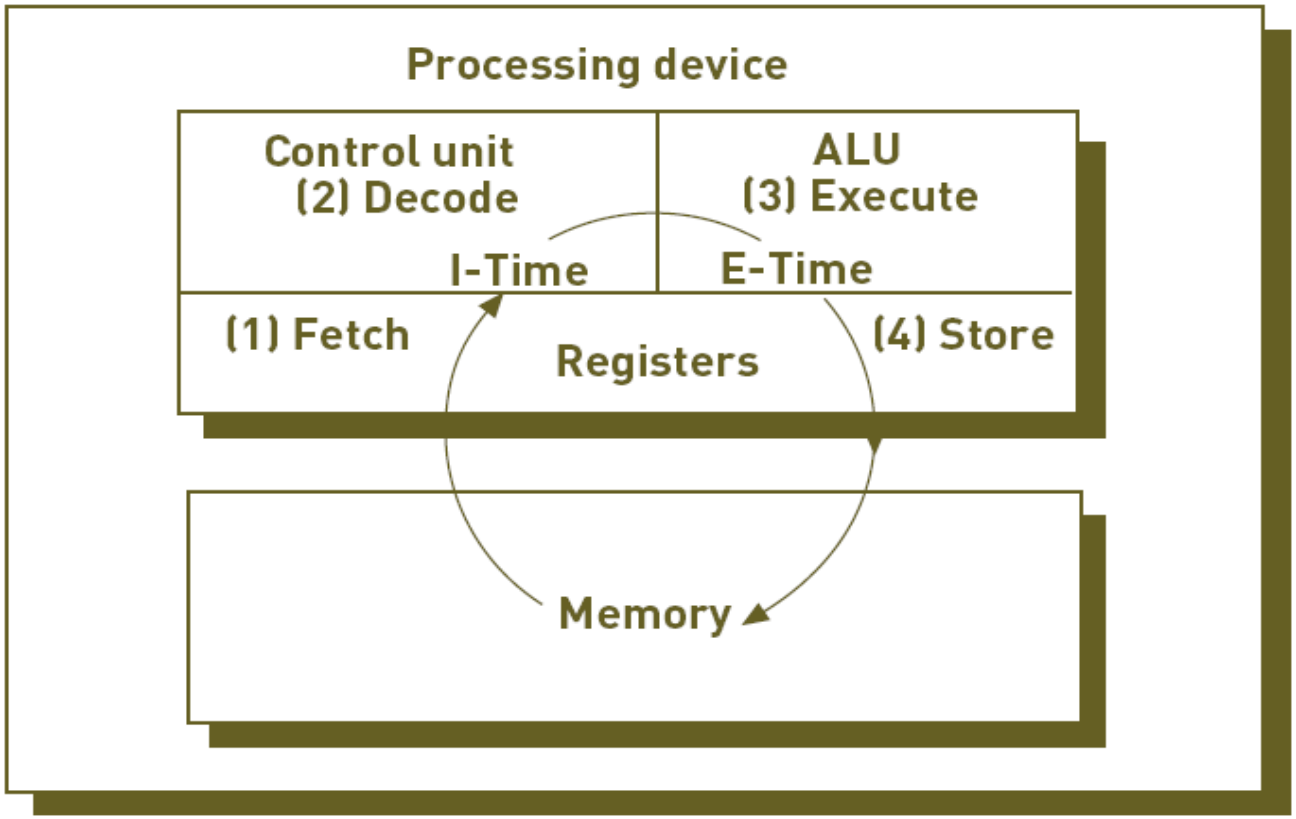

Figure 3.2

Execution of an Instruction

In the instruction phase, a program's instructions and any necessary data are read into the processor (1). Then the instruction is decoded so the central processor can understand what to do (2). In the execution phase, the ALU does what it is instructed to do, making either an arithmetic computation or a logical comparison (3). Then the results are stored in the registers or in memory (4). The instruction and execution phases together make up one machine cycle.

Processing and Memory Devices: Power, Speed, and Capacity

- System unit
  - Houses the components responsible for processing (the CPU and memory)
- All other computer system devices are linked either directly or indirectly into the system unit housing

Processing Characteristics and Functions

- Machine cycle time is measured in:
  - Nanoseconds (1 billionth of a second)
  - Picoseconds (1 trillionth of a second)
  - MIPS (millions of instructions per second)

Processing Characteristics and Functions (continued)

- Clock speed
  - Series of electronic pulses produced at a predetermined rate that affects machine cycle time
  - Often measured in:
    - Megahertz (MHz): millions of cycles per second
    - Gigahertz (GHz): billions of cycles per second
- Microcode
  - Predefined, elementary circuits and logical operations that the processor performs when it executes an instruction

Physical Characteristics of the CPU

- Digital circuits on chips
- Electrical current flows through silicon
- Moore's Law
  - Transistor densities on a single chip double every two years

Memory Characteristics and Functions

- Main memory
  - Located physically close to the CPU, but not on the CPU chip itself
  - Rapidly provides data and instructions to the CPU
- Storage Capacity
  - Eight bits together form a byte (B)

Memory Characteristics and Functions (continued)

Name	Abbreviation	Number of Bytes
Byte	B	1
Kilobyte	KB	2^{10} or approximately 1,024 bytes
Megabyte	MB	2^{20} or 1,024 kilobytes (about 1 million)
Gigabyte	GB	2^{30} or 1,024 megabytes (about 1 billion)
Terabyte	TB	2^{40} or 1,024 gigabytes (about 1 trillion)
Petabyte	PB	2^{50} or 1,024 terabytes (about 1 quadrillion)
Exabyte	EB	2^{60} or 1,024 petabytes (about 1 quintillion)

Table 3.1

Computer Storage Units

Types of Memory

- Random access memory (RAM)
  - Temporary and volatile
- Types of RAM
  - DRAM (Dynamic RAM)
  - DDR2 SDRAM and DDR3 SDRAM
  - Static Random Access Memory (SRAM)
  - Double Data Rate Synchronous Dynamic Random Access Memory (DDR SDRAM)

Types of Memory (continued)

- Read-only memory (ROM)
  - Nonvolatile
  - Provides permanent storage for data and instructions that do not change
- Cache memory
  - High-speed memory that a processor can access more rapidly than main memory

Types of Memory (continued)

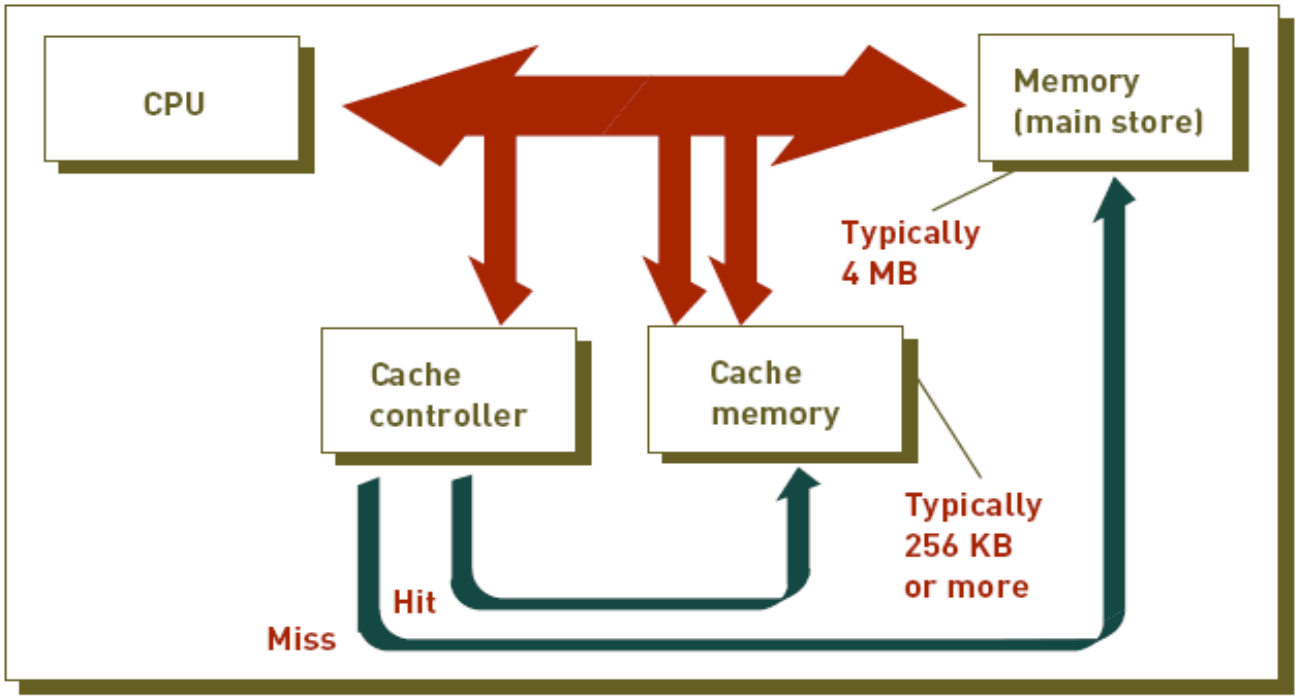

Figure 3.4

Cache Memory

Processors can access this type of high-speed memory faster than main memory. Located on or near the CPU chip, cache memory works with main memory. A cache controller determines how often the data is used, transfers frequently used data to cache memory, and then deletes the data when it goes out of use.

Multiprocessing

- Multiprocessing
  - Simultaneous execution of two or more instructions at the same time
- Coprocessor
  - Speeds processing
- Multicore microprocessor
  - Combines two or more independent processors into a single computer

Parallel Computing

- Parallel computing
  - Simultaneous execution of the same task on multiple processors to obtain results faster
- Massively parallel processing
  - Systems with thousands of such processors
- Grid computing
  - Use of a collection of computers to work in a coordinated manner to solve a common problem

Parallel Computing (continued)

- Cloud computing
  - Uses giant cluster of computers, that serves as a host, to run applications that require high-performance computing
  - Supports a wider variety of applications than grid computing
  - Pools computing resources so they can be managed primarily by software rather than people

Secondary Storage

- Compared with memory, offers the advantages of nonvolatility, greater capacity, and greater economy
- On a cost-per-megabyte basis
  - Most forms of secondary storage are considerably less expensive than primary memory
- Storage media that allow faster access
  - Generally more expensive than slower media

Access Methods

- Sequential access
  - Records must be retrieved in order in which it is stored
  - Devices used called sequential access storage devices (SASDs)
- Direct access
  - Records can be retrieved in any order
  - Devices used are called direct access storage devices (DASDs)

Devices

- Magnetic tapes
- Magnetic disks
- RAID
- Virtual tape
- Optical disks
- Digital video disk (DVD)
- Holographic versatile disc (HVD)

Enterprise Storage Options

- Attached storage
- Network-attached storage (NAS)
- Storage area network (SAN)

Enterprise Storage Options (continued)

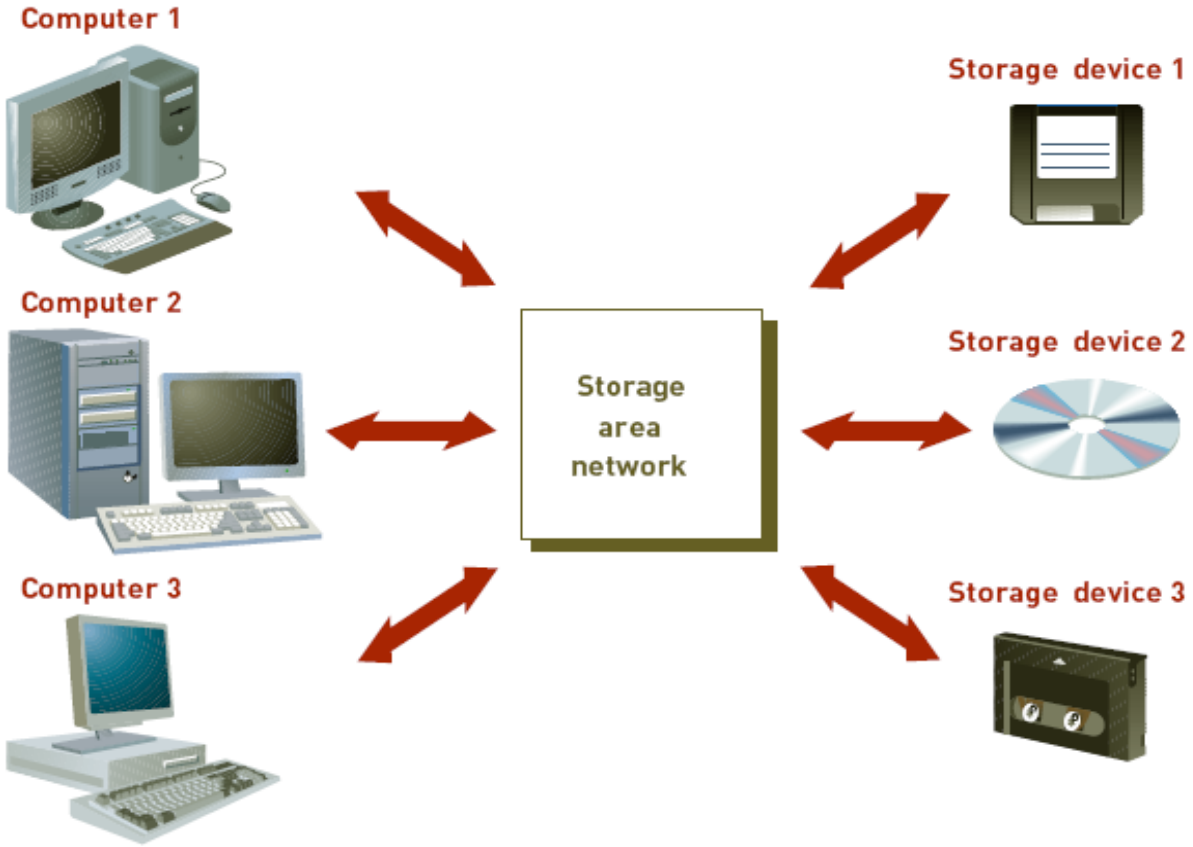

Figure 3.9

Storage Area Network

A SAN provides high-speed connections between data-storage devices and computers over a network.

Input and Output Devices: The Gateway to Computer Systems

- Input and output devices
  - Gateways to the computer system
  - Part of a computer's user interface
- Organizations
  - Should keep their business goals in mind when selecting input and output devices

Characteristics and Functionality

- Data can be human-readable or machine-readable
- Data entry
  - Converts human-readable data into machine-readable form
- Data input
  - Transfers machine-readable data into system
- Source data automation
  - Capturing and editing data where the data is initially created and in a form that can be directly input to a computer

Input Devices

- Personal computer input devices
  - Keyboard
  - Mouse
- Speech-recognition technology
- Digital cameras
- Terminals
- Scanning devices
- Optical data readers
- Magnetic ink character recognition (MICR) devices

Input Devices (continued)

- Magnetic stripe card
- Point-of-sale devices
- Automated teller machine (ATM) devices
- Pen input devices
- Touch-sensitive screens
- Bar-code scanners
- Radio frequency identification

Input Devices (continued)

Figure 3.12

RFID Tag

An RFID tag is small compared to current bar-code labels used to identify items.

(Source: Courtesy of Intermec Technologies Corporation.)

Output Devices

- Display monitors
- Plasma displays
- Liquid crystal displays (LCDs)
- Organic light-emitting diodes
- Printers and plotters
- Digital audio player

Output Devices

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- Organic light-emitting diodes (OLEDs)
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Special-Purpose Input and Output Devices

- E-books
  - Digital media equivalent of a conventional printed book
- Eyebud screens
  - Portable media devices that display video in front of one eye

Computer System Types

- Special-purpose computers
  - Used for limited applications by military and scientific research groups such as the CIA and NASA
- General-purpose computers
  - Used for a wide variety of applications

Computer System Types

- Handheld computers
- Portable computers
- Thin client
- Desktop computers

Computer System Types (continued)

- Workstations
- Servers
- Mainframe computers
- Supercomputers

Summary

- Computer hardware
  - Should be selected to meet specific user and business requirements
- Random access memory (RAM)
  - Temporary and volatile
- ROM (read-only memory)
  - Nonvolatile

Summary (continued)

- Multicore microprocessor
  - Combines two or more independent processors into a single computer so they can share the workload
- Computer systems
  - Can store larger amounts of data and instructions in secondary storage
- Overall trend in secondary storage
  - Toward direct access methods, higher capacity, increased portability, and automated storage management

Summary (continued)

- Data
  - Placed in a computer system in a two-stage process
- Computer systems categories
  - Single user and multiple users
- CPU processing speed
  - Limited by physical constraints such as the distance between circuitry points and circuitry materials
- Cloud computing
  - Involves use of giant cluster of computers