Chapter 5

Computer Organization

OBJECTIVES

- Distinguish between the three components of a computer hardware.
- List the functionality of each component.
- Understand memory addressing and calculate the number of bytes for a specified purpose.
- Distinguish between different types of memories.
- Understand how each input/output device works.

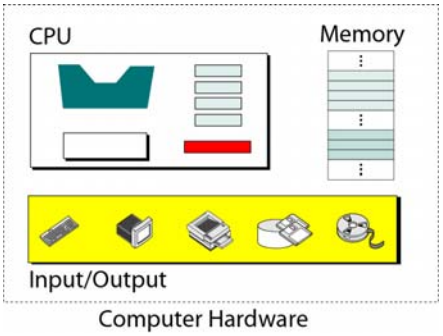
Continued on the next slide

Reading

- Ch5: 5.1, 5.2, 5.3 (skip magnetic tape, skim through the process of creation for CD-R, CD-RW), 5.4 (p 83-85), 5.5 (87-89)

Figure 5-1

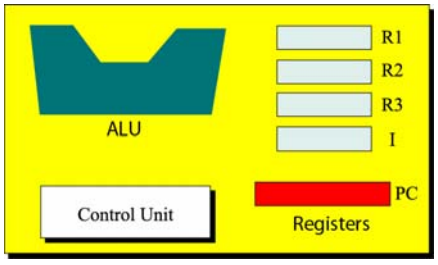
Computer hardware (subsystems)



5.1 CENTRAL PROCESSING UNIT (CPU)

Figure 5-2

CPU



CPU

- Registers are fast stand-alone storage locations that hold data temporarily
- Data Registers
- Instructional Registers
- Program Counter
- Control Unit

5.2 MAIN MEMORY

Main Memory

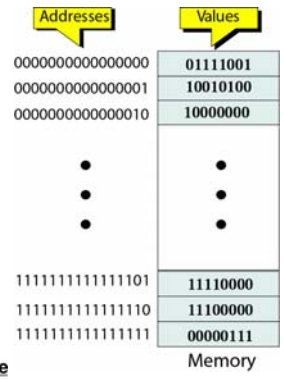
- Main memory is a collection of storage locations, each with a unique identifier called the address
- Word – a group of 8, 16 ,32, 64 bits
- Address space – the total number of uniquely identifiable locations in memory

Table 5.1 Memory units

Unit	*Exact Number of bytes*	*Approximation*
kilobyte	2^{10} bytes	10^{3} bytes
megabyte	2^{20} bytes	10^{6} bytes
gigabyte	2^{30} bytes	10^{9} bytes
terabyte	2^{40} bytes	10^{12} bytes
petabyte	2^{50} bytes	10^{15} bytes
exabyte	2^{60} bytes	10^{18} bytes

Figure 5-3

Main memory



Note:

Memory addresses are defined using unsigned binary integers.

Example 1

A computer has 32 MB (megabytes) of memory. How many bits are needed to address any single byte in memory?

Solution

The memory address space is 32 MB, or 2^{25} (2^5 x 2^{20}). This means you need $\log_2 2^{25}$ or 25 bits, to address each byte.

Example 2

A computer has 128 MB of memory. Each word in this computer is 8 bytes. How many bits are needed to address any single word in memory?

Solution

The memory address space is 128 MB, which means 2^{27}. However, each word is 8 (2^3) bytes, which means that you have 2^{24} words. This means you need $\log_2 2^{24}$ or 24 bits, to address each word.

Memory Types

- RAM (random access memory): write and read, volatile;
- ROM (read only memory): content is written by manufacturer, it's nonvolatile;

Figure 5-4

Memory hierarchy

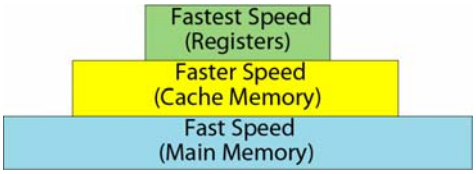
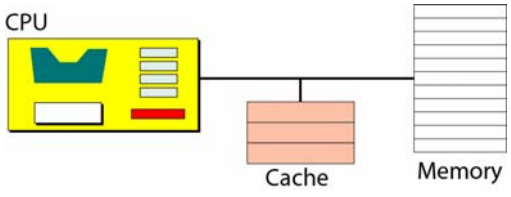


Figure 5-5

Cache



80-20 rule !

- Most computers typically spend 80 percent of the time accessing only 20 percent of the data
- In other words, the same data is accessed over and over again

5.3 INPUT / OUTPUT

Input/Output

- Non-storage devices: keyboard and monitor, printer
- Storage devices: cheaper then main memory and nonvolatile

Figure 5-6

Physical layout of a magnetic disk

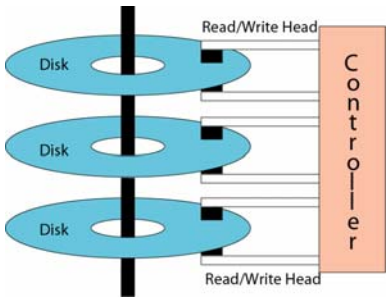
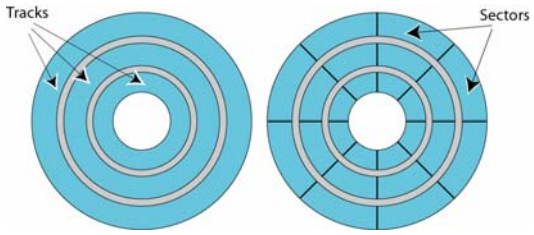


Figure 5-7

Surface organization of a disk



Optical Storage Devices

- Optical storage devices use light to store and retrieve data
- Devices that use this technology include CD-ROM, CD-Rs, CD-RWs and DVDs
- The CD-ROM is read using a low-power laser beam coming from the computer drive
- Low-power laser beam passes in front of the simulated pits and lands
- For a land, the beam reaches the reflective layer and is reflected
- For a simulated pit, the spot is opaque and not reflected

Figure 5-10

Creation and use of CD-ROM

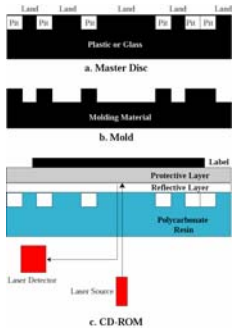


Table 5.2 CD-ROM speeds

Speed	Data Rate		Approximation
1x	153,600	bytes per second	150 KB/s
2x	307,200	bytes per second	300 KB/s
4x	614,400	bytes per second	600 KB/s
6x	921,600	bytes per second	900 KB/s
8x	1,228,800	bytes per second	1.2 MB/s
12x	1,843,200	bytes per second	1.8 MB/s
16x	2,457,600	bytes per second	2.4 MB/s
24x	3,688,400	bytes per second	3.6 MB/s
32x	4,915,200	bytes per second	4.8 MB/s
40x	6,144,000	bytes per second	6 MB/s

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Figure 5-11

CD-ROM format

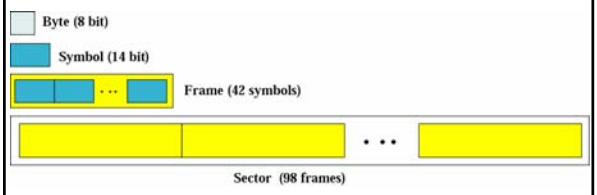

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Table 5.3 DVD capacities

Feature	Capacity
single-sided, single-layer	4.7 GB
single-sided, dual-layer	8.5 GB
double-sided, single-layer	9.4 GB
double-sided, dual-layer	17 GB

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Summary

- A computer has three subsystem: the CPU, main memory, and the input/output subsystem
- The CPU performs operations on data and has an ALU, a control unit, and a set of registers
- The ALU performs arithmetic and logical operations
- The registers are stand-alone storage devices that hold data temporarily
- The control unit oversees operations in a computer
- Main memory is a collection of storage locations

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Summary

- Memory locations are defined using unsigned binary integers
- RAM provides the bulk of the memory in a computer
- The input/output subsystem is a collection of devices that allow a computer to communicate with the outside world
- CD-R is an optical storage device in which the user burns the data onto the disk. The data cannot be erased.
- CD-RW: the data can be erased and rewritten multiple times.
- A DVD is a high-capacity optical storage device

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