HNDIT1032 Computer and Network Systems

Introduction

- From the moment you switch on a computer till you switch it off, computer uses its primary memory.
- When you request for the processing of data and instructions, the processor uses its registers, cache memory, primary memory

and secondary memory.

- As a computer user, you need to be aware of the memory present in a computer.

Memory

What is memory?

- The computer's memory stores data, instructions required during the processing of data, and output results.
- Storage may be required for a limited period of time, instantly, or, for an extended period of time.
- Different types of memories, each having its own unique features, are available for use in a computer.

Memory Representation

1 bit = 0 or 1

1 Byte (B) = 8 bits

1 Kilobyte (KB) = 2^{10} = 1024 bytes

1 Megabyte (MB) = 2^{20} = 1024KB

1 Gigabyte (GB) = 2^{30} = 1024 MB = 1024 *1024 KB

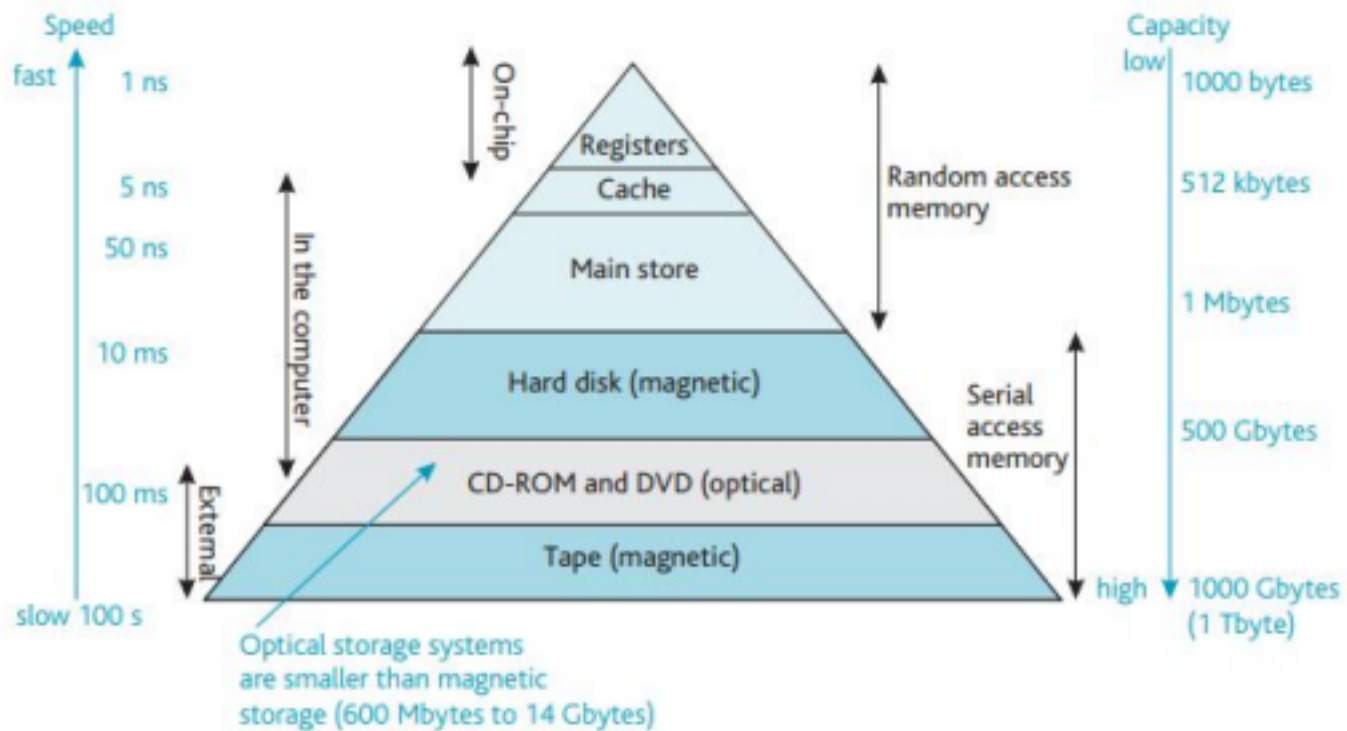1 Terabyte (TB) = 2^{40} = 1024 GB = 1024 * 1024 *1024 KB

Memory Hierarchy

• The memory is characterized on the basis of two key factors—capacity and access time. • Capacity is the amount of information (in bits) that a memory can store.

• Access time is the time interval between the read/ write request and the availability of data. The lesser the access time, the faster is the speed of memory.
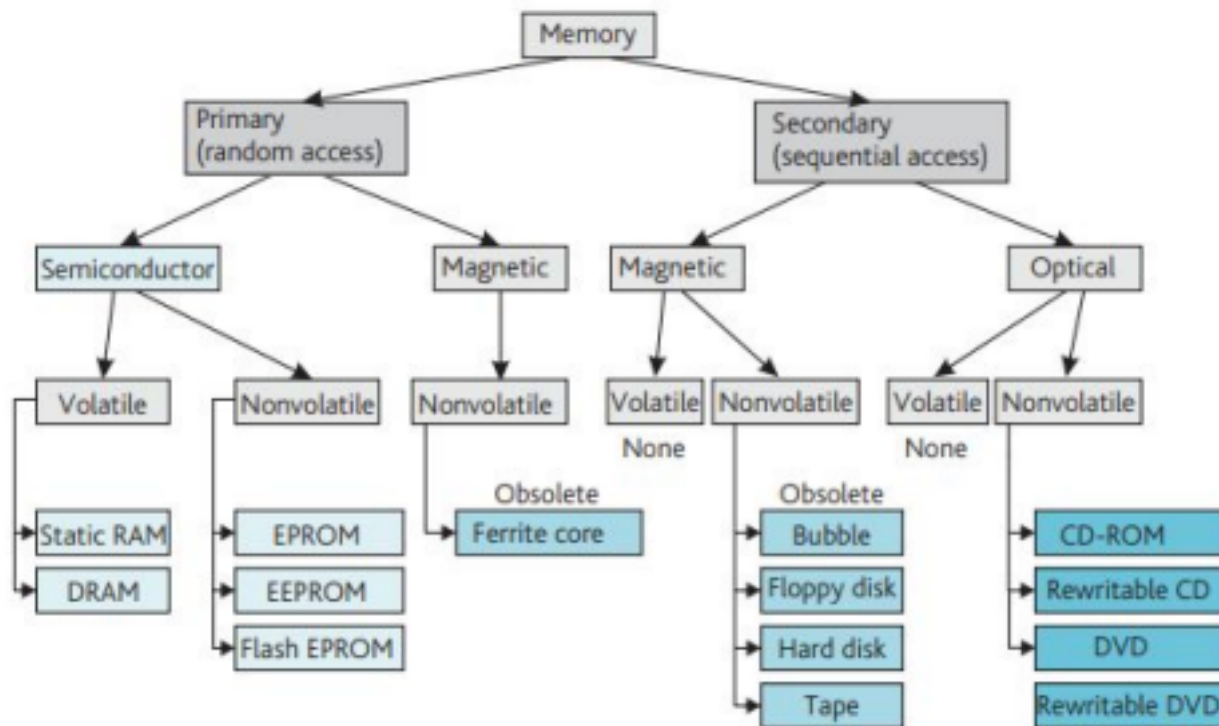
Memory Hierarchy

Speed
fast
1 ns
5 ns
50 ns
10 ms
100 ms
slow 100 s

On-chip

In the computer

External

Registers
Cache
Main store
Hard disk (magnetic)
CD-ROM and DVD (optical)
Tape (magnetic)

Random access memory

Serial access memory

Capacity
low
1000 bytes
512 kbytes
1 Mbytes
500 Gbytes
high
1000 Gbytes (1 Tbyte)

Optical storage systems are smaller than magnetic storage (600 Mbytes to 14 Gbytes)

Classes of Memory

In general, referring to the computer memory
- Internal memory or primary
- Secondary memory

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                          Memory
                        /        \
              Primary              Secondary
          (random access)        (sequential access)
           /        \              /          \
   Semiconductor   Magnetic    Magnetic       Optical
    /       \         |         /    \         /    \
Volatile  Nonvolatile Nonvolatile Volatile Nonvolatile Volatile Nonvolatile
                                   None                 None

                                Obsolete    Obsolete
Static RAM   EPROM      Ferrite core  Bubble      CD-ROM
DRAM         EEPROM                   Floppy disk Rewritable CD
             Flash EPROM              Hard disk   DVD
                                      Tape        Rewritable DVD
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Primary Memory

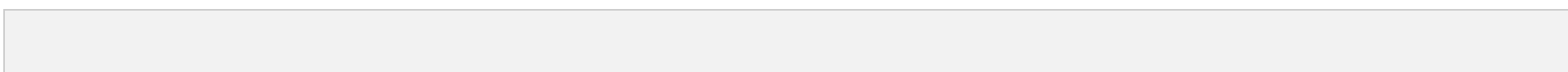Primary memory is the main memory of computer. It is a chip mounted on the motherboard of computer.

Primary memory is categorized into two main types

   Random Access Memory (RAM)

   Read Only Memory (ROM)

Random Access Memory

- RAM is used to store data and instructions during the operation of computer.
- RAM loses information when the computer is powered off. It is a volatile memory.
- When the power is turned on, again, all files that are required by the CPU are loaded from the hard disk to RAM.

Random Access Memory

- RAM provides random access to the stored bytes, words, or larger data units.
- RAM can be read from and written to with the same speed.
- The size of RAM is measured in MB or GB.
- The performance of RAM is affected by— o Access speed (how quickly information can be retrieved).
- The speed of RAM is expressed in nanoseconds.RAM affects the speed and power

of a computer.

Types of RAM

There are two categories of RAM, depending on the technology used to construct RAM
(1) Dynamic RAM (DRAM),
(2) Static RAM (SRAM).

Dynamic RAM(DRAM)

- DRAM is the most common type of memory chip.
- DRAM is mostly used as main memory since it is small and cheap.
- It uses transistors and capacitors.
- DRAM must be refreshed continually to store information.
- Access speed of DRAM ranges from 50 to 150 ns.
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Static RAM(SRAM)

- SRAM chip is usually used in cache memory due to its high speed.
- SRAM uses multiple transistors (four to six), for each memory cell.
- It does not need constant refreshing and therefore is faster than DRAM.
- SRAM is more expensive than DRAM.
- The access speed of SRAM ranges from 2 - 10 nanosecond.

Memory Module

- The memory chips (Figure 3.4) are available on a separate Printed Circuit Board (PCB) that is plugged into a special connect or on the motherboard.
- There are generally two types of RAM modules—Single Inline Memory Module (SIMM) and Dual Inline Memory Module (DIMM).

SIMM & DIMM

Read Only Memory(ROM)

- ROM is a non-volatile primary memory. It does not lose its content when the power is switched
- off.
- ROM comes programmed by the manufacturer. It stores standard processing programs
- that permanently reside in the computer. • The ROM memory chip stores the Basic Input Output System (BIOS) & POST.

Types of ROM

- Programmable ROM (PROM)
- Erasable Programmable ROM (EPROM)
- Electrically Erasable Programmable ROM (EEPROM)
  - Flash Memory is a kind of semiconductor based non-volatile, rewritable computer memory that can be electrically erased and reprogrammed

Storage
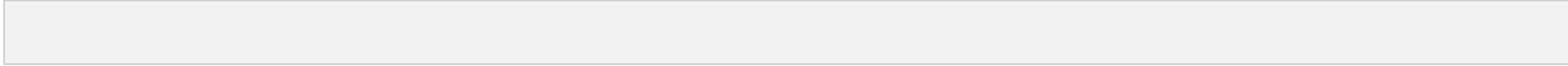
Secondary Memory

· In the previous section, we saw that RAM is expensive and has a limited storage capacity. · Since it is a volatile memory, it cannot retain information after the computer is powered off.

· Thus, in addition to primary memory, an auxiliary or secondary memory is required by a computer.

Secondary Memory

The information stored in storage devices can be accessed in two ways

accessed in two ways
1. Sequential access
2. Direct access

Sequential Access Devices

- Starting from the beginning, in order to locate a particular piece of data.
- Magnetic tape is an example of sequential access device.
- Sequential access devices are generally slow devices.

Direct Access Devices

- Direct access devices are the ones in which

any piece of data can be retrieved in a non-sequential

- manner by locating it using the data's address.
- It accesses the data directly, from a desired · location.
- Magnetic disks and optical disks are examples of direct access devices.

Magnetic Tape

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- Inexpensive storage device
- Can store a large amount of data
- Easy to carry or transport
- Not suitable for random access data
- Slow access device
- Needs dust prevention, as dust can harm the tape
- Suitable for back-up storage or archiving
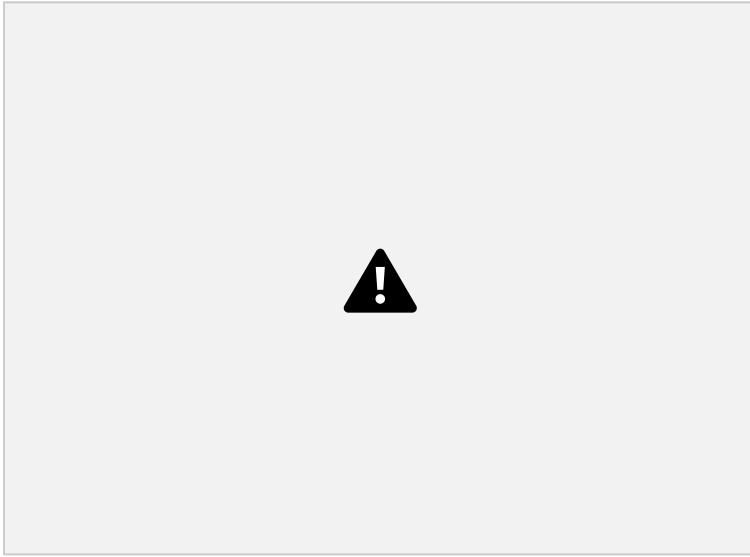
Magnetic Disk

- Magnetic disk is a direct access secondary storage device.
- It is a thin plastic or metallic circular plate

coated with magnetic oxide and encased in a protective cover.

- Data is stored on magnetic disks as magnetized spots.
- The presence of a magnetic spot represents the bit 1 and its absence represents the bit 0.

Magnetic Disk
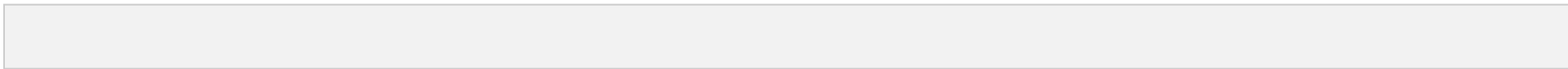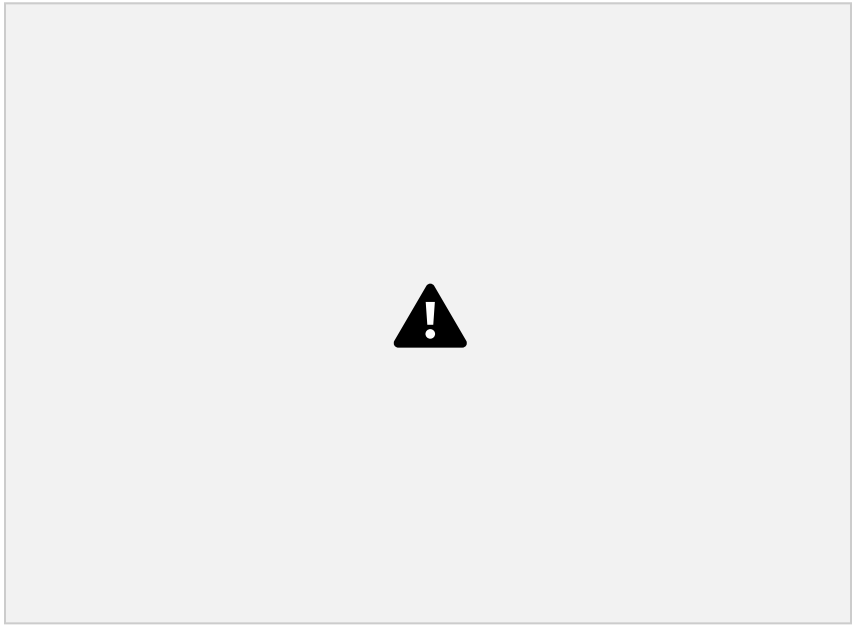
Magnetic Disk

- The time taken to move the read/write head to the desired track is called the seek time. • The time taken for desired sector of the track to come under read/write head is called the latency time.
- The rate at which data is written to disk or read from disk is called data transfer rate.

Floppy Disk

They are portable.

They are small and inexpensive.

They come in two basic sizes—5-¼ inch and 3-½ inch.

The 5-¼ inch disk came around 1987. It can store 360 KB to 1.2 MB of data

Optical Disk

- Optical disk is a flat and circular disk which is coated with reflective plastic material that can be altered by laser light.
- Optical disk does not use magnetism.
- The bits 1 and 0 are stored as spots that are relatively bright and light.
- CD ROM, DVD

CD ROM

- A CD-ROM drive reads data from the compact disk.
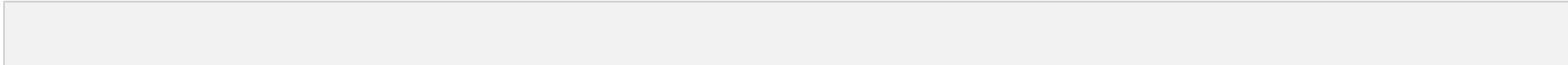- Data is stored as pits(depressions) and lands

(flat area) on CD-ROM disk.
- When the laser light is focused on the disk, the pits scatter the light (interpreted as 0) and the lands reflect the light to a sensor.
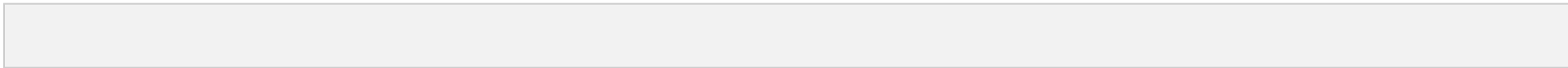
DVD ROM

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- It is a high-density medium with increased track and bit density.
  - DVD-ROM uses both sides of the disk and special data compression technologies.

- The tracks for storing data are extremely small. A full-length movie can be stored on a single disk.
- Each side of DVD-ROM can store 4.7 GB of data, so a single DVD can store 9.4 GBof data.

Central Processing Unit(CPU)

CPU

- Central Processing Unit (CPU) or the processor is also often called the brain of computer.
- CPU
- It consists of Arithmetic Logic Unit (ALU) and Control Unit (CU).
- Also has a set of registers which are temporary storage areas for holding data, and instructions

CPU

CPU executes the stored program instructions, i.e. instructions and data are stored in memory before execution.

For processing, CPU gets data and instructions from the memory.

The CPU is fabricated as a single Integrated Circuit (IC) chip, and is also known as the

microprocessor.

Arithmetic Logic Unit

- ALU consists of two units—arithmetic unit and logic unit.
- Some of the arithmetic operations supported by the arithmetic unit are—addition, subtraction, multiplication and division.
- Logic unit performs comparisons of numbers, letters and special characters.

- Logic operations include testing for greater than, less than or equal to condition

Registers

- ALU performs arithmetic and logic operations, and uses registers to hold the data that is being processed.
- Registers are high-speed storage areas within the CPU, but have the least storage capacity. ·

Registers store data, instructions, addresses and intermediate results of processing.

Registers

Accumulator (ACC) stores the result of arithmetic and logic operations.

Instruction Register (IR) contains the current instruction most recently fetched.

Program Counter (PC) contains the address of next instruction to be processed.

Memory Address Register (MAR) contains the address of next

location in the memory to be accessed.

Memory Buffer Register (MBR) temporarily stores data from memory or the data to be sent to memory.

Data Register (DR) stores the operands and any other data.

Control Unit

- CU coordinates the input and output devices of a computer.
- It directs the computer to carry out stored program instructions by communicating with

the ALU and the registers.

- CU tells when to fetch the data and instructions, what to do, where to store the results,the sequencing of events during processing etc.

References

- Clements, A., The Principles of Computer Hardware, Oxford University Press (4th Ed),

2006.

- https://www.electronics-tutorials.ws/logic