# Chapter=3

~~Data Representation and Number System~~

# COMPUTER MEMORY

## 1. Defination of computer memory :-

Computer memory is a physical device capable of storing information temporarily or permanently. RAM (random access memory) stores information temporarily and ROM (read only memory) stores information permanentaly. Memory devices utilize integrated circuits and are used by operating systems, software and hardware.

## 2. Memory representation :-

i) **Bit** → A bit is a single binary digit i.e. 0 or 1, corresponding to the electrical values of off or on respectively. It is the smallest unit of representation of data in a computer.

ii) **Byte** → A group of 8 bits is called byte. It can handle 256 different combination of bits.

iii) **Kilobyte (KB)** :— A kilobyte (K.B) is 1,024 bytes.

iv) **Megabyte (MB)** :— A megabyte (M.B) is 1024 K.B

v) **Gigabyte (G.B)** :— A gigabyte is 1024 M.B

vi) **Terabyte (T.B)** :— A terabyte is 1024 G.B

**Note** :- A group of bytes can be further combined to form a word.

## 3. Memory Hierarchy:-

The memory is characterized on the basis of two key factors i.e. capacity and access time. The lesser the access time the faster is the speed of memory. The computer uses a hierarchy of memory that is organized in a manner to enable the fastest speed and largest capacity of memory.

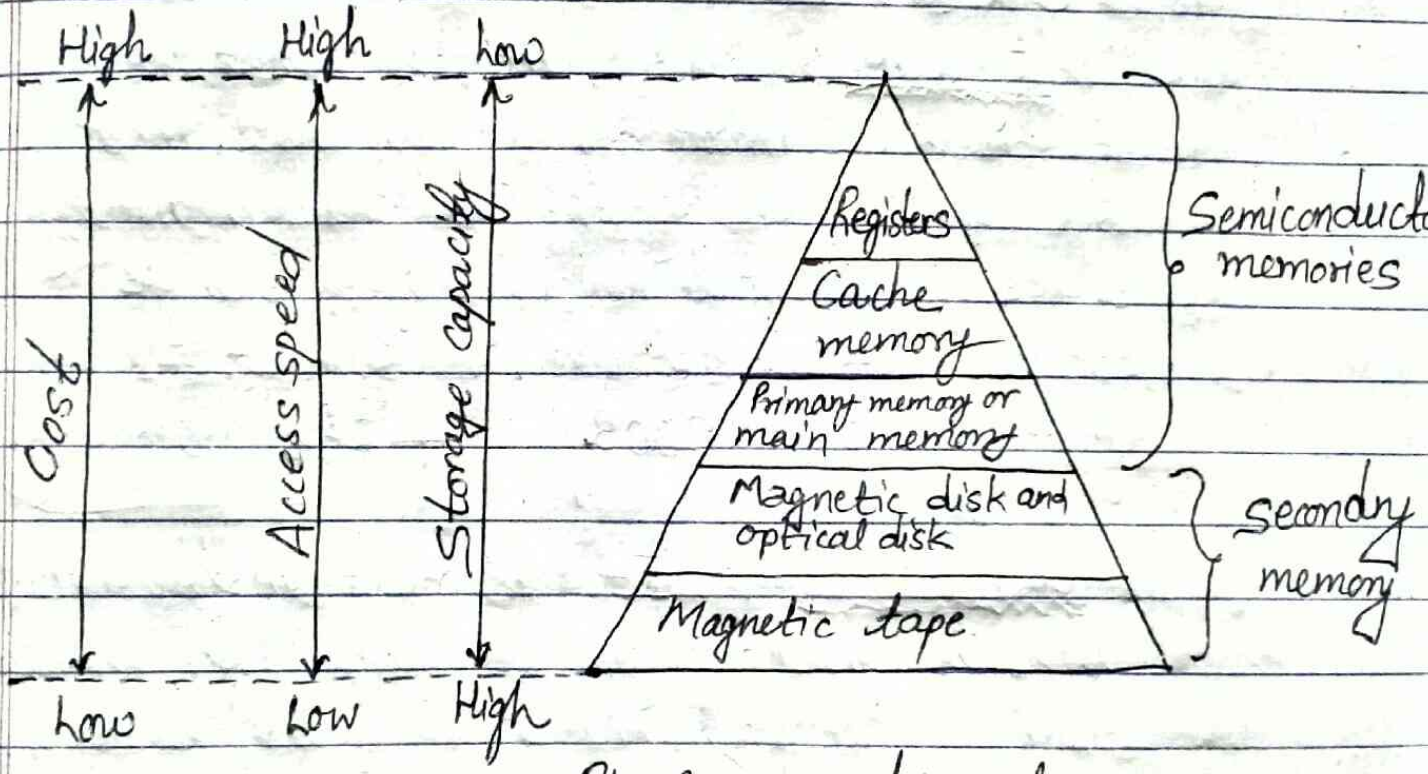


Fig. Memory hierarchy.

Thus the classification of memory on the basis of capacity, access time, cost etc. is called memory hierarchy. In general, referring to the computer memory usually means the interal memory.

### a) Internal memory:-

Key features of internal memory:-

i) limited storage capacity.
ii) temporary storage.
iii) fast access
iv) high cost.

Internal memory constitute of registers, cache memory and primary memory. The primary memory is of further two kinds - RAM and ROM.

i) Registers → registers are the fastest and the most expensive among all memory types. The registers are located inside the CPU, and are directly accessible by CPU. The speed of register is between 1-2 nanosecond. The sum of the size of registers is about 200B. (+ Its working)

ii) Cache memory → It is next in the hierarchy and is placed between the CPU and the main memory. The speed of cache is between 2-10 nanoseconds. The cache size varies between 32 KB to 4 MB. (+ Its levels)

iii) Primary memory → Any program or data that has to be executed must be brought into RAM from the secondary memory. The speed of RAM is around 60 nanoseconds. The RAM size varies from 512 KB to 3 GB. The primary memory is further of two kinds RAM and ROM.

Primary memory and its types

accessed directly by CPU, holds currently working data and instructions, limited capacity and data is lost when powered off, made of semiconductor device, volatile memory, working memory of computer, divided into 2 types

(*) Explain functions of memory.

EPROM PROM
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(*) Discuss different auxilary storage devices in detail.

(a) Random Access Memory (RAM) :-

RAM is used to store data and instructions during the operation of computer. CPU interacts with RAM to get the data and instructions for processing. RAM looses information when the computer is powered off. It is a volatile memory, so it can not store permanentaly. When the power is turned on, again all the fieles required by the CPU are loaded from hard disk to RAM. The size of RAM is limited due to its high cost. RAM affects the speed and power of computer. There are two types of RAM depending on the technology used to construct RAM, they are as follows:-

DRAM → Dynamic RAM (DRAM) is the most common memory chip. It is mostly used as mainy memory since it is small and cheap. It uses transistors and capacitors. The capacitor holds the bit of information 0 and 1 which act as switch. The transistor and capacitor are paired to make a memory cell.

DRAM must be refreshed continiously to store information. For this, a memory controller is used. The memory controller recharges all the capacitors holding a 1 before they discharge. DRAM is slow because the refreshing takes time. Access speed of DRAM ranges from 50 to 150 ns.

SRAM → Static RAM (SRAM) is usually used in cache memory due to its high speed. It uses multiple transistors (four to six), for each memory cell. It does not have capacitor in each cell. A SRAM memory cell has more parts so it takes more space on a chip than DRAM cell.

It does not need constant refreshing and therefore is faster than DRAM. It is more expensive than DRAM and takes more space. It stores information as long as it is supplied with power. The access speed of SRAM ranges from 2-10 nanosecond.

(b). Read only Memory (ROM):-

It is non-volatile primary memory. It does not loose it's content when the power is switched off. It has only read capability and no write capability. After, the information is stored in ROM, it is permanent and cannot be corrected. ROM comes programmed by manufacturer. It ~~doe~~ stores the data needed for the start up of computer. The ROM stores the Basic Input Output System (BIOS). It provides the system with the settings and resources that are available on the system. When the computer is turned on, the BIOS does following things:-

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i) Power On Self Test (POST):- It checks that the major hardware components are working properly or not.

ii) BIOS setup [redacted]:- It set many functions for user that control how computer works. BIOS displays the system settings and finds the bootable devices. It loads the device drivers.

iii) Bootstrap loader:- It is a program whose purpose is to start the computer software for operation when the power is turned on. It loads the operating system into RAM and launches it.

ROMs are of different kinds, some of the main kinds are as follows:-

i) Programmable ROM (PROM):- It is a programmable ROM. In PROM, user can store programs only once. The process of making program in PROM is called burning. High voltage (12V) is applied to the fuses to be burnt. The burnt fuses correspond to 0 and the others to 1.

ii) Erasable PROM (EPROM):- It is erasable PROM. Informations can be removed by ultra violet rays. It is cheaper than PROM because it is re-usuable. EPROM chips have to be removed from computer for re-writing.

iii) Electricity Erasable PROM (EEPROM):- It is electricity erasable PROM. Informations can be removed by electric signals. EEPROM chips do not have to be removed from computer for re-writing.

iv) Secondry Memory :- (Auxilary memory).

The secondary memory is also called the auxilary memory and storage device of computer. In comparision to the primary memory the secondry memory stores much larger amounts of data and information for extended periods of time. The data and instructions stored in secondry memory must be fetched into RAM before processing is done by CPU. Magnetic tape drives, magnetic disk drives, optical disk drives and magneto-optical disk drives are the different types of storage devices.

a) Magnetic tape :-

It is a plastic tape with magnetic coating. It is a storage medium on a large open reel or cassette. They are cheaper storage media. They are durable, can be written, erased and re-written. Magnetic tapes are generally used to store back-up data that is not frequently used or to transfer data from one system to other.

Working of magnetic tape → Magnetic tape is divided horizontally into tracks and vertically into frames. A frame stores one byte of data and a track in a frame stores one bit. Data is recorded on tape in the form of blocks, where a block consists of a group of data also called as records. The magnetic tape

moves on tape drive from the supply reel to take-up reel, with its magnetic coated side passing over the read/write head.

Features:-

i) Inexpensive storage device.
ii) Can store a large amount of data.
iii) Easy to carry or transport.
iv) Slow access device.
v) Needs dust prevention, as dust can harm the tape.

(b) Magnetic disk:-

It is a thin plastic or 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. It is a direct access secondy storage device.

Working of magnetic disk →

The surface of magnetic disk is divided into concentric circles known as tracks. The outermost track is numbered 0 and the innermost ~~data~~ track is the last track. It is inserted into a magnetic disk drive for access. The drive consists of a read/write head that is attached to a disk arm, which moves the head. The disk arm can move inward and outward on the disk.

Features:-

i) Cheap storage device.
ii) Can store a large amount of data
iii) Easy to carry or transport.
iv) Fast access device.
v) More reliable storage device.

Types

Magnetic disk are of ~~following~~ many types ~~floopy~~ Floppy disk, hard disk and zip disk are some of them.

Floppy disk →

Floppy disk is a flat, round, single disk made of Mylar plastic and ~~et~~ enclosed in square plastic jacket. Floppy Disk Drive is a ~~drive~~ disk drive for floppy disk. They are portable. They can be removed from the disk drive, carried or stored separately. They are small and inexpensive. A floppy disk may be single sided or double sided.

Hard disk → Hard disk is a fixed disk. The disk is not removable from the drive, unlike floppy disk. It can store much more data than floppy disk. Hard disk is the key secondary storage device of computer. The operating systems are stored on the hard disk.

Zip disk → Zip disk are high-capacity removable disk and drive. These have the speed and capacity of hard disk and portability of floppy disk. The capacity of zip disk ranges from 100MB to 750MB. They can be used to store large files, audio and video 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. An optical disk consists of a single spiral track that starts from the edge to the centre of disk. The random access on optical disk is slower than that of magnetic disk, due to its spiral shape. The access time for an optical disk ranges from 100 to 200 ms. Mostly there are two types of optical disks read only optical disks and recordable optical disks.

Types

1) CD-ROM → Compact Disk (CD) was a popular medium for storing music. Now, it is used in computers to store data and is called Compact Disk – Read Only Memory (CD-ROM). It is an optical disk that only can read. As CD-ROM is read only, no changes can be made into the data contained in it. It is commonly used medium for distributing software and large data.

2) DVD-ROM → Digital Versatile Disk (DVD) Read Only Memory (DVD-ROM) is an optical storage device used to store digital video or computer data. DVD's look like CD's in shape and physical size. It improves on CD technology. A full-length movie can be stored on a single disk. It has more storage capacity than CD's.

+ Sequential access and direct access short description (only concept)

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### Recordable optical Disk:-

In addition to the read only CD's and DVD's, recordable Optical disks are also available. Users can record music, video, audio and data on it. The recordable Optical disks are:-

Compact disk-Recordable (CD-R) → It allows user to write data permanentaly on the disk. Once the data is written it can not be erased. CD-R disk uses a laser that burns pits into the disk surface. It looks like a CD disk externally.

Compact Disk-ReWritable (CD-RW) → It allows data to be written, erased and re-written on. The capacity of CD-RW is same as a CD.

Digital Video Disk-Recordable (DVD-R) → It allows recording of data on a DVD. The data once written on a DVD cannot be erased or changed.

### (d) Magneto-optical disk:-

Magnetic-optical disks use laser beam to read data and magnetic field to write data to disk. These are optical disks where data can be written, erased and re-written. They are expensive and outdated. They were used during the mid 1990's. They have now been replaced by CD-RW and DVD-R.

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Q. Different Memory Used by Computer from Switched on till the time it is switched off.

The computer starts using the memory from the moment the computer is switched on, till time it is switched off. The list of steps that the computer performs from the time it is switched on are :-

i) Turn the computer on.
ii) The computer loads data from ROM. It makes sure that all the major components of the computer are functioning properly.
iii) The computer loads the BIOS from ROM. The BIOS provides most basic information to the computer.
iv) The computer loads the OS from hard drive into the system's RAM. As long as the computer is on CPU has direct access to the OS as main parts of OS are maintained in RAM.
v) Now the system is ready for use.
vi) When we load or open an application it is loaded in the RAM.
vii) The CPU requests the data it needs from RAM, processes it and writes new data back to RAM in a continious cycle.
viii) When we save a file and close the application, the file is written to the secondary memory as specified by us.
ix) If the files are not saved to a storage device before being closed, they are lost.
x) Turn off the computer.