

UNIT 3:

Computer Memory and Storage

Computer memory representation

The computer memory stores different kinds of data and instructions.

Binary digit or bit is the **basic unit of memory**.

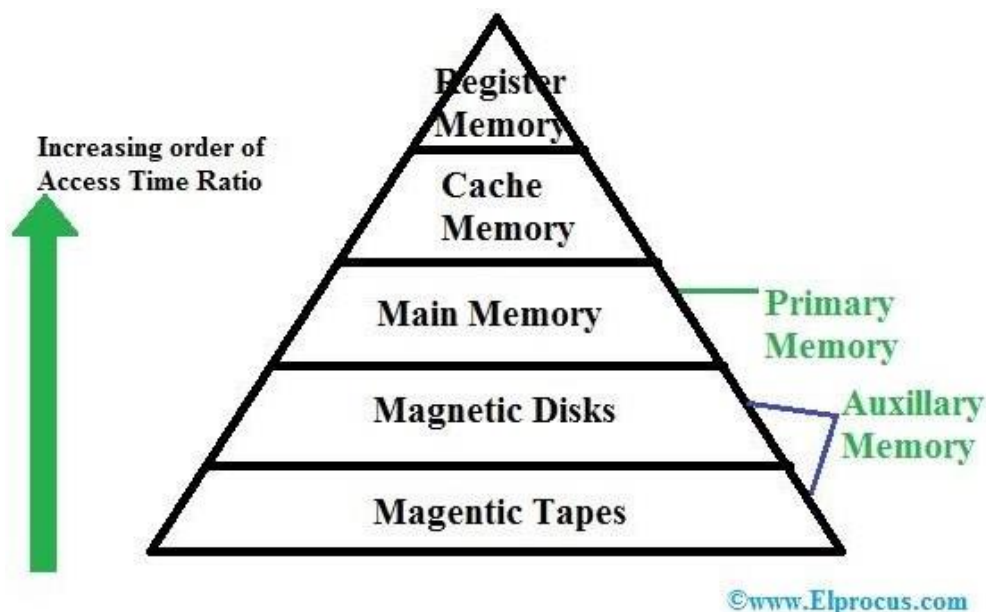
A bit is a single binary digit, i.e., **0 or 1**.

A bit is the smallest unit of representation of data in a computer.

A group of 8 bits form a **byte**.

1 bit	= 0 or 1
1 Byte (B)	= 8 bits
1 Kilobyte (KB)	= 1024 bytes
1 Megabyte (MB)	= 1024KB
1 Gigabyte (GB)	= 1024 MB
1 Terabyte (TB)	= 1024 GB

Memory Hierarchy



The memory in a computer can be divided into **five levels / hierarchies** based on the **speed** as well as **use**.

The processor can move from one level to another based on its requirements. The five hierarchies in the memory are registers, cache, main memory, magnetic discs, and magnetic tapes.

The first three hierarchies are **volatile** memories, whereas the last two hierarchies are **non-volatile**.

Memory hierarchy is divided into two types

1. Primary Memory

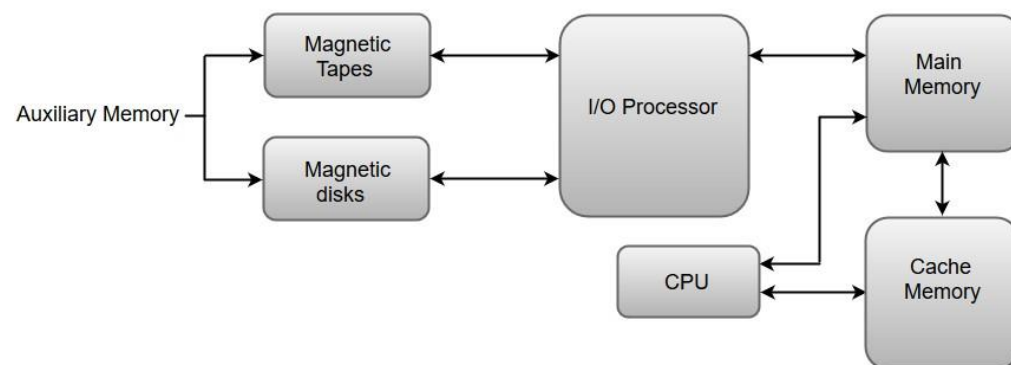
The memory unit that establishes **direct communication with the CPU** is called **Primary Memory**. This memory includes main, cache, as well as CPU registers.

2. Secondary/ Auxiliary Memory

Auxiliary memory is known as the lowest-cost, highest-capacity and slowest- access storage in a computer system.

Auxiliary memory **provides storage for programs and data that are kept for long-term storage** or when not in immediate use. The most common examples of auxiliary memories are magnetic tapes and magnetic disks.

Memory Hierarchy in a Computer System:



I/O Processor

The primary function of an I/O Processor is to manage the data transfers between auxiliary memories and the main memory.

Main Memory

The main memory in a computer system is often referred to as **Random Access Memory (RAM)**. This memory unit communicates directly with the CPU and with auxiliary memory devices through an I/O processor.

The programs that are not currently required in the main memory are transferred into auxiliary memory to provide space for currently used programs and data.

Cache Memory

Cache memory is a **high-speed memory** inside CPU, which is small in size but faster than the main memory (RAM).

Cache memory acts **as a buffer between RAM and the CPU**. Cache memory is used to reduce the average time to access data from the Main memory.

Whenever the CPU requires data, it first checks the cache. If the data is found, it is read from the cache memory (Finding data or instruction in cache is called **cache hit**). Otherwise, the CPU moves onto the main memory (**cache miss**).

The cache memory stores the program currently being executed or which may be executed within a short period of time.

Types of Cache

1. Primary Cache (L1 cache) –

A primary cache is always located on the processor chip. This cache is small and its access time is comparable to that of processor registers.

2. Secondary Cache (L2 cache) –

Secondary cache is placed between the primary cache and the rest of the memory. It is referred to as the level 2 (L2) cache.

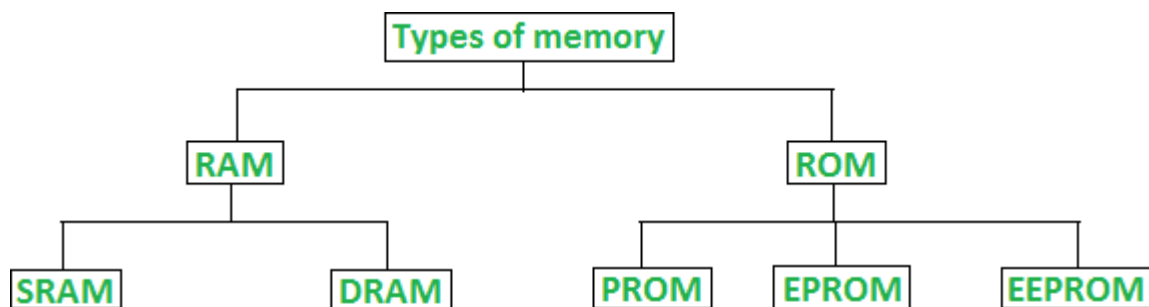
Primary memory

The memory unit that establishes direct communication with the CPU is called **Primary Memory**.

Primary memory stores the intermediate results and final results of the processing before it is stored in the permanent storage. Some of this memory is volatile i.e. contents stored will get erased if power is switched off and some of them are non-volatile i.e. contents cannot be erased.

Primary memory can be classified into two parts:

- Read-Only Memory (ROM)
- Random Access Memory (RAM)



Classification of computer memory

Read-Only Memory (ROM)

ROM is a **permanent memory chip** in motherboard which contains booting programs.

They are present in computers and many other types of electronic products.

The programs inside ROM are executed each time we switch ON the computer.

Normally the contents are not erased.

Types of ROM:

ROM can be broadly classified into 4 types based on their behavior:

- **MROM** (*Masked ROM*)

They are pre-programmed ROM. Program once written cannot be changed anyhow.

- **PROM** (*Programmable ROM*)

- **PROM** can be programmed **once** by the user. Once written the content cannot be altered.

- **EPROM** (*Erasable and Programmable ROM*)

Here the content of ROM can be erased by exposing EPROM to Ultra violet radiation.

- **EEPROM** (*Electrically Erasable and Programmable ROM*)

Here the content of ROM can be erased using electric signals.

However, only one byte can be erased at a time. Hence, reprogramming of EEPROM is a slow process.

Random Access Memory (RAM)

RAM stands for **Random Access Memory**. It is also called "**direct access memory**".

Random access means that data can be accessed **directly**.

RAM is **used to store data and instructions temporarily**. A program must be loaded into RAM before execution.

RAM is volatile memory. It means that its contents are lost when the power is turned off. **RAM is read/write memory**. CPU can read data from RAM and write data to RAM.

It is used to store data and instruction while it is being executed. RAM is also called main memory or primary storage.

RAM plays very important role in the processing speed of a computer. A bigger RAM size provides larger amount of space for processing. So *the processing speed is increased.* The amount of data that can be stored in RAM is measured in bytes. Most desktop computers typically have **2 GB to 4 GM of RAM**. It also allows the addition of more memory if needed.

RAM is of two types –

- **Static RAM (SRAM)**
- **Dynamic RAM (DRAM)**

Difference between Static RAM and Dynamic RAM

SRAM	DRAM
Transistors are used to store information in SRAM.	Capacitors are used to store data in DRAM.
Capacitors are not used hence no refreshing is required.	It needs to be refreshed periodically.
SRAM is faster	DRAM is slower as compared to SRAM.
These are expensive.	These are cheaper.
These are used in cache memories.	These are used in main memories.
SRAMs are low density devices.	DRAMs are high density devices.

Secondary memory

Secondary memory is also known as **External Memory/Auxiliary memory/Backup memory**. It is **used for storing data and instructions both permanently**. It is also used to transfer data from one computer to another.

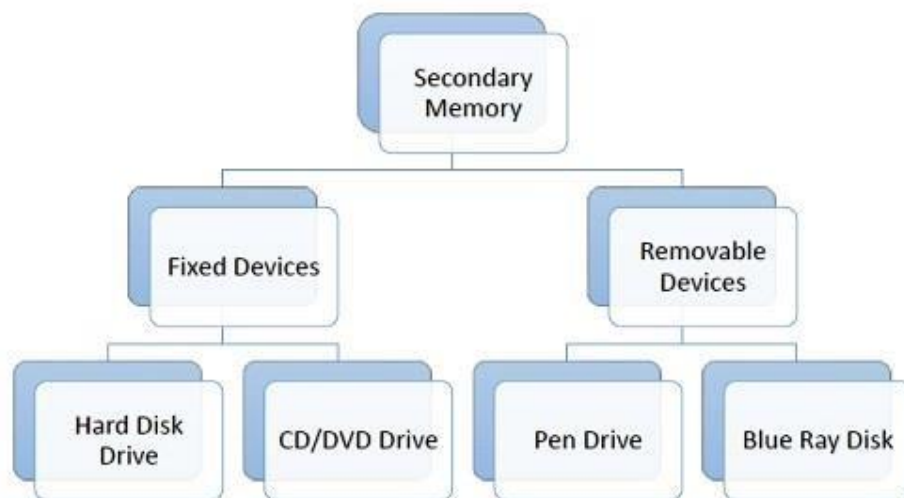
Secondary memory is not directly accessible to the CPU. They are non- volatile in nature and data does not disappear when the computer turned off. Secondary memory is *cheaper than primary memory* and also *slower* in both reading and writing.

Example: Hard disk, CD, DVD, Pen drive, etc.

Uses of secondary memory

- **Permanent storage:** It stores data permanently even if the power supply is off.
- **Large Storage:** It provides large storage
- **Portable:** Some secondary devices are removable. So, we can transfer data from one computer to another.

Types of Secondary memory



Secondary memory is of two types:

1. Fixed devices

Fixed storage is also known as fixed disk drives or **hard drives**. Here data is stored in a built-in fixed storage device.

Types of fixed storage:

- SSD (solid-state disk)
- Hard disk drives (HDD)

2. Removable devices

Removable storage is also known as disks drives or **external drives**.

It is a storage device that can be inserted or removed from the computer according to our requirements. They are portable so that we can easily transfer data from one computer to another. Also, they provide the fast data transfer.

Types of Removable Storage:

- Optical discs (like CDs, DVDs, Blu-ray discs, etc.)
- Memory cards
- Floppy disks
- Magnetic tapes

Secondary memory devices

Floppy Disk

A floppy disk consists of a magnetic disc in a square plastic case. It is used to store data and to transfer data from one device to another device. Floppy disks are available in two sizes

Size: 3.5 inches, the Storage capacity of 1.44 MB

Size: 5.25 inches, the Storage capacity of 1.2 MB.

To use a floppy disk, our computer needs to have a floppy disk drive.

This storage device becomes obsolete now and has been replaced by CDs, DVDs, and flash drives.

Compact Disc

A Compact Disc (CD) is a commonly used secondary storage device. It contains tracks and sectors on its surface. Its shape is circular and is made up of polycarbonate plastic. The storage capacity of CD is up to 700 MB of data. A CD may also be called a CD-ROM (Compact Disc Read-Only Memory), in these computers can read the data present in a CD-ROM, but cannot write new data onto it.

CD is of two types:

CD-R (compact disc recordable): Once the data has been written onto it cannot be erased, it can only be read.

CD-RW (compact disc rewritable): It is a special type of CD in which data can be erased and rewritten as many times as we want. It is also called an erasable CD.

Digital Versatile Disc

A Digital Versatile Disc also known as DVD it looks just like a CD, but the storage capacity is greater compared to CD, it stores up to 4.7 GB of data. DVD-ROM drive is needed to use DVD on a computer. The video files, like movies or video recordings, etc., are generally stored on DVD and you can run DVD using the DVD player. DVD is of three types:

DVD-ROM(Digital Versatile Disc Read only)

DVD-R(Digital Versatile Disc Recordable)

DVD-RW(Digital Versatile Disc Rewritable and Erasable)

Blu-ray Disc

A Blu-ray disc looks just like a CD or a DVD but it can store data or information up to 25 GB data. If you want to use a Blu-ray disc, you need a Blu-ray reader. The name Blu-ray is derived from the technology that is used to read the disc 'Blu' from the blue-violet laser and 'ray' from an optical ray.

Hard Disk

A hard disk is a part of a unit called a hard disk drive. **It is used to storing a large amount of data.** Hard disks or hard disk drives come in different storage capacities.(like 256 GB, 500 GB, 1 TB, and 2 TB, etc.). It is created using the collection of discs known as **platters**. The platters are placed one below the other. They are coated with magnetic material. Each platter consists of a number of invisible circles and each

circle having the same centre called tracks.

Hard disk is of two types (i) Internal hard disk (ii) External hard disk.