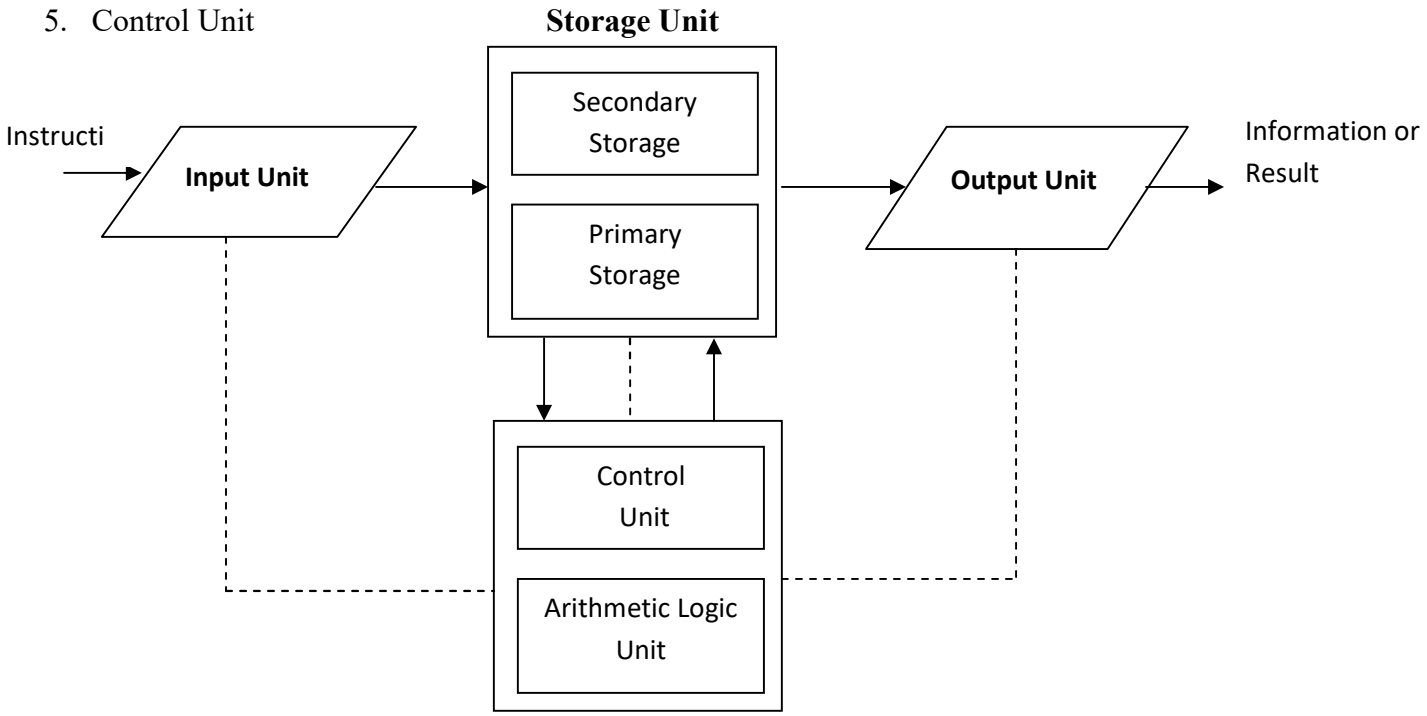
UNIT 1-B

Basic Computer Organization, Units of a computer, CPU, ALU, memory hierarchy, registers, input-output devices

Basic Architecture of Computer

Over the several years the size, processing speed, cost and reliability of computers has changed. But, the basic structure of computer is still the same as was given by Von Neumann in the year 1945 has not changed. According to Von Neumann architecture of computer every digital computer with these components:

1. Input Unit
2. Output Unit
3. Storage Unit
4. Arithmetic Logic Unit
5. Control Unit



Von Neumann Architecture or Basic Architecture of Computer

Input Unit

Input unit connects the external environment with internal computer system. It provides data and instructions to the computer system. Commonly used input devices are *keyboard*, *mouse*, *magnetic tape, scanner, webcam, joystick* etc.

Input unit performs following tasks:

- Accept the data and instructions from the outside environment.
- Convert it into machine language.
- Supply the converted data to computer system.

Output Unit

It connects the internal system of a computer to the external environment. It provides the results of any computation, or instructions to the outside world. Some output devices are *printers*, *monitor, plotter, speaker* etc.

Storage Unit

This unit holds the data and instructions. It also stores the intermediate results before these are sent to the output devices. It also stores the data for later use.

The storage unit of a computer system can be divided into two categories:

- **Primary Storage**: This memory is used to store the data which is being currently executed. It is used for temporary storage of data. The data is lost, when the computer is switched off. RAM and ROM are used as primary storage memory.
- **Secondary Storage**: The secondary memory is slower and cheaper than primary memory. It is used for permanent storage of data. Commonly used secondary memory devices are hard disk, CD etc.

CPU (Central Processing Unit)

It is Central Processing Unit of the computer. The control unit and ALU are together known as CPU. CPU is the brain of computer system. It performs following tasks:

- It performs all operations.
- It takes all decisions.
- It controls all the units of computer

Arithmetic Logical Unit

All the calculations are performed in ALU of the computer system. The ALU can perform basic operations such as addition, subtraction, division, multiplication etc. Whenever calculations are required, the control unit transfers the data from storage unit to ALU. When the operations are done, the result is transferred back to the storage unit.

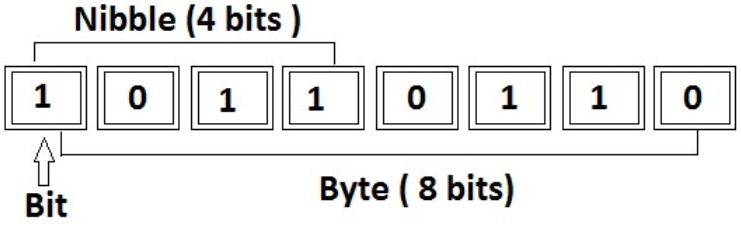
Control Unit

It controls all other units of the computer. It controls the flow of data and instructions to and from the storage unit to ALU. Thus it is also known as central nervous system of the computer.

Memory Units

Computer store data in binary format, binary format contain only two characters 0 and 1. All the information stored/represented in the computer is a code which contain a specific combination of 0's and 1's. The memory units are used to measure the size of data in computer. The memory units are as follow.

1. Smallest Memory Unit – Bit (Binary Digit)
2. Nibble – 4 bits
3. Byte or 1B- 8 Bites
4. Kilobyte or 1KB – 1024 bytes or 2^{10} bytes
5. Megabyte or 1 MB – 1024 Kilobyte or 2^{20} bytes
6. Gigabyte or 1 GB – 1024 MB or 2^{30} bytes
7. Terabyte or 1 TB- 1024 GB or 2^{40} bytes
7. Petabyte or 1 PB- 1024 TB or 2^{50} bytes
8. Exabyte or 1 EB – 1024 PB or 2^{60} bytes
9. Zetta or 1ZB – 1024 EB or 2^{70} bytes
10. Yotta or 1 YB- 1024 ZB or 2^{80} bytes



Memory Hierarchy Design and its Characteristics

Computer memories are broadly divided into two types

1. **External Memory or Secondary Memory** – These memories do not communicate directly with the CPU due to their slow speed in comparison to CPU. Examples of external memory : Magnetic Disk, Optical Disk, Magnetic Tape.

2. **Internal Memory or Primary Memory –** These memories can directly communicate with CPU. Examples of internal memory: Cache Memory & CPU registers.

On the basis of storage capacity, access time and cost per bit the various types of memories can be divided into 5 Levels :

Level 0 - CPU Registers : Processor registers are quickly accessible locations available to a computer's CPU. Registers usually consist of a small amount of fast storage, some registers have specific hardware functions, and may be read-only or write-only

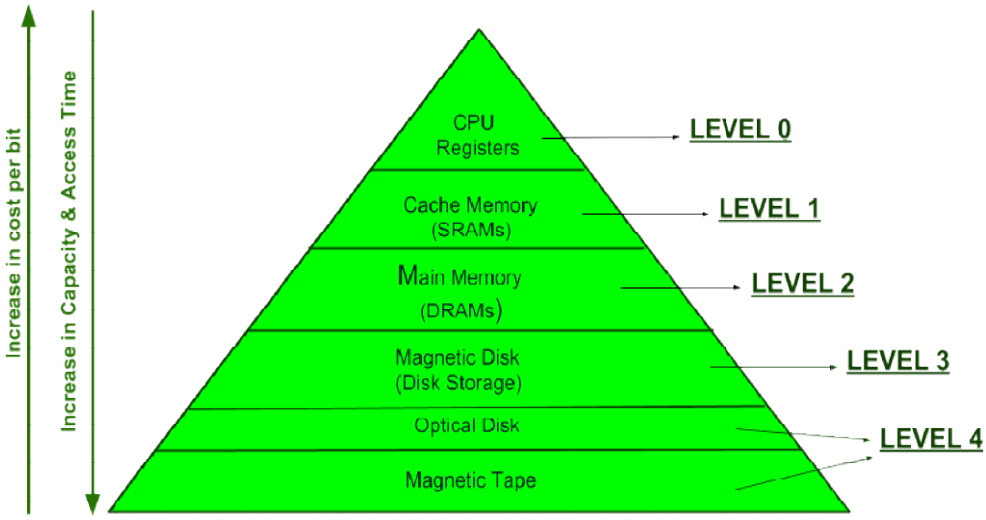
Level 1 - Cache Memory : Cache is hardware or software component that stores data so that future requests for that data can be served faster; the data stored in a cache might be the result of an earlier computation or a copy of data stored elsewhere. Cache is made up of SRAM (Static Random access Memory).

Level 2 - Main Memory : Main memory is used to store the data and instruction that are to be executed by the CPU. It also store the results obtained after the processing of instructions. RAM and ROM are two types of main memory.

Level 3 - Magnetic Disk Storage : It is the most commonly used secondary memory. It store the data on the surface of one or more rotating disks by using magnetic mechanism. HDD and SDD are two categories of magnetic disk storage.

Level 4 – Optical Disk and Magnetic Tape : Optical disk and magnetic disk allow sequential access of data. These memories are mostly used for backup and archiving purpose.

As indicated in the diagram, the storage capacity and access time increases as we move down the memory hierarchy levels where as the cost per bit to store increase as we move up in the memory hierarchy levels.



Memory Hierarchy

Main Memory Organisation

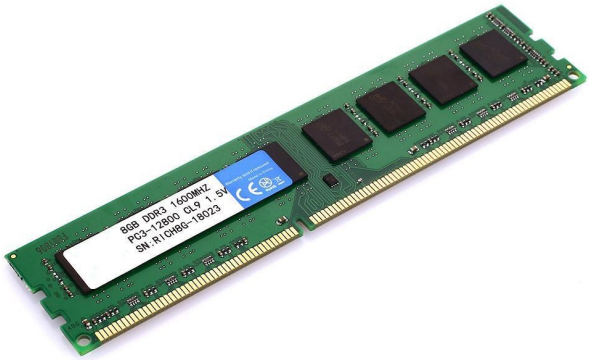
Main memory/ primary memory or Internal Memory stores the data and instruction that can be directly executed by the CPU. Primary memory store data in specific locations called memory location. Each memory location is identified by a unique number called memory address. The smallest amount of data that can be transferred to and from main memory is called memory word.

Primary Memory is of Two Types.

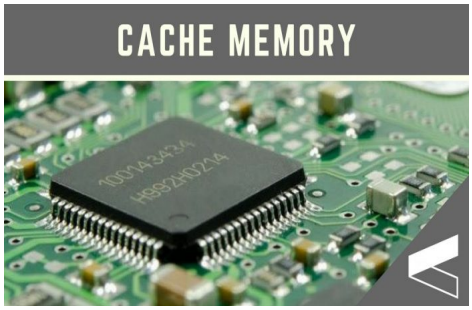
1. RAM (Random Access Memory)

The main characteristics of RAM are as follow :

- The word “random” refers to the fact that any memory location of RAM can be accessed at constant time regardless the physical location.
- RAM is Volatile or Temporary in nature i.e. Once the system is switched off , the information stored on RAM gets erased.
- RAM is read and write memory, it can be read as well as write as per the processing requirements.
- RAM is a semiconductor memory and is very costly in comparison to secondary memory.
- RAM size is limited, the storage size of RAM available these days varies from MB’s to GB’s. Example 512 MB, 1GB, 2GB, 4GB,8GB etc.



- RAM are of two types
  - DRAM (Dynamic RAM) : In this memory the data is continuously refreshed because Dynamic RAM looses data in few milliseconds, It stores data in the form of charge on capacitor which leaks away in short time. Dynamic memory is slower and cheaper than Static RAM.
  - SRAM (Static RAM) : In this memory data remained stored without the need of periodic refresh. Static RAM store uses transistors for data storage; Static RAM is fast and costly as compare to DRAM. One of the most popular example of SRAM is Cache memory.



2. ROM (Read Only Memory) : ROM is built in memory of a computer system. It is very small in size and store firmware, which store instruction which are necessary to run or boot the system.

The main characteristics of ROM are as follow :

- It is a read only memory, we cannot write into it.
- ROM is non volatile or permanent memory, The data and instructions does not get erased when the computer power is switched off.
- In ROM data/instruction are accessed in sequence, Random access is not possible.
- Instruction stored in ROM is executed automatically as soon as computer is switched on.
- There are mainly 3 types of ROM’s
  - PROM (Programmable Read only Memory) : These ROM’s are programmed by computer programmers for some special purposes. Once they are programmed the data gets stored in them permanently.
  - EPROM (Erasable Programmable Read only Memory). The data stored in EPROM’s can be erased by using Ultra Violet (UV) rays and these ROM chips can be reprogrammed.
  - EEPROM (Electrically Erasable Programmable Read only Memory) : The data stored in EEPROMs can be erased completely / partially electrically and new data can be stored on them.

Secondary Memory/ Secondary Storage Devices

Primary memory has two main limitations: Limited storage capacity and volatility. To overcome these limitations almost all computers use additional memory called secondary or auxiliary memory. Secondary memory is permanent, cheap and provides high storage capacity.

There are two methods of accessing information from secondary storage devices : **direct access and sequential access.**

In sequential access the desired information is accessed by searching the data in the sequential manner starting from the first record until the desired record is found, thus the access time here depends upon the distance of the desired information from the beginning.

In direct access method the information is directly fetched from its storage location. In this case search time is independent from the location of the data storage.

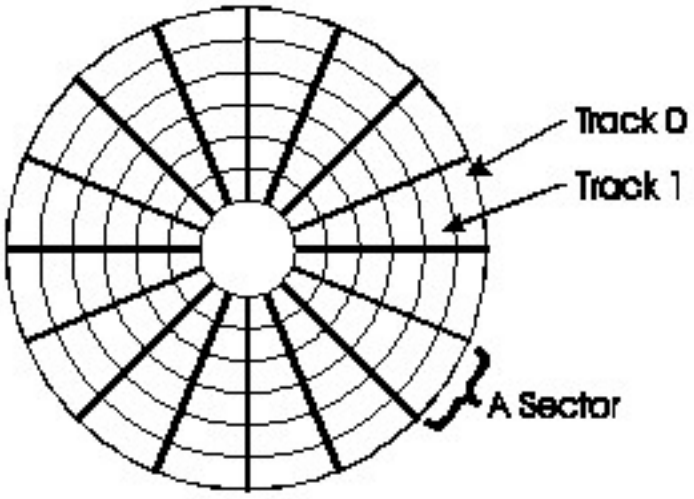
Examples Sequential Access : Magnetic Tape
Direct Access : Magnetic Disk, CD/DVD/ Pen Drive, Memory Card etc.

Brief information about the most common secondary storage devices :

Magnetic Disks: Magnetic disks are the most popular direct access secondary storage devices. A magnetic disk is made up of a thin circular plate / platter of metal or plastic. Its surface on both sides has a coating of magnetic material such as iron oxide that can record data by magnetization. Data is recorded on its coated surface as tiny magnetized and non magnetized spots (Represents 0 and 1).

Storage organization

A magnetic disk's surface has a number of invisible, concentric circles called tracks. A magnetic disk also has a pie shaped segments. If there are eight such segments than each track has eight parts. Each part of the track is called a sector. Typically a sector contains 512 bytes and every sector has a unique address. Magnetic disks store data in EBCDIC (Extended Binary coded decimal Interchange Code).



The disk drive has an access arm assembly having read/write heads for each recordable surface of the disk pack. All access arms of the assembly moves together, for fast data access the disk packs use the concept of cylinder for data organization. A set of corresponding tracks on all recording surfaces of a disk pack together form a cylinder.