Storage Devices

A storage unit is a part of the computer system which is employed to store the information and instructions to be processed. A storage device is an integral part of the computer hardware which stores information/data to process the result of any computational work. Without a storage device, a computer would not be able to run or even boot up. Or in other words, we can say that a storage device is hardware that is used for storing, porting, or extracting data files. It can be used either internally or externally to a computer system, server or any comparable computing device to hold information. It can also store information/data both temporarily and permanently.

The purpose of a storage device is to hold data-even when the computer is turned off-so the data can be used whenever it is needed. Storage involves two processes:

- Writing, or recording, the data so it can be found later for use.
- Reading the stored data, then transferring it into the computer's memory,

Computer storage is of two types:

Primary Storage Devices: It is also known as internal memory and main memory. This is a section of the CPU that holds program instructions, input data, and intermediate results. It is generally smaller in size. RAM (Random Access Memory) and ROM (Read Only Memory) are examples of primary storage.

Secondary Storage Devices: Secondary storage is a memory that is stored external to the computer. It is mainly used for the permanent and long-term storage of programs and data. Hard Disk, CD, DVD, SSD, etc, are examples of secondary storage.

1. Primary Storage Devices

(i) RAM: It stands for Random Access Memory. It is used to store information that is used immediately or we can say that it is a temporary memory. Computers load software from a hard disk into RAM to process it and make it available to the user. Once, the computer is turned off, the data is deleted. With the help of RAM, computers can perform multiple tasks like loading applications, browsing the web, editing a spreadsheet, experiencing the newest game, etc. It allows you to modify quickly among these tasks, remembering where you're in one task once you switch

to a different task. It is also used to load and run applications, like your spreadsheet program, answer commands, like all edits you made within the spreadsheet, or toggle between multiple programs, like once you left the spreadsheet to see the email. Memory is nearly always being actively employed by your computer. It ranges from 1GB – 32GB/64GB depending upon the specifications. There are different types of RAM, although they all serve the same purpose, the most common ones are:

- **DRAM** -Dynamic RAM must be continuously refreshed, or otherwise, all contents are lost.
- **SRAM** – Static RAM is faster, needs less power but is more expensive. However, it does need to be refreshed like DRAM.
- Synchronous Dynamic RAM **(SDRAM)** – This type of RAM can run at very high clock speeds.

(ii) ROM: It stands for Read-Only Memory. The data written or stored in these devices are non-volatile, i.e, once the data is stored in the memory cannot be modified or deleted. The memory from which will only read but cannot write it. This type of memory is non-volatile. The information is stored permanently during manufacture only once. ROM stores instructions that are used to start a computer. This operation is referred to as bootstrap. It is also used in other electronic items like washers and microwaves. ROM chips can only store few megabytes (MB) of data, which ranges between 4 and 8 MB per ROM chip. The most common types of ROM are:

- **PROM:** The full form of PROM is Programmable Read-Only memory. This type of ROM is written or programmed using a particular device.
- **EPROM**: The full form of EPROM is Erasable Programmable Read-only memory. It stores instructions, but you can erase only by exposing the memory to ultraviolet light.
- **EEPROM** stands for electrically Erasable Programmable Read-Only Memory. It stores and deletes instructions on a special circuit.
- **Mask ROM** is a full form of MROM is a type of read-only memory (ROM) whose contents can be programmed only by an integrated circuit manufacturer.

Differences between RAM and ROM

Difference	RAM	ROM
Data Retention	RAM is a volatile memory which could store the data as long as the power is supplied.	ROM is a non-volatile memory which could retain the data even when power is turned off.
Working type	Data stored in RAM can be retrieved and altered.	Data stored in ROM can only be read.
Speed	It is a high-speed memory.	It is much slower than the RAM.
CPU Interaction	The CPU can access the data stored on it.	The CPU cannot access the data stored on it unless the data is stored in RAM.
Size and Capacity	Large size with higher capacity.	Small size with less capacity.
Accessibility	The data stored is easily accessible	The data stored is not as easily accessible as in RAM
Cost	The price of RAM is quite high.	The price of ROM is comparatively low.

2. Secondary Storage Devices

The primary storage of a computer has some limitations. It has limited capacity because the cost per bit of storage is high. It is also volatile; data stored in it is lost when the electric power is turned off or interrupted. Secondary storage is used in a computer system to overcome the limitations of primary storage. It has virtually unlimited capacity because the cost per bit of storage is very low. It has an operating speed far slower than that of the primary storage. It is used to store large volumes of data on a permanent basis. It is also known as "auxiliary memory. Magnetic, optical and solid state devices are different types of secondary storage used to store the data and programs. Each type has different functions in terms of suitability, durability, portability and speed.

Secondary storage devices are generally separated into three types:

- Magnetic Storage Devices
- Optical Storage Devices
- Solid State Storage Devices (SSD)

Magnetic Storage Devices

In the Magnetic storage devices, all data are stored with using magnetized medium, and those types of data saved in that medium in the binary form like as 0 and 1. This magnetic storage has also non-volatile storage nature. Today's, mostly people are preferred to magnetic medium because on the magnetic storage devices can be performed read/write activities very easily. Magnetic storage devices have huge capacities for storing data that it's more attractive point. These storage devices are not more costly but their data accessing power is slow, but this magnetic mechanism also to be used in the RAM that have good data accessing power to other.

Data Storage and Retrieval in Magnetic Storage Devices

The surfaces of magnetic disks and tapes are coated with millions of tiny iron particles so that data can be stored on them. Each of these particles can act as a magnet, taking on a magnetic field when subjected to an electromagnet. The read/write heads of a magnetic disk or tape drive contain electromagnets that generate magnetic fields in the iron on the storage medium as the Tape head passes over the disk or tape. The read/write heads record strings of 1s (Positive Charge) and 0s (Negative Charges) by alternating the direction of the current in the electromagnets. To read data

from a magnetic surface, the process is reversed. The read/write head passes over the disk or tape while no current is flowing through the electro- magnet. The head possesses no charge, but the storage medium is covered with magnetic fields, which represent bits of data. The storage medium charges the magnet in the head, which causes a small current to flow through the head in one direction or the other, depending on the field's polarity. The disk or tape drive senses the direction of the flow as the storage medium passes by the head, and the data is sent from the read/write head into memory.

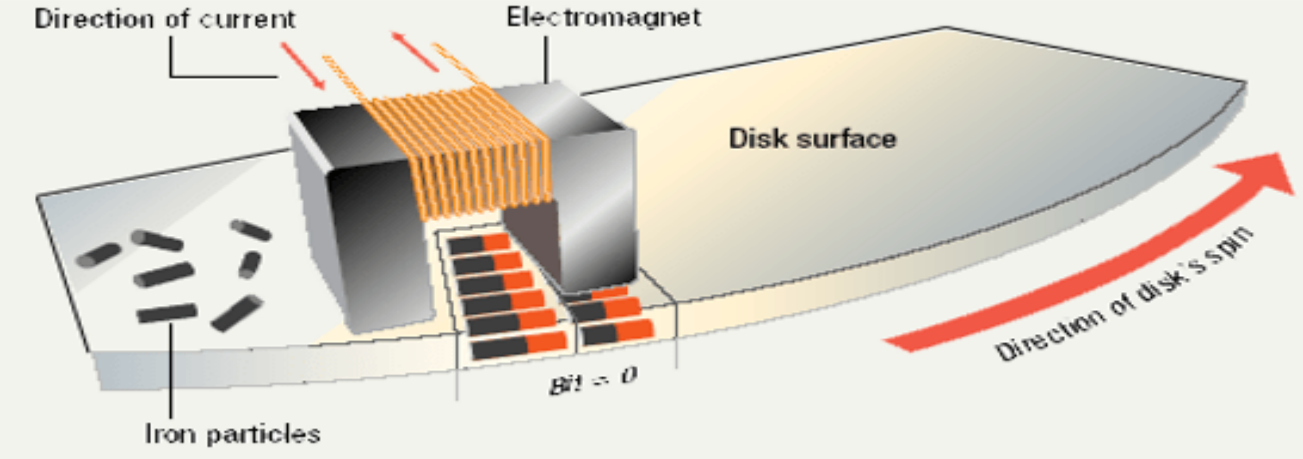

Figure: Data Storage and Retrieval

Storage Capacity Calculation

Storage capacity of a disk= Total number of surfaces x Number of tracks per surface x Number of sectors per track x Number of bytes per sector

Problem; Consider a disk pack with the following specifications- 16 surfaces, 128 tracks per surface, 256 sectors per track and 512 bytes per sector. What is the capacity of disk pack?

Solution;

Given,

- ✓ Number of surfaces = 16
- ✓ Number of tracks per surface = 128
- ✓ Number of sectors per track = 256
- ✓ Number of bytes per sector = 512 bytes

We Know,

Capacity of disk pack

= Total number of surfaces x Number of tracks per surface x Number of sectors per track x Number of bytes per sector

= 16 x 128 x 256 x 512 bytes

= 268435456 Bytes

=268435456/ (1024*1024) MB

= 256 MB

Data Organization in Magnetic Storage Devices

- Disks must be formatted before use
- Format draws tracks on the disk
- Uses magnet to access data
- Tracks is divided into sectors

Data is organized on the disk in the form of tracks and sectors, where tracks are the circular divisions of the disk. Tracks are further divided into sectors that contain blocks of data. All read and write operations on the magnetic disk are performed on the sectors. The floating heads require very precise control to read/write data due to the proximity of the tracks.

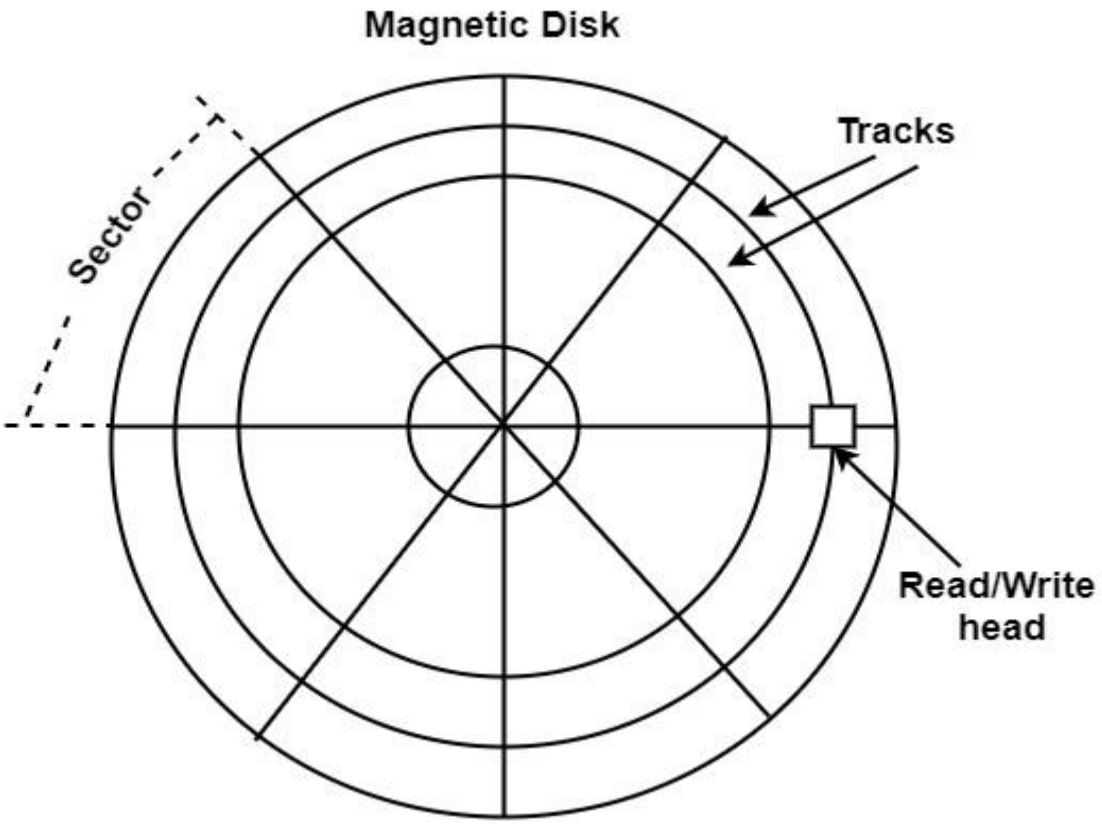

Figure: Tracks and Sectors

Types of Magnetic Storage Devices:-

There are different types of magnetic storage medium (device); below mentioned all:

Hard Drive

Hard drive is also known as the "Hard Disk Drive". Hard drive is a storage area, where are stored your all data (Files and Folders) in magnetic form with physically. It is capable to store data more than 200 GB. Hard drive contains the stack of disks which are mounted internally with solid encasement, and all data is stored on that disk. These disks move very higher speed (5500 to 7500 RPM), so any data can be retrieved immediately from any area on the hard drive. In Hard Drive, All data does not discard after getting to discontinue power supply.

Floppy Disk

Floppy disk was introduced by IBM, in 1969. Floppy disk is also called the "Floppy Diskette". It is a hardware data storage medium that is used in the personal computers. Floppy disk is a plastic

cartridge measuring 3.5 inches square and about 2 millimeters thick, and it is secured with protective casing. In the floppy disk, iron oxide was used to coat internally for storing data in magnetic form, just similar to hard disk. But, now floppy disk is completely obsolete.

Magnetic Tape

Magnetic Tape was introduced by Fritz Pfleumer in 1928, and primary objective of magnetic tape of using was recording voice. It is traditional technology, but now it is replaced by CD and DVD.

Advantages of Magnetic Storage Devices

- Low cost per gigabyte - magnetic tape is the cheapest, but hard disk is very low as well.
- Huge capacity, offers up to several terabytes per device.
- Magnetic tape can hold its data for up to thirty years in the correct environment.

Disadvantages of Magnetic Storage Devices

- Slow read /write compared to new SSD drives.
- Need a special piece of equipment to record and read the data on the tape
- Easily broken if dropped
- The data may be corrupted if the tape is placed near a strong magnetic field e.g. a large speaker or magnet
- High energy uses as it uses moving parts (lower battery life on laptops)
- Not as portable as other technologies. But external hard disks are commonly available, but they need to be treated carefully

Optical Storage Devices

Optical storage is also known as “Optical Media” or “Optical Memory” or “Optical Medium“, and it allows all read and write activities which are performed by laser beam. It is also a secondary storage device. It is a removable storage device. Following are some optical storage devices:

CD-ROM

CD-ROM stands for “Compact Disc Read Only Memory”, and CD-ROM comes in the “Random Access” category’s devices. These types of disc can capable to store almost 650/700 MB of digital data. These data can’t discard by mistaken.

DVD-ROM

DVD-ROM stands for “Digital Versatile Disc – Read Only Memory”, and it also comes in the “Random Access” category’s devices. DVD-ROM discs can store data up to 4.7 GB, but Dual Layer DVD device’s storage capacity is double. These types of disc are used to store ultra-quality video.

Blu-Ray

It is just like CD and DVD but the storage capacity of Blu-ray is up to 25GB. To run a Blu-ray disc you need a separate Blu-ray reader. This Blu-ray technology is used to read a disc from a blue-violet laser due to which the information is stored in greater density with a longer wavelength. It is designed to supersede the DVD format, and capable of storing several hours of high-definition video (HDTV 720p and 1080p). The main application of Blu-ray is as a medium for video material such as feature films and for the physical distribution of video games.

Recordable Optical Devices

The latest innovations in consumer-grade optical technologies allow home users to create their own DVDs, filled with audio and video, music, or computer data. Here are some popular "writable" CD and DVD technologies:

- **CD-R:** It stands for Compact Disc read-only. In this type of CD, once the data is written cannot be erased. It is read-only.

- **CD-RW:** It stands for Compact Disc read Write. In this type of CD, you can easily write or erase data multiple times.
- **DVD-R:** It stands for Digital Versatile Disc read-only. In this type of DVD, once the data is written cannot be erased. It is read-only. It is generally used to write movies, etc.
- **DVD-RW:** It stands for Digital Versatile Disc read Write. In this type of DVD, you can easily write or erase data multiple times.
- **DVD-RAM:** DVD-RAM stands for "DVD-Random Access Memory", and it is able to Re-Write data. DVD-RAM are available in market like as floppy-disc style case. These types of discs have storage capacity of data similar to DVD (up to 4.7 GB). DVD-RAM devices are used in several Camcorders such as "Video Recording Cameras", and it can be used for data back-up and archiving.

Advantages of Optical Storage Devices

- It is capable to store vast amount of data.
- Affordable price
- It can be recycled (Re-used).
- Optical disks offer very high level of Stability. This is because unlike magnetic disks, it is not vulnerable to electromagnetic fields and other forms of environmental influences
- Despite their size, optical disks are still portable.
- It is not subjected to wear and no power failures can cause data losses, which makes it more durable and last for many years.

Disadvantages of Optical Storage Devices

- Some traditional PCs are not able to read these disks.
- It is getting trouble while recycling.
- Optical storage are more vulnerable to loss and theft due to their size.
- Optical disks are susceptible to to scratching because they are not protected by any plastic casings, which makes the disk unreadable. The data on it cannot be recovered anymore.
- The capacity of a CD, which comes in at 650/700 MB, and a DVD, which comes in at around 4.7 GB, is considered to be very little in this modern era.

Solid-State Storage Devices (SSD)

Solid-state storage devices are unique among today's storage devices because they do not use disks or tapes and have no moving parts. Solid-state storage is neither magnetic nor optical. Instead, it relies on integrated circuits to hold data. Some solid-state storage devices are nonvolatile, meaning they can retain their data even when the system's power is turned off. Others are volatile, meaning they require a constant supply of electricity or they will lose their data. The device's volatility depends on the type of memory circuits it uses. Standard magnetic or optical storage is less expensive and more reliable than solid-state storage. However, solid-state storage devices have a big advantage over standard storage devices: speed. Memory devices can move data in much less time than any mechanical storage device. This is because solid-state devices have no moving parts and because they already store data electronically. Flash memory and Smart Cards are examples of solid state storage devices.

Flash Memory

Flash memory is a special type of nonvolatile memory. It is often used in portable digital devices for storage. Digital cameras, portable MP3 players, USB "keychain" storage devices, and game consoles all use flash memory. Flash memory is used to store data in pen drives, SD cards, memory cards, and multimedia cards.

- **Pen Drive:** It is also known as a USB flash drive that includes flash memory with an integrated USB interface. We can directly connect these devices to our computers and laptops and read/write data into them in a much faster and efficient way. These devices are very portable. It ranges from 1GB to 256GB generally.
- **SD Card:** It is known as a Secure Digital Card. It is generally used with electronic devices like phones, digital cameras, etc. to store larger data. It is portable and the size of the SD card is also small so that it can easily fit into electronic devices. It is available in different sizes like 2GB, 4GB, 8GB, etc.
- **Memory Card:** It is generally used in digital cameras, printers, game consoles, etc. It is also used to store large amounts of data and is available in different sizes. To run a memory card on a computer you require a separate memory card reader.

- **Multimedia Card:** It is also known as MMC. It is an integrated circuit that is generally used in-car radios, digital cameras, etc. It is an external device to store data/information.

Smart Cards

Although it looks like an ordinary credit card, a smart card is a device with extraordinary potential. Smart cards contain a small chip that stores data. Using a special device, called a smart card reader, the user can read data from the card, add new data, or revise existing data. Some smart cards, called intelligent smart cards, also contain their own tiny microprocessors, and they function like a computer. Smart cards are finding many purposes---both current and future. For example, large hotels now issue guests a smart card instead of a key; the card not only allows guests to access their room, but it also allows them to charge other services and expenses to the card as well. It may be used to store digital cash that can be used to make purchases in stores or online. Smart cards could store a person's entire medical history, or they could be used as a source of secure ID.

Advantages of Solid-State Storage Devices (SSD)

- It performs fast operations because there are no mechanical parts in SSDs.
- Due to no mechanical parts, it has a lower chance of damage from vibrations, drops, accidents, and other wear and tear, which makes it more durable.
- HDDs have a size restriction, however SSDs don't.
- When the SSDs are in operation, they produce no noise at all because there are no metal platters or read/write arms in them. The noise value of SSDs has been found to be 0 decibels.
- Their lightweight components make them easier to carry.
- They don’t require as much power to operate as hard drives do, which results in a longer battery life.

Disadvantages of Solid-State Storage Devices (SSD)

- Consumer-grade SSDs are more expensive than consumer-grade hard drives.
- Solid state devices are highly expensive and are sold with a hefty price tag unlike conventional HDDs. Thus, SSDs are predominantly available in smaller and affordable storage sizes
- The memory chips in an SSD have a limited number of write cycles, which can lead to unrecoverable data loss.
- Because the data recovery process is so difficult and takes so long, it can be quite expensive.

Cloud and Virtual Storage

Nowadays, secondary memory has been upgraded to virtual or cloud storage devices. We can store our files and other stuff in the cloud and the data is stored for as long as we pay for the cloud storage. There are many companies that provide cloud services largely Google, Amazon, Microsoft, etc. We can pay the rent for the amount of space we need and we get multiple benefits out of it. Though it is actually being stored in a physical device located in the data centers of the service provider, the user doesn't interact with the physical device and its maintenance. These sorts of innovations represent the frontier of where storage media goes. Google Drive, Microsoft One Drive, Mega, Dropbox, Amazon AWS etc. are the example of cloud storage.