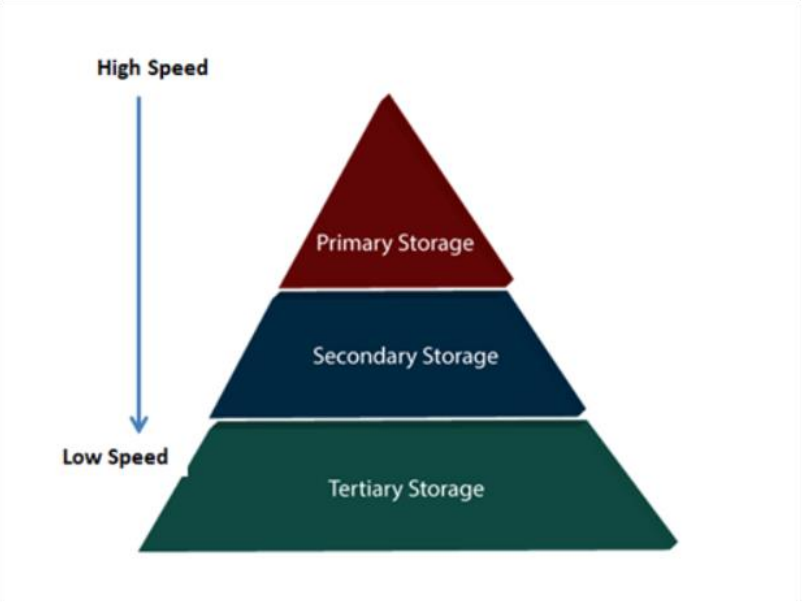
Storage System in DBMS

In a Database Management System (DBMS), the storage system is responsible for efficiently storing, retrieving, and managing data. It involves various components that ensure data integrity, performance, and reliability. There are the following types of storage devices used for storing the data:

1) Primary Storage
2) Secondary Storage
3) Tertiary Storage



1) Primary Storage (Main Memory)

Primary storage refers to **volatile memory** like **Random Access Memory (RAM)** that the DBMS uses to store data temporarily while it is being processed. Since it is much faster than disk storage, data that is currently being worked on or frequently accessed is loaded into RAM to improve performance. However, primary storage is **volatile**, meaning that data is lost when the system shuts down or restarts. For this reason, only a portion of the database (such as active query data, cache, or buffer) can be held in RAM, and the full database is typically stored on disk.

i. **Main Memory:** It is the one that is responsible for operating the data that is available by the storage medium. The main memory handles each instruction of a computer machine. This type of memory can store gigabytes of data on a system but is small enough to carry the entire database. At last, the main memory loses the whole content if the system shuts down because of power failure or other reasons.

ii. **Cache:** It is one of the costly storage media. On the other hand, it is the fastest one. A cache is a tiny storage media which is maintained by the computer hardware usually. While designing the algorithms and query processors for the data structures, the designers keep concern on the cache effects.

2) Secondary Storage (Disk Storage)

Secondary storage refers to **non-volatile storage** systems like **hard disk drives (HDDs)** or **solid-state drives (SSDs)** where the entire database is stored. Unlike RAM, secondary storage retains data even when the power is off, making it suitable for long-term data storage.

Most of the data managed by a DBMS resides in secondary storage. When a query is run, the relevant portions of the database are loaded into RAM for processing. As the size of databases can be vast, they are stored as files, and these files are broken down into fixed-size blocks or pages.

Key characteristics of secondary storage include:

- **Disk I/O**: The process of reading from and writing to disk is called I/O (Input/Output). DBMS minimizes disk I/O to enhance performance by using buffering and caching.
- **Page Size**: The DBMS reads and writes data in chunks known as pages, which are fixed-size blocks (typically 4KB or 8KB).
- **Data Access**: Depending on how data is organized on disk, access can be sequential (reading one record after another) or random (jumping directly to a specific record).

There are some commonly described secondary storage media which are available in almost every type of computer system:

i. **Flash Memory:** A flash memory stores data in USB (Universal Serial Bus) keys which are further plugged into the USB slots of a computer system. These USB keys help transfer data to a computer system, but it varies in size limits. Unlike the main memory, it is possible to get back the stored data which may be lost due to a power cut or other reasons. This type of memory storage is most commonly used in the server systems for caching the frequently used data. This leads the systems towards high performance and is capable of storing large amounts of databases than the main memory.

ii. **Magnetic Disk Storage:** This type of storage media is also known as online storage media. A magnetic disk is used for storing the data for a long time. It is capable of storing an entire database. It is the responsibility of the computer system to make availability of the data from a disk to the main memory for further accessing. Also, if the system performs any operation over the data, the modified data should be written back to the disk. The tremendous capability of a magnetic disk is that it does not affect the data due to a system crash or failure, but a disk failure can easily ruin as well as destroy the stored data**.**

3) Tertiary Storage (Backup Storage)

Tertiary storage refers to **offline storage systems** that are used for **backup and archival** purposes. These storage systems are often slower and less accessible than primary and secondary storage but are essential for **disaster recovery**. Common examples include **cloud storage**, **tape drives**, or **external hard drives**.

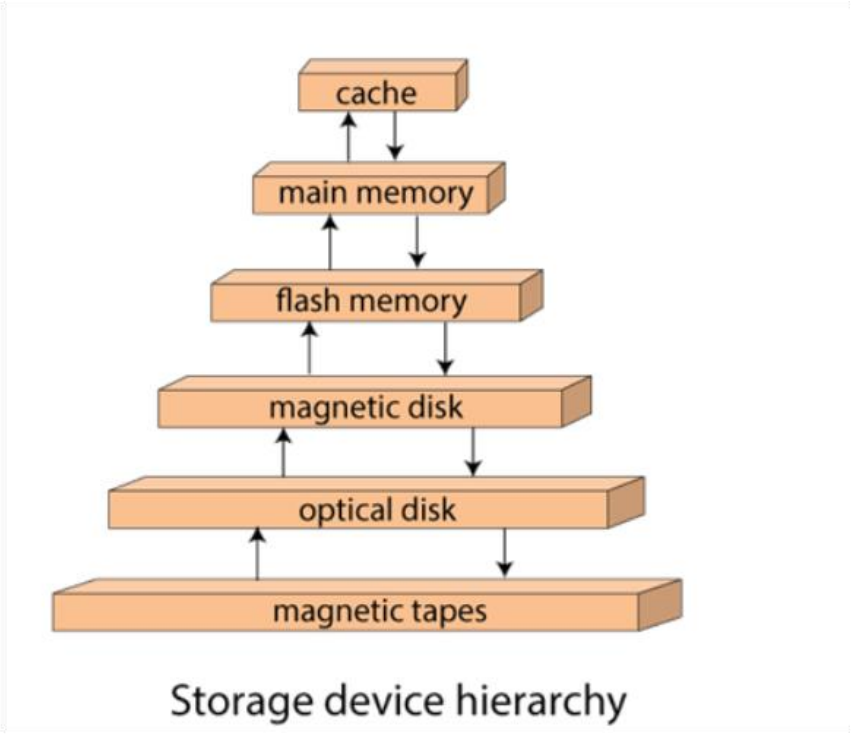
Tertiary storage is particularly useful in the event of hardware failure, corruption, or other catastrophic events. By periodically copying the contents of the database to a backup system, the DBMS ensures that data can be restored and critical operations can resume after a failure.

Here are following tertiary storage devices available:

i. **Optical Storage:** An optical storage can store megabytes or gigabytes of data. A Compact Disk (CD) can store 700 megabytes of data with a playtime of around 80 minutes. On the other hand, a Digital Video Disk or a DVD can store 4.7 or 8.5 gigabytes of data on each side of the disk.

ii. **Tape Storage**: It is the cheapest storage medium than disks. Generally, tapes are used for archiving or backing up the data. It provides slow access to data as it accesses data sequentially from the start. Thus, tape storage is also known as sequential-access storage. Disk storage is known as direct-access storage as we can directly access the data from any location on disk.

Besides the above, various other storage devices reside in the computer system. These storage media are organized on the basis of data accessing speed, cost per unit of data to buy the medium, and by medium's reliability. Thus, we can create a hierarchy of storage media on the basis of its cost and speed.
Thus, on arranging the above-described storage media in a hierarchy according to its speed and cost, we conclude the below-described image:



Storage device hierarchy