

UNIT-3 COMPUTER MEMORY

Outline

- ❑ Introduction Definition of computer memory. Memory Hierarchy Memory hierarchy from registers to magnetic tape.
- ❑ Internal and secondary memory. CPU Registers Description of CPU registers as working memory. Cache Memory Description cache memory and its levels. Primary Memory What is primary memory?
- ❑ Different types of primary memory. Secondary Memory What is secondary memory? Different types of secondary memory? Access Types of Storage Devices Sequential access and direct access. Magnetic Tape Description, working mechanism, and features magnetic tape. Magnetic Disk Description, working mechanism, and features magnetic disc.
- ❑ Different types of magnetic disks. Optical Disk Description, working mechanism, and types of optical disks. Magneto-Optical Disk What is magneto-optical disk? How the Computer uses its memory

WHAT IS COMPUTER MEMORY?

- **Computer memory** is also known as “**Computer Storage Device**” help to store or saves of all important data such as songs, movies, pictures, software, and more.
- Those all data are saved in two different modes it can either temporary or permanent nature.
- All data are stored in **computer memory (computer storage device)** in the digital form such as binary form like as 0 and 1.
- Users can retrieves of saved instruction or information anytime when they are needed

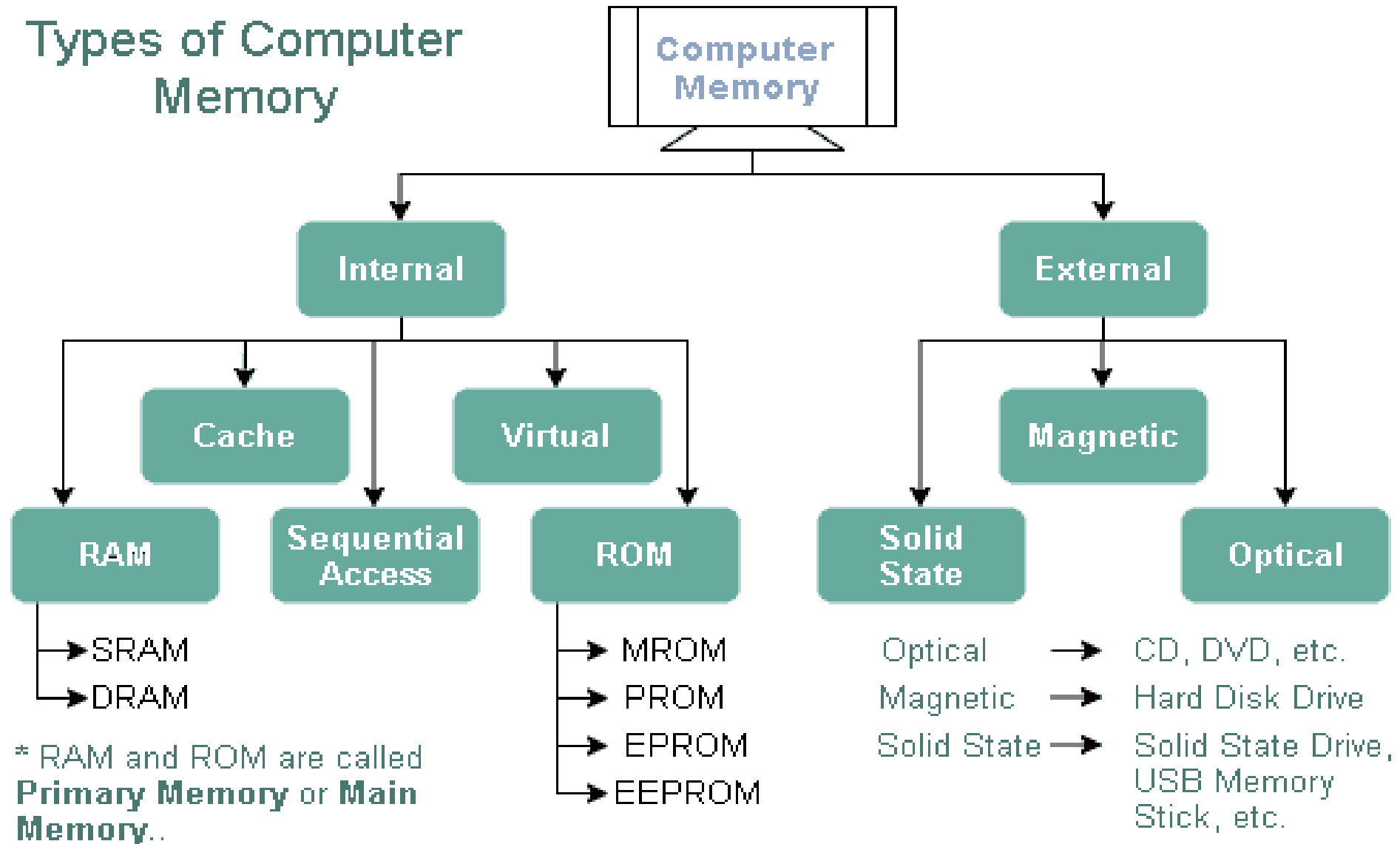
COMPUTER MEMORY

- **Computer memory**, device that is used to store data or programs (sequences of instructions) on a temporary or permanent basis for use in an electronic digital computer.
- Computers represent information in binary code, written as sequences of 0s and 1s.
- Each binary digit (or “bit”) may be stored by any physical system that can be in either of two stable states, to represent 0 and 1.
- Such a system is called bistable. This could be an on-off switch, an electrical capacitor that can store or lose a charge, a magnet with its polarity up or down, or a surface that can have a pit or not.
- Today capacitors and transistors, functioning as tiny electrical switches, are used for temporary storage, and either disks or tape with a magnetic coating, or plastic discs with patterns of pits are used for long-term storage.

TYPES OF COMPUTER MEMORY

- **Computer memory** plays vital role in the computer industry because without **computer memory** entire system like as plastic box.
- There are two types
 - **Primary Memory (Storage Device)**
 - **Secondary Memory (Storage Device)**

Types of Computer Memory



PRIMARY MEMORY (MAIN MEMORY)

- Primary memory holds only those data and instructions on which the computer is currently working.
- It has a limited capacity and data is lost when power is switched off.
- It is generally made up of semiconductor device.
- These memories are not as fast as registers. The data and instruction required to be processed resides in the main memory.
- It is divided into two subcategories RAM and ROM.



CHARACTERISTICS OF MAIN MEMORY

- These are semiconductor memories.
- It is known as the main memory.
- Usually volatile memory.
- Data is lost in case power is switched off.
- It is the working memory of the computer.
- Faster than secondary memories.
- A computer cannot run without the primary memory.

WHAT IS PRIMARY MEMORY(MAIN MEMORY)?

- **Primary memory** is known as “Main Memory” or “Internal Memory” or “Primary Storage Device” or “Internal Storage Device” as well as they play vital role in **computer**, because those memories are capable to access all data directly from **CPU** with the help of various buses.
- These memories have limited capacity for storage and made by integrated circuits (IC) or semiconductor components.
- **Primary storage devices** are available in two variance such as volatile and non volatile.
- Volatile memory is called temporary memory because all data deleted when power get turn off mode but its access time and response time much fine to secondary memory.
- Non volatile memory is permanent memory in which nothing data erase when system is turn off.

WHAT IS PRIMARY MEMORY(MAIN MEMORY)? CONT..

- The operating system and launched all application are loaded into **primary storage device (memory)** while turn on the computer because firstly CPU search all data in **primary memory (storage device)**.
- In this process, data transfer rate is very faster from CPU to RAM compare to transfer rate between CPU to Hard drive.
- So **Primary storage devices (memory)** are more costly compare to secondary memory.

TYPES OF PRIMARY MEMORY(STORAGE DEVICES)

- There are four examples of primary memory (storage device) as well as main memory is very important part of the computer.
- 4 Examples of Primary Memory
 - Register
 - Cache Memory
 - RAM
 - **ROM**

TYPES OF PRIMARY MEMORY(STORAGE DEVICES) CONT..

- Register

- Registers are included in the CPU. They have low capacity for storing the instructions, and data only on before and after processing mode.

- Cache Memory

- This cache memory has higher speed for accessing data, and allows to computer for storing piece of data in temporary nature.
- Cache memory is place at near the CPU and RAM.
- Cache memory speed is very fast because its travel distance is short between RAM to Cache memory.
- There are three types of Cache memory such as – Level 1 cache, Level 2 cache, Level 3 cache.

TYPES OF PRIMARY MEMORY(STORAGE DEVICES) CONT..

- **RAM**
- **RAM is primary memory** and RAM stands for “**Random Access Memory**”.
- Ram is capable to access any data randomly any time as well as from any location to **computer**.
- This is volatile storage memory means to temporary memory in nature, because entire data goes delete while computer get turn off mode.
- RAM regains all data from CPU in run-time and sends to control unit, and it is a fastest memory to hard disk.

TYPES OF PRIMARY MEMORY(STORAGE DEVICES) CONT..

- RAM Types are:
- Static RAM
- Static RAM is also volatile **primary memory**, and it made by flipflop.
- Static Ram works in computer as a form of Cache Memory, but it consumes more power as well as more costly to DRAM.
- In Static RAM uses six transistors, and each transistor use for one bit.
- Dynamic RAM
- Dynamic RAM is other types of RAM, and volatile also in nature. In which use the capacitors for storing data in few milliseconds when power turn on.
- Dynamic RAM has slow speed as well as consume low power but has capable to store more data compare to SRAM.
- DRAM is cost effective as well.

CHARACTERISTIC OF STATIC RAM

- Long life
- No need to refresh
- Faster
- Used as cache memory
- Large size
- Expensive
- High power consumption

CHARACTERISTICS OF DYNAMIC RAM

- Short data lifetime
- Needs to be refreshed continuously
- Slower as compared to SRAM
- Used as RAM
- Smaller in size
- Less expensive
- Less power consumption

TYPES OF PRIMARY MEMORY(STORAGE DEVICES) CONT..

■ ROM

- **ROM is primary memory** and ROM stands for “Read Only Memory”.
- This memory is able to store data in permanently means to have non-volatile in nature.
- ROM is programmable chip because in which stored all instructions that are most required when to start computer.
- This process is known as “Bootstrap”.
- ROM is not limited for computer because these chips use in other equipment like as washing machine and microwave as well.

ADVANTAGES OF ROM

- **Non-volatile in nature**
- **Cannot be accidentally changed**
- **Cheaper than RAMs**
- **Easy to test**
- **More reliable than RAMs**
- **Static and do not require refreshing**
- **Contents are always known and can be verified**

TYPES OF PRIMARY MEMORY(STORAGE DEVICES) CONT..

- There are four **types of ROM** such as:
- **MROM**
- MROM stands for “**Masked ROM**“. MROM has to contain the all pre-planned programs like as piece of instructions, and cheaper as well.
- **PROM**
- PROM Stands for “**Programmable Read Only Memory**“. Users can store any data as per their requirement because these ROM is available in market in blank.
- But in which store instructions (programs) only one time because after filling programs it cannot delete.

TYPES OF PRIMARY MEMORY(STORAGE DEVICES) CONT..

- **EPROM**

- EPROM Stands for “**Erasable and Programmable**“. In these types of ROM, users have power to editing (erase) the stored instruction (program) in EPROM.
- EPROM is erasable by ultra-violet light for some time like as 40 minutes.

- **EEPROM**

- EEPROM Stands for “**Electrically Erasable and Programmable Read Only Memory**“.
- In EEPROM, all activities such as programming and erasing are performed by electrically.
- This EEPROM is able to reprogrammed and erased in more than ten thousand time. Entire chip cannot be erased one time, only erase one byte at once.

RAM

1. Random Access Memory.
2. It is a Read-Write memory.
3. It is a Volatile memory.
4. Data in RAM can be modified.
5. RAM sizes from 64MB to 16GB.
6. Types of RAM are Static RAM and Dynamic RAM.
7. RAM is costlier memory.
8. Temporary storage.
9. Used in normal operations.

ROM

1. Read Only Memory.
2. It is a read only memory.
3. It is a non-Volatile memory.
4. Data in ROM can not be modified.
5. ROM is comparatively smaller than RAM.
6. Types of ROM are PROM, EPROM and EEPROM.
7. ROM is comparatively cheaper than RAM.
8. Permanent storage.
9. Used for startup process of computer.

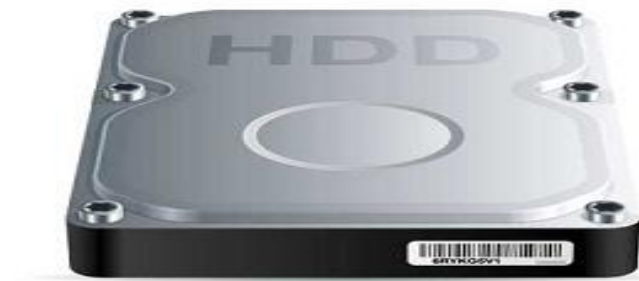
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DRAM	SRAM
1. Constructed of tiny capacitors that leak electricity.	1. Constructed of circuits similar to D flip-flops.
2. Requires a recharge every few milliseconds to maintain its data.	2. Holds its contents as long as power is available.
3. Inexpensive.	3. Expensive.
4. Slower than SRAM.	4. Faster than DRAM.
5. Can store many bits per chip.	5. Can not store many bits per chip.
6. Uses less power.	6. Uses more power.
7. Generates less heat.	7. Generates more heat.
8. Used for main memory.	8. Used for cache.

Difference between SRAM and DRAM

SECONDARY MEMORY

- This type of memory is also known as external memory or non-volatile.
- It is slower than the main memory.
- These are used for storing data/information permanently. CPU directly does not access these memories, instead they are accessed via input-output routines.
- The contents of secondary memories are first transferred to the main memory, and then the CPU can access it. For example, disk, CD-ROM, DVD, etc.



CHARACTERISTICS OF SECONDARY MEMORY

- These are magnetic and optical memories.
- It is known as the backup memory.
- It is a non-volatile memory.
- Data is permanently stored even if power is switched off.
- It is used for storage of data in a computer.
- Computer may run without the secondary memory.
- Slower than primary memories.

WHAT IS SECONDARY MEMORY

- **Secondary Memory** is also called “**storage device**” and “**auxiliary memory**”, “**external memory**”.
- **Secondary storage devices** are non-volatile in nature, it means that data does not discard while power turn-off, in which all data store for long time.
- **Secondary memory** has the speed of access of data is very slow compare to **primary memory**, and cheaper as well.
- Without primary memory, those **secondary storage devices** are useless because for processing the secondary memory must be needed the **primary memory**, first of all data are transferred into **primary memory** then these data make for executable

TYPES OF SECONDARY MEMORY

- **Secondary memory (Storage Devices) can be used in computer either internally or externally.**
- **Secondary Storage devices (memory) have four examples like as**
 - **Magnetic Storage Devices**
 - **Optical Storage Devices**
 - **Flash Memory Devices**
 - **Online Cloud System**

TYPES OF SECONDARY MEMORY CONT..

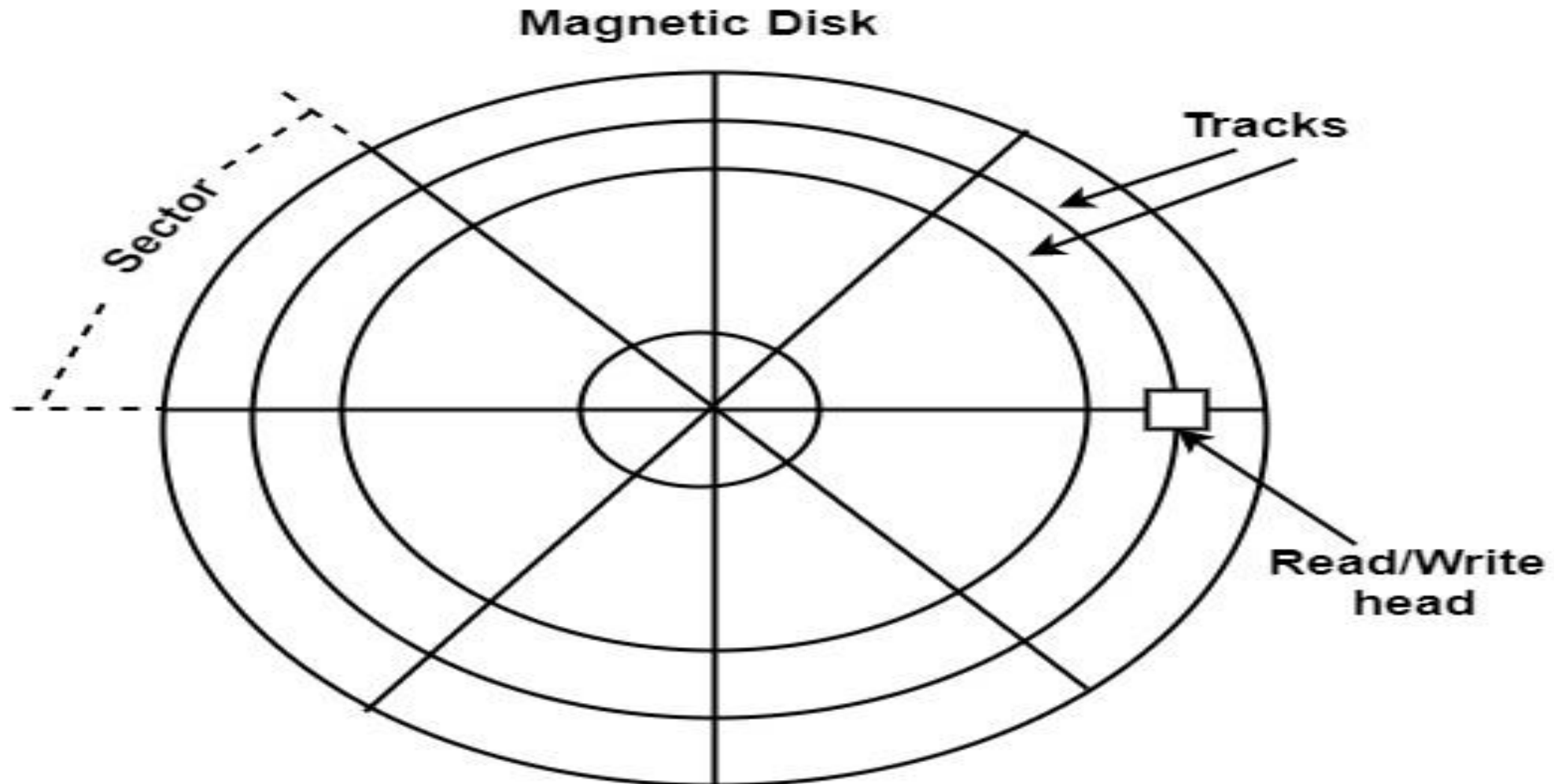
1. Magnetic Storage Devices

- 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.
- 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.
- Examples Are:
 - **Floppy diskette, Hard drive, Magnetic strip, Super Disk, Tape cassette**

WHAT ARE MAGNETIC DISKS?

- A magnetic disk is a storage device that can be assumed as the shape of a Gramophone record. This disk is coated on both sides with a thin film of Magnetic material.
- This magnetic material has the property that it can store either '1' or '0' permanently. The magnetic material has square loop hysteresis (curve) which can remain in one out of two possible directions which correspond to binary '1' or '0'.
- Bits are saved in the magnetized surface in marks along concentric circles known as tracks. The tracks are frequently divided into areas known as sectors.
- In this system, the lowest quantity of data that can be sent is a sector. The subdivision of one disk surface into tracks and sectors is displayed in the figure.

MAGNETIC DISKS



MAGNETIC DISKS CONT..

- Access time
- The access time of a record on a disk includes three components such as seek time, latency time, and data transfer time.
- **Seek time** — The time required to arrange the read/write head at the desired track is called seek time. For example, suppose that the read/write head is on track 2 and the record to be read is on track 5, then the read/write head must move from track 2 to track 5. The average seeks time on a modern disk is 8 to 12 ms.
- **Rotational delay or latency time** — The time required to position the read/write head on a specific sector when the head has already been placed on the desired track is called rotational delay. The rotational delay is based on the speed of rotation of the disk. On average the latency will be half of one revolution time. The average latency time on modern disks is 4.2 to 6.7ms.
- **Data transfer time** — Data transfer time is the actual time needed to send the data.

MAGNETIC DISKS CONT..

▪ Advantages of Magnetic Disk

- **Access time** — With a magnetic disk, it is achievable to access a record explicitly. Therefore access time is less in this case.
- **Flexibility** — Magnetic disk has to be the flexibility of being used as a sequential as well as direct access storage device.
- **Transmission Speed** — The rate of data transfer is fast in a magnetic disk.
- **Reusable** — It can remove a specific data and save another data at the same place.
- **Storage Capacity** — It can store a very large amount of data.

▪ Disadvantages of Magnetic Disk

- **Cost** — The cost of per character storage is much higher as compared to magnetic tape.
- **Non-Portability** — Portability of it is very less as compared to magnetic tape.
- **Limited size record** — Duration of record which can be saved on it is limited by the size of disk track or disk sector.
- **Non-human readable** — Data stored on it is not in human-readable form, therefore manual encoding is not possible at all.

OPTICAL STORAGE

- Optical storage, electronic storage medium that **uses low-power laser beams to record and retrieve digital (binary) data.**
- In optical-storage technology, a laser beam encodes digital data onto an optical, or laser, disk in the form of tiny pits arranged in a spiral track on the disk's surface.
- **How does optical devices store data?**
- Optical storage devices save data **as patterns of dots that can be read using light.**
- A laser beam is the usual light source.
- The data on the storage medium is read by bouncing the laser beam off the surface of the medium. If the beam hits a dot it is reflected back differently to how it would be if there were no dot.

TYPES OF SECONDARY MEMORY CONT..

2. Optical Storage Devices

- In the **optical storage devices**, all read and write activities are performed by light. All recording information stores at an optical disk.
- As per the opinions of data scientist that compact space is most useful for huge data storage.
- Their big **advantages** are not more costly, light weight, and easy to transport because it is removable device unlike hard drive.
- **Examples Are:**
 - **Blu-ray disc**
 - **CD-ROM disc**
 - **CD-R and CD-RW disc.**
 - **DVD-R, DVD+R, DVD-RW, and DVD+RW disc.**

TYPES OF SECONDARY MEMORY CONT..

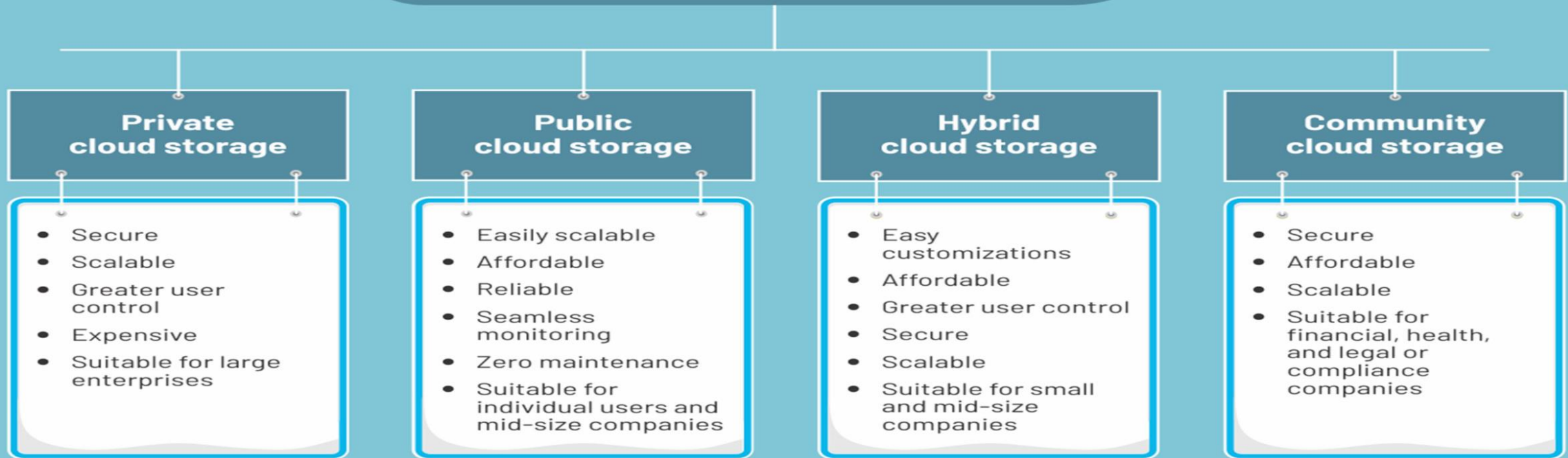
3. Flash Memory Devices

- **Flash Memory** is also known as electronically erasable programmable read only memory (EEPROM), because in which piece of code like as programming can be write and erased by electrically.
- Flash memory also uses for the storing data to computers as well as electronic devices such as USB flash drives, MP3 players, digital cameras and solid-state drives.
- Flash memory is non volatile in nature because all data are persisted in the memory when power is turn-off.
- **Examples Are:** USB flash drive, jump drive, or thumb drive.
- **CF (CompactFlash), Memory card, Smart Media Card, SD card,**

WHAT IS ONLINE CLOUD SYSTEM?

- Cloud computing is the delivery of different services through the Internet, including data storage, servers, databases, networking, and software.
- Cloud-based storage makes it possible to save files to a remote database and retrieve them on demand. Private cloud storage.
- Private cloud storage is also known as enterprise or internal cloud storage. ...
- Public cloud storage. ...
- Hybrid cloud storage. ...
- Community cloud storage

TYPES OF CLOUD STORAGE



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TYPES OF SECONDARY MEMORY CONT..

4. Online Cloud System

- Clouding is systematically model for storing data in computer, and in which entire data are stored in logically nature.
- Those clouding system are managed by other hosting companies. With the help of online clouding, all data can be access by couples of users anytime and anywhere.
- Big advantages are not place limitation as well as no need carry any storage device.
- There are some types:
 - **Cloud storage**
 - **Network media**

CACHE MEMORY

- Cache memory is a very high speed semiconductor memory which can speed up the CPU.
- It acts as a buffer between the CPU and the main memory.
- It is used to hold those parts of data and program which are most frequently used by the CPU.
- The parts of data and programs are transferred from the disk to cache memory by the operating system, from where the CPU can access them.



CACHE MEMORY CONT..

- **Advantages**

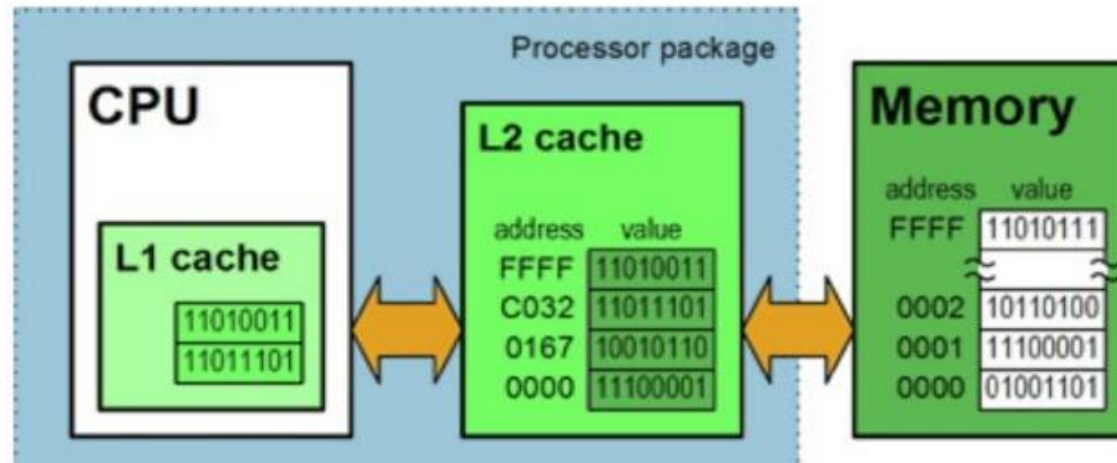
- The advantages of cache memory are as follows —
 - Cache memory is faster than main memory.
 - It consumes less access time as compared to main memory.
 - It stores the program that can be executed within a short period of time.
 - It stores data for temporary use.

- **Disadvantages**

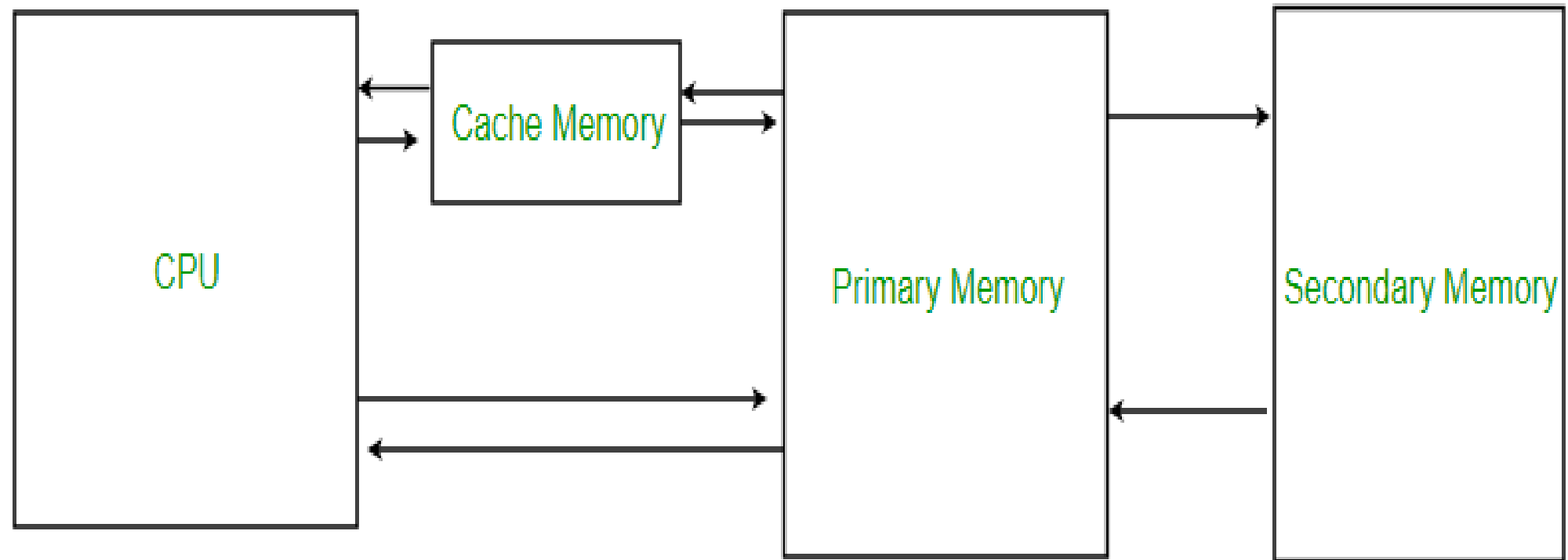
- The disadvantages of cache memory are as follows —
 - Cache memory has limited capacity.
 - It is very expensive.

Cache memory

Cache memory, also called CPU memory, is high-speed memory that a CPU can access more quickly than it can access regular random access memory (RAM). This memory is typically integrated directly into the CPU chip. The purpose of cache memory is to store program instructions and data that are used repeatedly in the operation of programs or information that the CPU is likely to need next.



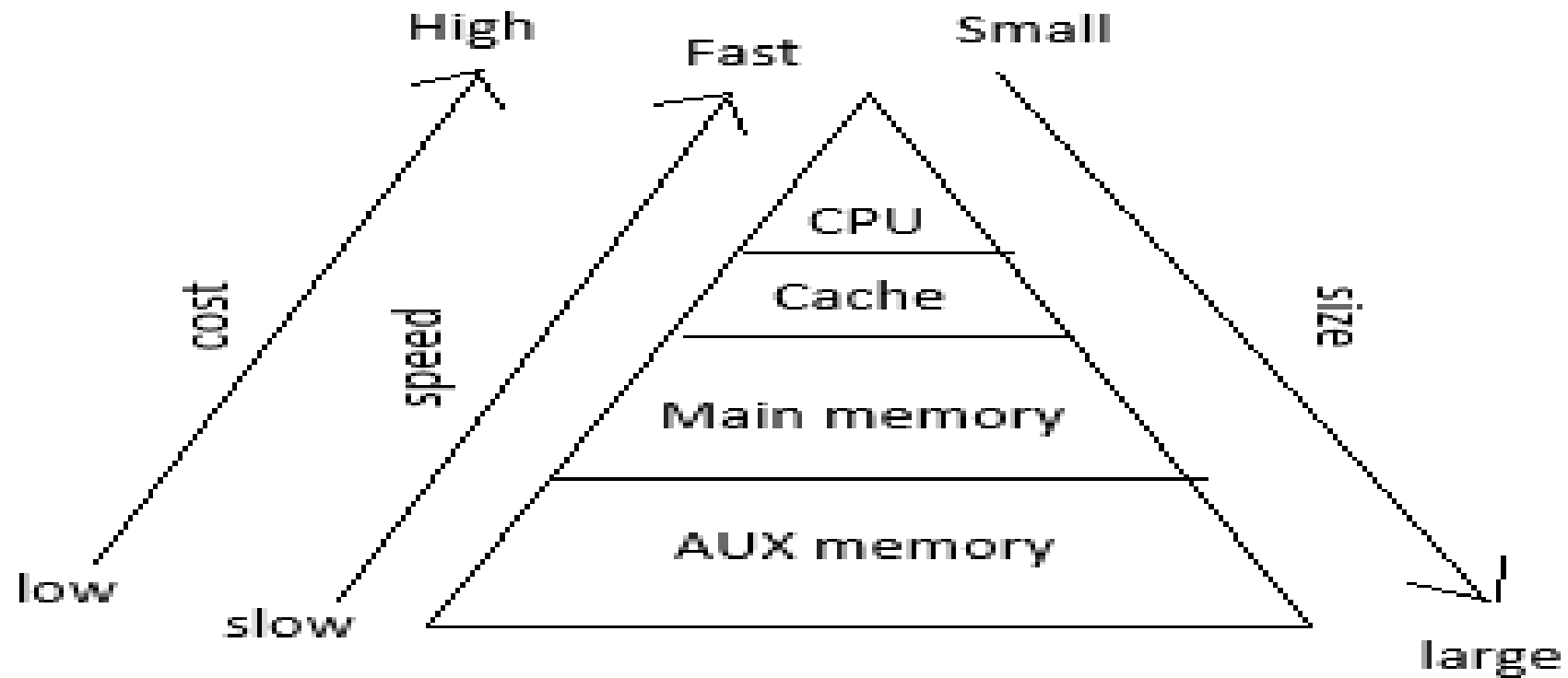
CACHE MEMORY CONT..



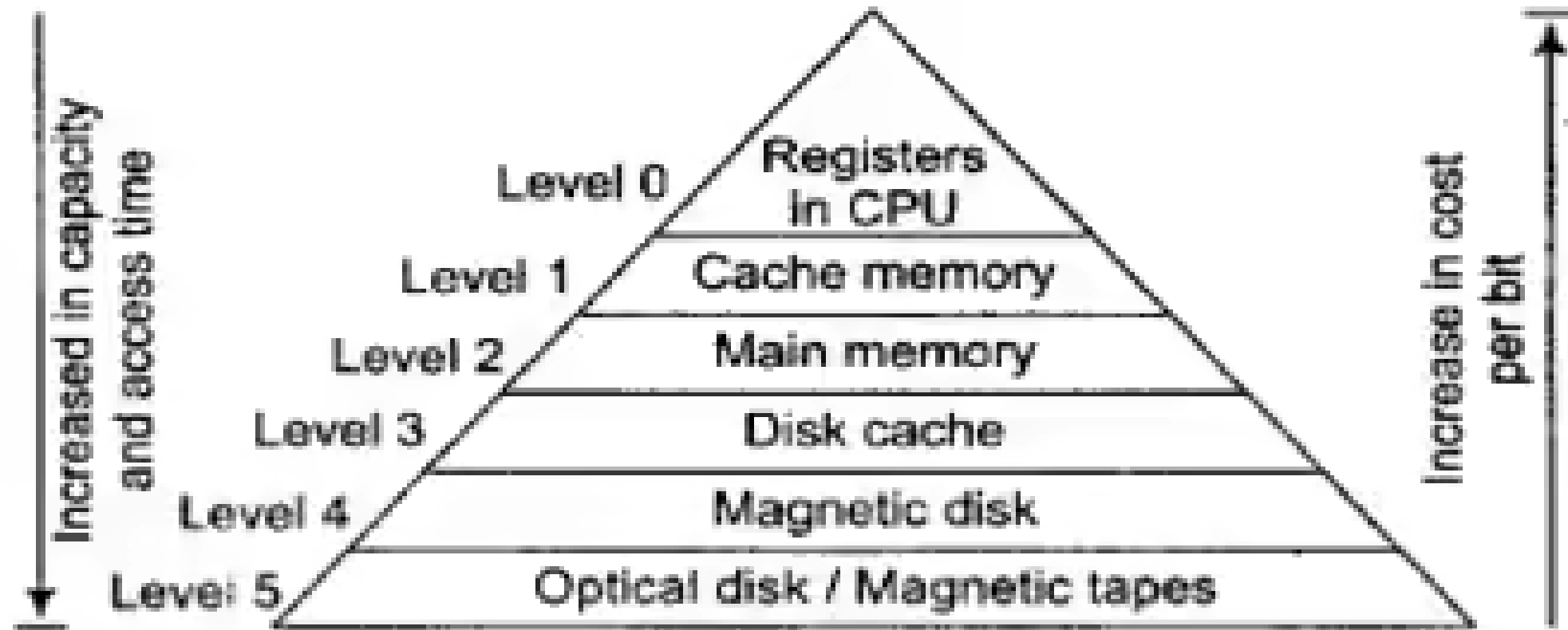
Primary and Secondary Memory Comparison

Primary memory	Secondary memory
Fast Expensive Low capacity Connects directly to the processor	Slow Cheap Large capacity Not connected directly to the processor

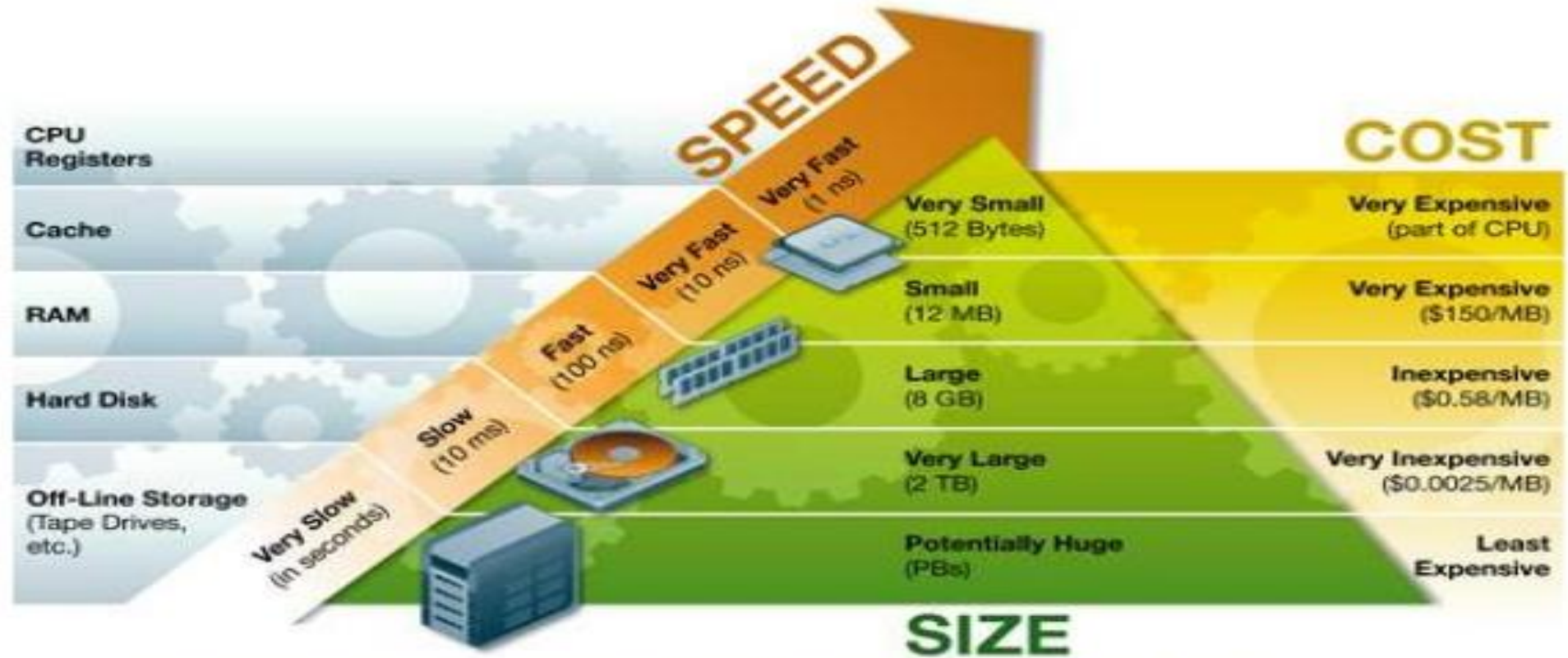
MEMORY HIERARCHY



MEMORY HIERARCHY CONT..



Extended Memory Hierarchy



Source: http://www.ts.avnet.com/uk/products_and_solutions/storage/hierarchy.html

MEMORY UNIT

- Memory unit is the amount of data that can be stored in the storage unit.
- This storage capacity is expressed in terms of Bytes.

THE FOLLOWING TABLE EXPLAINS THE MAIN MEMORY STORAGE UNITS

S.No.	Unit & Description
1	Bit (Binary Digit) A binary digit is logical 0 and 1 representing a passive or an active state of a component in an electric circuit.
2	Nibble A group of 4 bits is called nibble.
3	Byte A group of 8 bits is called byte. A byte is the smallest unit, which can represent a data item or a character.
4	Word A computer word, like a byte, is a group of fixed number of bits processed as a unit, which varies from computer to computer but is fixed for each computer. The length of a computer word is called word-size or word length. It may be as small as 8 bits or may be as long as 96 bits. A computer stores the information in the form of computer words.

THE FOLLOWING TABLE LISTS SOME HIGHER STORAGE UNITS

S.No.	Unit & Description
1	Kilobyte (KB) 1 KB = 1024 Bytes
2	Megabyte (MB) 1 MB = 1024 KB
3	GigaByte (GB) 1 GB = 1024 MB
4	TeraByte (TB) 1 TB = 1024 GB
5	PetaByte (PB) 1 PB = 1024 TB

WHAT IS VIRTUAL MEMORY?

- Virtual memory is a technique used in computing to optimize memory management by transferring data between different storage systems, such as random access memory (RAM) and disk storage.
- A virtual memory system has many advantages, including:
 - Freeing applications from having to compete for shared memory space and allowing multiple applications to run at the same time
 - Allowing processes to share memory between libraries (a collection of code that provides the foundation for a program's operations)
 - Improving security by isolating and segmenting where the computer stores information
 - Increasing the amount of memory available by working outside the limits of a computer's physical memory space
 - Optimizing central processing unit (CPU) usage

HOW THE COMPUTER USES ITS MEMORY?

- The computer loads the BIOS from ROM. The BIOS provides the most basic information about storage devices, boot sequence, security, plug and play capability and other items.
- The computer loads the OS from the hard drive into the system's RAM. CPU has immediate access to the OS as the critical parts of the OS are maintained in RAM as long as the computer is on. This enhances the performance and functionality of the overall system.
- Now the system is ready for use. When you load or open an application it is loaded in the RAM. Since the CPU looks for information in the RAM, any data and instructions that are required for processing (read, write or update) is brought into RAM. To conserve RAM usage, many applications load only the essential parts of the program initially and then load other pieces as needed. Any files that are opened for use in that application are also loaded into RAM.
- The CPU requests the data it needs from RAM, processes it and writes new data back to RAM in a continuous cycle. The shuffling of data between the CPU and RAM happens millions of times every second.
- When you save a file and close the application, the file is written to the secondary memory as specified by you. The application and any accompanying files usually get deleted from RAM to make space for new data.
- If the files are not saved to a storage device before being closed, they are lost.



Thank you!