

Unit-3

Computer Memory

Memory is the storage media or device which stores data permanently or temporarily.

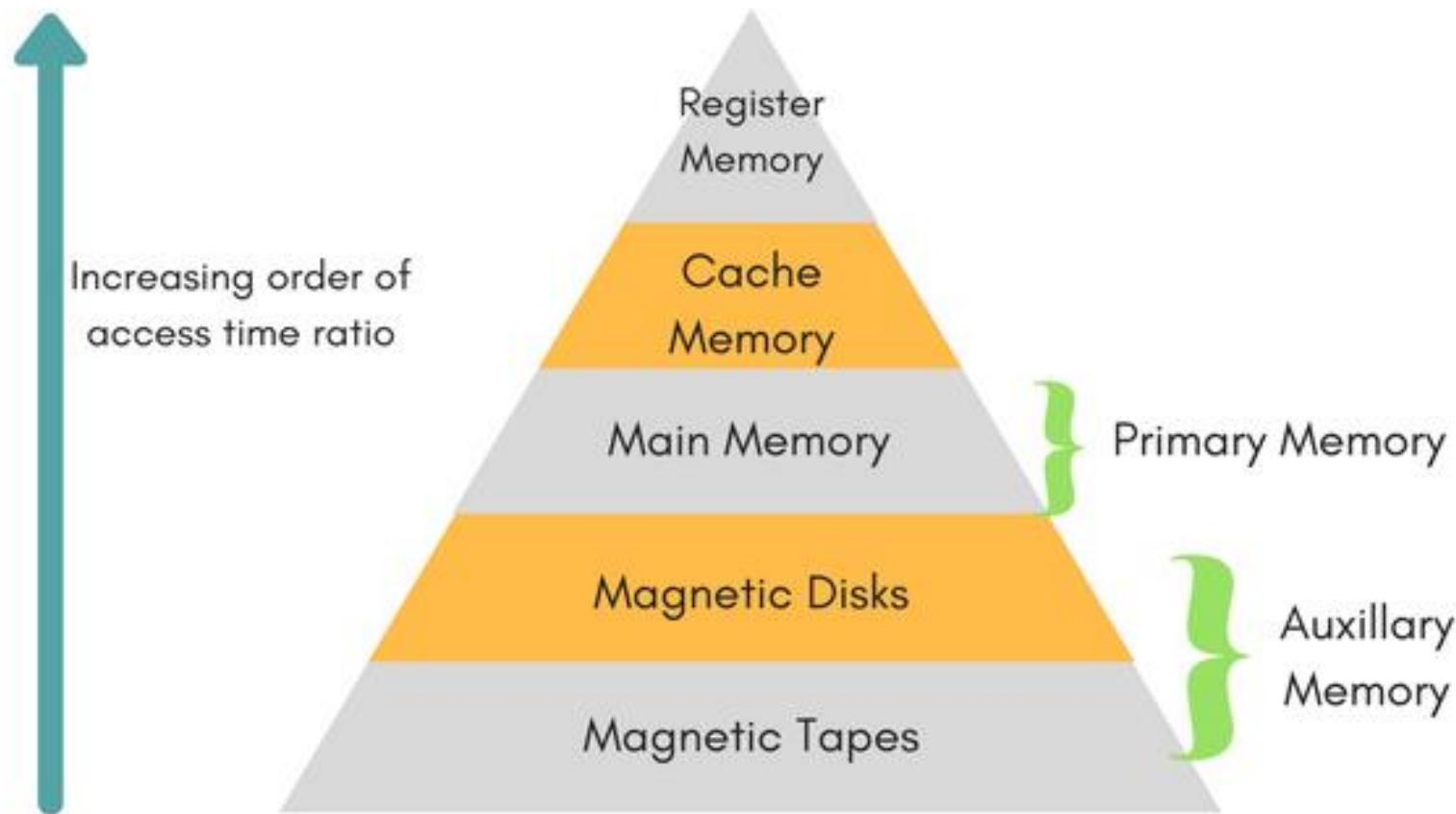
Memory Representation

- Computer uses *a fixed number of bits* to represent a piece of data, which could be a number, a character, or others. A n-bit storage location can represent up to 2^n distinct entities. For example, a 3-bit memory location can hold one of these eight binary patterns: 000B, 001B, 010B, 011B, 100B, 101B, 110B, or 111B. Hence, it can represent at most 8 distinct entities. You could use them to represent numbers 0 to 7, 11 to 18, characters 'A' to 'H', or up to 8 kinds of fruits like apple, orange, banana, etc.

Computer Memory

Integers, for example, can be represented in 8-bit, 16-bit, 32-bit or 64-bit. You, as the programmer, choose an appropriate bit-length for your integers. Your choice will impose constraint on the range of integers that can be represented. As for example, unsigned vs. signed integers. An 8-bit signed integer has a range of -128 to 127; while an 8-bit unsigned integer has a range of 0 to 255.

Memory Hierarchy



Main Memory

The memory unit that communicates directly within the CPU, Cache memory, is called main memory. It is the central storage unit of the computer system. It is a large and fast memory used to store data during computer operations. Main memory is made up of **RAM** and **ROM**.

Main Memory

RAM

- Random access memory
- RAM is volatile.
- RAM can both read & write.
- When the computer switch is off, then its contents will be lost or erased.
- So, It is also known as temporary memory.

RAM

RAM is two types

- SRAM
- DRAM

SRAM(Static RAM)

- SRAM holds information in a flip-flop circuit consisting of six transistors is needed in each memory cell.
- It is costly RAM.
- Its speed is high.

SRAM

- It occupies large space.
- Refresh circuit is not needed.
- Consumes less power than DRAM.

DRAM(Dynamic RAM)

- It requires less number of transistors per memory cell because information is stored in capacitors. Only one transistors is needed to form a memory cell of the RAM.
- It is less costly than SRAM.
- Its speed is slower than SRAM.
- Refresh circuit is needed.
- Consumed more power.

ROM

- ROM means read only memory.
- It can only read.
- It is non-volatile memory.
- When the computer switch is off, then its contents will not be lost or deleted.
- So, it is permanent memory.

ROM

ROM can be divided into three parts.

- PROM(Programmable read only memory)
- EPROM(Erasable PROM)
- EEPROM(Electrically Erasable PROM)

Types of ROM

PROM

- Programmable ROM.
- It is also called one –time programmable ROM and can be written to or programmed using a special device called a PROM programmer.
- Its contents cannot be erased or lost.
- The working of a PROM is similar to that of a CD-ROM.
- E.g. Firmware, CD-R

Types of ROM

EPROM

- Erasable PROM.
- Information stored can be lost in ultraviolet light and reprogrammed whenever necessary.
- E.g. CD-RW

Types of ROM

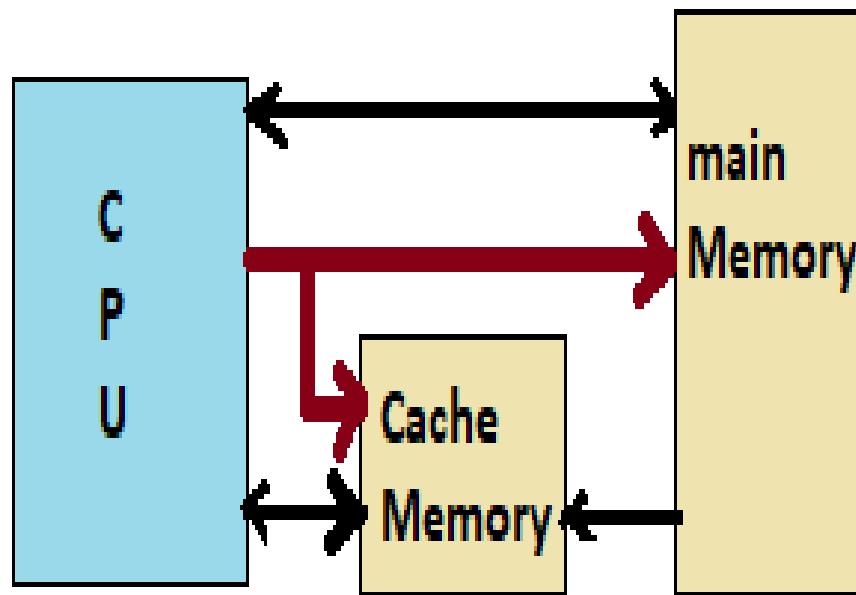
EEPROM

- Electrically Erasable PROM.
- Its contents can be lost by electricity & again it can be programmed like EPROM.
- E.g. Flash memory(Pen drive),memory card etc.

Cache memory

- Cache memory is a small memory chip which attached between CPU & main memory whose access time is very close to the processing speed of CPU. The speed of CPU is extremely high. So, cache memory makes faster.
- Cache Memory is a special very high-speed memory. It is used to speed up and synchronize with high-speed CPU. Cache memory is costlier than main memory or disk memory but more economical than CPU registers. Cache memory is an extremely fast memory type that acts as a buffer between RAM and the CPU.

Cache Memory



Types of Cache Memory

Cache memory can be three types

- L1 Cache
- L2 Cache
- L3 Cache

L1 Cache

- L1 cache is also primary cache or internal cache which build directly into the processor chip.
- Its capacity is very small(8 KB to 64 KB).
- E.g. Pentium I, Pentium II
- Fastest but smallest data and instructions

L2 Cache

- L2 cache is also called external cache.
- It is not part of the processor chip.
- slower but bigger data-only.
- Its capacity is large(64 KB to 2 MB).
- E.g. SRAM

Types of Cache Memory

L3 Cache(Level 3) Memory

The L3 cache is larger in size but also slower in speed than L1 and L2. Its size is between 1MB to 8MB. In Multi core processors, each core may have separate L1 and L2, but all core share a common L3 cache. In L3 cache, speed is double than the RAM.

Register

- Computers also have several additional storage locations called registers. It makes processing more efficient. Their contents can therefore be handled much faster than the contents of the memory.
- Registers are a type of computer memory used to quickly accept, store and transfer data and instructions that are being used immediately by the CPU. The registers used by the CPU are often termed as Processor registers.

Types of Registers

1. Program Counter Register

- Program Counter Register holds the address of the next instruction to be fetched. Instruction is fetched from the address specified by the Program Counter (PC).

2. Memory Address Register

- The address specified by the PC first goes to another register known as memory address register. CPU finds this address from MAR to read the instruction or data from memory.

Types of Registers

3. Instruction Register

- Once the instruction is fetched from memory then fetched instruction is stored in Instruction Register, Decoder is connected with this instruction register and decode the fetched instruction.

4. Memory Buffer Register (MBR)

- This register is used for buffering of the memory so that instruction is not halted abruptly to the processor.

Types of Registers

5. Memory Data Register (MDR)

- When an instruction is decoded then we get the information about op code, mode, and address field. This address field provides the information either directly or indirectly about the address of the operand.

6. Accumulator

- An **accumulator** is a type of registers that are used by CPU. This accumulator acts as a temporary storage location which holds an intermediate value in mathematical and logical calculations.

Secondary Memory

- Secondary memory is also known as auxiliary or supplement memory. Auxiliary storage are stores data permanently. It stores large amount of data. E.g. Magnetic(tape, disk & drum),floppy disk, pen drive, CD-ROM,DVD,DVD-RW etc.

Examples



Hard Disk



RAM



ROM



CD/DVD



Floppy



Memory Card



Pen Drive



Tape

Secondary Memory

Sequential & Direct access devices

Sequential or serial access:

A sequential access storage device is one in which data can be accessed one by one or sequence. E.g. magnetic tape.

Random Access storage or direct access:

A random access storage device is one in which any location in the device may be selected at random, access to the direct. E.g. Magnetic disk

Magnetic Tape

Magnetic tape is the most popular storage medium for large data that are accessed & processed sequentially.

Magnetic Tape

Magnetic tape has following features.

- Economical
- Long term storage & reusability
- Compact
- Backup data

Advantages

- Their storage capacity is unlimited because many tapes can be used for storing large amount of data.
- Low cost of data reels & cartridges & high data recording densities, cost per bit of storage is very low. Tapes can be erased & reuse many times.

Disadvantages

- It is sequential access nature. They are not suitable for random access.
- They must be stored in a dust free environment because dust can cause tape reading errors.

Magnetic Tape figure



Magnetic Disk

- Magnetic disks are most popular direct access storage medium. A magnetic disk is a thin circular plate made of metal & coated with magnetic material. Magnetic disk can also be erased & reused indefinitely. Each disk consists of a number of circles called tracks. Most popular magnetic disks are floppy disk & hard disk. Information is recorded on tracks. These track is divided into sectors. A good example of magnetic disk is hard disk.

Advantages

- It supports direct access medium but magnetic tape supports sequential access.
- Magnetic disks are suitable for both online & offline storage of data.
- Data transfer rate for a magnetic disk system is normally higher than a tape system.

Disadvantages

- It is expensive.
- Can be easily damaged, will slow down and eventually break over time.
- Slower access than Solid State Drives.

Magnetic Disk or Hard disk or Hard Drive

- Hard disk is direct access storage medium. Data is stored in circles called tracks. Each track is divided into sectors. It is a circular path which stores information on these paths.
- A **hard disk drive (HDD)**, **hard disk**, **hard drive**, or **fixed disk**, is an electro-mechanical data storage device that stores and retrieves digital data using magnetic storage with one or more rigid rapidly rotating platters coated with magnetic material. The platters are paired with magnetic heads, usually arranged on a moving actuator arm, which read and write data to the platter surfaces.

Magnetic Disk or Hard disk

- Introduced by IBM in 1956, HDDs were the dominant secondary storage device for general-purpose computers beginning in the early 1960s. HDDs maintained this position into the modern era of servers and personal computers.

Hard Disk or Hard Drive



Types of Hard Disks

1. Zip disk

- 100 MB
- Disk drive
- Single hard disk

Types of Hard disk

2. Disk pack

- Multiple platter hard disk. Separate read & write head.
- A storage device for a computer that consists of a stack of magnetic disks mounted on a central hub and their removable protective cover and that can be handled and stored as a unit.

It was introduced in the 1960s. 1970s vintage 200 mega byte disk pack.

Types of Hard disk

3. Winchester disk

- Introduced by IBM in 1973 as the model 3340, the **Winchester disk drive** was a hard drive. It had 30 MB of fixed and 30 MB of removable storage.
- It featured a smaller, lighter read/write head that was designed to ride on an air film only 18 millionths of an inch thick. The disks also had a 30 ms access time, and lubricated coating allowing the heads to remain in contact with the surface when rotation speed changes.

Floppy disk

Floppy disk are small removable storage device. It is also known as floppy diskette.

There are two types of floppy disk

1. Mini floppy disk
2. Micro floppy disk

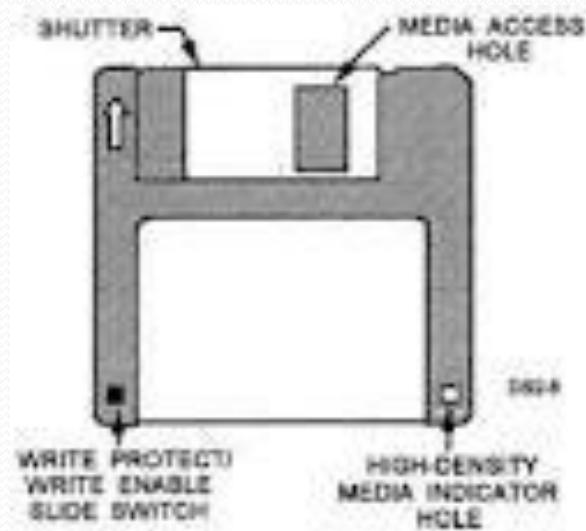
Mini floppy disk

- Its size is 5.25”*5.25”
- Its capacity is 1.2 MB.
- Its speed is 720 rpm(round per minute).

Micro floppy disk

- Its size is 3.5”*3.5”
- Its capacity is 1.44 MB
- Its speed is 360 rpm.

Floppy disk



Pen drive(Flash memory)

- Flash memory is a memory chip that holds data. It is less expensive. Its capacity are 8 MB,16 MB,32 MB,64 MB,128 MB,256 MB,512 MB,1024 MB(1 GB),2 GB,4 GB,8 GB,16 GB,32 GB,64 GB etc.
- It is a plug & play device that simply plugs into a USB(Universal Serial Bus) port of a computer.The computer detects it automatically as removable drive.

Flash Memory

SanDisk Ultra Flair
128 GB USB Flash Drive



Memory Card

- A **memory card** is an electronic data storage device used for storing digital information, typically using flash memory. These are commonly used in digital portable electronic devices. They allow adding memory to such devices using a card in a socket instead of a protruding USB flash drives

Memory Card



Optical disk

- Optical disk is latest new secondary storage medium. It is a random access medium for high capacity secondary storage because it can store extremely large amount of data in a limited space. An optical disk consists of a thin circular path coated with a thin metal or some other material that is highly reflective. Optical disks are also known as laser disks because they use laser beam technology for data read/write.

Optical disks

Storage capacity of an optical disk= No. of sectors*No. of bytes per sector

5.25" optical disks have 3,30,000 sectors each of 2352 bytes.

Total capacity=3,30,000*2352

$$= 776*1000000 \text{ bytes.}$$

$$= 776 \text{ megabytes.}$$

Storage capacity of optical disks are 776 MB(Total).

Formatted capacity is 650 MB.

Optical Disk



Types of Optical Disks

Commonly used optical disks are CD-ROM,WORM(CD-R),CD-RW,DVD,DVD-RW.

- A **CD-ROM(compact disc read-only memory)** is a type of read-only memory consisting of a pre-pressed optical compact disc that contains data. Computers can read—but not write or erase—CD-ROMs. Some CDs, called enhanced CDs, hold both computer data and audio with the latter capable of being played on a CD player, while data (such as software or digital video) is only usable on a computer (such as ISO 9660^[2] format PC CD-ROMs).

CD-ROM

- During the 1990s and early 2000s, CD-ROMs were popularly used to distribute software and data for computers and fifth generation video game consoles. DVD started to replace it in these roles starting in the early 2000s.

CD-R

- **CD-R (Compact disc-recordable)** is a digital optical disc storage format. A CD-R disc is a compact disc that can be written once and read arbitrarily many times.
- CD-R discs (CD-Rs) are readable by most CD readers manufactured prior to the introduction of CD-R, unlike CD-RW discs.

CD-R



CD-RW

- **CD-RW (Compact Disc-Rewritable)** is a digital optical disc storage format introduced in 1997. A CD-RW compact disc (CD-RWs) can be written, read, erased, and re-written.
- CD-RWs, as opposed to CDs, require specialized readers that have sensitive laser optics. Consequently, CD-RWs cannot be read in many CD readers built prior to the introduction of CD-RW. CD-ROM drives with a "Multi Read" certification are compatible.
- CD-RWs must be erased or blanked before reuse.

CD-RW



DVD

- The **DVD** (common abbreviation for **Digital Video Disc** or **Digital Versatile Disc**) is a digital optical disc data storage format. It was invented and developed in 1995 and first released on November 1, 1996, in Japan. The medium can store any kind of digital data and has been widely used for video programs (watched using DVD players) or formerly for storing software and other computer files as well. DVDs offer significantly higher storage capacity than compact discs (CD) while having the same dimensions. A standard DVD can store up to 4.7 GB of storage, while variants can store up to a maximum of 17.08 GB.

DVD



DVD-RW

- DVD-RW is one of two standards for rewritable DVDs, along with DVD+RW. A rewritable DVD-RW disc can be written to, erased and then written to again up to 1,000 times. DVD-RW discs have a capacity of 4.7 GB of data or video. Rewritable optical discs like DVD-RW are not as well-supported by DVD players as write-once formats (like DVD-R).

DVD-RW



Magneto Optical Disk



The Institute of Chartered Accountants of India
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Magneto Optical Disc



- A magneto-optical drive is a kind of optical disc drive capable of writing and rewriting data upon a magneto-optical disc.
- Both 130 mm (5.25 in) and 90 mm (3.5 in) form factors exist.
- The technology was introduced at the end of the 1980s.

Close up of Magneto-optical Disk surface

100 Hours ITT Course

Magneto-optical disks

- Magneto-optical discs are a **hybrid storage medium**. In reading, spots with different directions of magnetization give different polarization in the reflected light of a low-power laser beam. In writing, every spot on the disk is first heated by a strong laser beam.