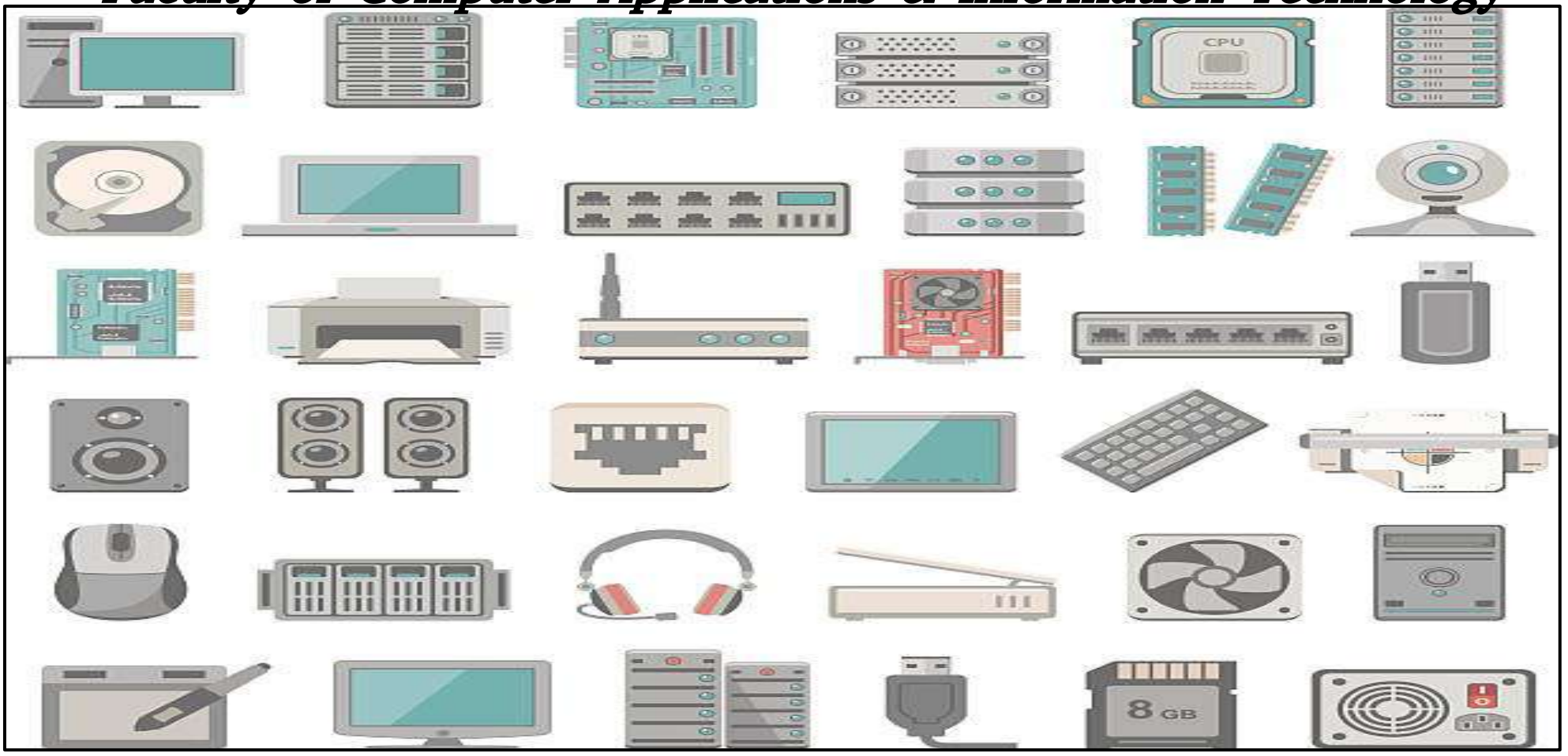


Computer Hardware Devices

UNIT II

Integrated MSCIT

Introduction to Hardware Devices

- Computer hardware refers to any physical components of computer.
- The term hardware represents the tangible aspects of a computing device.
- Computer hardware can be categorized as being either internal or external components.
  - Internal hardware components are those necessary for the proper functioning of the computer.
  - External hardware components are attached to the computer to add or enhance functionality.

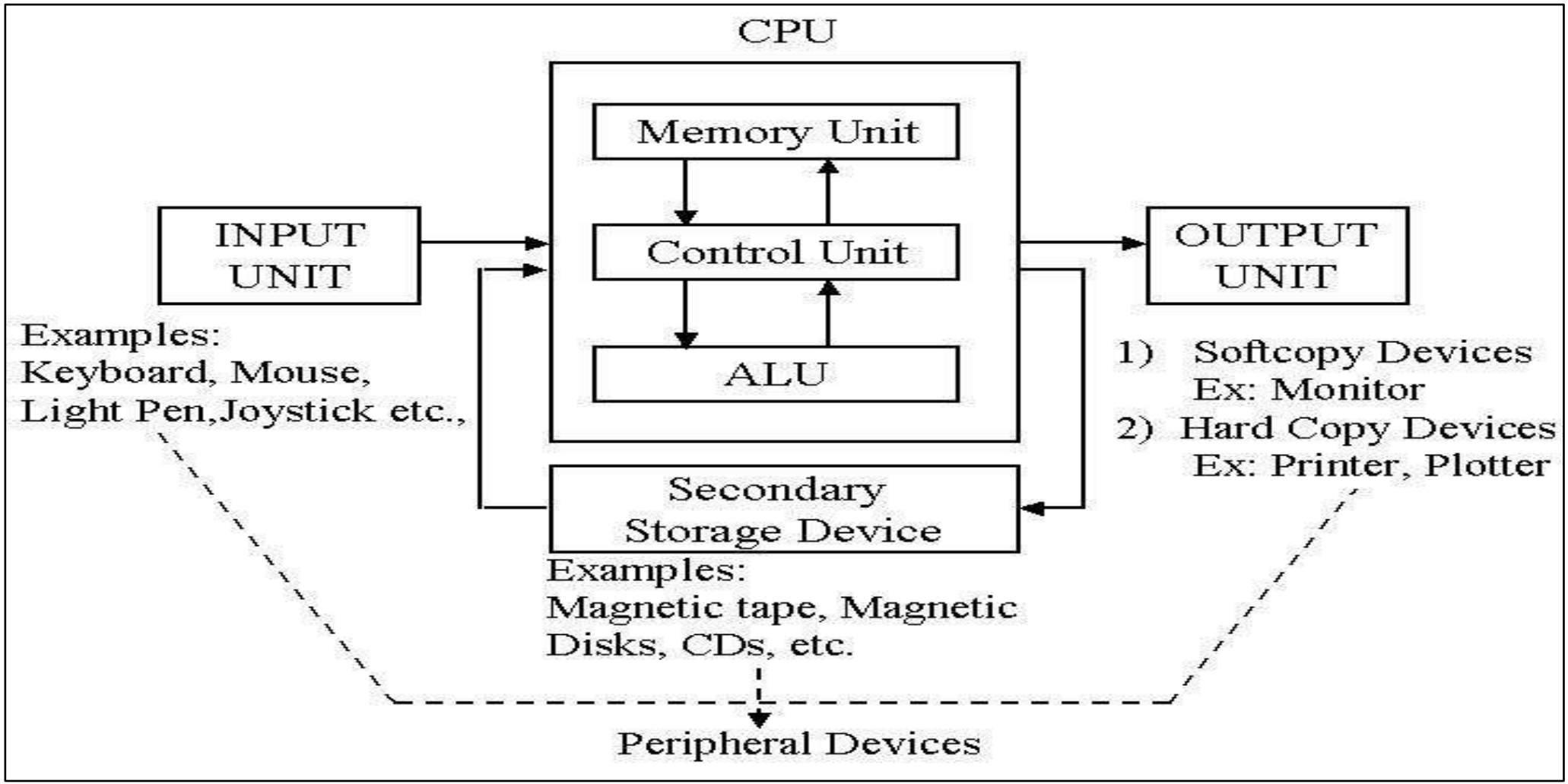
Central Processing Unit

- Computer hardware are the physical parts or components of a computer, such as the central processing unit, monitor, keyboard, computer data storage, graphic card, sound card and motherboard.

Central Processing Unit

- CPU is also known as Processor.
- The CPU is like the brains of the computer.
- A processor (CPU) is the logic circuitry that responds to and processes the basic instructions that drive a computer.
- The CPU is seen as the main and most crucial integrated circuitry (IC) chip in a computer, as it is responsible for interpreting most of computers commands.
- CPUs will perform most basic
  - Arithmetic
  - Logic
  - I/O Operations
  - Allocate Commands For Other Chips & Components Running In A computer.

Processor – Architecture of CPU



PROCESSOR

- The processors are small size chips made of silicon semi conductor material that are placed inside the devices to perform the task or operation.
- Its speed is measured in terms of megahertz.
- The four main primary functions of the processor include fetching, decoding, executing and write back the instructions are the four main primary functions of the processor.
- The processor is also called the brain of any system which incorporates computers, laptops, smartphones, embedded systems, etc

PROCESSOR

- A processor is made up of hardware that works together to deliver information, allowing your computer to complete the tasks that you request when you open an application or make changes to a file.
- Processor cores and clock speeds determine how much information can be received at a time, and how quickly that information can be processed on your computer.
- The speed at which your computer's cores and clock speed work together is considered its processing speed.

Processor – Family of Processor

- Most desktop computers contain a CPU developed by either Intel or AMD, both of which use the x86 processor architecture.
- Mobile devices, such as laptops and tablets may use Intel and AMD CPUs, but can also use specific mobile processors developed by companies like ARM or Apple.
- Modern CPUs often include multiple processing cores, which work together to process instructions.
- While these "cores" are contained in one physical unit, they are actually individual processors.
- Processors that include two cores are called dual-core processors, while those with four cores are called quad-core processors.
- Some high-end workstations contain multiple CPUs with multiple cores, allowing a single machine to have eight, twelve, or even more processing cores.

PROCESSOR CORES

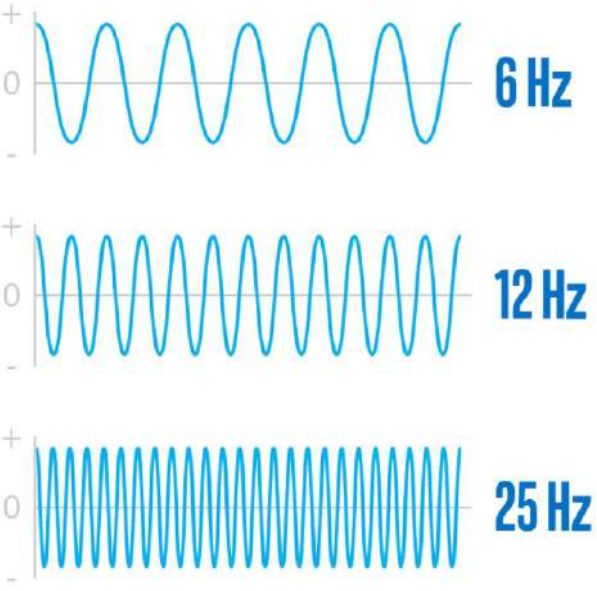
- Processor cores are individual processing units within the computer's central processing unit (CPU).
- The processor core receives instructions from a single computing task, working with the clock speed to quickly process this information and temporarily store it in the Random Access Memory (RAM).
- Permanent information is saved to your hard drive when you request it.
- Most computers now have multiple processor cores that enable your computer to complete multiple tasks at once. Having the ability to run numerous programs and request multiple tasks like making edits to a document, while watching a video, while opening a new program, is made possible with multiple processor core units.

CLOCK SPEED

- A computer's processor clock speed determines how quickly the central processing unit (CPU) can retrieve and interpret instructions.
- Clock speeds are measured in gigahertz (GHz), with a higher number equating to higher clock speed.
- Faster clock speeds mean that CPU completes its tasks quicker, making user experience seamless and reducing the time you wait to interface with your favorite applications and programs.
- CPU processes many instructions (low-level calculations like arithmetic) from different programs every second.

CLOCK SPEED

- The clock speed measures the number of cycles your CPU executes per second, measured in GHz (gigahertz).
- A “cycle” is technically a synchronised pulse, but for our purposes, they’re a basic unit that helps understand a CPU’s speed.
- During each cycle, billions of transistors within the processor open and close.
- A CPU with a clock speed of 3.2 GHz executes 3.2 billion cycles per second. (Older CPUs had speeds measured in megahertz, or millions of cycles per second.)



CLOCK SPEED

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Processor – Speed of Processor

- Each computer has a built-in electronic clock, known as System Clock.
- **System clock emits millions of regularly spaced electric pulses per second, known as clock cycles.**
- **The shorter the clock cycle, the faster is the processor.**
- Speed of clock is measured in megahertz (Mhz) or gigahertz (Ghz).

Processor – Speed of Processor

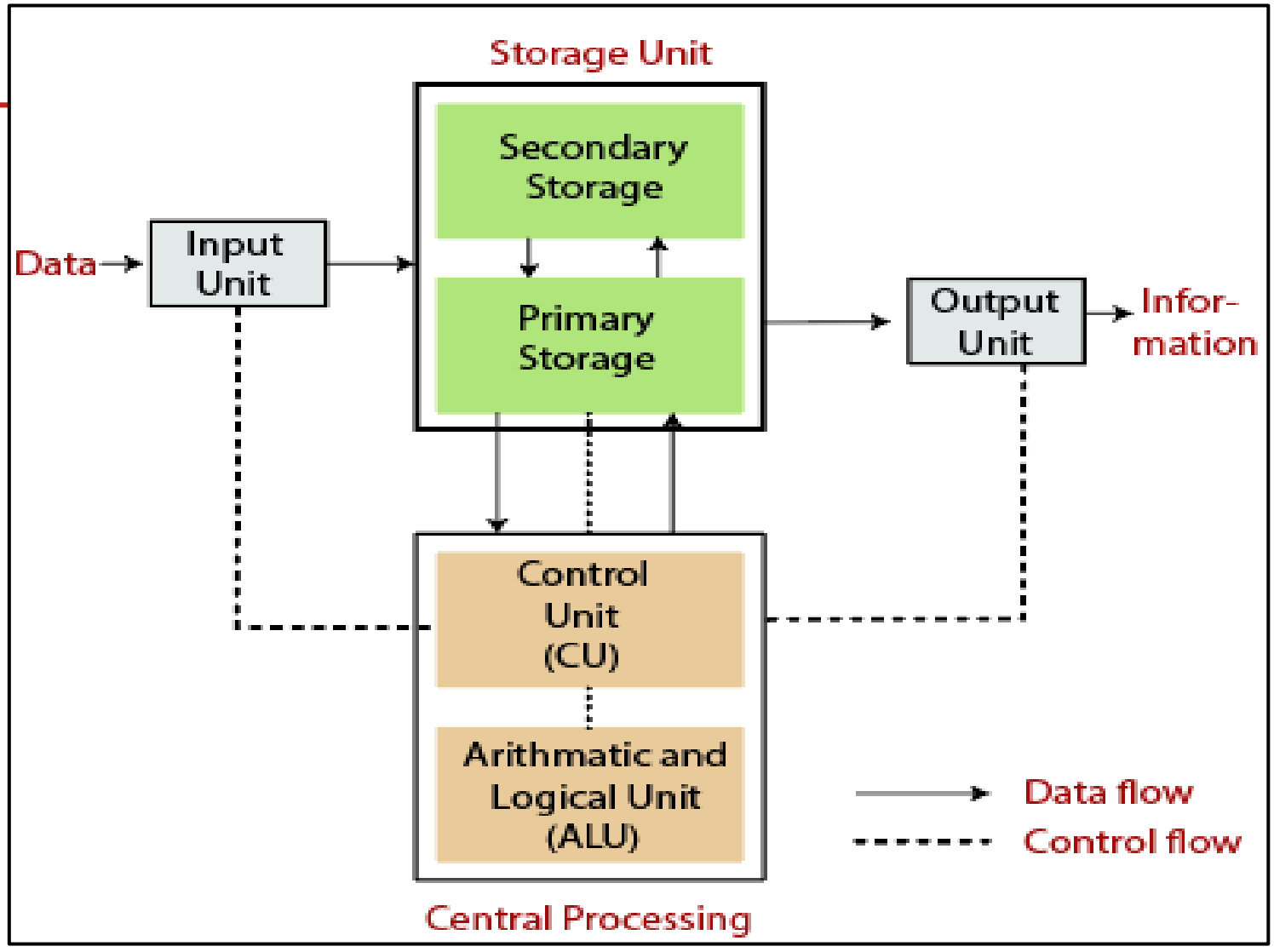
- **The range of personal computers lies between 500 MHz to 4000 Mhz.**
- The speed of workstations and mainframe systems is measured in:
  - MIPS (Millions of Instructions Per Second)
  - BIPS (Billions of Instructions Per Second)
  - Supercomputers in TFLOPS (teraflops, refers to 10 raise to 12 floating point operaions per second)
  - PFLOPS (10 raise to 15)

Processor – Modern Multicore Processors

- A multi-core processor is a single computing component with two or more independent processing units called cores, which read and execute program instructions.

- Dual core chip running multiple applications is about 1.5 times faster than a chip with just one comparable core.
- A **dual-core** processor has two cores (e.g. AMD Phenom II X2, Intel Core Duo)
- A **quad-core** processor contains four cores (e.g. AMD Phenom II X4, the Intel 2010 core line that includes three levels of quad-core processors, see i3, i5, and i7 at Intel Core),
- A **hexa-core** processor contains six cores Intel Core i7 Extreme Edition 980X),
- An **octa-core** processor contains eight cores (e.g. AMD FX-8150).

PROCESSOR


Storage Unit
Secondary Storage
Primary Storage
Data
Input Unit
Output Unit
Infor-mation
Control Unit (CU)
Arithmatic and Logical Unit (ALU)
Central Processing
Data flow
Control flow

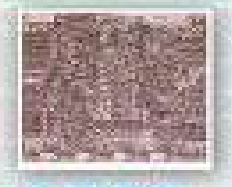
PROCESSOR

- **Arithmetic Logic Unit (ALU):** ALU performs arithmetic and logical operation. Arithmetic operation comprises of (Addition, subtraction, division, multiplication) and the logical unit carries out the operation such (AND, OR, Equal, less than, greater then), and later the control is changed to ALU and the result generated in ALU.
- **Control Unit (CU):** Control Unit of a computer system manages and coordinates the operations of all other components of the computer system. It tells the logic unit, memory as well as the input and output devices how to handle the program or instruction in proper order.
- **Central Processing Unit (CPU):** It is the brain or heart of a computer system. It is responsible for controlling the operations of all other units of a computer system. The CPU is also called ***PROCESSOR***.

EVOLUTION OF THE PROCESSOR

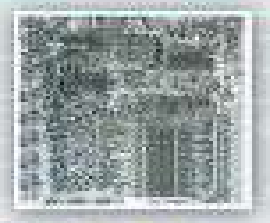
1971

Intel launched its first microprocessor, the 4004.



1972

The company announced the first 8-bit microprocessor - the 8008.



1974

The Intel 8080 microprocessor was introduced, considered by many to be the first true general-purpose microprocessor.

1976

Intel 8085 microprocessor was introduced, delivering a 5-volt power supply advantage.

1978

Introduced the 8086 16-bit microprocessor which became an industry standard.

1982

Launched the high-performance 16-bit 80286 microprocessor with 134,000 transistors.

1985

A 32-bit chip, the advanced Intel 386™ processor was launched.

1989

Introduced the Intel i860 processor, the first commercial microprocessor with more than **1M transistors.**

1992

Introduced **first OverDrive processors,** which allowed users of certain upgradable PCs to boost system performance.

1993

Intel **Pentium** Processors arrives, **five times more powerful** than the original Intel 486™ processor.

1995

The Intel Pentium Pro processor: high-performance chip for 32-bit workstations and servers.

1998

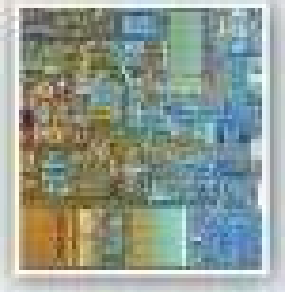
Intel rolls out the Intel Pentium II Xeon processor for workstation and server markets.

1998

The Intel Celeron processor is introduced for the value PV market segment.

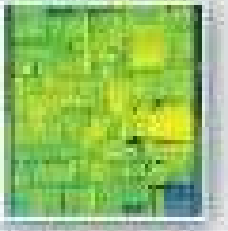
1998

Intel announced its first high-performance, low-power processors based on the Intel StrongARM technology, for handheld computing and communication devices.



1999

Intel Pentium III and Pentium III Xeon processors hits the market.

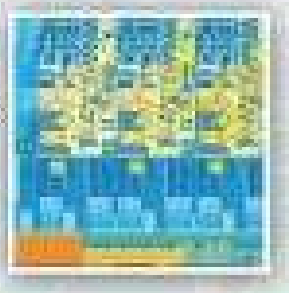


2000

The Intel Pentium 4 Processor heralds new performance with **42-million transistors.**

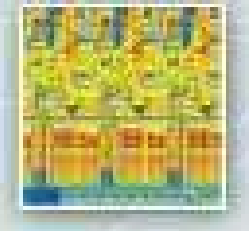
2012

Intel 3rd-gen Core™ processor (IVY Bridge) launched.



2011

'Visibly Smart' 2nd Gen Intel Core™ Processors (Sandy Bridge) launched.



2008

Energy-efficient computer chip, Intel Atom™ processor introduced to provide wireless capability to small mobile computing devices.

2007

Launched Core™ 2 Quad processors. This year also sees breakthrough in 45nm process technology that allows more than 2 million Intel 45nm transistors to fit in a sentence period.

2006

World's first Quad-Core Processor for desktop & mainstream servers and more ... Intel Centrino® Duo Mobile Technology, Intel VIV™ technology and Intel Core™ 2 Duo processor is launched.

2001

Server workhorses; Intel Itanium Processor and Intel Xeon Processors launched.

2002

Intel delivered its first chip **0.13 micron technology** on 300mm (12-inch) wafers.

2003

Introduced Intel Centrino Processor Technology: high performance, great battery life, and integrated wireless LAN capability to thinner laptop PCs.

TYPES OF PROCESSOR

- **Microcontroller**: The reading input and responding to output is the basic function of the microcontroller. Generally, it is known as General Purpose Input Output (GPIO).
- **Microprocessor**: The microprocessor is also a general-purpose processor that consists of a control unit, ALU, a bunch of registers also called scratchpad registers, control registers and status registers.
- **Embedded Processor:** An embedded processor is one type of processor which is designed to control mechanical functions and electrical functions. It consists of several blocks they are the processor, timer, an interrupt controller, program memory and data memory, power supply, reset and clock oscillator circuits, system application-specific circuits, ports and interfacing circuits.

TYPES OF PROCESSOR

- **DSP**: The digital signal processor is one type of processor used for measuring, filtering and/or compress digital or analog signals. These processors are fast and use for real-time applications.
- **Media Processor:** The image/video processor is the media processor that is designed or created to deal with the data in real-time. The voice user interface and professional audio are the applications of the audio processor.

PRIMARY STORAGE

- Primary storage is the component of the computer that holds data, programs and instructions that are currently in use.
- It is also known as main memory.
- Primary storage is located on the motherboard. As a result, data can be read from and written to primary storage extremely quickly.
- Primary storage is comparatively limited in size, especially when compared with secondary storage.
- A primary storage device is a medium that holds memory for short periods of time while a computer is running. Although it has a much lower access time and faster performance, it is also about two orders of magnitude more costly than secondary storage.

PRIMARY STORAGE

There are four types of primary storage:

- Read Only Memory (ROM)
- Random Access Memory (RAM)
- Flash Memory
- Cache Memory

ROM – Read Only Memory

- ROM is a memory device or storage medium that stores information permanently.
- It is called read only memory as we can only read the programs and data stored on it but cannot write on it.
- It is restricted to reading words that are permanently stored within the unit.
- The manufacturer of ROM fills the programs into the ROM at the time of manufacturing the ROM. After this, the content of the ROM can't be altered, which means you can't reprogram, rewrite, or erase its content later.

ROM – Read Only Memory

- ROM contains special internal electronic fuses that can be programmed for a specific information. The binary information stored in the chip is specified by the designer and then embedded in the unit at the time of manufacturing.
- Once information is stored, it stays within the unit even when the power is turned off. So, it is a non-volatile memory as it holds the information even when the power is turned off, or you shut down your computer.

ROM – Read Only Memory

- When you start your computer, the screen does not appear instantly.
- It takes time to appear as there are startup instructions stored in ROM which are required to start the computer during the booting process.
- The work of the booting process is to start the computer.
- It loads the operating system into the main memory (RAM) installed on your computer.
- The BIOS program, which is also present in the computer memory (ROM) is used by the microprocessor of the computer to start the computer during the booting process.
- It allows you to open the computer and connects the computer with the operating system.

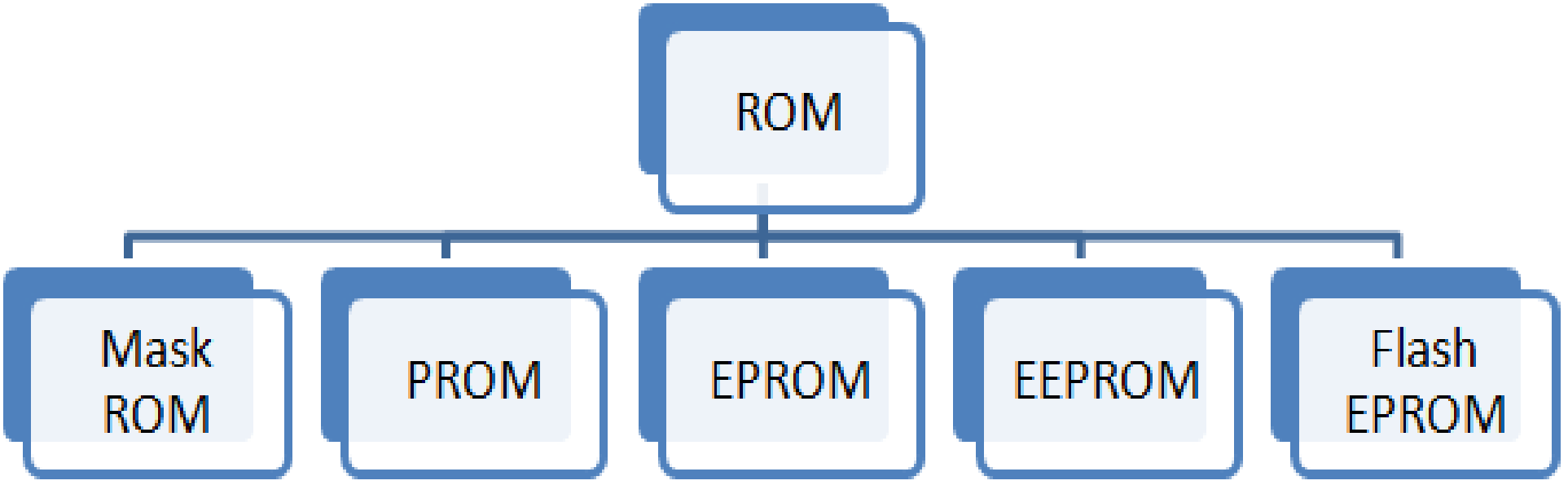
ROM – Read Only Memory

- A simple example of ROM is the cartridge used in video game consoles that allows the system to run many games. The data which is stored permanently on personal computers and other electronic devices like smartphones, tablets, TV, AC, etc. is also an example of ROM.
- ROM is also used to store Firmware, which is a software program which remains attached to the hardware or programmed on a hardware device like a keyboard, hard drive, video cards, etc. It is stored in the flash ROM of a hardware device. It provides instructions to the device to communicate and interact with other devices.

Advantages of ROMs

- The advantages of ROM are as follows −
  - 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 ROMs



Types of ROMs: MROM

- MROM is an abbreviation for Masked Read Only Memory.
- It is a read only memory chip that is programmed (data is stored in it) during it's manufacturing.
- MROMs cost relatively low.
- MROMs are the first ROMs to be developed and hard wired, contain a pre-programmed set of instructions or data.
- During the design phase in the manufacturing process of a MROM, a software mask is burned directly onto the chip.
- The customer receives the specifications of the MROM in a certain format and in tabular form. It's the job of the manufacturer to make the corresponding mask for the paths to generate the required output.

Types of ROMs: PROM

- PROM is an abbreviation for Programmable Read Only Memory.
- PROMs are also called as PLD, as they are used in logic designs.
- PROM is read-only memory that can be modified only once by a user.
- The user buys a blank PROM and enters the desired contents using a PROM program.
- Inside the PROM chip, there are small fuses which are burnt open during programming. It can be programmed only once and is not erasable.

Types of ROMs: EPROM

- EPROM stands for Erasable Programmable Read Only Memory.
- It is a chip that is non-volatile in nature and was invented in 1971 by Dov Frohman at Intel.
- An EPROM can be reprogrammed if required by exposing it to ultraviolet light.
- But otherwise, an EPROM does not save or accept any new data.
- EPROM chips are not used in modern computers as they have been replaced by EEPROM chips. E
- PROM is used by hardware manufacturers when it is required that the data stored in the ROM be changed.
- A distinguishing feature of EPROM chips is a small quartz crystal circle window exposing the chip so that it could be reprogrammed.

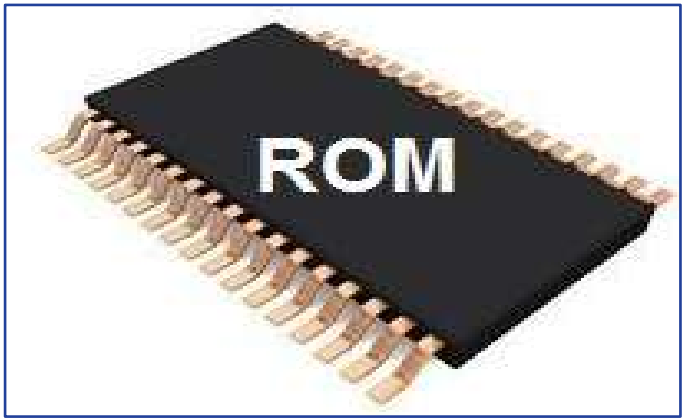
Types of ROMs: EEPROM

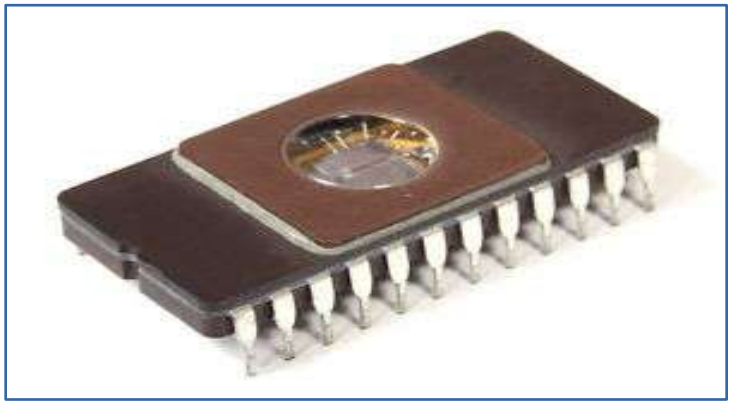
- EEPROM is an abbreviation for Electrically Erasable Programmable Read Only Memory.
- It is non-volatile in nature and is used for storing small amounts of data in computer systems or some other electronic devices.
- In an EEPROM, write and erase operations are performed one byte at a time.
- EEPROM technology was developed in 1978 at Intel by George Perlegos.
- EEPROM is programmed and erased electrically.
- It can be erased and reprogrammed about ten thousand times.
- Both erasing and programming take about 4 to 10 ms (millisecond).
- In EEPROM, any location can be selectively erased and programmed.
- EEPROMs can be erased one byte at a time, rather than erasing the entire chip.
- Hence, the process of reprogramming is flexible but slow.

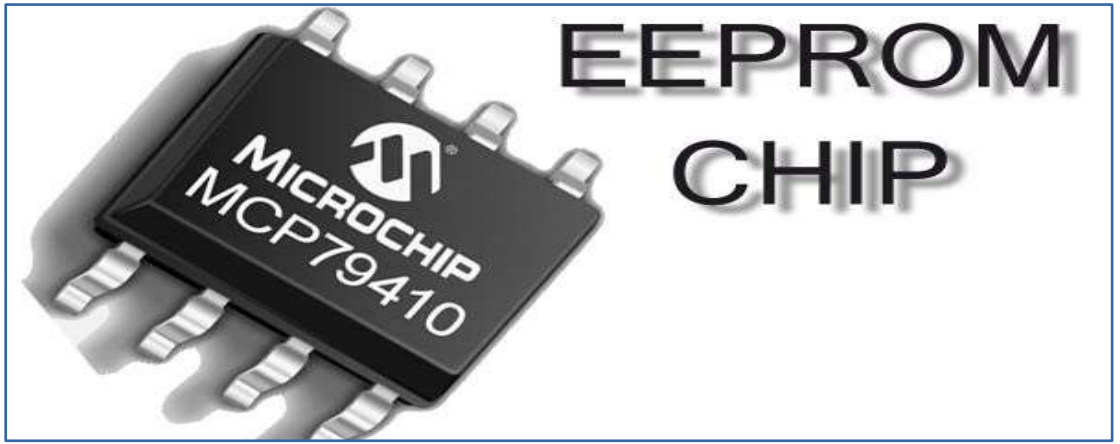
Types of ROMs: Flash ROM

- Flash memory is one of the most widely used forms of memory. Flash memory storage was born out of a combination of the traditional EPROM and E2PROM.
- Flash memory utilizes the same method of programming as does EPROM.
- A relevant benefit of using flash memory is that it can be erased electrically.

Primary Storage – Types







RAM – Random Access Memory

- Random access memory (RAM) is a high-speed component in devices that temporarily stores all information a device needs for the present and future.
- RAM is found in servers, PCs, tablets, smartphones, backup drives, and other devices.
- RAM takes the form of integrated circuit chips with metal-oxide-semiconductor (MOS) memory cells.
- The speed and performance of a system is directly correlated with the amount of RAM installed.
- RAM stores the information a computer is actively using, so it can be accessed quickly.
- It allows computers to perform everyday tasks such as loading applications, browsing the internet, editing a spreadsheet, and switching quickly among all these tasks.

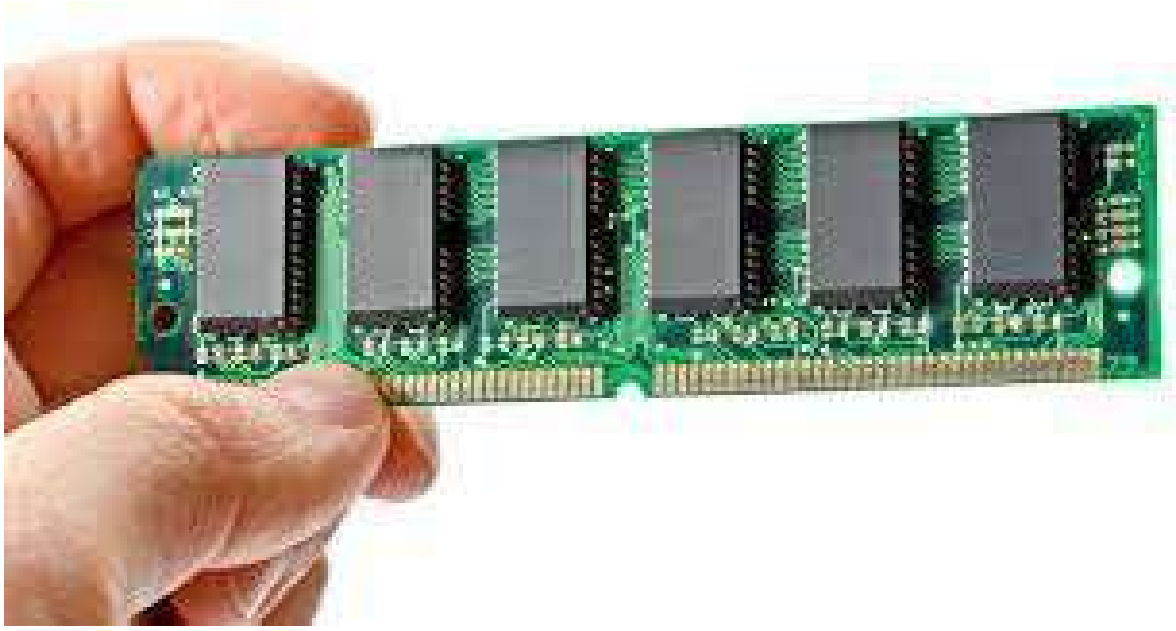
RAM – Random Access Memory

- RAM (Random Access Memory) is the internal memory of the CPU for storing data, program, and program result.
- It is a read/write memory which stores data until the machine is working. As soon as the machine is switched off, data is erased.
- Access time in RAM is independent of the address, that is, each storage location inside the memory is as easy to reach as other locations and takes the same amount of time.
- Data in the RAM can be accessed randomly but it is very expensive.
- RAM is volatile, i.e. data stored in it is lost when we switch off the computer or if there is a power failure.

Types of RAM

RAM is of two types –

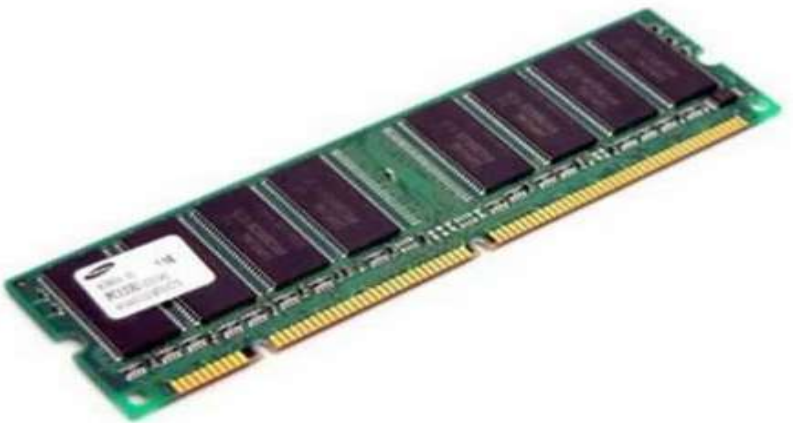
- Static RAM (SRAM)
- Dynamic RAM (DRAM)



Types of RAMs

SRAM – Static RAM

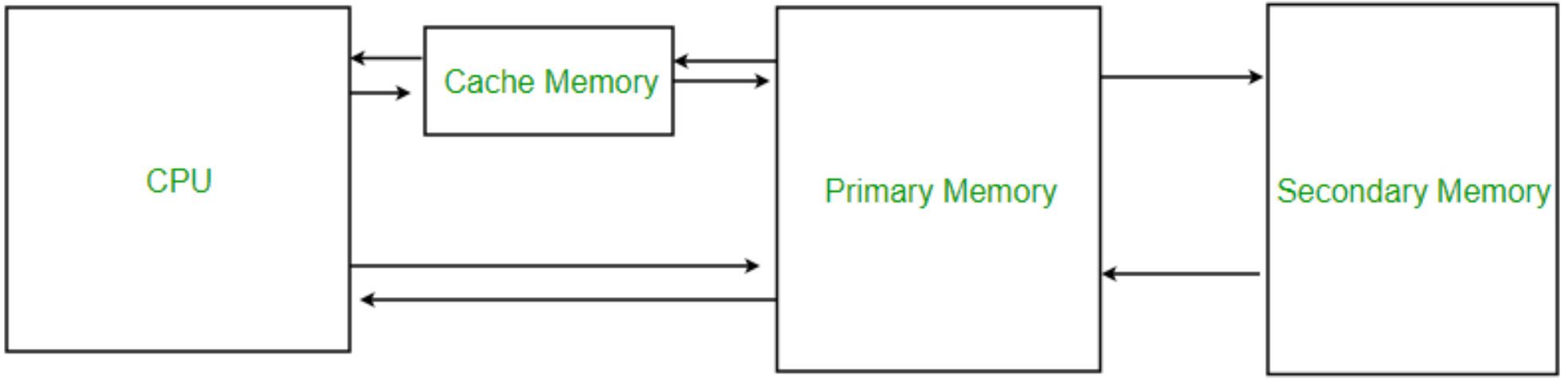
DRAM – Dynamic RAM



SRAM	DRAM
Faster as compared to DRAM	Slower as compared to SRAM
On-chip memory with minimal access time; can run at the speed of the host microprocessor	Slower: Off-chip memory with longer access time
Costlier than DRAM	Costs less than SRAM
Less storage capacity	Higher storage capacity
Consumes more power	Consumes less power
Low packaging density	Higher packaging density
Smaller: Acts as cache; storage measured in MBs	Connects directly to CPU bus; volatile storage measured in GBs
Does not require additional charges while it is receiving power but eventually loses data without it	Must have active power supply plus frequent charges while active
Placed in Processors or between processor and main memory	Placed in Motherboard

Cache Memory

- Cache memory is a small-sized type of volatile computer memory that provides high-speed data access to a processor and stores frequently used computer programs, applications and data.
- A temporary storage of memory, cache makes data retrieving easier and more efficient.
- It is the fastest memory in a computer, and is typically integrated onto the motherboard and directly embedded in the processor or main random access memory (RAM)
- Cache memory provides faster data storage and access by storing instances of programs and data routinely accessed by the processor. Thus, when a processor requests data that already has an instance in the cache memory, it does not need to go to the main memory or the hard disk to fetch the data.
- It acts as a buffer between RAM and the CPU. The processor checks whether a corresponding entry is available in the cache every time it needs to read or write a location, thus reducing the time required to access information from the main memory.
- When that data is accessed again, if a copy is available in the cache, that copy is accessed first so the speed and efficiency is increased. If it's not available, then larger, more distant, and slower memories are accessed (such as the RAM or the hard disk)


CPU
Cache Memory
Primary Memory
Secondary Memory

Flash Memory

- Flash memory is a non-volatile memory chip used for storage and for transfering data between a personal computer (PC) and digital devices.
- It has the ability to be electronically reprogrammed and erased. It is often found in USB flash drives, MP3 players, digital cameras and solid-state drives.
- Flash memory was named after its capability to erase a block of data “"in a flash.”
- It is a lot less expensive than EEPROM and does not require batteries for solid-state storage such as static RAM (SRAM).
- It is non-volatile, has a very fast access time and has a higher resistance to kinetic shock compared to a hard disc drive.
- Flash memory is extremely durable and can withstand intense pressure or extreme temperatures.
- It can be used for a wide array of applications such as digital cameras, mobile phones, laptop computers, PDAs (personal digital assistants), digital audio players and solid-state drives (SSDs).

Levels of Memories

- **Level 1 or Register**: It is a type of memory in which data is stored and accepted that are immediately stored in CPU. Most commonly used register is accumulator, Program counter, address register etc.
- **Level 2 or Cache memory**: It is the fastest memory which has faster access time where data is temporarily stored for faster access.
- **Level 3 or Main Memory**: It is memory on which computer works currently. It is small in size and once power is off data no longer stays in this memory.
- **Level 4 or Secondary Memory**: It is external memory which is not as fast as main memory but data stays permanently in this memory.

Difference: RAM vs ROM

	RAM	ROM
Volatility	RAM is volatile in nature as it automatically erased when computer shutdowns	ROM is non-volatile since it is never erased when there is any shutdown or restart of computer.
Accessibility	RAM can be directly accessed by the processor	ROM can't be directly accessed by the processor since it is transferred into RAM where it is executed by the processor.
Storage	RAM is used to store the temporary information for limited time.	ROM is used to store permanent information which can't be deleted.
Hardware structure	RAM is in form of chip while	ROM is generally optical drivers made of magnetic tapes
Cost	Costlier than ROM	Cheaper than RAM
Size	Chip Size is larger than ROM	Chip Size is smaller than ROM
Writing speed	Writing data to a RAM chip is a faster process	Writing data to a ROM chip is a slow process
Storage Limit	A RAM chip can store multiple gigabytes (GB) of data , up to 16 GB or more per chip	A ROM chip typically stores only several megabytes (MB) of data, up to 4 MB or more per chip
Examples	Static and dynamic RAM	PROM, EPROM and EEPROM are types of ROM.

Address and Content of a Memory Location

- The memory consists of many millions of small storage areas called **location or cells.**
- Each cells can store 1 bit of information having value as 0 or 1.
- The usual approach is to handle cells in **Fixed size.**
- The memory is organised
- Each of these locations can store a fixed number of bits called **word length** of the memory.

Address and Content of a Memory Location

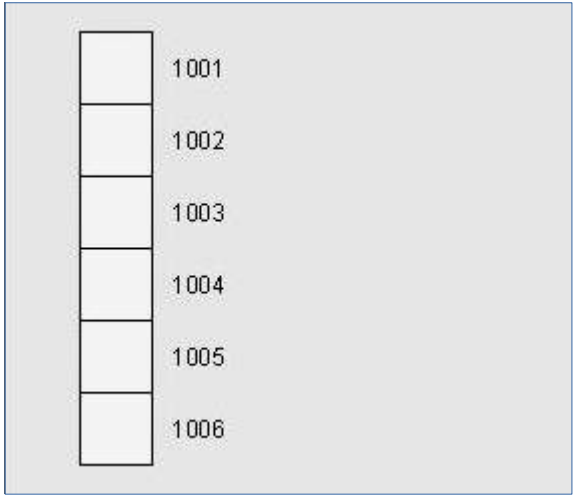
- Each word has a built in and unique number assigned to it, called the **address of the location.**
- e.g memory is divided into N words, where N is some power of 2. (10 to the power of 2 = 1024 = 1GB).
- Each location can hold either data items or an instruction.
- **Address normally starts with 0** and highest address equals the number of words that can be stored in the memory minus 1.
- eg. memory has 1024 locations,address ranges between 0 and 1023.

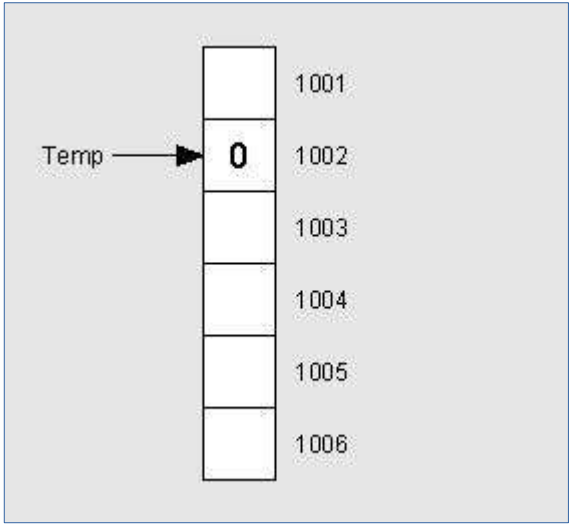
Memory Location

- Memory locations and addresses determine how the computer's memory is organized so that the user can efficiently store or retrieve information from the computer.
- The computer's memory is made of a silicon chip which has millions of storage cell, where each storage cell is capable to store a bit of information which value is either 0 or 1.
- Computer memory holds instructions and data.
- A single bit is very small to hold this information so bits are rarely used individually.
- So, the bits are grouped in fixed sizes of n bits.
- The memory of the computer is organized in such a way that the group of these n bits can be stored and retrieved easily by the computer in a single operation.

Memory Location

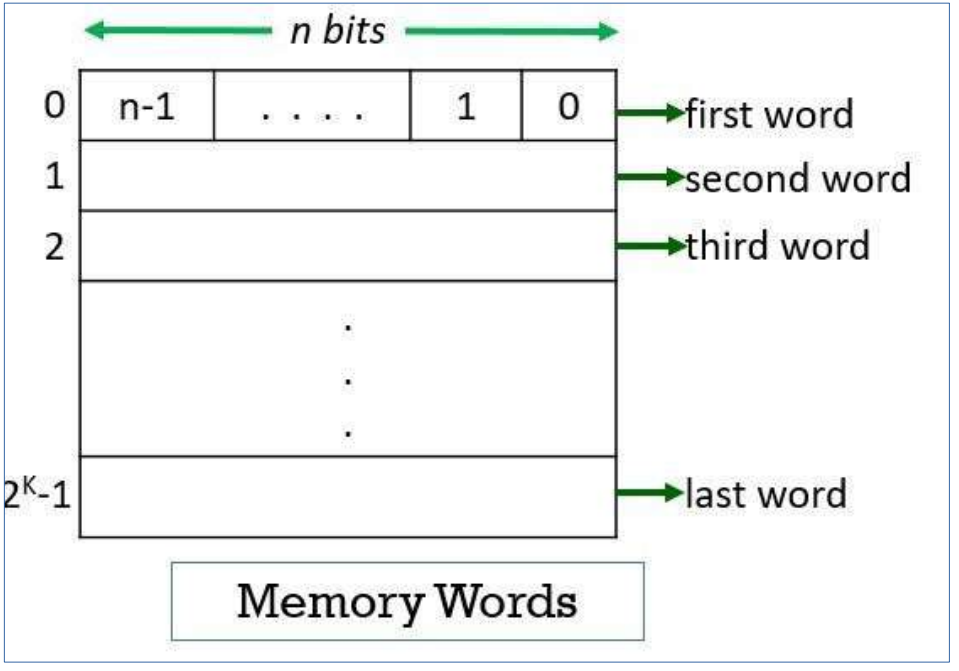
- When you declare variables you are given a memory location to use from the free memory available.





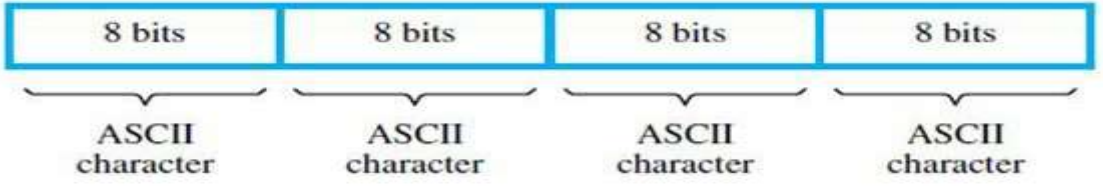
Memory Location

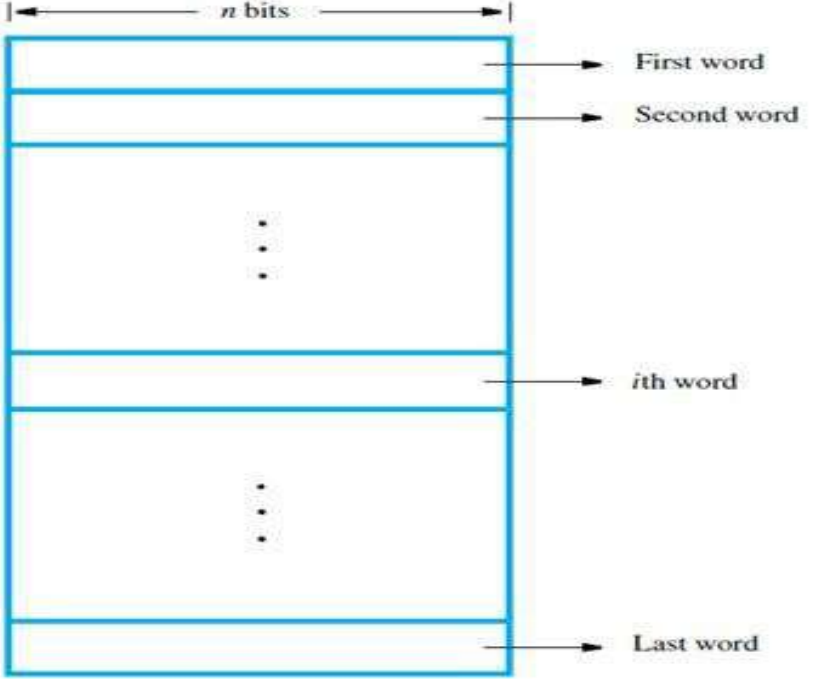
- The group of n bit is termed as word where n is termed as the word length.
- The word length of the computer has evolved from 8, 16, 24, 32 to 64 bits.
- General-purpose computers nowadays have 32 to 64 bits.
- The group of 8 bit is called a byte.



Address and Content of a Memory Location

- Modern computers usually have word length of 16 to 64 bits.
- So, a computer with word length 16 is called 16 bit computer. It can store 2 ASCII encoded characters of 8 bits each.
- So tell me what will
  - 32 bit computer store?
  - 64 bit computer store?





Storage Capacity of Main Memory

- Storage capacity of main memory is equal to the number of bytes that can be stored in it.
- The units of storage capacity is B (Bytes), KB(Kilo Bytes), MB(Mega Bytes) , GB(Giga Bytes), TB(Tera Bytes), PB (Peta Bytes).
- A memory size ranges from few kilobytes in small system to several thousand Megabytes or Gigabytes in large mainframe and super computer.
- In your personal computer you will find memory capacity in the range of 64 KB, 4 MB, 8 MB and even 16 MB (MB = Million bytes).

Storage Conversions

1 bit	Bit	=	0 veya 1
1 byte	Byte	=	8 bit
1 Kilobyte	KB	=	1024 bytes
1 Megabyte	MB	=	1024 KB
1 Gigabyte	GB	=	1024 MB
1 Terabyte	TB	=	1024 GB
1 Petabyte	PB	=	1.024 TB

Storage Capacity

Put them in order from lowest to highest:

A. GB

B. KB

C. Byte

D. MB

E. Nibble

F. Bit

Storage Capacity

Which storage device/media might have the following capacities:

A. 700MB

B. Up to 185 TB

C. 4.7 GB

D. 128GB – 4TB

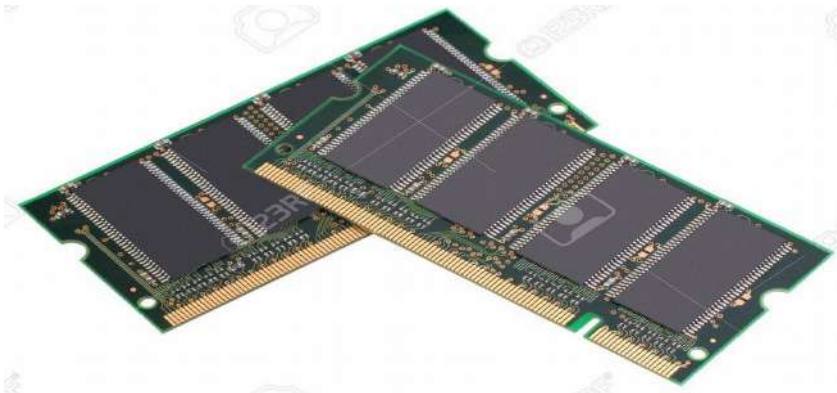
E. 1.44MB

Memory Chips

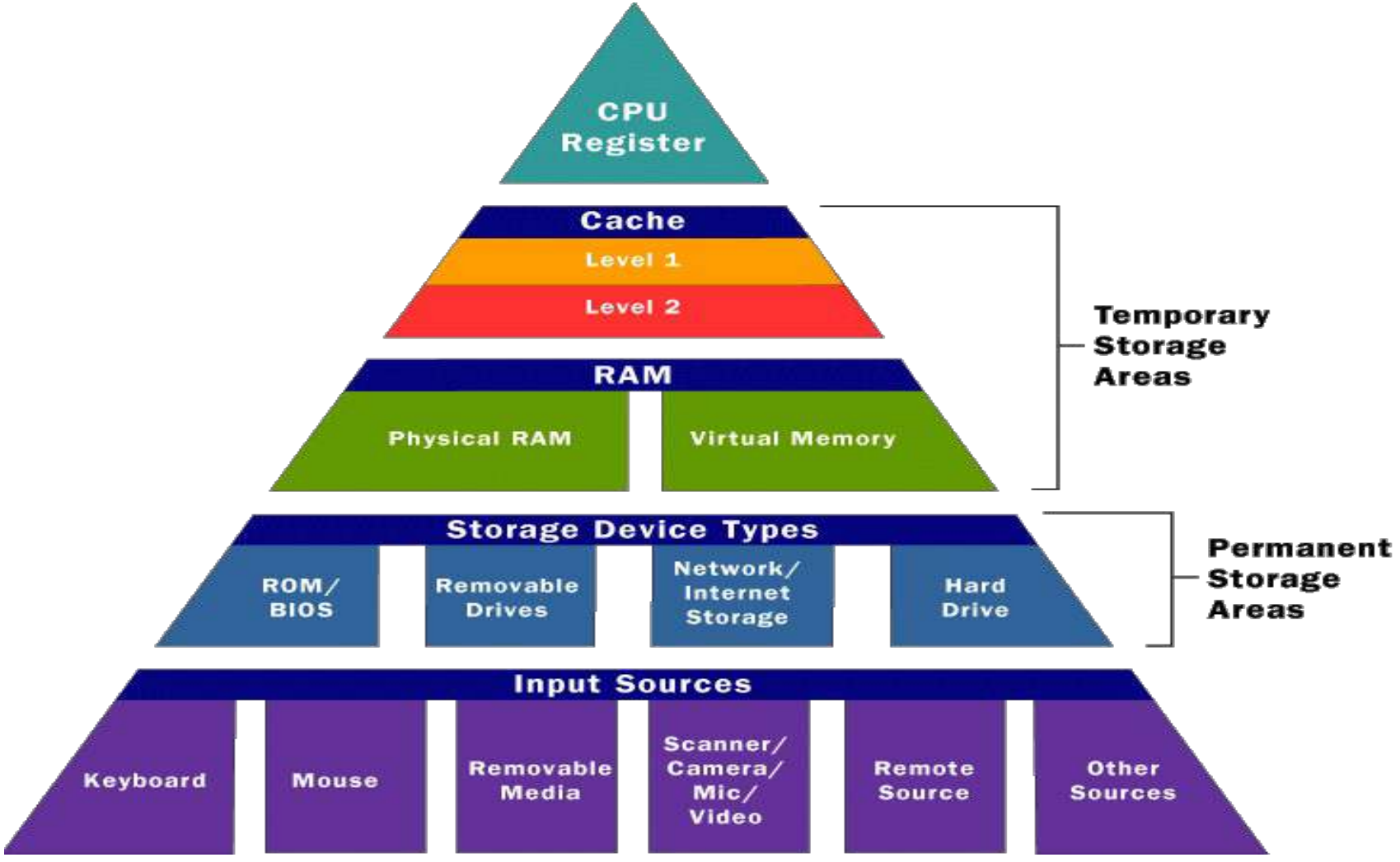
- Memory chips are semiconductor devices used as internal storage areas within a computer.
- The main memory of a computer system consists of **Integrated Circuit** (IC) chips mounted either on the computer's motherboard or on a small circuit board attached to the motherboard.
- A memory chip is an integrated circuit made out of millions of capacitors and transistors that can store data or can be used to process code.

Memory Chips

- **Memory Chips:** are composed of transistors and capacitors: the capacitors serve to store two binary logic bits (0 or 1)
- **Transistors:** allow reading and writing of data to the capacitors.
- A memory chip is comprised of thousands of these tiny circuits, known as memory cells.



Memory Chips

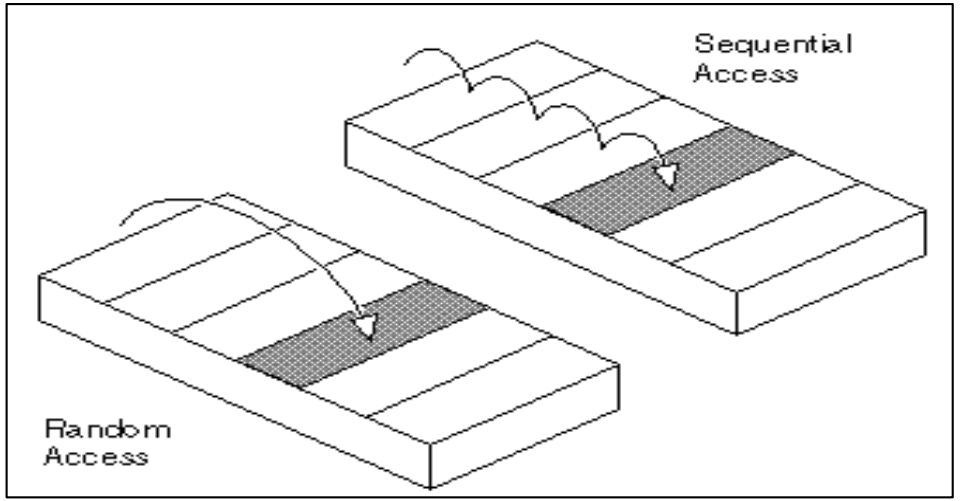


Secondary Strorage

- It is **Secondary Memory Or External Memory.**
- It is a **non-volatile memory** (does not lose stored data when the device is powered down).
- It is not accessed via the **input/output channels** (it is an external device) so it is not directly accessible by the CPU.
- Also called **Auxiliary memory** or auxiliary storage
- Types of Secondary Storage Devices have:
  - **Random Access**
  - **Sequential Access**

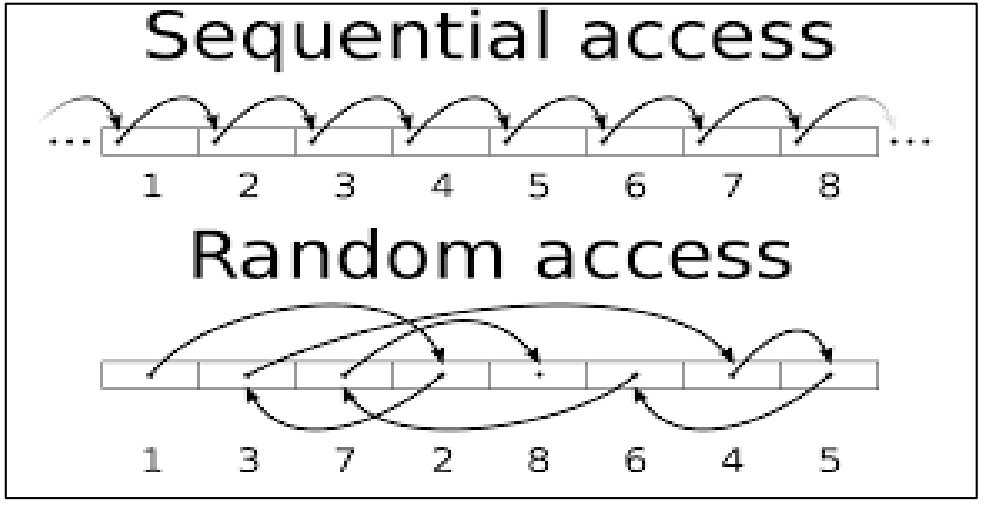
Secondary Storage - Random Access

- **Random Access** – Any location in storage can be accessed at any moment in approximately the same amount of time.



Secondary Storage - Random Access

- **Sequential Access** – The accessing of pieces of information will be in a serial order, one after the other; therefore the time to access a particular piece of information depends upon which piece of information was last accessed

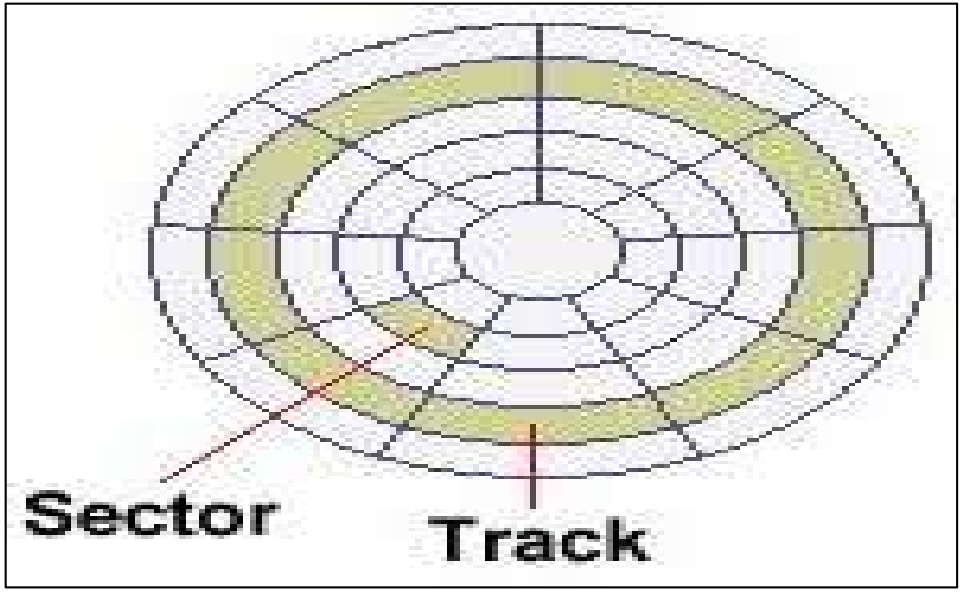


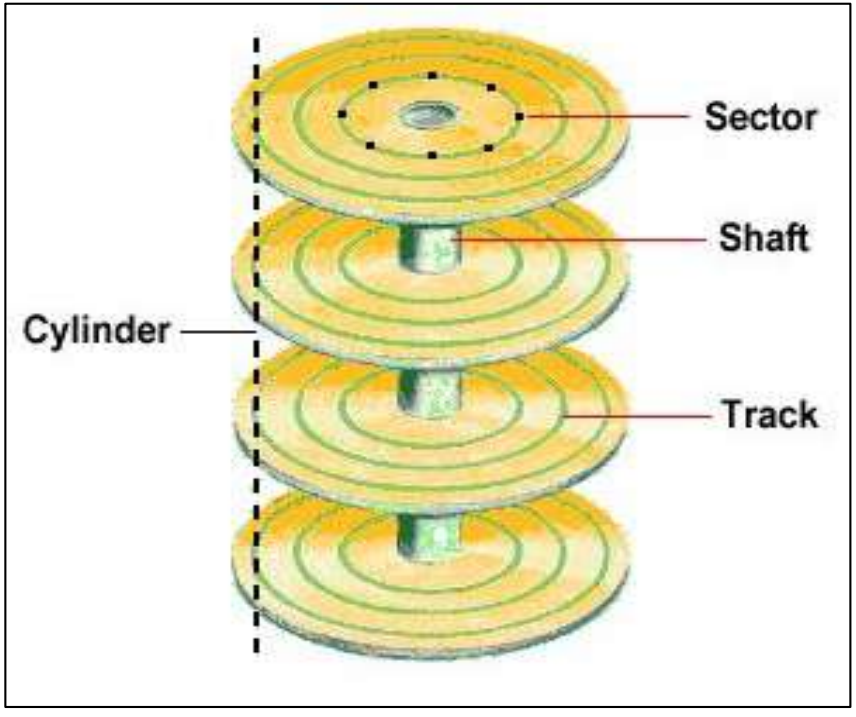
Secondary Storage - Magnetic Disks

- A magnetic disk primarily consists of a **rotating magnetic** surface and a **mechanical arm** that moves over it.
- The **mechanical arm** is used to read from and write to the disk.
- The data on a magnetic disk is read and written using a **magnetization** process.
- Data is organized on the disk in the form of **tracks** and **sectors**
- Magnetic disks come in various **sizes** range from 1 to 14 inch diameter.
- Commonly used **sizes** are 1.0, 2.5 and 3.5 inch

Secondary Storage - Magnetic Disks

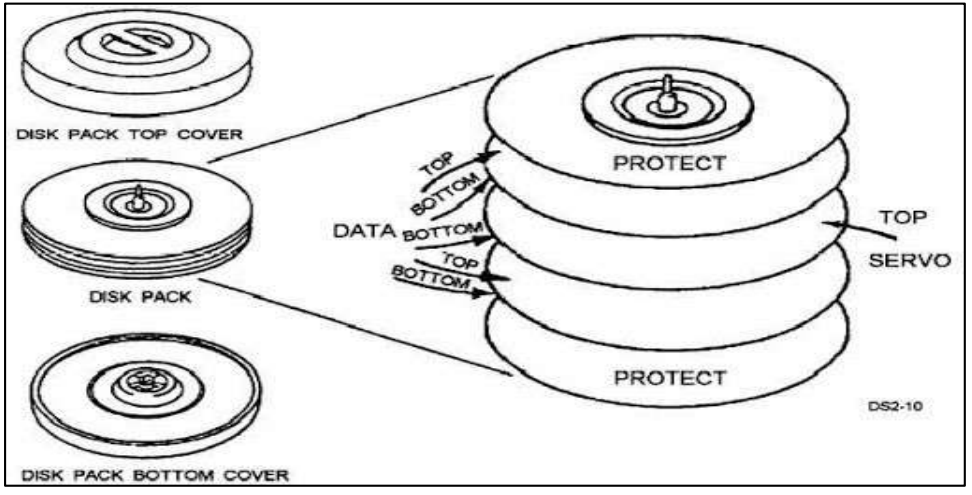
- **Tracks are the circular divisions of the disk.**
- Tracks are further divided into **sectors** that contain blocks of data.
- **All read and write operations on the magnetic disk are performed on the sectors.**





Types of Magnetic Disks – Disk Pack

- 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 consists of a motor to rotate the disk pack about its axis.
- It also has an access arms having separate read/write heads.



Types of Magnetic Disks – Disk Pack

- Depending on the size and number of platters used in a disk pack the storage capacity of a single disk pack varied from a few terabytes to a few petabytes.

Optical Disk

- An optical disk is any computer disk that uses optical storage techniques and technology to read and write data.
- It is a computer storage disk that **stores data digitally.**
- **It uses laser beams** (transmitted from a laser head mounted on an optical disk drive) to read and write data.
- It uses two laser beams:
  - a high intensity beam for writing data
  - a low intensity beam for reading data
- Size range : 3 to 12 inch diameter (5.25 inch commonly used)
- Storage capacity : 700 MB of data
- Types : CD-ROM, CD-WROM, CD-RW, DVD

Types of Optical Disk

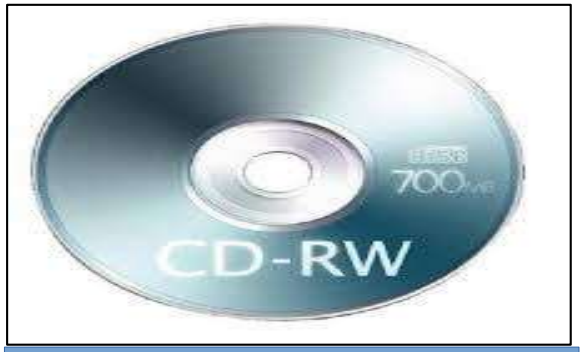
- **CD-ROM (Compact Disc Read-Only Memory) –** is a type of optical disc that users can read but not write or erase - hence the name read-only.
- **Picture CDs –** is a single-session CD-ROM that stores digital versions of film using a jpg file format.
- **CD-R (Compact Disc-Recordable) –** is a multisession optical disc on which users can write, but not erase, their own items such as text, graphics and audio.
- **CD-RW (Compact Disc-Rewritable) –** is an erasable multisession disc you can write on multiple times.

Types of Optical Disk

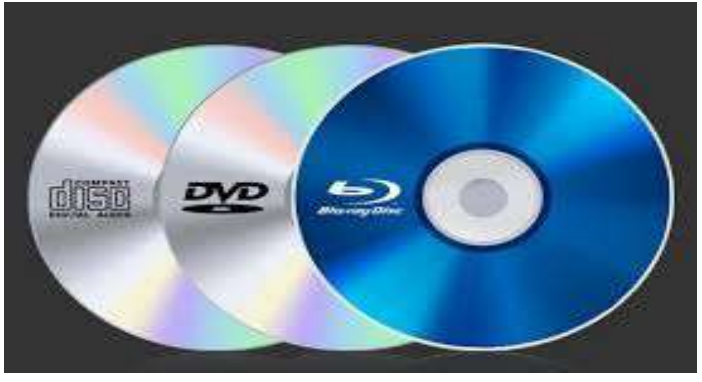
- **DVD (Digital Versatile/Video) –** is a high-capacity optical disc on which data can be read and write. Once user write a data into it, he/she can not erase or write in it again.
- Two newer, more expensive competing DVD formats are :-
  - **Blu-ray Disc-ROM** has storage capacities of 100 GB, with expectations of exceeding 200 GB in the future.
  - **HD DVD-ROM** disc has storage capacities up to 60 GB with future projections of 90 GB capacities.

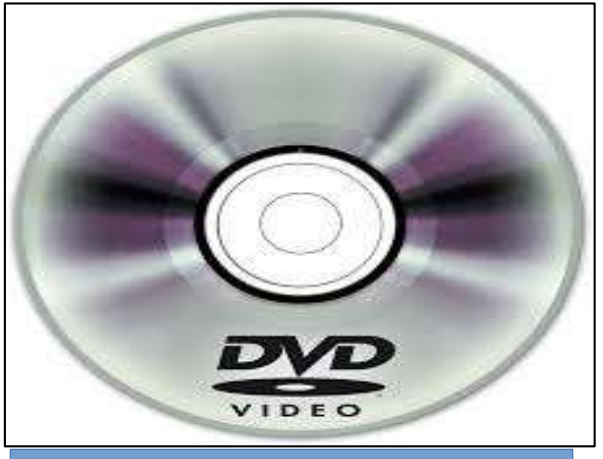
Compct Disk Write Once Read Many

Compact Disk Read Only Memory



Compact Disk Read Write





Digital Video Disk

Magnetic Tapes

- Magnetic taps are popular storage medium for sequential access storage devices.
- It is a storage medium that allows for data archiving, collection, and backup.
- One side of the tape is coated with a magnetic material. Data on the tape is written and read sequentially.
- Finding a specific record takes time, because the machine has to read every record in front of it.


DAT
R-94
DAT
DAT
R-94


maxell
TR-1
800 MB
400 MB
TDK
DC-2120
MINI DATA CARTRIDGE
QIC80 FORMATTED


IBM
Extended High Performance
Cartridge Tape
3590

Linear Tape Open

- Linear Tape-Open (LTO) is a magnetic tape data storage technology originally developed in the late 1990s as an open standards alternative to the proprietary magnetic tape formats that were available at the time. Hewlett Packard Enterprise, IBM, and Quantum control the LTO Consortium, which directs development and manages licensing and certification of media and mechanism manufacturers.
- The standard form-factor of LTO technology goes by the name Ultrium, the original version of which was released in 2000 and stored 100 GB of data in a cartridge. The ninth generation of LTO Ultrium was announced in 2020 and can hold 18 TB in a cartridge of the same physical size.
- Upon introduction, LTO Ultrium rapidly defined the super tape market segment and has consistently been the best-selling super tape format. LTO is widely used with small and large computer systems, especially for backup.

ULTRIUM
LTO

Solid State Drive

- A solid-state drive (SSD) is a solid-state storage device that uses integrated circuit assemblies to store data persistently, typically using flash memory, and functioning as secondary storage in the hierarchy of computer storage. It is also sometimes called a semiconductor storage device, a solid-state device or a solid-state disk, even though SSDs lack the physical spinning disks and movable read–write heads used in hard disk drives (HDDs) and floppy disks.
- SSD also has rich internal parallelism for data processing.
- In comparison to hard disk drives and similar electromechanical media which use moving parts, SSDs are typically more resistant to physical shock, run silently, and have higher input/output rates and lower latency.
- SSDs store data in semiconductor cells.


SUPER TALENT
64GB


intel
D33025
N232
E139761
HF
b6
e1


SSD

Pen Drive

- It is a portable storage device like a pen or keychain.
- Plugs into computer's USB port & computer automatically detects it.
- Pendrives use flash memory which is non volatile and EEPROM.
- It can be used to store graphics-heavy documents, photos, music files and video clips.
- A pen drive plugged into a USB port can be used as an interfacing device to transfer files, documents and photos to a PC.
- Similarly, selected files can be transferred from a pen drive to any workstation.
- Storage : capacity range from
  8 GB to 256 GB and more

Memory Card

- Memory card is a small, thin portable device like a small cardboard piece, which plugs into a specially designed interface of the electronic equipment for which it serves as a pluggable storage device.
- **Two types :**
  - **Secure Digital (SD) –** used with electronics.
  - **Multimedia Card (MMC) -**
- SD memory cards
- MMC card is available as flash memory or ROM in devices as car radios, cell phones, digital cameras, PDAs, MP3 players, and printers.
- Storage capacity : 8 MB to 64 GB & More