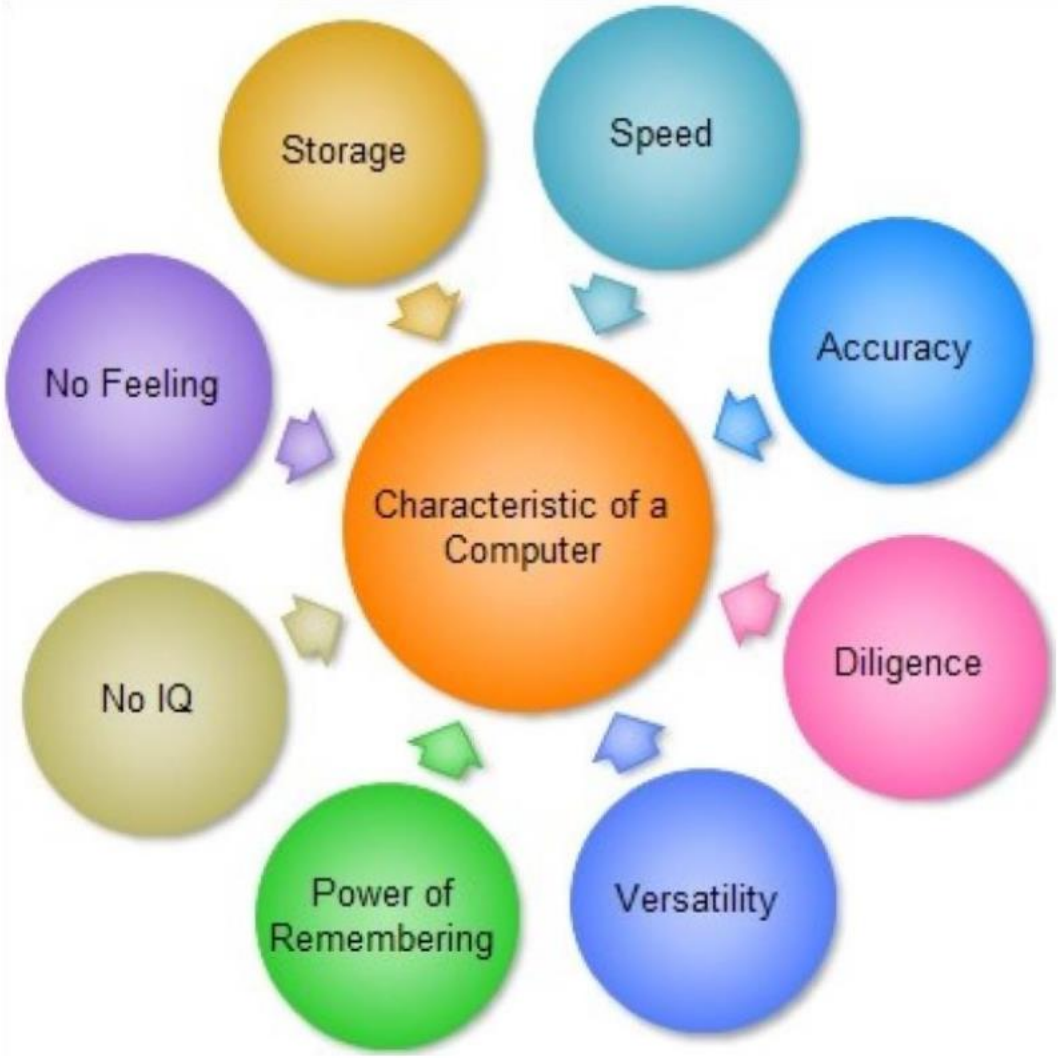
Introduction to computers

Characteristics of computers:



1.Speed: – As you know computer can work very fast. It takes only few seconds for calculations that we take hours to complete. You will be surprised to know that computer can **perform millions (1,000,000) of instructions** and even more per second. Therefore, we determine the speed of computer in terms of **microsecond** (10-6 part of a second) or **nanosecond** (10 to the power -9 part of a second). From this you can imagine how fast your computer performs work.

2. Accuracy: – The degree of accuracy of computer is very high and **every calculation** is performed with the same accuracy. The accuracy level is 7 determined based on design of computer. The errors in computer are due to human and inaccurate data.

3. Diligence: – A computer is free from tiredness, lack of concentration, fatigue, etc. It can **work for hours** without creating any error. If millions of calculations are to be performed, a computer will perform every calculation with the same accuracy. Due to this capability, it overpowers human being in routine type of work.

4. Versatility: – It means the capacity to **perform completely different type of work**. You may use your computer to prepare payroll slips. Next moment you may use it for inventory management or to prepare electric bills.

5. Power of Remembering: – Computer has the power of storing any amount of information or data. Any information can be **stored and recalled as long as you require it**, for any numbers of years. It depends entirely upon you how much data you want to store in a computer and when to lose or retrieve these data.

6. No IQ: – Computer is a dumb machine, and it cannot do any work without instruction from the user. It performs the instructions at tremendous speed and with accuracy. It is **you to decide what you want to do and in what sequence**. So, a computer cannot take its own decision as you can.

7. No Feeling: – It does not have feelings or emotion, taste, knowledge and experience. Thus, it does not get tired even after long hours of work. It does not distinguish between users.

8. Storage: – The Computer has an in-built memory where it can store a large amount of data. You can also store data in secondary storage devices such as floppies, which can be kept outside your computer and can be carried to other computers.

Types of Digital Computers

- Digital computer is a digital system that performs various computational tasks.
- Digital computer operate on digital data such as numbers.
- To perform tasks, the digital computer uses a binary number system that has two digits 1 and 0.
- A binary digit is called a bit.
- It uses **electronic technology to generate, process, and store** the different types of data.
- They **convert data into digits(0 & 1)** and all the operations carried out on these digits at extremely fast rate.
- A digital computer knows how to count digits and add the digits.
- Digital computer are **much faster** than an analog computer and far **more accurate.**
- Computer used for **business and scientific applications** are digital computers.
- Based on the types and size of the device, these digital computers are divided into 4 types of namely
    1. Micro computer
    2. Mini computer
    3. Mainframe computer
    4. Super computer

1. Microcomputers

- A microcomputer is a small, relatively inexpensive computer with a microprocessor as its CPU (Central Processing Unit).
- Also known as PC(Personal computer), it was introduced in 1970.
- The number of processors in microcomputers will be **one or two processors**.
- It contains input devices, output devices, storage device and processors.
- It is **used by one person at a time**.
- Example: Desktops, Laptops, Notebooks, Tablets, Smartphones.

Uses of microcomputers

- They are used as desktops either in offices or even in homes.
- Children enjoy playing games & watching movies in these computers.
- They are cheap and user-friendly.
- Their operation can be easily learned by anyone having the logical aptitude.

2. Minicomputers

- Minicomputer is a computer that has the same functionality as large computers but appears in a smaller size.
- Minicomputer is smaller than a mainframe computer but larger than a microcomputer.
- Minicomputer can execute **5 million** instructions per second.
- Mobile phones, tablet PCs, laptops, desktop mini-computer, high-end MP3 players are some of the examples of minicomputers. Minicomputers are mainly used by **businesses** to manage the process of production.
- Mini computers are less in cost as compared to supercomputer and mainframe computers.
- It is more powerful than a microcomputer but no powerful as a supercomputer and a mainframe computer.
- This computer can handle **one or more processors**.
- It allows multiple users at a time and supports multitasking and multiprocessing to perform a few the task at a time.
- Minicomputer is also known as **minis.**
- Example: VAX-800, Digital Alpha, AS 400

Uses of minicomputers

- They are often used by **small and medium sized companies** to provide centralized storage of information.
- They are used for **data processing.**

3. Mainframe computers (1975)

- Mainframe computers are the computers that are used in large organizations to manage critical operations such as bulk data processing, transaction processing, and enterprise resource planning.
- It is very large computer in size.
- It is more powerful and consists of **multiple processors**.
- It is designed to perform multiple tasks for multiple users at the same time.
- User can access mainframe computer through personal computer.
- Can execute **16 million** instruction per second.
- Example: DEC 10, NEC 610, CDC 6600

Uses of mainframe computers

- Used in large organization.
- They can be used for **more mathematical calculations**.
- They are **not user friendly**. Qualified & trained operators are required to operate them.
- They can use a wide variety of software's.
- They have large storage capacity.
- They have wide range of peripherals attached.

4. Supercomputers (1980)

- Supercomputer is a computer with a high level of performance as compared to a general purpose computer.
- Instead of MIPS (Million instructions per second), Its performance is measured in FLOPS (Floating point operations per second) format.
- Super computer is the fastest computer.
- Super computer is the biggest in size and the most expensive in price than any other computers.
- It has a very large storage capacity.
- It can process **trillions of instructions** in one second.
- Example: IBM Roadrunner, IBM Blue Gene, PARAM Padma etc.

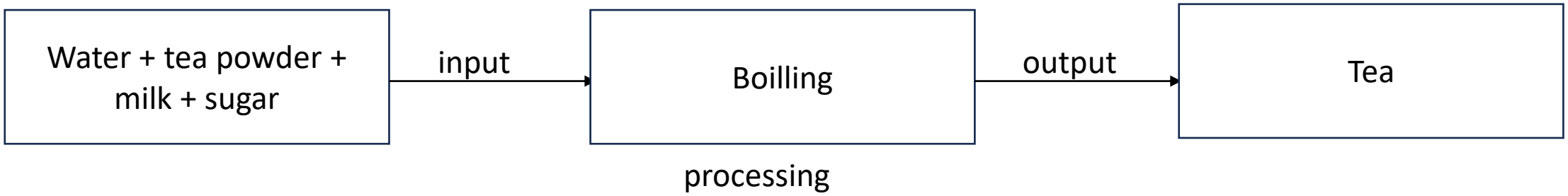
Uses of supercomputers

- Weather forecasting.
- Animated Graphics like Hollywood Movies
- Space science
- Weapons and missile design

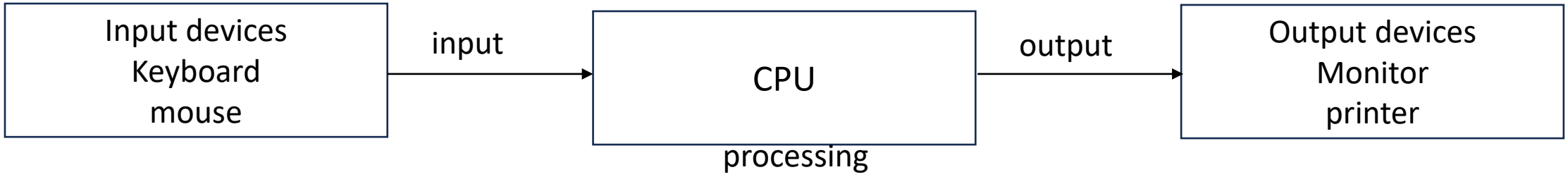
Anatomy of computer

- Computer is an electronic device that can store, recall and process data.
- It can perform tasks or complex calculations according to a set of instructions or programs.

How does computer works:



Similarly computer works based on the input , processing and output



Components of computer system

- There are 4 components in the computer system.

1. Hardware
2. Software
3. Data and information
4. Users

Functional components of computer system

- Basically any computer is supposed to carry out the following functions.

➢ Accept the data and program as input.

➢ Stores the data, program and retrieve as and when required.

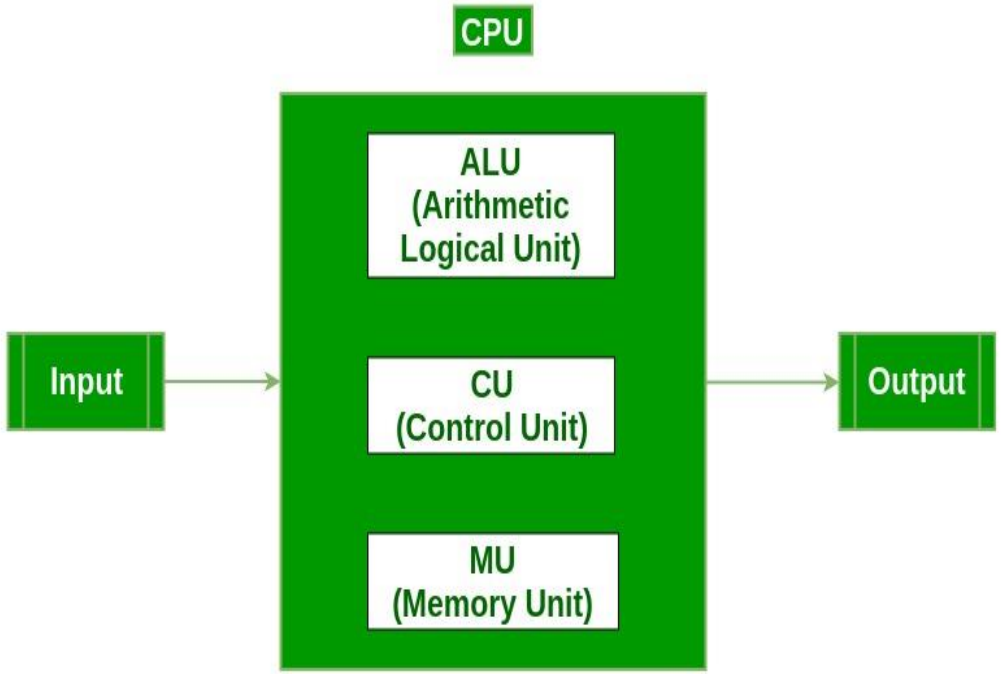
➢ Process the data as per instructions given by the program and convert it into useful information.

➢ Communicate the information output.

Block diagram of a computer

A computer is designed using 4 basic units.

1. Input unit
2. Central processing unit
3. Memory unit
4. Output unit



1. Input Unit:

- Computers need to receive data and instructions to solve any problem.
- The input unit links the external world or environment to the computer system.
- It consists of one or more input devices.
- The keyboard and mouse are the most commonly used input devices.
- Whenever a key is pressed, the corresponding letter or digit is automatically translated into its corresponding binary code and transmitted over a cable to either the memory or the processor.

2. Central Processing Unit(CPU)

- Once the data and instructions are received from the input device, they are to be processed in this unit.
- It can be considered the heart or brain of the computer system. Because it is the control center of the computer.
- It first fetches instructions from memory and then interprets them so as to know what is to be done.
- If required, data is fetched from memory or input device.
- Thereafter CPU executes or performs the required computation and then either stores the output or displays on the output device.
- It consists of three major units:

2.1 Control Unit

- Control Unit controls and coordinates the activities of all computer system units.
- It acts as a supervisor to the computer system.

It performs the following functions:

- Fetching the data and instructions from the main memory.
- Interpreting these instructions.
- Controlling the transfer of data and instructions to and from the main memory.
- Controlling input and output devices.
- The overall supervision of the computer system

2.2 Arithmetic and Logic Unit :

- All the arithmetic and logical calculations are carried out in the ALU.
- And controls the speed of these operations
- An ALU consists of electronic circuitry which performs arithmetic operations such as addition, subtraction, multiplication, and division.
- It also consists of logical circuitry which performs logical operations like AND, OR, and NOT.
- And relational operations like not equal to, = greater than, and == equal to.

2.3 Registers:

- The CPU consists of several temporary storage units, which are used to store instructions & intermediate data which may be generated during processing.

3. Memory Unit:

- The data and instructions required for processing have to be stored in the memory unit before actual processing starts. Similarly, the results generated have to be preserved before it is displayed.
- The memory unit thus provides space to store input data, intermediate results and final output generated. eg: hard disks, pen drives, floppy disks.

4. Output Unit :

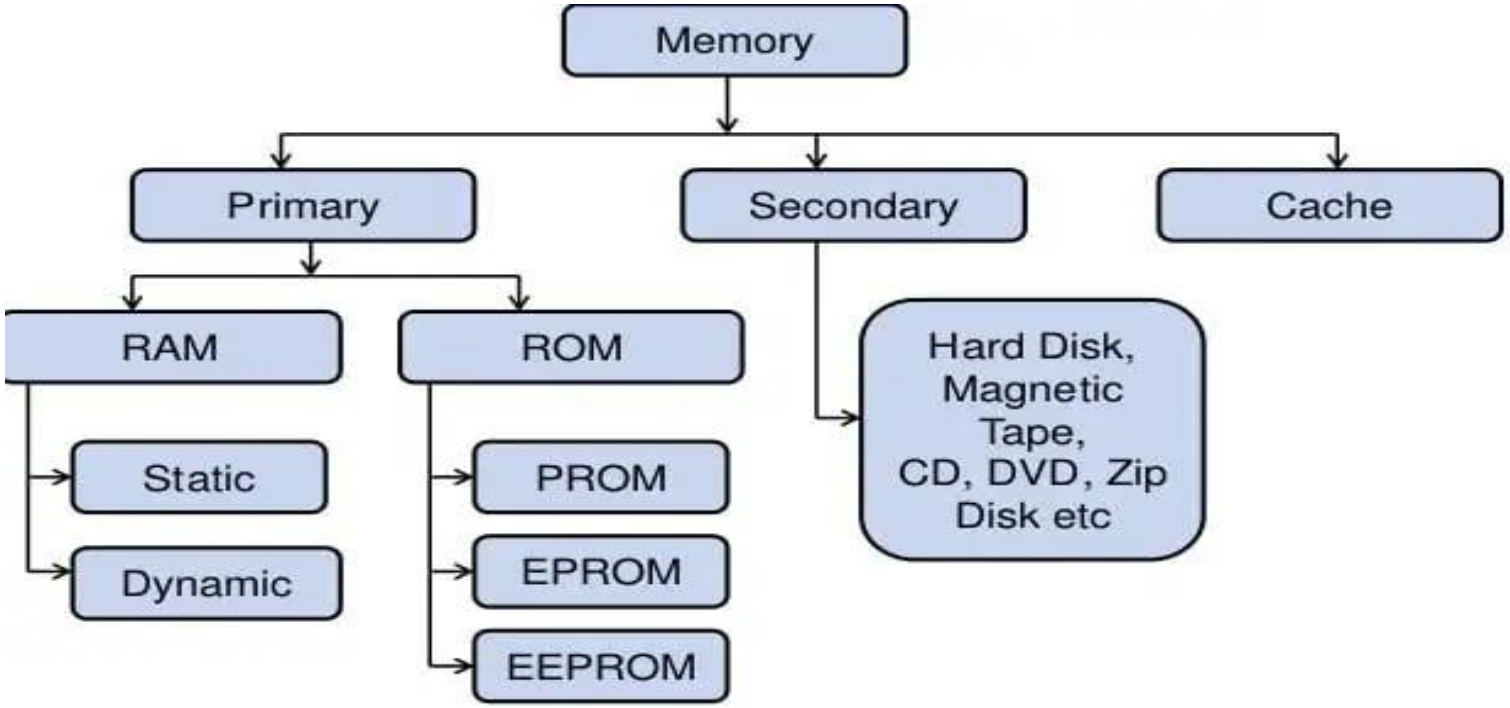
- It is used to print or display the result obtained by the execution of a program.
- Whenever the user wants output from the computer, the control unit sends a signal to this unit to be ready to accept processed data from memory and display it.
- Eg. Monitor, Printer, Speakers, etc.

Microprocessor

- **Microprocessor**, any of a type of miniature electronic device that contains the arithmetic, logic, and control circuitry necessary to perform the functions of a digital computer's central processing unit.
- In effect, this kind of integrated circuit can **interpret and execute program instructions** as well as **handle arithmetic operations.**
- A microprocessor may also be called a **processor or central processing unit**, but it is more advanced in terms of architectural design and is **built over a silicon microchip**.
- A Microprocessor is an **important part of a computer architecture** without which you will not be able to perform anything on your computer.
- It is a programmable device that **takes in input, performs some arithmetic and logical operations over it and produces the desired output.**
- In simple words, a Microprocessor is a **digital device on a chip** that can fetch instructions from memory, decode and execute them and give results.
- Responsible for **processing a unique set of instructions and processes**.
- Microprocessor are generally classified according to the **number of instructions they process within a given time**, their clock speed measured in megahertz and the number of bits used per instruction.

Computer memory

- Memory is an essential component of a digital computer system.
- It is storing device. It stores programs and data , which is required by CPU, and the result generated after processing.
- This storage enables us to use the stored data to in future.
- The storage capacity of a computer is measured in terms of Bytes.
- One byte includes a total of 8 individual units called as bits. one bit can store either a 0 or 1 in it.
- In general, computer memory is of three types:



1. Primary Memory

- It is also known as the main memory of the computer system.
- It is used to store data and programs or instructions which are **currently needed by the CPU**.
- Size of memory is comparatively much smaller than that of the secondary memory **because of its high cost.**
- The CPU **communicate directly** only with the main memory.
- As the CPU works at very high speed, its matching memory must be very fast.
- Only primary memory devices can **provide the matching speed**.
- It **uses semiconductor technology** and hence is commonly called semiconductor memory.
- Primary memory is of two types.

  1.Random Access Memory (RAM)

  2.Read Only Memory (ROM)

•**RAM (Random Access Memory):**

- RAM is also called as main memory of computer.
- It is a volatile memory. Volatile memory **stores information based on the power supply.**
- If the power supply fails/ interrupted/stopped, all the data and information on this memory will be lost.
- RAM is **used for booting up** or start the computer. It temporarily stores programs/data which has to be executed by the processor.
- This is really the main store and is the place where the program gets stored temporary.
- When CPU runs a program it fetches the program instructions from the RAM and carries them out.
- If CPU needs to store the **result of the calculations** it can store them in RAM.

RAM is of two types:

- **S RAM (Static RAM):** S RAM uses transistors and the circuits of this memory are capable of retaining their state as long as the power is applied. This memory consists of the number of flip flops with each flip flop storing 1 bit. It has less access time and hence, it is faster.

- **D RAM (Dynamic RAM):** D RAM uses capacitors and transistors and stores the data as a charge on the capacitors. They contain thousands of memory cells. It needs refreshing of charge on capacitor after a few milliseconds. This memory is slower than S RAM.

•**ROM (Read Only Memory):**

- It is a non-volatile memory.
- Non-volatile memory stores information even when there is a power supply failed/ interrupted/stopped.
- ROM is used to **store information that is used to operate the system.**
- As its name refers to read-only memory, we can only read the programs and data that is stored on it.
- It contains some electronic fuses that can be programmed for a piece of specific information.
- The information stored in the ROM in binary format. It is also known as **permanent memory.**

ROM is of four types:

- **PROM (Programmable Read Only Memory):** This read-only memory is modifiable once by the user. ie it is a memory on which data can be written only once. The user purchases a blank PROM and uses a PROM program to put the required contents into the PROM. Its content can't be erased once written.

- **EPROM (Erasable Programmable Read Only Memory):** EPROM is an extension to PROM where you can erase the content of ROM by exposing it to Ultraviolet rays for nearly 40 minutes.

- **EEPROM (Electrically Erasable Programmable Read Only Memory):** Here the written contents can be erased electrically. You can delete and reprogramme EEPROM up to 10,000 times. Erasing and programming take very little time, i.e., nearly 4 -10 ms(milliseconds). Any area in an EEPROM can be wiped and programmed selectively.

s.no	RAM (Random Access Memory)	ROM (Read Only Memory)
1	RAM stands for Random Access Memory.	ROM stands for Read Only Memory.
2	RAM data is volatile. Data is present till power supply is present after power supply data is removed.	ROM data is permanent. Data remains even after power supply is not present.
3	RAM speed is quite high.	ROM speed is slower than RAM.
4	RAM data can be read, erased or modified.	ROM data is read only.
5	RAM is used to store data that CPU needs for current instruction processing.	ROM is used to store data that in needed to bootstrap the computer.
6	RAM memory is large and high capacity.	ROM is generally small and of low capacity.
7	RAM is expensive.	ROM is cheap.

2. Secondary Memory

- It is also known as auxiliary memory and backup memory.
- It is a non-volatile memory and used to store a **large amount** of data or information.
- The data or information stored in secondary memory is permanent, and it is slower than primary memory. A CPU cannot access secondary memory directly.
- The data/information from the auxiliary memory is first transferred to the main memory, and then the CPU can access it.
- The magnetic memory like Hard Disk Drive (HDD), Compact Disk, Pen Drive, Memory Cards is the most commonly used secondary memory in the computer.

Characteristics of Secondary Memory

•It is a slow memory but reusable.

•It is a reliable and non-volatile memory.

•It is cheaper than primary memory.

•The storage capacity of secondary memory is large.

•A computer system **can run without secondary memory**.

•In secondary memory, data is stored permanently even when the power is off.

1. **Magnetic Tapes:**

Magnetic tape is a long, narrow strip of plastic film with a thin, magnetic coating on it that is **used for magnetic recording**. Bits are recorded on tape as magnetic patches called RECORDS that run along many tracks. Typically, 7 or 9 bits are recorded concurrently. Each track has one read/write head, which allows data to be recorded and read as a sequence of characters. It can be stopped, started moving forward or backward, or rewound.

2. Magnetic Disks:

A magnetic disk is a circular metal or a plastic plate and these plates are coated with magnetic material. The disc is used on both sides. Bits are stored in magnetized surfaces in locations called tracks that run in concentric rings. Sectors are typically used to break tracks into pieces. **Two types of magnetic disk are Hard Disk and Floppy Disk.**

3. Optical Disks:

It's a laser-based storage medium that can be written to and read. Optical disk is a random access, removable disk on which data is written and read through the use of laser beam. It is reasonably priced and has a long lifespan. The optical disk can be taken out of the computer by occasional users.

Types of Optical Disks

CD – ROM (Compact disk read only memory)

•It's called compact disk. Only read from memory.
•Accessing of data from CD-ROM is quite a bit faster than a floppy disk but slower than hard disk.
•**To read** a CD-ROM a device called **CD-ROM drive** is needed.
•The diameter of the disc is 5.25 inches.
•16000 tracks per inch is the track density.
•The capacity of a CD-ROM is 682 MB, with each sector storing 2048 bytes of data.
•The data transfer rate is about 4800KB/sec. & the new access time is around 80 milliseconds.

DVDs

•The term “DVD” stands for “Digital Versatile/Video Disc”.
•It is a optical disk technology with a 4.7 GB storage capacity.
•DVD can be single or double sided, and can have two layers on each side.
•DVD technology uses a **red laser**.
•There are two types of DVD,

- DVD-R : It is also called DVD Recordable.
- DVD-RW : It is also called as DVD Re-Writable.

3. Cache Memory

It is a type of **high-speed semiconductor memory** that can help the **CPU run faster**. Between the CPU and the main memory, it serves as a buffer. It is used to store the data and programs that the CPU uses the most frequently.

Advantages of Cache Memory

•It is faster than the main memory.
•When compared to the main memory, it takes less time to access it.
•It keeps the programs that can be run in a short amount of time.
•It stores data in temporary use.

Disadvantages of Cache Memory

•Because of the semiconductors used, it is very expensive.
•The size of the cache (amount of data it can store) is usually small.

Working of a CPU and memory

- Although memory is technically any form of electronic storage, it is used most often to identify fast, temporary forms of storage.
- If your computer CPU had to constantly access the hard drive to retrieve every piece of data it needs, it would operate very slowly.
- When the information is kept in memory the CPU can access it much more quickly.
- Most forms of memory are intended to store data temporarily.
- The CPU access memory according to a **distinct hierarchy.**
- Whether it comes from permanent storage (hard drive) or input (keyboard) most data goes in RAM first.
- The CPU then stores pieces of data it will need to access , often in a cache, and maintains certain special instructions in the register.
- All the components in computer , such as CPU, the hard drive, os , work together as a team and memory is one of the most essential parts of this team.
- From the moment you turn your computer on until the time you shut it down, your CPU is constantly using memory.

Look at a typical scenario:

1. You turn the computer on.
2. The **computer loads data from ROM** and performs a power-on self-test (POST) to make sure all the components are functioning properly. As part of this test the **memory controller checks all of the memory addresses** with a quick read/write operation to ensure that there are no errors in the memory chips.
3. The computer loads basic input/output system (BIOS) from ROM. That **provides most basic information** about storage devices, boot sequences, security, and few other items.
4. The computer load the os from the hard drive into system's RAM. Critical parts of os are maintained in RAM as long as computer is on. This allows the cpu to have immediate access to the os, which enhances the performance and functionality of the overall system.
5. When you open application, it is loaded into RAM. To conserve RAM usage many application **load only essential part of the program initially** and then load other pieces as needed.
6. After an application is loaded, any files that are opened for use in that application are loaded into RAM.

Program execution with illustrative example

Six steps are involved in execution of an instruction by OS.

1. FETCH INSTRUCTION

- Execution cycle starts with fetching instruction from main memory.
- The instruction at the current PC will be fetched and will be stored in instruction register(IR).

2. DECODE INSTRUCTION

- During this cycle the encoded instruction present in the IR is interpreted by the decoder.

3. PERFORM ALU OPERATION.

- ALU is where two operands in the instruction will be operated on given operator in the instruction .
- Such as if the instruction was to add two numbers, then the addition will happen.
- Takes two values and output one.

4. ACCESS MEMORY

- There are only two kind of instruction that access memory.
- LOAD AND STORE
- LOAD: copies value from memory to register.
- STORE: copies a register values to memory.
- Any other instruction skips this step.

5. UPDATE REGISTER FILE.

- In this step, the output or result of the ALU is written back to the register file to update file.
- The result could also be due to a LOAD from memory.
- Some instruction don’t have results to store for eg: BRANCH and JUMP instruction do not have any result to store.

6. UPDATE THE PROGRAM COUNTER (PC)

- At the end of execution of the current instruction, we need to update the program counter, to the address of next instruction.
- So that we can go back to step 1 where the CPU will fetch instruction.
- However the program counter might need to be set to other memory address than the next one if the instruction was BRANCH or JUMP

Let us take an example and understand how CPU and memory works together to execute a given instruction.

- Let us consider the multiplication of two numbers. Various steps involved for multiplying two numbers is shown in below.
- The control unit recognizes that the program has been loaded into the memory.
- It begins to execute the first step in the program.

1. The program tells the user “enter the 1st number”.
2. The user types the number 100 on the keyboard . An electrical signal is sent to the CPU.
3. The control unit recognizes this signal and routes the signal to an address in memory –say address 2000.
4. After completing the above instruction , the next instruction tells the user “enter 2nd number”.
5. The user types the number 4 on the keyboard. An electronic signal is sent to the CPU.
6. The control unit recognizes this signal and routes the signal to an address in memory –say address 2100.
7. The next program instruction is executed “multiply 1st and 2nd numbers”.
8. To execute this instruction, the control unit informs the ALU that two numbers are coming and the ALU has to multiply them. The CU next sends to the ALU a copy of the contents of address 2000(100) and address 2100(4).
9. ALU perform the multiplication : 100 *4=400
10. The control unit sends a copy of the multiplied result (400) back to memory to store it in address 2500.
11. The next program instruction is executed : “Print the Result”
12. To execute this instruction , the control unit sends the contents of the address 2500(400) to the monitor.
13. Monitor displays the value 400.
14. Final instruction is executed :”end “. The program is end.

Introduction to Micro Controller

- A microcontroller is a compact integrated circuit designed to **govern a specific operation** in an embedded system.
- Used to perform specific task like washing machine, microwave oven e
- Microprocessor finds application where tasks are unspecified like laptop, PC. (Task are not predefined)
- Microprocessor only provides processing power to system.
- Microcontroller is mini computer or computer in a single chips.
- They almost look very identical(visually).
- But they are different in terms of application . They are different in terms of processing power, Cost.
- All the memory RAM,ROM, I/O ports, Timers **connected externally** in microprocessor where as in microcontroller all these are **integrated along with CPU**.
- A typical microcontroller includes a processor, memory, and input/output (I/O) peripherals on a single chip.
- That is microcontroller is **complete microprocessor system**, consisting of microprocessors, limited amount of ROM or RAM & I/O ports all built on a single integrated circuit.
- Microcontroller can be **used to perform control functions** so it is comparable with a microcomputer.
- More complex than a microprocessor.

Advantages of Microcontroller over Microprocessor

1. Cost of microcontroller is **less** than microprocessor based system.
2. Microcontroller has **more I/O components** than microprocessor based system.
3. Unlike microprocessor microcontroller can be used in wide variety of intelligent products like **personal computers keyboards** or can be used in **devices with AI**.
4. **Many low cost products** like toys, washing machines, microwave ovens, electric drills etc, are based on microcontroller & not on microprocessor based system.

Features of Microcontroller 8051

- 8051 microcontroller has an 8-bit ALU.
- 4KB ROM’EPROM
- 128 byte RAM
- Dual 16-bit timer, event counter.
- 32 I/O lines for four 8-bit I/O ports.
- Full featured serial port.
- Two external interrupt.

Applications of Microcontroller

- They are used as independent controllers in machines or as slaves in distributed processing.
- They are used as a machine tools, chemical processors, medical instrumentation.
- Many low cost products like toys, washing machines, microwave ovens, electric drills etc, are based on microcontroller.
- Personal computers keyboards are implemented with microcontroller.