## Course Contents

**Unit-01:Introduction to Computer (3 Hrs.)**

- **Introduction**
- **Digital and Analog Computers**
- **Characteristics of Computer**
- **History of Computer**
- **Generations of Computer**
- **Classification of Computer**
- **The Computer System**
- **Application of Computers**

## Introduction to computer

**Computer:**

- A computer is an electronic device, operating under the control of instructions stored in its own memory that can accept data (input), process the data according to specified rules, produce information (output), and store the information for future use.
- A computer is a programmable machine. The two principal characteristics of computer are:
  - It responds to a specific set of instructions in a well-defined manner.
  - It can execute a prerecorded list of instructions ( program)

## Introduction to computer

**Computer:**

- All general-purpose computers require the following hardware components.
- Central Processing Unit (CPU) : The heart of the computer, the component that actually executes instructions.
- Memory: Enables a computer to store, at least temporarily, data and programs.
- Input Device: Input devices are the devices which are used to feed programs and data to the computer. The input system connects the external environment with the computer system.

## Introduction to computer

**Computer:**

- Output Device: The output devices give the results of the process and computations to the outside world. The output units accept the results produced by the computer, convert them into a human readable form and supply them to the users. The more common output devices are printers, plotters, display screens, magnetic tape drives etc.
- Mass storage device: Allows a computer to permanently retain large amounts of data. Common mass storage devices include disk drives and tape drives.

## Introduction to computer

**Block Diagram of Computer:**

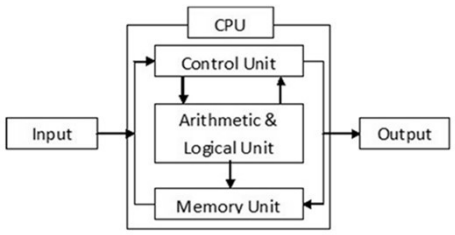
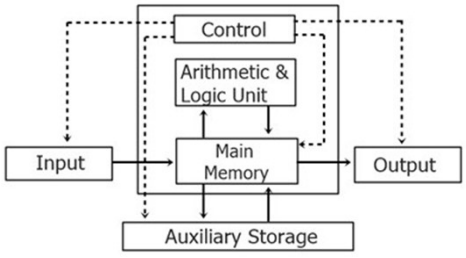



Fig. Block Diagram of Computer

## Introduction to computer

**Block Diagram of Computer:**




Block Diagram of Computer

## Introduction to computer

**8085 Block Diagram:**

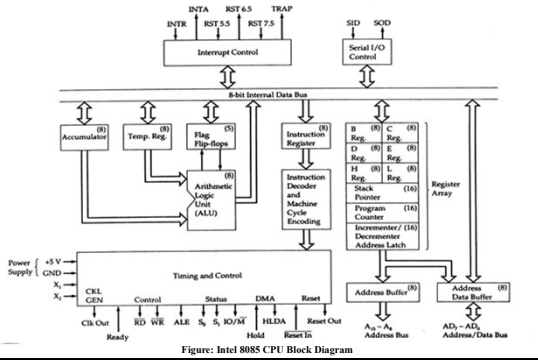



Figure: Intel 8085 CPU Block Diagram

## Characteristics of Computer

**Characteristics of Computer:**

1. **Word length**
2. **Speed**
3. **Storage**
4. **Accuracy**
5. **Versatility**
6. **Automation**
7. **Deligence**

## Characteristics of Computer

**Characteristics of Computer:**

**1. Word length:**

Difference between bit, nibble, byte and wordlength.

Word length is the computing power of computer and varies as 8, 16, 32 or 64 bits. Longer the word length, more powerful the computer is.

**2. Speed:** time taken to perform any task by computer is called the speed of the computer. The speed of computer is measured in terms of micro or nano-second.

Milliseconds(ms ) = 1/1,000 ; microseconds(μs)= (1/1,000,000), Nanoseconds(ns)=(1/1,000,000,000) , Picoseconds(ps) = (1,000,000,000,000)

## Characteristics of Computer

**Characteristics of Computer:**

**3. Storage:**

- Digital data storage is essentially the recording of digital information in a storage medium, typically by electronic means.
- Computers have their own main memory and auxiliary memory storage systems which computer use when needed.
- The storage capacity is measured in terms of

| Symbol | Prefix |
|---|---|
| k | kilo |
| M | mega |
| G | giga |
| T | tera |

## Characteristics of Computer

**Characteristics of Computer:**

**3. Storage:**

| Symbol | Prefix | SI Meaning | Binary meaning | Size difference |
|---|---|---|---|---|
| k | kilo | $10^3 = 1000^1$ | $2^{10} = 1024^1$ | 2.40% |
| M | mega | $10^6 = 1000^2$ | $2^{20} = 1024^2$ | 4.86% |
| G | giga | $10^9 = 1000^3$ | $2^{30} = 1024^3$ | 7.37% |
| T | tera | $10^{12} = 1000^4$ | $2^{40} = 1024^4$ | 9.95% |
| P | peta | $10^{15} = 1000^5$ | $2^{50} = 1024^5$ | 12.59% |
| E | exa | $10^{18} = 1000^6$ | $2^{60} = 1024^6$ | 15.29% |
| Z | zetta | $10^{21} = 1000^7$ | $2^{70} = 1024^7$ | 18.06% |
| Y | yotta | $10^{24} = 1000^8$ | $2^{80} = 1024^8$ | 20.89% |

## Characteristics of Computer

**Characteristics of Computer:**

**4. Accuracy:**

- Computer is the accurate machine with high accuracy and every calculation is performed with the same accuracy.
- It can perform large number of task without errors but if we feed wrong data, it returns the same wrong information called GIGO(Garbage In Garbage Out).

5. Versatility:

Versatile means, computer can not only perform calculation but same computer can perform many different types of Job depend upon the different program fed to it.

## Characteristics of Computer

**Characteristics of Computer:**

**6. Automation:**

- Automation is the technology by which a process or procedure is performed with minimal human assistance.
- Computers are capable for automation, provided they are programmed correctly.
- Computers can proceed on its own till its completion.

## Characteristics of Computer

**7. Diligence:**

- Diligence of computer is the capacity of performing same task repeatedly multiple times without feeling tiredness, boring, lack of concentration and fatigue with same speed and accuracy.

## Characteristics of Computer

7. Diligence:

- Human being suffer from weakness like tiredness, lack of concentration etc. Human have feelings they become sad, depressed, bored, and negligent and will reflect on the work they do.
- Human beings can't perform the same or similar tasks over and over again with the same precision, accuracy and enthusiasm as the first time. This will effect the performance.

Being a machine, a computer doesn't have any of these human weaknesses.

## History of Computer

**History of Computer:**

## History of Computer

**Generations of Computer:**

- Computer generation is a change in technology a computer is/was being used.
- Initially, the generation term was used to distinguish between varying hardware technologies.
- But nowadays, generation includes both hardware and software, which together make up an entire computer system.

## Generations of Computer

**Generations of Computer:**

**Following are the main five generations of computers.**

| S.N. | Generation & Description |
|---|---|
| 1 | First Generation<br>The period of first generation: 1942-1954. **Vaccum tube based**. |
| 2 | Second Generation<br>The period of second generation: 1952-1964. **Transistor based**. |
| 3 | Third Generation<br>The period of third generation: 1964-1972. **Integrated Circuit based**. |
| 4 | Fourth Generation<br>The period of fourth generation: 1972-1990. **VLSI microprocessor based**. |
| 5 | Fifth Generation<br>The period of fifth generation: 1990-onwards.**ULSI microprocessor based** |

## Generations of Computer

**Generations of Computer:**

**Following are the main five generations of computers.**

*Vacuum tube*

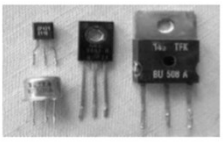
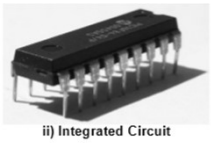


Fig 1.5 Transistors

Fig 1.6 i) Integrated Circuit



ii) Integrated Circuit

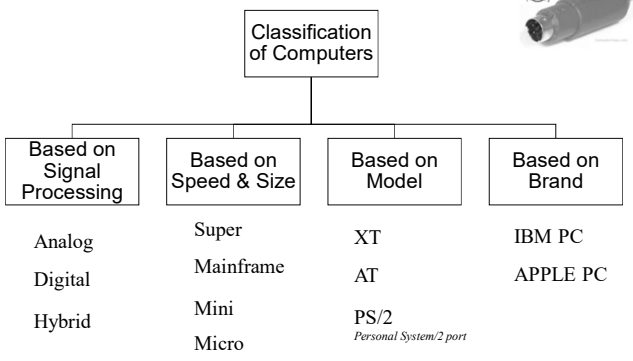
Fig. 1.7 VLSI

## Introduction to computer

# Classification of Computer

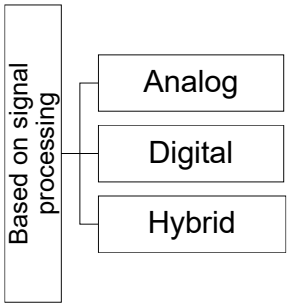
## Classification of Computers

Classification of Computers:




## Classification of Computers

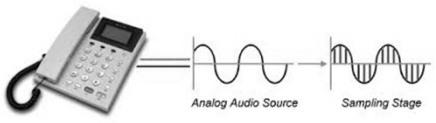
**Classification of Computers based signal processing:**




## Classification of Computers

**Classification of Computers:(Based on Signal Processing)**

- Analog Computer: Analog computer is that computer, which is use to process continuously varying data. Everything we see and hear is change continuously. This changeable continuous stream of data is called analog data. Analog computer can be used in scientific and industrial applications such as measure the electrical current, frequency and resistance of capacitor, etc.




## Classification of Computers

Classification of Computers:

- Digital Computer: These are high speed electronic devices. These devices are programmable. They process data by way of mathematical calculations, comparison, sorting etc. They accept input and produce output as discrete signals representing high (on) or low (off) voltage state of electricity. Numbers, alphabets, symbols are all represented as a series of 1s and 0s.

## Classification of Computers

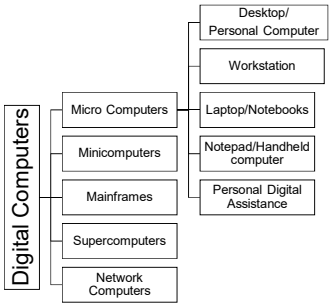
Classification of Computers:

- Hybrid Computer: Hybrid computer is a digital computer that accepts analog signals, converts them to digital and processes them in digital form.
- Hybrid computer processes both analog and digital data.
- Examples: Computer used in hospitals to measure the heartbeat of the patient. Devices used in petrol pump.
- In scientific applications or in controlling industrial processes.
- The first desktop hybrid computing system was the Hycomp 250, released by Packard Bell in 1961.

## Classification of Computers

**Classification of Computers:**

Classification of digital computers on the basis of their capacity to access memory and size are like:




## Introduction to computer

**Classification of Computers:**

Digital Computer: Classification of digital computers on the basis of their capacity to access memory and size are like:

- Micro Computer
  - Desktop
  - Laptops/Notebooks
  - Notepad/handheld computer
  - Personal Digital Assistants (PDAs)
- Minicomputers
- Mainframes
- Supercomputers
- Network Computers

## Classification of Computers

**Classification of Computers based on size:**

**Super Computer:**

- A supercomputer is a type of computer that has the architecture, resources and components to achieve massive computing power. Today's supercomputers consists of tens of thousands of processors that are able to perform billions and trillions of calculations or computations per second.
- As of 2013, IBM Sequoia is the fastest supercomputer to date. It has more than 98,000 processors that allow it to process at a speed of 16,000 trillion calculations per second.

## Classification of Computers

**Classification of Computers based on size:**

**Mainframe:**

- Mainframe Computers are less costly, small in size and slower in speed than the super computers.
- used as a storage for large database and serve as a maximum number of users simultaneously.
- millions of instructions are executed simultaneously.
- The first successful mainframe computer is invented by IBM. Mainframe computer's speed is comparatively less than Supercomputers.

## Classification of Computers

**Classification of Computers based on size:**

**Minicomputer:**

- **A minicomputer is a type of computer that possesses most of the features and capabilities of a large computer but is smaller in physical size.**
- **A minicomputer fills the space between the mainframe and microcomputer.**
- **Minicomputers are mainly used as small or mid-range servers operating business and scientific applications. However, the use of the term minicomputer has diminished and has merged with servers.**
- **A minicomputer may also be called a mid-range computer.**
- **Examples are IBM AS, Prime series, HP 9000, PDP 11, IBM 8000 series.**

# Classification of Computers

**Classification of Computers:**

| BASIS FOR COMPARISON | SUPERCOMPUTER | MAINFRAME COMPUTER |
|---|---|---|
| **Basic** | Supercomputers fastly perform large and complex mathematical computations. | Mainframe computers act as a server, stores large database and serve a large number of users simultaneously. |
| **Invention** | The first successful Supercomputer was invented by Seymour Cray in the year 1976 Cray 1. | IBM invented the first successful mainframe computer and is still a dominant company for producing the mainframe computers. |
| **Speed** | The supercomputer can execute billions of floating point operations in a second. | Mainframe computers can execute millions of instruction simultaneously. |
| **Size** | Supercomputers are the largest computers in the world. | Mainframe computers are also large computers but somewhat smaller than supercomputer. |
| **Expense** | Supercomputers are the most expensive computers of the worlds. | Mainframe computers are also expensive but less than supercomputers. |
| **Operating system** | The modern supercomputers have Linux operating system and derivative variants of Linux operating system. | Mainframe computer has the ability to run multiple operating system. simultaneously. |

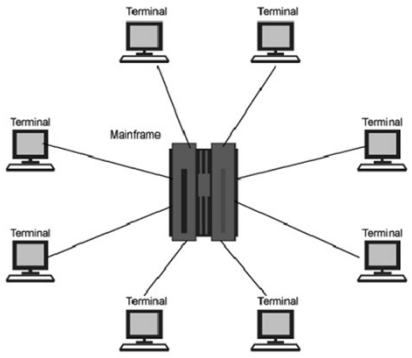
# Classification of Computers

**Classification of Computers:**

| Mainframe | Minicomputer |
|---|---|
| In mainframe computer, large size of disk is used. | While in minicomputer, small size of disk is used. |
| Mainframe computers have large memory storage. | While minicomputers have small or less memory storage than mainframe computer. |
| The processing speed of mainframe computer is faster than minicomputer. | While the processing speed of minicomputer is slower than mainframe computer. |
| Mainframe computer is costlier than minicomputers. | Whereas supercomputer's cost is less or it is Inexpensive. |
| The first microcomputer was invented by the team leader Bill Pentz . | The first successful mainframe computer is invented by IBM. |
| Mainframe computers support thousand or millions of users simultaneously. | Whereas minicomputers support hundreds of users at a time. |

# Classification of Computers

**Mainframe Computer:**




# Classification of Computers

**Classification of Computers based on size:**

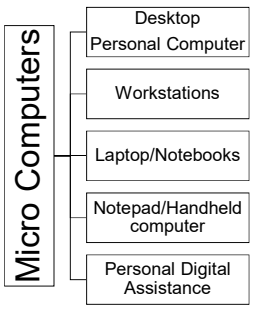
**Network Computer:**

- A network computer is an inexpensive personal computer designed for a centrally-managed network where data are stored and updated on a network server.
- Network computer doesn't have a disk drive, CD-ROM drive or expansion slots.
- A network computer depends on network servers for processing power and data storage.

# Classification of Computers

**Classification of Computers based on size:**

**Micro computer:**




# Classification of Computers

**Classification of Computers based on size:**

**Micro computer:**

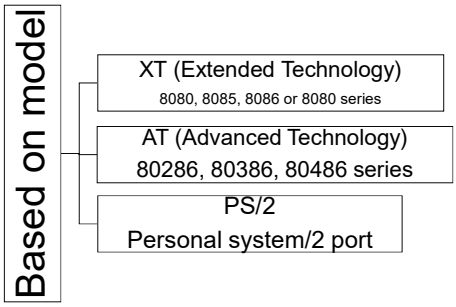
**1. Desktop/Personal Computer**

A desktop computer is a personal computer designed for regular use at a single location on or near a desk or table due to its size and power requirements.

## Classification of Computers

**Classification of Computers based on model:**

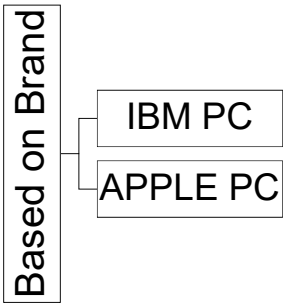
Classification of digital computers on the basis of their model are like:




## Classification of Computers

**Classification of Computers based on model:**

Classification of digital computers on the basis of brand/Manufacturer are like:



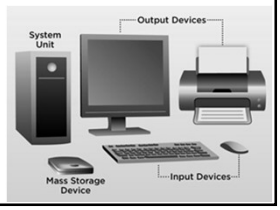

## The Computer System

**The Computer System:**

COMPUTER SYSTEM is a collection of entities (hardware, software and liveware/humanware) that are designed to receive, process, manage and present information in a meaningful format.

There are three major components of a computer system:

- Computer Hardware
- Computer Software
- Humanware




## The Computer System

COMPONENTS OF COMPUTER SYSTEM

1. Computer Hardware - Are physical parts/ intangible parts of a computer. e.g. Input devices, output devices, central processing unit and storage devices
2. Computer Software - also known as programs or applications. They are classified into two classes namely - system software and application software
3. Liveware - is the computer user. Also kwon as orgwareor the humanware. The user commands the computer system to execute on instructions.

## The Computer System

COMPONENTS OF COMPUTER SYSTEM**:**

- Hardware and software exist together to make up the actual computer. The humanware component adds in the human factor in order to bring the whole computer into functional and productive existence.
- Each of these components is necessary in order to enable meaningful productivity. If installed separately, each may be useful to an extent but incapable of achieving complete computing potential. Hardware and software need the human factor in order to make input and connectivity possible.

## The Computer System

COMPONENTS OF COMPUTER SYSTEM

1. Computer Hardware - Are physical parts/ intangible parts of a computer. e.g. Input devices, output devices, central processing unit and storage devices
2. Computer Software - also known as programs or applications. They are classified into two classes namely - system software and application software
3. Liveware - is the computer user. Also known as humanware. The user commands the computer system to execute on instructions.

## The Computer System

1. Computer Hardware –

These are computer system components that can be touched by the human hand. Examples include:

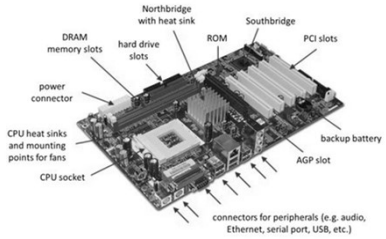
- Display monitor.
- Keyboard.
- Mouse.
- Motherboard.
- Memory modules.
- Disk drive.

These parts are housed within the laptop or desktop system unit housing. For the desktop, however, the keyboard, mouse and monitor are attached externally.

## The Computer System

1. Computer Hardware –

- The most important piece of hardware is the microprocessor chip. It is commonly known as the central processing unit (CPU).



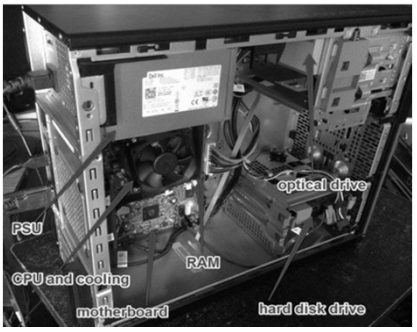

## The Computer System

1. Computer Hardware –

- Another important component is the disk drive. This is where computer data is stored. It is classified as secondary memory.
- Hard disk: This drive is mechanical by design and stores data on magnetic and metallic platters. Its data is read magnetically by read/write heads which make it reliant on an uninterrupted supply of power. A sudden power outage can lead to data loss or drive failure. It must be used properly for the sake of data integrity and long lifespan.
- Solid state disk: This new type of disk drive stores data on flash memory chips and is less prone to erratic behavior. It is faster and reliable even in the event of sudden power outages.

## The Computer System

1. Computer Hardware –

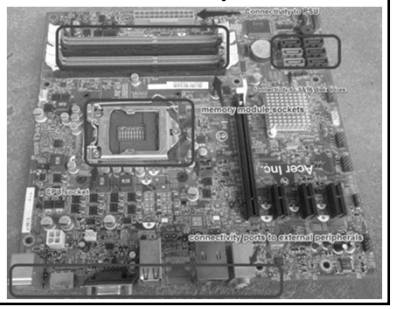



*various hardware components inside the system unit.*

## The Computer System

1. Computer Hardware –

Another vital part within a system is the motherboard. It provides communication and direct connectivity to devices throughout the computer.




## The Computer System

1. Computer Hardware –

Connectivity to a motherboard can be internal or external. Internal devices that connect to the motherboard include:

- Microprocessor (CPU).
- Disk drive.
- Random access memory (memory modules).
- Power supply unit (PSU).

External peripherals that connect to the motherboard include:

- Monitor.
- Keyboard.
- Mouse.
- Printer.

## The Computer System

2. Computer Software –

The software component refers to the instructions, programs, data, and protocols which run on top of hardware. It is also retained temporarily and persistently in primary and secondary hardware media. The random access memory chip is an example of primary hardware while the hard disk drive is an example of secondary hardware.

Software can be divided into following categories:

- system
- application
- malicious
- programming

## The Computer System

2. Computer Software –

The software component refers to the instructions, programs, data, and protocols which run on top of hardware. It is also retained temporarily and persistently in primary and secondary hardware media. The random access memory chip is an example of primary hardware while the hard disk drive is an example of secondary hardware.

Software can be divided into following categories:

- system
- application
- malicious
- programming

## The Computer System

2. Computer Software – System Software

- The system manages other software and devices inside the computer. The foremost example of system software is the operating system (OS).
- In a typical setup, the operating system is like the motherboard for software. It is the first thing that is installed, followed by applications and other software. Three popular operating systems for traditional computers include Windows, Mac OS X, and Linux.
- Popular mobile operating systems include Android OS, iPhone OS, Windows Phone OS, and Firefox OS.

## The Computer System

2. Computer Software – Application Software

- This is designed for end users to perform a specialized assignment in order to output useful information.
- An example would be a word processing application used to compose letters or brochures, such as Microsoft Word.
- Other popular examples include Adobe Photoshop, Corel Draw, and AutoCAD.
- A collection of application software is bundled in a package that is commonly known as a software suite. A typical suite includes software for word processing, presentation, graphic design, and spreadsheet.
- Examples include Microsoft Office, OpenOffice, and iWork.
- Software is written in computer languages such as Visual Basic, C, and Java.

## The Computer System

2. Computer Software – Malicious Software

- Malware, is short for malicious software, which is a generic term that refers to exploitative code designed by criminals and black hat hackers to maim normal operations of a computer. Malware attack will result in data loss and hacker access to private information.
- Affected computers can also be converted into zombies and used in a bigger mission of criminal activities like launching denial of service attack and spreading spam.
- Malware scripts are delivered to the computer as viruses, trojans, rootkits, keyloggers, worms, or through email and websites as adware, spyware, ransomware and scareware.

## The Computer System

2. Computer Software – Programming Software

- These are tools used by developers to create all kinds of software like Windows OS and Word processing. Also called languages, they are used to write source codes, debug errors, maintain and create new software for computers and write malicious scripts like viruses and trojans.
- Popular examples of high-level languages are Java, Javascript, BASIC, PHP, Visual Basic, Visual C++, Visual Basic, Python, Ruby, Perl, Java.

## The Computer System

3. Humanware

- The humanware component refers to the person that uses the computer. More specifically, it is about the individual that makes hardware and software components productive.
- Typically, a great deal of testing is done on software packages and hardware parts to ensure they enhance the end-user experience to aid in creating documents, musical and video recordings, and all forms of raw and finished data.

## Applications of computers

Applications of computers:

Today computers find widespread applications in all activities of the modern world. Some of the major application areas include:

- Scientific, Engineering and Research
- Business
- Medicine
- Information
- Education
- Games and Entertainment

## Applications of computers

Applications of computers:

- Uses of Computers in Education
  - Benefits of CBT
  - Computer Aided Learning (CAL)
  - Distance Learning
  - Online Examination
  - Online Training Resources
- Uses of computers in Medical Field
  - Hospital Management System
  - Patient History
  - Patients Monitoring
  - Life Support Systems
  - Diagnosis Purpose

## Applications of computers

Applications of computers:

- Computers in Business
  - Marketing
  - Stock Exchange
- Use of computer at Home
  - Computer Games
  - Working from Home
  - Entertainment
  - Information

## Introduction to computer

# Computer Architecture

## Computer Architecture

**Computer Architecture:**

- Computer architecture is a science or a set of rules stating how computer software and hardware are joined together and interact to make a computer work.
- It not only determines how the computer works but also of which technologies the computer is capable.
- Computers continue to be a major part of our lives, and computer architects continue to develop new and better programs and technologies.
- Computer architecture is a specification describing how hardware and software technologies interact to create a computer platform or system.

## Computer Architecture

**Computer Architecture:**

- Similar to making a building by building architect, computer architecture involves building a computer and all that goes into a computer system.

## Computer Architecture

**Computer Architecture:**

Computer architecture consists of three main categories.

System design: This includes all the hardware parts, such as CPU, data processors, multiprocessors, memory controllers and direct memory access. This part is the actual computer system.

Instruction set architecture: This includes the CPU's functions and capabilities, the CPU's programming language, data formats, processor register types and instructions used by computer programmers. This part is the software/instructions or similar programs.

Microarchitecture: This defines the data processing and storage element or data paths and how they should be implemented into the instruction set architecture. These might include storage devices and others.

All these parts go together in a certain order and must be developed in a pattern so they will function correctly.

## Computer Architecture

**Computer Architecture:**

Computer Architecture

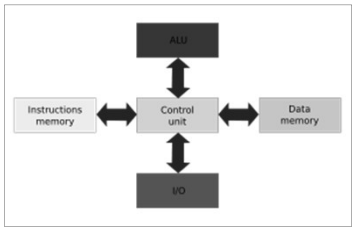
- Von Newmann Vs Hardvard
- CISC Vs RISC

**CISC : Complex Instruction Set Computer**

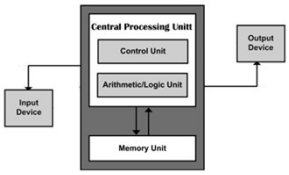
**RISC : Reduced Instruction set Computer**

## Computer Architecture

**Computer Architecture:** Harvard architecture Vs Von Neumann Architecture




Harvard architecture




Von Neumann architecture

Instruction and Data are in the same memory space in Von Neumann architecture and use single bus to both fetch instructions from memory and transfer data from one part of a computer to another while Harvard architecture has separate memory space for data and instruction.

## Computer Architecture

**Computer Architecture:** Harvard architecture Vs Von Neumann Architecture

- The Von Neumann architecture is a theoretical computer design based on the concept of stored-program where programs and data are stored in the same memory. The concept was designed by a mathematician John Von Neumann in 1945 and which presently serves as the basis of almost all modern computers.
- The Harvard architecture was based on the original Harvard Mark I relay-based computer model which employed separate buses for data and instructions.

## Computer Architecture

**Computer Architecture:** Harvard architecture Vs Von Neumann Architecture

| BASIS FOR COMPARISON | VON NEUMANN ARCHITECTURE | HARVARD ARCHITECTURE |
|---|---|---|
| **Basic** | Theoretical computer design based on the concept of stored-program where programs and data are stored in the same memory. The concept was designed by a mathematician John Von Neumann in 1945 and which presently serves as the basis of almost all modern computers. | The Harvard architecture was based on the original Harvard Mark I relay-based computer model which employed separate buses for data and instructions. |
| **Memory System** | Has only one bus that is used for both instruction fetches and data transfers, and the operations must be scheduled because they cannot be performed at the same time. | Has separate memory space for instructions and data, which physically separate signals and storage for code and data memory, which in turn makes it possible to access each of the memory system simultaneously. |

## Computer Architecture

**Computer Architecture:** Harvard architecture Vs Von Neumann Architecture

| BASIS FOR COMPARISON | VON NEUMANN ARCHITECTURE | HARVARD ARCHITECTURE |
|---|---|---|
| **Instruction Processing** | The processing unit would need two clock cycles to complete an instruction. The processor fetches the instruction from memory in the first cycle and decodes it, and then the data is taken from memory in the second cycle. | The processing unit can complete an instruction in one cycle if appropriate pipelining strategies are in place. |
| **Cost** | As instructions and data use the same bus system in the Von Neumann architecture, it simplifies design and development of the control unit, which eventually brings down the production cost to minimal. | Development of control unit in the Harvard architecture is more expensive than the former because of the complex architecture that employs two buses for instructions and data. |
| **Use** | Von Neumann architecture is mainly used in every machine you see from desktop computers and notebooks to high performance computers and workstations. | Harvard architecture is a fairly new concept used primarily in microcontrollers and digital signal processing (DSP). |

## Computer Architecture

**Computer Architecture:**

**CISC**

- Pronounced *sisk,* and stands for **C**omplex **I**nstruction **S**et **C**omputer. Most PC's use CPU based on this architecture. For instance Intel and AMD CPU's are based on CISC architectures.
- Typically CISC chips have a large amount of different and complex instructions. The philosophy behind it is that hardware is always faster than software, therefore one should make a powerful instructionset, which provides programmers with assembly instructions to do a lot with short programs.
- In common CISC chips are relatively slow (compared to RISC chips) per instruction, but use little (less than RISC) instructions.
- Intel and AMD CPU's are based on CISC architectures.
- Typically CISC chips have a large amount of different and complex instructions. The philosophy behind it is that hardware is always faster than software, therefore one should make a powerful instruction set, which provides programmers with assembly instructions to do a lot with short programs.
- In common CISC chips are relatively slow (compared to RISC chips) per instruction, but use little (less than RISC) instructions.

## Computer Architecture

**Computer Architecture:**

**RISC**

- Pronounced *risk,* and stands for **R**educed **I**nstruction **S**et **C**omputer. RISC chips evolved around the mid-1980 as a reaction at CISC chips. The philosophy behind it is that almost no one uses complex assembly language instructions as used by CISC, and people mostly use compilers which never use complex instructions. Apple for instance uses RISC chips.
- Therefore fewer, simpler and faster instructions would be better, than the large, complex and slower CISC instructions. However, more instructions are needed to accomplish a task.
- An other advantage of RISC is that - in theory - because of the more simple instructions, RISC chips require fewer transistors, which makes them easier to design and cheaper to produce.
- Finally, it's easier to write powerful optimised compilers, since fewer instructions exist.

## Computer Architecture

**Computer Architecture:**

- The first RISC projects came from IBM, Stanford, and UC-Berkeley in the late 70s and early 80s. The IBM 801, Stanford MIPS, and Berkeley RISC 1 and 2 were all designed with a similar philosophy which has become known as RISC. Certain design features have been characteristic of most RISC processors:
- *one cycle execution time*: RISC processors have a CPI (clock per instruction) of one cycle. This is due to the optimization of each instruction on the CPU and a technique called PIPELINING.
- *pipelining*: a technique that allows for simultaneous execution of parts, or stages, of instructions to more efficiently process instructions;
- *large number of registers*: the RISC design philosophy generally incorporates a larger number of registers to prevent in large amounts of interactions with memory

## Introduction to computer

# Memory and its classification

## Memory and its classification

**Memory and its classification:**

- Computer memory in generic term is an electronic circuit to store a data in computer.
- It uses a different types of data storage technology including RAM, ROM, flash memory and secondary storage.
- Another way, computer memories are non-volatile and Volatile type
- Non-Volatile means they can store data on a long term basis even when there is no power and volatile which are often faster but lose all the data stored on them as soon as the power is switched off.

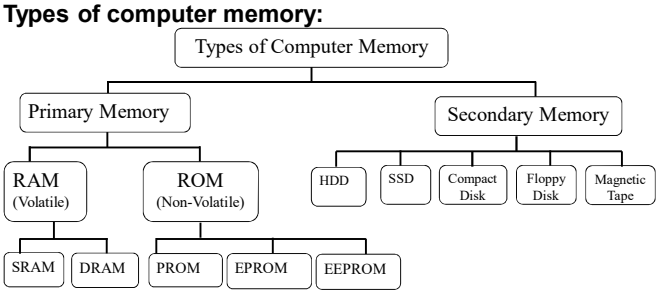
## Memory and its classification

**Memory and its classification:**

- A computer system is built using a combination of these types of computer memory, and the exact configuration can be optimized to produce the maximum data processing speed or the minimum cost, or some compromise between the two.

## Computer Architecture

**Types of computer memory:**




- Single Data Rate: (SDR) DRAM
- Dual Data Rate :(DDR) DRAM
- DDR2 , DDR3, and DDR4, which offer better performance and are more energy efficient than DDR. Different versions are incompatible, so it is not possible to mix DDR2 with DDR3 DRAM in a computer system.

## Memory and its classification

**Types of computer memory:**

**Primary Memory:**

- Primary memory includes ROM and RAM, and is located close to the CPU on the computer motherboard, enabling the CPU to read data from primary memory very quickly indeed. It is used to store data that the CPU needs imminently so that it does not have to wait for it to be delivered.

**Secondary Memory:**

- Secondary memory by contrast, is usually physically located within a separate storage device, such as a hard disk drive or solid state drive (SSD), which is connected to the computer system either directly or over a network. The cost per gigabyte of secondary memory is much lower, but the read and write speeds are significantly slower.

## Memory and its classification

**Types of Primary memory:**

- With computer evolution, many computer memory types has been deployed, each with its own strengths and weaknesses.

There are two key types of primary memory:

- RAM = Random Access Memory
- ROM = Read Only Memory

## Memory and its classification

**RAM Computer Memory:**

- RAM stems from the fact that data stored in Random Access Memory can be accessed in any random order.
- RAM memory is very fast both in write and read.
- It is volatile (so all data stored in RAM memory is lost when it loses power).
- It is very expensive compared to all types of secondary memory in terms of cost per gigabyte.
- It is because of the relative high cost of RAM compared to secondary memory types that most computer systems use both primary and secondary memory.
- Data that is required for imminent processing is moved to RAM where it can be accessed and modified very quickly, so that the CPU is not kept waiting.
- When the data is no longer required it is shunted out to slower but cheaper secondary memory, and the RAM space that has been freed up is filled with the next chunk of data that is about to be used.

## Memory and its classification

**Types of RAM:** DRAM (Dynamic RAM):

- It is the most common type of RAM used in computers.
- The oldest type is known as Single Data Rate (SDR) DRAM
- Newer computers use faster Dual Data Rate (DDR) DRAM.
- DDR comes in several versions including DDR2 , DDR3, and DDR4, which offer better performance and are more energy efficient than DDR.
- It is not possible to mix DDR2 with DDR3 DRAM in a computer system. Different versions are incompatible.

## Memory and its classification

**Types of RAM:** DRAM (Dynamic RAM):

| DDR3 | DDR4 |
|---|---|
| DDR3 stands for Double Data Rate version 3. | Whereas DDR4 stands for Double Data Rate version 4. |
| The cost of DDR3 is less than DDR4. | While it's cost is higher or more than DDR3. |
| In DDR3, auto-refresh and self-refresh are performed to refresh its content. | While in DDR4, only self-refresh is performed to refresh its content. |
| DDR3 consumes low power than DDR2 but less than DDR4. | Whereas DDR4 consumes low power than DDR3. |
| The speed of DDR3 is slightly slow in comparison of DDR4. | While it's speed is faster than DDR3. |
| DDR3 has a maximum of 16 GB memory. | While DDR4 has no maximum limit or capability. |
| The clock speed of DDR3 vary from 800 MHz to 2133 MHz. | While the minimum clock speed of DDR4 is 2133 MHz and it has no defined maximum clock speed. |
| DDR3 has lower latency than DDR4. | While DDR4 has slightly more latency than DDR3. |

## Memory and its classification

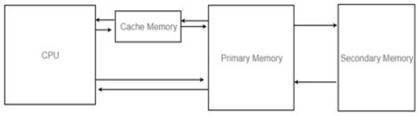
**Types of RAM:** SRAM (Static RAM):

- SRAM is Faster than DRAM
- More expensive and bulker, having six transistors in each cell.
- For those reasons SRAM is generally only used as a data cache within a CPU itself or as RAM in very high-end server systems.
- A small SRAM cache of the most imminently-needed data can result in significant speed improvements in a system

## Memory and its classification

**Cache Memory:**

- Cache Memory is a special very high-speed memory used to speed up and synchronizing with high-speed CPU.
- Cache memory is costlier than main memory or disk memory but economical than CPU registers.
- Cache memory is an extremely fast memory type that acts as a buffer between RAM and the CPU. It holds frequently requested data and instructions so that they are immediately available to the CPU when needed.
- Cache memory is used to reduce the average time to access data from the Main memory. The cache is a smaller and faster memory which stores copies of the data from frequently used main memory locations.




## Memory and its classification

**Keys differences between DRAM and SRAM:**

- The key differences between DRAM and SRAM is that SRAM is 2 or 3 times faster than DRAM - but more expensive and bulkier.
- SRAM is usually available in megabytes, while DRAM is purchased in gigabytes.
- DRAM uses more energy than SRAM because it constantly needs to be refreshed to maintain data integrity
- SRAM does not need constant refreshing when it is powered up.

## Memory and its classification

**ROM Computer Memory:**

- ROM (read-only memory) means data can be read from this type of memory, data cannot normally be written to it.
- It is a very fast type of computer memory which is usually installed close to the CPU on the motherboard.
- ROM is a type of non-volatile memory, which means that the data stored in ROM persists in the memory even when it receives no power. In that sense it is similar to secondary memory, which is used for long term storage.
- When a computer is turned on, the CPU can begin reading information stored in ROM without the need for drivers or other complex software to help it communicate.
- The ROM usually contains "bootstrap code" which is the basic set of instructions a computer needs to carry out to become aware of the operating system stored in secondary memory, and to load parts of the operating system into primary memory so that it can start up and become ready to use.
- ROM is also used in simpler electronic devices to store firmware which runs as soon as the device is switched on.

## Memory and its classification

**Types of ROM:**

- **ROM**(or **Masked ROM)** Preprogrammed set of data or instructions are stored in ROM. The contents of such ROMs have to be specified before chip production. ROM is available in several different types, including PROM, EPROM, EEPROM and Flash ROM.
- **PROM** (Programmable Read-Only Memory), and it is different from true ROM. ROM is programmed during the manufacturing process, a PROM is manufactured in an empty state and then programmed later using a PROM programmer or burner.
- **EPROM** (Erasable Programmable Read-Only Memory) and data stored in an EPROM can be erased and the EPROM reprogrammed. Erasing an EPROM involves removing it from the computer and exposing it to ultraviolet light before re-burning it.

## Memory and its classification

- **EEPROM** (Electrically Erasable Programmable Read-Only Memory). Distinction between EPROM and EEPROM is that the latter can be erased and written to by the computer system it is installed in. EEPROM is not strictly read-only. However in many cases the write process is slow, so it is normally only done to update program code such as firmware or BIOS code on an occasional basis.
- Flash ROM: Also called Flash BIOS or flash memory. This memory should be constantly powered and act as non-volatile memory in computer. Function of Flash ROM are
  - Power On Self Test(POST) – Checks the major hardware components
  - BIOS Setup program – built in utility in BIOS which control how the computer works i.e. system settings, find bootable devices, interrupt handlers and device drivers
  - Bootstrap loader: is a program to start the computer software for operation when the power is ON.

## Memory and its classification

**Differences between RAM and ROM:**

| ROM | RAM |
|---|---|
| Non-volatile | Volatile |
| Fast to read | Fast to read and write |
| Usually used in small quantities | Used as system memory to store data (including program code) that the CPU needs to process imminently |
| Cannot be written to quickly | Write quickly |
| Used to store boot instructions or firmware | |
| Relatively expensive per megabyte stored compared to RAM | Relatively cheap per megabyte stored compared to ROM, but relatively expensive compared to secondary memory |

## Memory and its classification

**Types of Secondary memory:**

Secondary memory comprises many different storage media which can be directly attached to a computer system. These include:

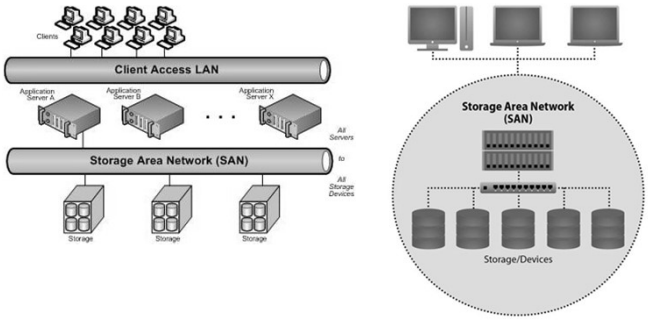
- Hard disk drives
- Solid State Drives (SSDs)
- Optical (CD or DVD) drives
- Tape drives

Secondary memory also includes:

- Storage arrays including 3D NAND flash arrays connected over a Storage Area Network (SAN)
- Storage devices which may be connected over a conventional network (known as network attached storage, or NAS)
- Cloud storage can also be called secondary memory.

## Memory and its classification

Storage Area Network (SAN) **:**

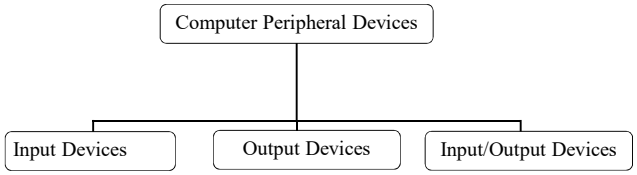



## Memory and its classification

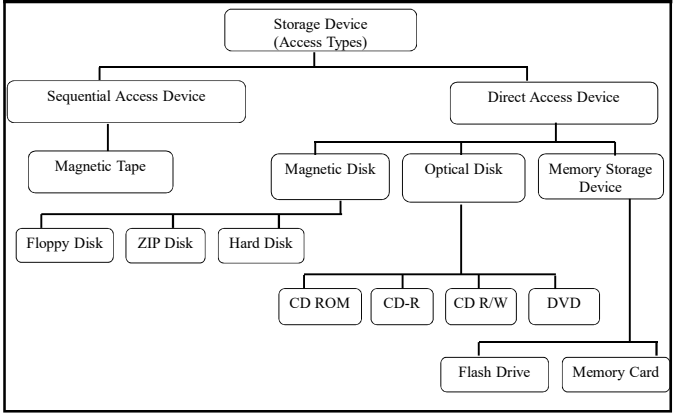
**Network Attached Storage (NAS) : NAS systems are networked appliances which contain one or more storage drives, often arranged into logical, redundant storage containers or RAID. Network-attached storage removes the responsibility of file serving from other servers on the network.**

## Input devices, Output devices, Interfaces

**Input devices, Output devices, Interfaces:**



## Access Types of Storage Devices




## Input devices, Output devices, Interfaces

**Input devices, Output devices, Interfaces:**

- An input device sends information to a computer system for processing, and an output device reproduces or displays the results of that processing.
- Input devices only allow for input of data to a computer and output devices only receive the output of data from another device.
- Most devices are only input devices or output devices, as they can only accept data input from a user or output data generated by a computer.
- However, some devices can accept input and display output, and they are referred to as I/O devices (input/output devices).

## Input devices, Output devices, Interfaces

**Input devices:**

An input device can send data to another device, but it cannot receive data from another device. Examples of input devices include the following.

- Keyboard and Mouse - Accepts input from a user and sends that data (input) to the computer. They cannot accept or reproduce information (output) from the computer.
- Microphone - Receives sound generated by an input source, and sends that sound to a computer.
- Webcam - Receives images generated by whatever it is pointed at (input) and sends those images to a computer.

## Input devices, Output devices, Interfaces

**Types of input devices:**

- Audio conversion device
- Barcode reader
- Biometrics (e.g., fingerprint scanner).
- Business card reader
- Digital camera and digital camcorder.
- EEG (electroencephalography)
- Finger (with touch screen or Windows Touch).
- Gamepad, joystick, paddle, steering wheel, and Microsoft Kinect.
- Gesture recognition
- Graphics tablet
- Keyboard
- Light gun
- Light pen
- Magnetic ink (like the ink found on checks).
- Magnetic stripe reader
- Medical imaging devices (e.g., X-ray, CAT scan, and ultrasound images).
- Microphone (using voice speech recognition or biometric verification).
- MIDI keyboard
- MICR
- Mouse, touchpad, or other pointing devices.
- OMR (optical mark reader)
- Paddle
- Pen or stylus
- Punch card reader
- Remote
- Scanner
- Sensors (e.g., heat and orientation sensors).
- Sonar imaging devices
- Stylus (with touch screen).
- Touch screen
- Voice (using voice speech recognition or biometric verification).
- Video capture device
- VR helmet and gloves
- Webcam
- Yoke

## Input devices, Output devices, Interfaces

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- Yoke

## Computer Architecture

**Output devices:**

An output device can receive data from another device and generate output with that data, but it cannot send data to another device. Examples of output devices include the following.

- **Monitor** - Receives data from a computer (output) and displays that information as text and images for users to view. It cannot accept data from a user and send that data to another device.
- **Projector** - Receives data from a computer (output) and displays, or projects, that information as text and images onto a surface, like a wall or a screen. It cannot accept data from a user and send that data to another device.
- **Speakers** - Receives sound data from a computer and plays the sounds for users to hear. It cannot accept sound generated by users and send that sound to another device.

## Input devices, Output devices, Interfaces

**Types of output devices**

- **3D Printer**
- **Braille embosser**
- **Braille reader**
- **COM (Computer Output Microfilm)**
- **Flat-panel**
- **GPS**
- **Headphones**
- **Monitor**
- **Plotter**
- **Printer (dot matrix printer, inkjet printer, and laser printer)**
- **Projector**
- **Sound card**
- **Speakers**
- **SGD (Speech-generating device)**
- **TV**
- **Video card**

## Input devices, Output devices, Interfaces

**Input/output devices:**

An input/output device can receive data from users, or another device (input), and send data to another device (output). Examples of input/output devices include the following.

- CD-RW drive and DVD-RW drive - Receives data from a computer (input), to copy onto a writable CD or DVD. Also, the drive sends data contained on a CD or DVD (output) to a computer.
- USB flash drive - Receives, or saves, data from a computer (input). Also, the drive sends data to a computer or another device (output).

Note: Drives such as a CD-ROM, DVD, floppy diskette drive, and USB flash drive are also considered storage devices.

## Input devices, Output devices, Interfaces

**Input - Output Interface:**

- Input Output Interface provides a method for transferring information between internal storage and external I/O devices.
- Peripherals connected to a computer need special communication links for interfacing them with the central processing unit.
- The purpose of communication link is to resolve the differences that exist between the central computer and each peripheral.

## Input devices, Output devices, Interfaces

**Input - Output Interface:**

The Major Differences are:-

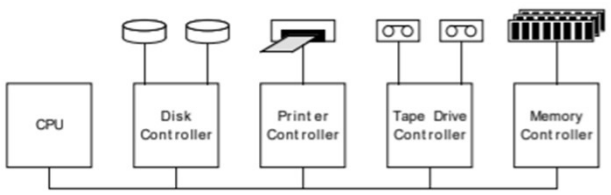
1. Peripherals are electromechnical and electromagnetic devices and CPU and memory are electronic devices. Therefore, a conversion of signal values may be needed.
2. The data transfer rate of peripherals is usually slower than the transfer rate of CPU and consequently, a synchronization mechanism may be needed.
3. Data codes and formats in the peripherals differ from the word format in the CPU and memory.
4. The operating modes of peripherals are different from each other and must be controlled so as not to disturb the operation of other peripherals connected to the CPU.

To Resolve these differences, computer systems include special hardware components between the CPU and Peripherals to supervises and synchronizes all input and out transfers

- These components are called Interface Units because they interface between the processor bus and the peripheral devices.

## Input devices, Output devices, Interfaces

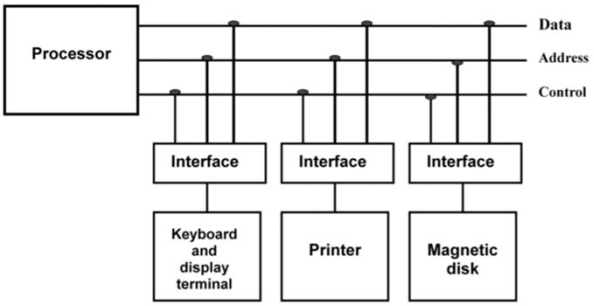
**Input - Output Interface:**




**CPU and device controllers all use a common bus for communication**

## Input devices, Output devices, Interfaces

**Input - Output Interface:**




**Connection of I/O bus to input-output devices**