

FUNDAMENTALS OF COMPUTER SCIENCE

SYLLABUS

UNIT I:

A Simple Computer System: Central processing unit, the further need of secondary storage, Types of memory, Hardware, Software and people.

Peripheral Devices: Input, Output and storage, Data Preparation, Factors affecting input, Input devices, Output devices, Secondary devices, Communication between the CPU and Input/ Output devices.

UNIT II:

Problem Solving and Programming: Algorithm development, Flowcharts, Looping, some programming features, Pseudo code, the one-zero game, some structured programming concepts, documents.

Programming Languages: Machine Language and assembly language, high -level and low level languages, Assemblers, Compilers, and Interpreters

UNIT III:

Computer Networks : Introduction to computer Networks, Network topologies-Bus topology, star topology, Ring topology, Mesh topology, Hybrid topology, Types of Networks: Local area Network, Wide Area Networks, Metropolitan Networks, Campus/ Corporate Area Network, Personal Area Network, Network Devices- Hub, Repeater, Switch, Bridge, Router, Gateway, Network interface Card, Open System Inter connection Model.

Operating systems: Introduction, Evolution of operating systems, Process Management- Process control block, Process operations, Process scheduling, Command Interpreter, Popular operating systems- Microsoft DOS, Microsoft Windows, UNIX and Linux.

UNIT-I

Central Processing Unit

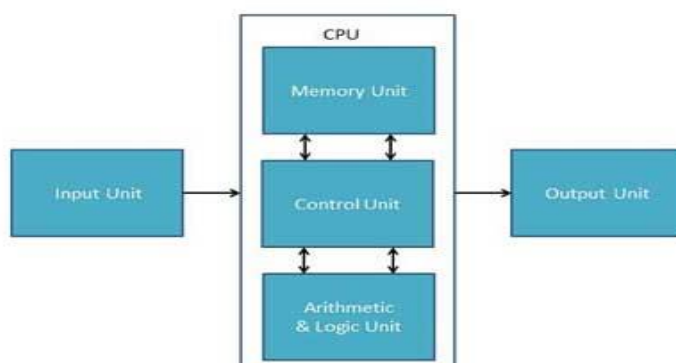
Central Processing Unit (CPU) consists of the following features –

- CPU is considered as the brain of the computer.
- CPU performs all types of data processing operations.
- It stores data, intermediate results, and instructions (program).
- It controls the operation of all parts of the computer.



CPU itself has following three components.

- Memory or Storage Unit
- Control Unit
- ALU(Arithmetic Logic Unit)



Memory or Storage Unit:-This unit can store instructions, data, and intermediate results. This unit supplies information to other units of the computer when needed. It is also known as internal storage unit or the main memory or the primary storage or Random Access Memory (RAM).

Its size affects speed, power, and capability. Primary memory and secondary memory are two types of memories in the computer. Functions of the memory unit are –

- It stores all the data and the instructions required for processing.
- It stores intermediate results of processing.
- It stores the final results of processing before these results are released to an output device.
- All inputs and outputs are transmitted through the main memory.

Control Unit:-This unit controls the operations of all parts of the computer but does not carry out any actual data processing operations.

Functions of this unit are –

- It is responsible for controlling the transfer of data and instructions among other units of a computer.
- It manages and coordinates all the units of the computer.
- It obtains the instructions from the memory, interprets them, and directs the operation of the computer.
- It communicates with Input/Output devices for transfer of data or results from storage.
- It does not process or store data.

ALU (Arithmetic Logic Unit):-This unit consists of two subsections namely,

- Arithmetic Section
- Logic Section

Arithmetic Section:-Function of arithmetic section is to perform arithmetic operations like addition, subtraction, multiplication, and division. All complex operations are done by making repetitive use of the above operations.

Logic Section:-Function of logic section is to perform logic operations such as comparing, selecting, matching, and merging of data.

THE FURTHER NEED OF SECONDARY MEMORY

- **Permanent Storage:** Primary Memory (RAM) is volatile, i.e. it loses all information when the electricity is turned off, so in order to secure the data permanently in the device, Secondary storage devices are needed.
- **Portability:** Storage medium, like the CDs, flash drives can be used to transfer the data from one device to another.
- **Security:**-Sensitive information can be copied(back up) and kept in safe places.
- **Space:**-Large volume of electronic information can be stored easily

Primary Memory (Main Memory)

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

Characteristics of Main Memory

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

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. Hence, a backup Uninterruptible Power System (UPS) is often used with computers. RAM is small, both in terms of its physical size and in the amount of data it can hold.

RAM is of two types –

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

Static RAM (SRAM)

The word **static** indicates that the memory retains its contents as long as power is being supplied. However, data is lost when the power gets down due to volatile nature. SRAM chips use a matrix of 6-transistors and no capacitors. Transistors do not require power to prevent leakage, so SRAM need not be refreshed on a regular basis.

There is extra space in the matrix, hence SRAM uses more chips than DRAM for the same amount of storage space, making the manufacturing costs higher. SRAM is thus used as cache memory and has very fast access.

Characteristic of Static RAM

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

Dynamic RAM (DRAM)

DRAM, unlike SRAM, must be continually **refreshed** in order to maintain the data. This is done by placing the memory on a refresh circuit that rewrites the data several hundred times per second. DRAM is used for most system memory as it is cheap and small. All DRAMs are made up of memory cells, which are composed of one capacitor and one transistor.

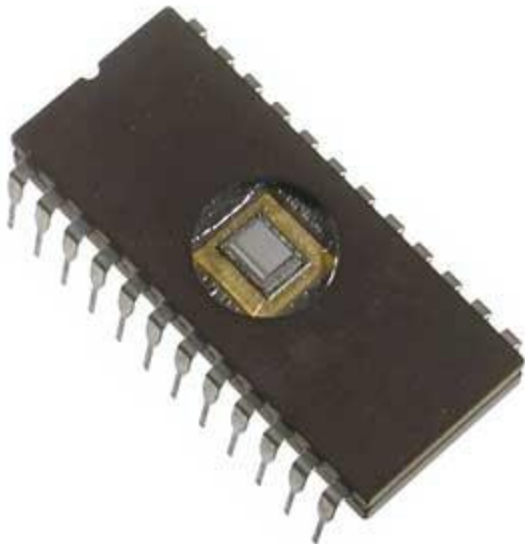
Characteristics of Dynamic RAM

- Short data lifetime
- Needs to be refreshed continuously
- Slower as compared to SRAM

- Used as RAM
- Smaller in size
- Less expensive
- Less power consumption

Read Only Memory

ROM stands for **Read Only Memory**. The memory from which we can only read but cannot write on it. This type of memory is non-volatile. The information is stored permanently in such memories during manufacture. A ROM stores such instructions that are required to start a computer. This operation is referred to as **bootstrap**. ROM chips are not only used in the computer but also in other electronic items like washing machine and microwave oven.



Let us now discuss the various types of ROMs and their characteristics.

MROM (Masked ROM): The very first ROMs were hard-wired devices that contained a pre-programmed set of data or instructions. These kind of ROMs are known as masked ROMs, which are inexpensive.

PROM (Programmable Read Only Memory): 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.

EPROM (Erasable and Programmable Read Only Memory): EPROM can be erased by exposing it to ultra-violet light for a duration of up to 40 minutes. Usually, an EPROM eraser achieves this function. During programming, an electrical charge is trapped in an insulated gate region. The charge is retained for more than 10 years because the charge has no leakage path.

For erasing this charge, ultra-violet light is passed through a quartz crystal window (lid). This exposure to ultra-violet light dissipates the charge. During normal use, the quartz lid is sealed with a sticker.

EEPROM (Electrically Erasable and Programmable Read Only Memory):-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.

Advantages of ROM :-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

Hardware:-Hardware represents the physical and tangible components of a computer, i.e. the components that can be seen and touched.

Examples of Hardware are the following

- **Input devices** – keyboard, mouse, etc.
- **Output devices** – printer, monitor, etc.
- **Secondary storage devices** – Hard disk, CD, DVD, etc.
- **Internal components** – CPU, motherboard, RAM, etc.



Relationship between Hardware and Software:-

- Hardware and software are mutually dependent on each other. Both of them must work together to make a computer produce a useful output.
- Software cannot be utilized without supporting hardware.
- Hardware without a set of programs to operate upon cannot be utilized and is useless.
- To get a particular job done on the computer, relevant software should be loaded into the hardware.
- Hardware is a one-time expense.
- Software development is very expensive and is a continuing expense.
- Different software applications can be loaded on a hardware to run different jobs.
- Software acts as an interface between the user and the hardware.
- If the hardware is the 'heart' of a computer system, then the software is its 'soul'. Both are complementary to each other.

Software:-Software is a set of programs, which is designed to perform a well-defined function. A program is a sequence of instructions written to solve a particular problem. There are two types of software

- System Software
- Application Software

System Software:-The system software is a collection of programs designed to operate, control, and extend the processing capabilities of the computer itself. System software is generally prepared by the computer manufacturers. These software products comprise of programs written in low-level languages, which interact with the hardware at a very basic level. System software serves as the interface between the hardware and the end users.

Some examples of system software are Operating System, Compilers, Interpreter, Assemblers, etc.



Here is a list of some of the most prominent features of a system software –

- Close to the system
- Fast in speed
- Difficult to design
- Difficult to understand

- Less interactive
- Smaller in size
- Difficult to manipulate
- Generally written in low-level language

Application Software:-Application software products are designed to satisfy a particular need of a particular environment. All software applications prepared in the computer lab can come under the category of Application software.

Application software may consist of a single program, such as Microsoft's notepad for writing and editing a simple text. It may also consist of a collection of programs, often called a software package, which work together to accomplish a task, such as a spreadsheet package.

Examples of Application software are the following –

- Payroll Software
- Student Record Software
- Inventory Management Software
- Income Tax Software
- Railways Reservation Software
- Microsoft Office Suite Software
- Microsoft Word
- Microsoft Excel
- Microsoft PowerPoint



Features of application software are as follows –

- Close to the user
- Easy to design
- More interactive
- Slow in speed
- Generally written in high-level language
- Easy to understand
- Easy to manipulate and use
- Bigger in size and requires large storage space

A flowchart is a blueprint that pictorially represents the algorithm and its steps. The steps of a flowchart do not have a specific size and shape rather it is designed in different shapes and sizes (see the image given below).

Further needs of secondary memories:-

- 1) Secondary memory is used to store the data, when there is no secondary memory then computer can't store the data.
- 2) If there is no secondary memory then there will not be RAM because RAM is the type of secondary memory
- 3) If there is no memory then there is no space in the computer, due to there is no space data also cannot be stored
- 4) If data can't store in the computer then there is no use of that computer

Input Devices:-Following are some of the important input devices which are used in a computer.

- Keyboard
- Mouse
- Joy Stick
- Light pen
- Track Ball
- Scanner
- Graphic Tablet
- Microphone
- Magnetic Ink Card Reader(MICR)
- Optical Character Reader(OCR)
- Bar Code Reader
- Optical Mark Reader(OMR)

Keyboard:-Keyboard is the most common and very popular input device which helps to input data to the computer. The layout of the keyboard is like that of traditional typewriter, although there are some additional keys provided for performing additional functions.



Keyboards are of two sizes 84 keys or 101/102 keys, but now keyboards with 104 keys or 108 keys are also available for Windows and Internet. The keys on the keyboard are as follows

S.No	Keys & Description
	Typing Keys
1	These keys include the letter keys (A-Z) and digit keys (0-9) which generally give the same layout as that of typewriters.
	Numeric Keypad
2	It is used to enter the numeric data or cursor movement. Generally, it consists of a set of 17 keys that are laid out in the same configuration used by most adding machines and calculators.
	Function Keys
3	The twelve function keys are present on the keyboard which are arranged in a row at the top of the keyboard. Each function key has a unique meaning and is used for some specific purpose.
	Control keys
4	These keys provide cursor and screen control. It includes four directional arrow keys. Control keys also include Home, End, Insert, Delete, Page Up, Page Down, Control(Ctrl), Alternate(Alt), Escape(Esc).
	Special Purpose Keys
5	Keyboard also contains some special purpose keys such as Enter, Shift, Caps Lock, Num Lock, Space bar, Tab, and Print Screen.

Mouse:- Mouse is the most popular pointing device. It is a very famous cursor-control device having a small palm size box with a round ball at its base, which senses the movement of the mouse and sends corresponding signals to the CPU when the mouse buttons are pressed.

Generally, it has two buttons called the left and the right button and a wheel is present between the buttons. A mouse can be used to control the position of the cursor on the screen, but it cannot be used to enter text into the computer.



Advantages

- Easy to use
- Not very expensive
- Moves the cursor faster than the arrow keys of the keyboard.

Joystick:-

Joystick is also a pointing device, which is used to move the cursor position on a monitor screen. It is a stick having a spherical ball at its both lower and upper ends. The lower spherical ball moves in a socket. The joystick can be moved in all four directions.



The function of the joystick is similar to that of a mouse. It is mainly used in Computer Aided Designing (CAD) and playing computer games.

Light Pen:-Light pen is a pointing device similar to a pen. It is used to select a displayed menu item or draw pictures on the monitor screen. It consists of a photocell and an optical system placed in a small tube.



When the tip of a light pen is moved over the monitor screen and the pen button is pressed, its photocell sensing element detects the screen location and sends the corresponding signal to the CPU.

Track Ball:-Track ball is an input device that is mostly used in notebook or laptop computer, instead of a mouse. This is a ball which is half inserted and by moving fingers on the ball, the pointer can be moved.



Since the whole device is not moved, a track ball requires less space than a mouse. A track ball comes in various shapes like a ball, a button, or a square.

Scanner:-

Scanner is an input device, which works more like a photocopy machine. It is used when some information is available on paper and it is to be transferred to the hard disk of the computer for further manipulation.



Scanner captures images from the source which are then converted into a digital form that can be stored on the disk. These images can be edited before they are printed.

Digitizer:-

Digitizer is an input device which converts analog information into digital form. Digitizer can convert a signal from the television or camera into a series of numbers that could be stored in a computer. They can be used by the computer to create a picture of whatever the camera had been pointed at.



Digitizer is also known as Tablet or Graphics Tablet as it converts graphics and pictorial data into binary inputs. A graphic tablet as digitizer is used for fine works of drawing and image manipulation applications.

Microphone:-

Microphone is an input device to input sound that is then stored in a digital form.



The microphone is used for various applications such as adding sound to a multimedia presentation or for mixing music.

Magnetic Ink Card Reader (MICR):- MICR input device is generally used in banks as there are large number of cheques to be processed every day. The bank's code number and cheque number are printed on the cheques with a special type of ink that contains particles of magnetic material that are machine readable.



This reading process is called Magnetic Ink Character Recognition (MICR). The main advantages of MICR is that it is fast and less error prone.

Optical Character Reader (OCR):-

OCR is an input device used to read a printed text.



OCR scans the text optically, character by character, converts them into a machine readable code, and stores the text on the system memory.

Bar Code Readers:-

Bar Code Reader is a device used for reading bar coded data (data in the form of light and dark lines). Bar coded data is generally used in labeling goods, numbering the books, etc. It may be a handheld scanner or may be embedded in a stationary scanner.



Bar Code Reader scans a bar code image, converts it into an alphanumeric value, which is then fed to the computer that the bar code reader is connected to.

Optical Mark Reader (OMR):-

OMR is a special type of optical scanner used to recognize the type of mark made by pen or pencil. It is used where one out of a few alternatives is to be selected and marked.



It is specially used for checking the answer sheets of examinations having multiple choice questions.

Output Devices:-

Output Devices

Following are some of the important output devices used in a computer.

- Monitors
- Graphic Plotter
- Printer
- Speakers
- projectors

Monitors:-Monitors, commonly called as **Visual Display Unit (VDU)**, are the main output device of a computer. It forms images from tiny dots, called pixels that are arranged in a rectangular form. The sharpness of the image depends upon the number of pixels. There are two kinds of viewing screen used for monitors.

- Cathode-Ray Tube (CRT)
- Flat-Panel Display

Cathode-Ray Tube (CRT) Monitor:-The CRT display is made up of small picture elements called pixels. The smaller the pixels, the better the image clarity or resolution. It takes more than one illuminated pixel to form a whole character.



A finite number of characters can be displayed on a screen at once. The screen can be divided into a series of character boxes - fixed location on the screen where a standard character can be placed. Most screens are capable of displaying 80 characters of data horizontally and 25 lines vertically. There are some disadvantages of CRT

- Large in Size
- High power consumption

Flat-Panel Display Monitor

A flat panel display is a television, monitor or other display appliance that uses a thin panel design instead of a traditional cathode ray tube (CRT) design. These screens are much lighter and thinner, and can be much more portable than traditional televisions and monitors. They also have higher resolution than older models.



LCD MONITOR:-

The LCD monitor is a flat panel screen that is compact and light-weight as compared to CRT monitors. It is based on liquid crystal display technology which is used in the screens of laptops, tablets, smart phones, etc. An LCD screen comprises two layers of polarized glass with a liquid crystal solution between them. When the light passes through the first layer,

an electric current aligns the liquid crystals. The aligned liquid crystals allow a varying level of light to pass through the second layer to create images on the screen.

LED MONITORS:-

The LED monitor is an improved version of an LCD monitor. It also has a flat panel display and uses liquid crystal display technology like the LCD monitors. The difference between them lies in the source of light to backlight the display. The LED monitor has many LED panels, and each panel has several LEDs to backlight the display, whereas the LCD monitors use cold cathode fluorescent light to backlight the display. Modern electronic devices such as mobile phones, LED TVs, laptop and computer screens, etc., use a LED display as it not only produces more brilliance and greater light intensity but also consumes less power.

Printers:-Printer is an output device, which is used to print information on paper. There are two types of printers

- Impact Printers
- Non-Impact Printers

Impact Printers:-Impact printers print the characters by striking them on the ribbon, which is then pressed on the paper. Characteristics of Impact Printers are the following

- Very low consumable costs
- Very noisy
- Useful for bulk printing due to low cost
- There is physical contact with the paper to produce an image

These printers are of two types

- Character printers
- Line printers

Character Printers:-Character printers are the printers which print one character at a time. Examples of Character printers are Dot Matrix Printer (DMP), Daisy Wheel printer.

Dot Matrix Printer:-In the market, one of the most popular printers is Dot Matrix Printer. These printers are popular because of their ease of printing and economical price. Each character printed is in the form of pattern of dots and head consists of a Matrix of Pins of size (5*7, 7*9, 9*7 or 9*9) which comes out to form a character which is why it is called Dot Matrix Printer.

**Advantages**

- Inexpensive
- Widely Used
- Other language characters can be printed

Disadvantages

- Slow Speed
- Poor Quality

Daisy Wheel: - The daisy wheel is a disk made of plastic or metal on which characters stand out in relief along the outer edge. To print a character, the printer rotates the disk until the desired letter is facing the paper. Then a hammer strikes the disk, forcing the character to hit an ink ribbon, leaving an impression of the character on the paper. You can change the daisy wheel to print different fonts. Daisy-wheel printers cannot print graphics, and in general they are noisy and slow, printing from 10 to about 75 characters per second

**Advantages**

- More reliable than DMP
- Better quality
- Fonts of character can be easily changed

Disadvantages

- Slower than DMP
- Noisy
- More expensive than DMP

Line Printers:-Line printers are the printers which print one line at a time.



These are of two types

- Drum Printer
- Chain Printer

Drum Printer:-This printer is like a drum in shape hence it is called drum printer. The surface of the drum is divided into a number of tracks. Total tracks are equal to the size of the paper, i.e. for a paper width of 132 characters, drum will have 132 tracks. A character set is embossed on the track. Different character sets available in the market are 48 character set, 64 and 96 characters set. One rotation of drum prints one line. Drum printers are fast in speed and can print 300 to 2000 lines per minute.

Advantages

- Very high speed

Disadvantages

- Very expensive
- Characters fonts cannot be changed

Chain Printer:-In this printer, a chain of character sets is used, hence it is called Chain Printer. A standard character set may have 48, 64, or 96 characters.

Advantages

- Character fonts can easily be changed.
- Different languages can be used with the same printer.

Disadvantages

- Noisy

Non-impact Printers:-Non-impact printers print the characters without using the ribbon. These printers print a complete page at a time, thus they are also called as Page Printers. These printers are of two types

- Laser Printers
- Inkjet Printers

Characteristics of Non-impact Printers

- Faster than impact printers
- They are not noisy
- High quality
- Supports many fonts and different character size

1. Laser Printers

These are non-impact page printers. They use laser lights to produce the dots needed to form the characters to be printed on a page.

**Advantages**

- Very high speed
- Very high quality output
- Good graphics quality
- Supports many fonts and different character size

Disadvantages

- Expensive
- Cannot be used to produce multiple copies of a document in a single printing

2. Inkjet Printers:-Inkjet printers are non-impact character printers based on a relatively new technology. They print characters by spraying small drops of ink onto paper. Inkjet printers produce high quality output with presentable features.



They make less noise because no hammering is done and these have many styles of printing modes available. Color printing is also possible. Some models of Inkjet printers can produce multiple copies of printing also.

Advantages

- High quality printing
- More reliable

Disadvantages

- Expensive as the cost per page is high

Plotters:-A plotter is a computer hardware device much like a printer that is used for printing vector graphics. Instead of toner, plotters use a pen, pencil, marker, or another writing tool to draw multiple, continuous lines onto paper rather than a series of dots like a traditional printer. Plotters are used to produce a hard copy of schematics and other similar applications.

Advantages of plotters

1. Plotters can work on very large sheets of paper while maintaining high resolution.
2. They can print on a wide variety of flat materials including plywood, aluminum, sheet steel, cardboard, and plastic.
3. Plotters allow the same pattern to be drawn thousands of times without any image degradation.

Disadvantages of plotters

1. Plotters are quite large when compared to a traditional printer.
2. Plotters are also much more expensive than a traditional printer.

Speakers:-speakers are attached to computers to facilitate the output of sound. Sound cards are required in the computer for speakers to function. The different kinds of speakers range from simple, two-speaker output devices right the way up to surround-sound multi-channel units.

Projector: - this is a display device that projects a computer-created image onto another surface: usually some sort of whiteboard or wall. The computer transmits the image data to its video card, which then sends the video image to the projector. It is most often used for presentations, or for viewing videos.

Data Preparation:-

Data preparation is the process of cleaning and transforming raw data prior to processing and analysis. It is an important step prior to processing and often involves reformatting data, making corrections to data and the combining of data sets to enrich data.

Data preparation is often a lengthy undertaking for data professionals or business users, but it is essential as a prerequisite to put data in context in order to turn it into insights and eliminate bias resulting from poor data quality.

Data Preparation Steps

The specifics of the data preparation process vary by industry, organization and need, but the framework remains largely the same. For example, the data preparation process usually includes standardizing data formats, enriching source data, and/or removing outliers.

1. Gather data

The data preparation process begins with finding the right data. This can come from an existing data catalog or can be added ad-hoc.

2. Discover and assess data

After collecting the data, it is important to discover each dataset. This step is about getting to know the data and understanding what has to be done before the data becomes useful in a particular context.

Discovery is a big task, but Talend's data preparation platform offers visualization tools which help users profile and browse their data.

3. Cleanse and validate data

Cleaning up the data is traditionally the most time consuming part of the data preparation process, but it's crucial for removing faulty data and filling in gaps. Important tasks here include:

- Removing extraneous data and outliers.
- Filling in missing values.
- Conforming data to a standardized pattern.
- Masking private or sensitive data entries.

Once data has been cleansed, it must be validated by testing for errors in the data preparation process up to this point. Often times, an error in the system will become apparent during this step and will need to be resolved before moving forward.

4. Transform and enrich data

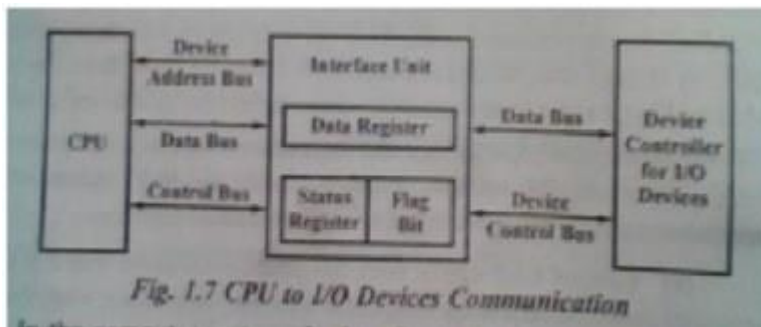
Transforming data is the process of updating the format or value entries in order to reach a well-defined outcome, or to make the data more easily understood by a wider audience. *Enriching* data refers to adding and connecting data with other related information to provide deeper insights.

5. Store data

Once prepared, the data can be stored or channeled into a third party application—such as a business intelligence tool—clearing the way for processing and analysis to take place.

The communication between CPU and input/output devices

The communication between CPU and input/output devices is implemented using an interface unit. In a computer system, data is transferred from an input device to the processor and from the processor to an output device. Each input and output device is provided with a device controller, which is used to manage the working of various peripheral devices. Actually, the CPU communicates with the device controllers for performing the I/O operations.



In the computer system, the interface unit works as an intermediary between the processor and the device controllers of various peripheral devices. The interface unit accepts the control commands from the processor and interprets the commands so that they can be easily understood by the device controllers for performing the required operations. Hence, the interface unit is responsible for controlling the input and output operations. The processor to I/O devices communication involves two important operations-I/O read and I/O write.

operations-I/O read and I/O write.

The I/O operation helps the CPU to read the data from an input device. The sequence of steps done during transferring the data from and an input device to the CPU are as follows-

1. The input device kept the data that needs to be transferred on the data bus which transfers single byte of data at a time.
2. The input device then issues the data valid signal through the device control bus to the data register, showing that the data is present on the data bus.
3. After accepting the data by the data register of the interface unit, it issues a data accepted signal through the device control bus as an acknowledgement to the input device, showing that the data is received. Then, the input device disables the data valid signal.
4. The flag bit of the status register is set to 1 because the data register holds the data.
5. Now, the CPU issues an I/O read signal to the data register in the interface unit.
6. The data register then places the data on the data bus connected to the CPU. When the data is received, the CPU sends an acknowledgement signal to the input device, showing that the data has been received.

The I/O write operation helps the processor to write the data to an output device. The sequence of steps done during transferring the data from CPU to the output device are as follows-

1. The CPU kept the data that needs to be transferred on the data bus connected to the data register of the interface unit.
2. The CPU also kept the address of the output device on the device address bus.
3. The CPU then issues the I/O write signal which writes the data on the data register. The data register holds the data, showing that flag bit of the status register is set to 1.
4. Now, the data register issues a data accepted signal through the control bus to the CPU, showing that the data has been received.
5. Then, the interface unit kept the data on the data bus connected to the device controller of the output device.
6. The output device receives the data and sends an acknowledgement signal to the CPU through the interface unit, showing that the desired data has been received.

Memory

A memory is just like a human brain. It is used to store data and instructions. Computer memory is the storage space in the computer, where data is to be processed and instructions required for processing are stored. The memory is divided into large number of small parts called cells. Each location or cell has a unique address, which varies from zero to memory size minus one. For example, if the computer has 64k words, then this memory unit has $64 * 1024 = 65536$ memory locations. The address of these locations varies from 0 to 65535.

Memory is primarily of three types

- Cache Memory
- Primary Memory/Main Memory
- Secondary Memory

Cache Memory

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

Advantages

The advantages of cache memory are as follows

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

Disadvantages

The disadvantages of cache memory are as follows

- Cache memory has limited capacity.
- It is very expensive.

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

Primary memory has limited storage capacity and is volatile. Secondary memory overcomes this limitation by providing permanent storage of data and in bulk quantity. Secondary memory is also termed as external memory and refers to the various storage media on which a computer can store data and programs. The Secondary storage media can be fixed or removable. Fixed Storage media is an internal storage medium like hard disk that is fixed inside the computer. Storage medium that are portable and can be taken outside the computer are termed as removable storage media.



Characteristics of Secondary Memory

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

Uses of Secondary Media:

- **Permanent Storage:** Primary Memory (RAM) is volatile, i.e. it loses all information when the electricity is turned off, so in order to secure the data permanently in the device, Secondary storage devices are needed.
- **Portability:** Storage medium, like the CDs, flash drives can be used to transfer the data from one device to another.

Fixed and Removable Storage

Fixed Storage:

A Fixed storage is an internal media device that is used by a computer system to store data, and usually these are referred to as the Fixed Disks drives or the Hard Drives.

Fixed storage devices are literally not fixed, obviously these can be removed from the system for repairing work, maintenance purpose, and also for upgrade etc. But in general, this can't be done without a proper toolkit to open up the computer system to provide physical access, and that needs to be done by an engineer.

Technically, almost all of the data i.e. being processed on a computer system is stored on some type of a built-in fixed storage device.

Types of fixed storage:

- Internal flash memory (rare)
- SSD (solid-state disk) units
- Hard disk drives (HDD)

Removable Storage:

A Removable storage is an external media device that is used by a computer system to store data, and usually these are referred to as the Removable Disks drives or the External Drives.

Removable storage is any type of storage device that can be removed/ejected from a computer system while the system is running. Examples of external devices include CDs, DVDs and Blu-Ray disk drives, as well as diskettes and USB drives. Removable storage makes it easier for a user to transfer data from one computer system to another.

In a storage factors, the main benefit of removable disks is that they can provide the fast data

transfer rates associated with storage area networks (SANs)

Types of Removable Storage:

- Optical discs (CDs, DVDs, Blu-ray discs)
- Memory cards
- Floppy disks
- Magnetic tapes
- Disk packs
- Paper storage (punched tapes , punched cards)

Secondary Storage Media:- There are the following main types of storage media:

1. Magnetic storage media:

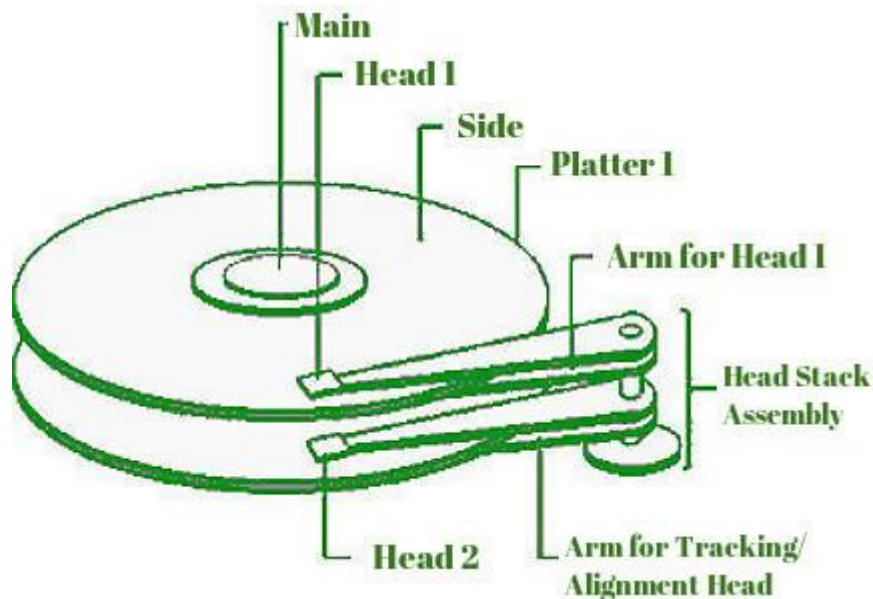
Magnetic media is coated with a magnetic layer which is magnetized in clockwise or anticlockwise directions. When the disk moves, the head interprets the data stored at a specific location in binary 1s and 0s at reading.

Examples: hard disks, floppy disks and magnetic tapes.

- **Floppy Disk:** A floppy disk is a flexible disk with a magnetic coating on it. It is packaged inside a protective plastic envelope. These are one of the oldest type of portable storage devices that could store up to 1.44 MB of data but now they are not used due to very less memory storage.
- **Hard disk:** A hard disk consists of one or more circular disks called platters which are mounted on a common spindle. Each surface of a platter is coated with a magnetic material. Both surfaces of each disk are capable of storing data except the top and bottom disk where only the inner surface is used. The information is recorded on the surface of the rotating disk by magnetic read/write heads. These heads are joined to a common arm known as access arm.

Hard disk drive components:-

Most of the basic types of hard drives contains a number of disk platters that are placed around a spindle which is placed inside a sealed chamber. The chamber also includes read/write head and motors. Data is stored on each of these disks in the arrangement of concentric circles called tracks which are divided further into sectors. Though internal Hard drives are not very portable and used internally in a computer system, external hard disks can be used as a substitute for portable storage. Hard disks can store data upto several terabytes.



2. Optical storage media

In optical storage media information is stored and read using a laser beam. The data is stored as a spiral pattern of pits and ridges denoting binary 0 and binary 1.

Examples: CDs and DVDs

- **Compact Disk:** A Compact Disc drive (CDD) is a device that a computer uses to read data that is encoded digitally on a compact disc(CD). A CD drive can be installed inside a computer's compartment, provided with an opening for easier disc tray access or it can be used by a peripheral device connected to one of the ports provided in the computer system. A compact disc or CD can store approximately 650 to 700 megabytes of data. A computer should possess a CD Drive to read the CDs. There are three types of CDs:

CD- ROM	CD-R	CD-RW
It stands for Compact Disk – Read Only Memory	It stands for Compact Disk- Recordable.	It stands for Compact Disk-Rewritable.
Data is written on these disks at the time of manufacture. This data cannot be changed, once is it written by the manufacturer, but can only be	Data can be recorded on these disks but only once. Once the data is written in a CD-R, it cannot be	It can be read or written multiple times but a CD-RW drive needs to be installed

CD- ROM	CD-R	CD-RW
read. CD- ROMs are used for text, audio and video distribution like games, encyclopedias and application software.	erased/modified.	on your computer before editing a CD-RW.

- **DVD:-**

It stands for Digital Versatile Disk or Digital Video Disk. It looks just like a CD and use a similar technology as that of the CDs but allows tracks to be spaced closely enough to store data that is more than six times the CD's capacity. It is a significant advancement in portable storage technology. A DVD holds 4.7 GB to 17 GB of data.

- **Blue Ray Disk:-**

This is the latest optical storage media to store high definition audio and video. It is similar to a CD or DVD but can store up to 27 GB of data on a single layer disk and up to 54 GB of data on a dual layer disk. While CDs or DVDs use red laser beam, the blue ray disk uses a blue laser to read/write data on a disk.

3. Solid State Memories

Solid-state storage devices are based on electronic circuits with no moving parts like the reels of tape, spinning discs etc. Solid-state storage devices use special memories called flash memory to store data. Solid state drive (or flash memory) is used mainly in digital cameras, pen drives or USB flash drives.

Pen Drives:

Pen Drives or Thumb drives or Flash drives are the recently emerged portable storage media. It is an EEPROM based flash memory which can be repeatedly erased and written using electric signals. This memory is accompanied with a USB connector which enables the pendrive to connect to the computer. They have a capacity smaller than a hard disk but greater than a CD. Pen drive has following advantages:

- **Transfer Files:**

A pen drive being plugged into a USB port of the system can be used as a device to transfer files, documents and photos to a PC and also vice versa. Similarly, selected files can be transferred between a pen drive and any type of workstation.

- **Portability:**

The lightweight nature and smaller size of a pen drive make it possible to carry it from place to place which makes data transportation an easier task.

- **Backup Storage:**

Most of the pen drives now come with a feature of having password encryption, important

information related to family, medical records and photos can be stored on them as a backup.

- **Transport Data:**

Professionals/Students can now easily transport large data files and video/audio lectures on a pen drive and gain access to them from anywhere. Independent PC technicians can store work-related utility tools, various programs and files on a high-speed 64 GB pen drive and move from one site to another.

FACTORS AFFECTING INPUT

1. **COST:-**The initial and recurrent cost to be weighed against expected benefits or operational characteristics of the facility.
2. **INPUT SPEED:-**This is a crucial factor because if quicker response is required then fast method of data input may be suitable though expensive.
3. **VOLUME:-**The facility selected should cope with the data volume to be input within appropriate timing.
4. **ACCURACY:-**The data being input should be accurate and give confidence and appropriateness in the intended application.
5. **RELIABILITY:-**It is important that the facility selected is to known have a success record in the market on the application, it is to be acquired for.
6. **MODE OF OPERATION:-**The choice of input medium depends much on the nature of the system (data processing system)

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UNIT-II

Development of Algorithm & Flowcharts

Development of Algorithm & Flowcharts is first step towards learning programming language. Generally you need to develop algorithm/flowchart of some process with step by step procedure. Let's start!

The main purpose of using an algorithm is to illustrate the flow of data and problem solution logic.

Algorithm Definition:-An algorithm is a finite sequence of well-defined steps or operations for solving a problem in a systematic manner. In another words we can say that an algorithm is a step-by-step problem-solving procedure.

An algorithm generally takes some input, carries out a number of effective steps in a finite amount of time, and produces some output.

Rules for writing Algorithm

Each instruction should be precise and unambiguous.

Each instruction should be executed in a finite time.

One or more instructions should not be repeated infinitely.

After executing the instructions, the desired results are obtained.

Algorithm Example 1: Write an algorithm to add two nos.

Step1: start
Step2: Read a, b
Step3: $\text{sum} = a + b$
Step4: write sum
Step5: stop

Algorithm Example 2 Simple Calculator:

1. Start
2. Read a, b
3. Compute $\text{sum} = a + b$
4. Compute $\text{sub} = a - b$
5. Compute $\text{mul} = a * b$
6. Compute $\text{div} = a / b$
7. Compute $\text{mod} = a \% b$
8. Write sum, sub, mul, div, mod

Algorithm Example 3 Find Simple Interest:

1. Start
2. Read p, r, n
3. $\text{si} = (p * r * n) / 100$
4. Write si
5. Stop

Algorithm Example 4 Find volume of a circle

1. Start
2. Read r
3. $v = \frac{4}{3} * (3.14) * (r * r * r)$
4. Write v
5. Stop

Algorithm Example 5 Calculate the amount to be paid by a customer.

1. Start
2. Read cr, pr, cpu
3. Compute $\text{uc} = \text{cr} - \text{pr}$
4. Compute $\text{total_bill} = \text{uc} * \text{cpu}$
5. Write total_bill
6. Stop

Algorithm Example 6 Check whether given no. is odd or even.

1. Start
2. Read n
3. Is $(n \% 2 == 0)$? Goto step 5
4. Write no is odd
5. Write no is even
6. Stop

Flow chart:-

It is a graphical representation of a program flow or an algorithm of a problem to be solved by a computer.

It is an aid to solve a complex problem easily and efficiently. It shows the detailed view of a program flow.

Rules for drawing flowchart:-

1. Use common statements that are easy to understand for words within flowchart symbols.
2. Be consistent in using names and variables in the flowchart.
3. Go from left to right and top to bottom in constructing flowcharts.
4. Keep the flowchart as simple as possible.
5. If a new flow charting page is needed, break the flowchart at an input or output point. Use properly labeled connectors to link the flowchart on different pages.

Advantages of drawing a flowchart:-

1. It helps a programmer to get a good visual reference of the structure of a program.
2. It not only serves as program documentation but also helps as a means to communicate with several programmers, as it is language independent.
3. It allows a programmer to test alternative solutions to a problem without even coding the program. It is much easier to find and correct logic errors prior to coding.
4. It serves as a useful reference or a programming aid due to its simple and efficient method of representing the program logic of a problem.







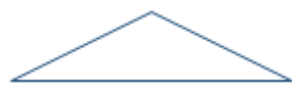



Flowchart

A flowchart is a blueprint that pictorially represents the algorithm and its steps. The steps of a flowchart do not have a specific size and shape rather it is designed in different shapes and sizes.

Benefits of Flowchart:-

- Let us now discuss the benefits of a flowchart.
- **Simplify the Logic**
- As it provides the pictorial representation of the steps; therefore, it simplifies the logic and subsequent steps.
- **Makes Communication Better**
- Because of having easily understandable pictorial logic and steps, it is a better and simple way of representation.
- **Effective Analysis**
- Once the flowchart is prepared, it becomes very simple to analyze the problem in an effective way.
- **Useful in Coding**
- The flowchart also helps in coding process efficiently, as it gives directions on what to do, when to do, and where to do. It makes the work easier.
- **Proper Testing**
- Further, flowchart also helps in finding the error (if any) in program
- **Applicable Documentation**
- Last but not the least, a flowchart also helps in preparing the proper document (once the codes are written).

Flow Chart Symbols:-The following table illustrates the symbols along with their names (used in a flow-chart)

Name	Symbol	Name	Symbol
	Flow Line		Magnetic Disk
	Terminal		Communication Link
	Processing		Offline Storage
	Decision		Annotation
	Connector		Flow line

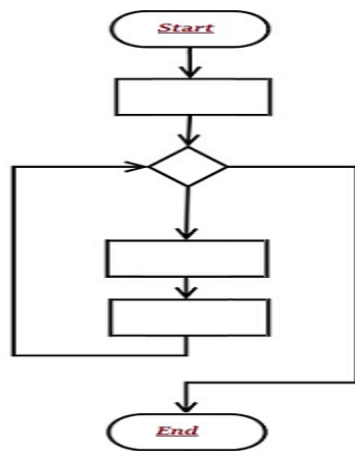


Document



Off-Page Connector

Sample of Flow Chart



Computer Programming - Loops

Let's consider a situation when you want to print **Hello, World!** five times. Here is a simple C program to do the same –

Ex:-

```
#include <stdio.h>
```

```
int main() {  
    printf( "Hello, World!\n");  
    printf( "Hello, World!\n");  
    printf( "Hello, World!\n");  
    printf( "Hello, World!\n");  
    printf( "Hello, World!\n");  
}
```

When the above program is executed, it produces the following result –

```
Hello, World!  
Hello, World!  
Hello, World!  
Hello, World!  
Hello, World!
```

It was simple, but again, let's consider another situation when you want to write **Hello, World!** a thousand times. We can certainly not write `printf()` statements a thousand times. Almost all the programming languages provide a concept called **loop**, which helps in executing one or more statements up to a desired number of times. All high-level programming languages provide various forms of loops, which can be used to execute one or more statements repeatedly.

Let's write the above C program with the help of a **while loop** and later, we will discuss how this loop works

Ex:-

```
#include <stdio.h>

int main() {
    int i = 0;

    while ( i < 5 ) {
        printf( "Hello, World!\n");
        i = i + 1;
    }
}
```

When the above program is executed, it produces the following result –

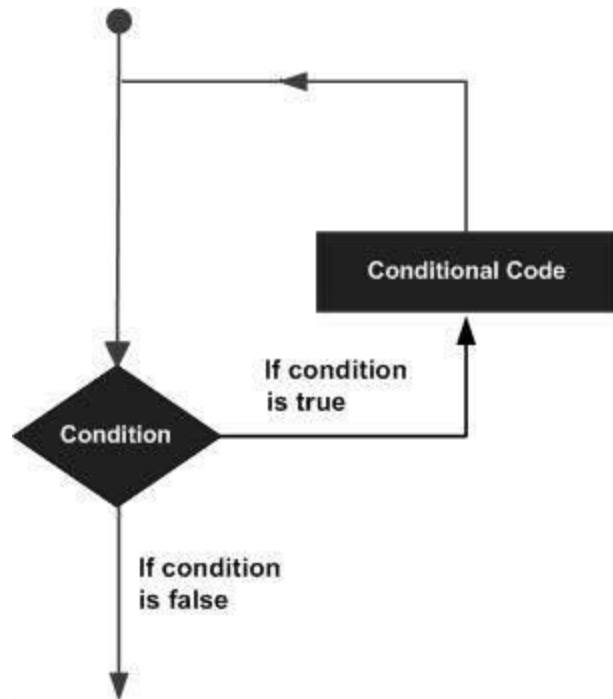
```
Hello, World!
Hello, World!
Hello, World!
Hello, World!
Hello, World!
```

The above program makes use of a **while loop**, which is being used to execute a set of programming statements enclosed within {...}. Here, the computer first checks whether the given condition, i.e., variable "a" is less than 5 or not and if it finds the condition is true, then the loop body is entered to execute the given statements. Here, we have the following two statements in the loop body –

- First statement is `printf()` function, which prints Hello World!
- Second statement is `i = i + 1`, which is used to increase the value of variable **i**

After executing all the statements given in the loop body, the computer goes back to `while(i < 5)` and the given condition, (`i < 5`), is checked again, and the loop is executed again if the condition holds true. This process repeats till the given condition remains true which means variable "a" has a value less than 5.

To conclude, a loop statement allows us to execute a statement or group of statements multiple times. Given below is the general form of a loop statement in most of the programming languages –

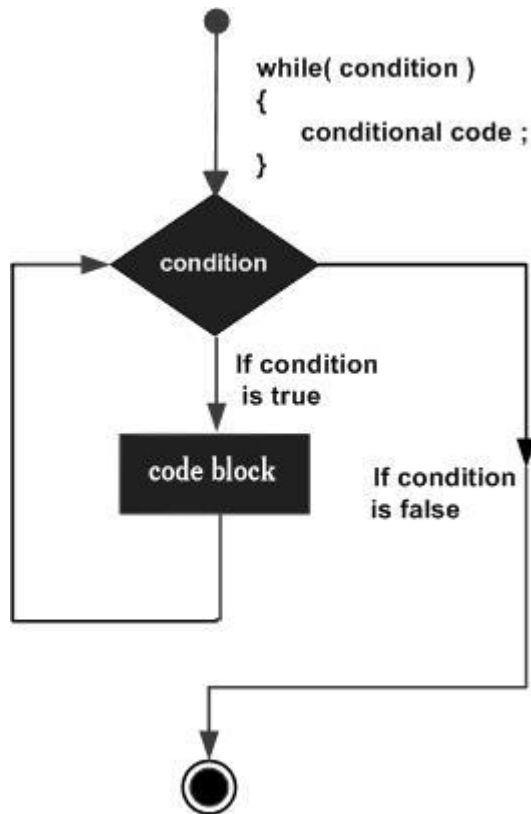


This tutorial has been designed to present programming's basic concepts to non-programmers, so let's discuss the two most important loops available in C programming language. Once you are clear about these two loops, then you can pick-up C programming tutorial or a reference book and check other loops available in C and the way they work.

The while Loop:-A while loop available in C Programming language has the following syntax –

```
while ( condition ) {  
    /*....while loop body ....*/  
}
```

The above code can be represented in the form of a flow diagram as shown below –



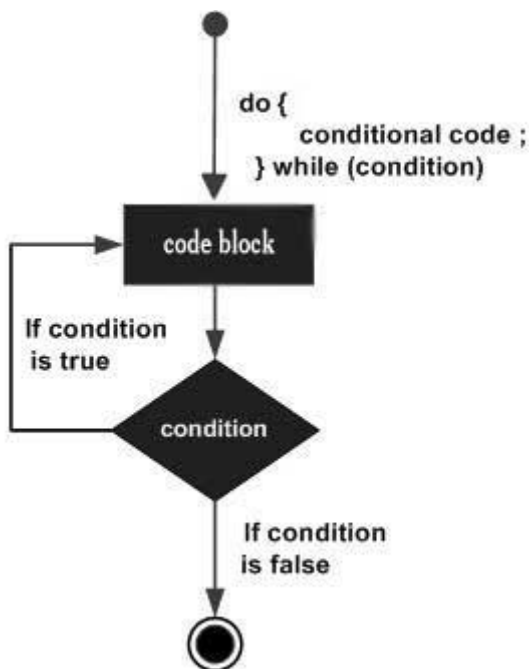
The following important points are to be noted about a while loop

- A while loop starts with a keyword **while** followed by a **condition** enclosed in ().
- Further to the while() statement, you will have the body of the loop enclosed in curly braces {...}.
- A while loop body can have one or more lines of source code to be executed repeatedly.
- If the body of a while loop has just one line, then it's optional to use curly braces {...}.
- A while loop keeps executing its body till a given **condition** holds true. As soon as the condition becomes false, the while loop comes out and continues executing from the immediate next statement after the while loop body.
- A condition is usually a relational statement, which is evaluated to either true or false. A value equal to zero is treated as false and any non-zero value works like true.

The do...while Loop:- A while loop checks a given condition before it executes any statements given in the body part. C programming provides another form of loop, called **do...while** that allows executing a loop body before checking a given condition. It has the following syntax –

```
do {  
    /*....do...while loop body ....*/  
}  
while ( condition );
```

The above code can be represented in the form of a flow diagram as shown below –



If you will write the above example using **do...while** loop, then **Hello, World** will produce the same result –

```
EX:#include <stdio.h>
```

```
int main() {  
    int i = 0;  
  
    do {  
        printf( "Hello, World!\n");  
        i = i + 1;  
    }  
    while ( i < 5 );  
}
```

When the above program is executed, it produces the following result –

```
Hello, World!  
Hello, World!  
Hello, World!  
Hello, World!  
Hello, World!
```

Pseudo code

pseudo code is a term which is often used in programming and algorithm based fields. It is a methodology that allows the programmer to represent the implementation of an algorithm. Simply, we can say that it's the cooked up representation of an algorithm. Often at times, algorithms are represented with the help of pseudo codes as they can be interpreted by programmers no matter what their programming background or knowledge is. Pseudo code, as the name suggests, is a false code or a representation of code which can be understood by even a layman with some school level programming knowledge.

Algorithm: It's an organized logical sequence of the actions or the approach towards a particular problem. A programmer implements an algorithm to solve a problem. Algorithms are expressed using natural verbal but somewhat technical annotations.

Pseudo code: It's simply an implementation of an algorithm in the form of annotations and informative text written in plain English. It has no syntax like any of the programming language and thus can't be compiled or interpreted by the computer.

Advantages of Pseudo code

- Improves the readability of any approach. It's one of the best approaches to start implementation of an algorithm.
- Acts as a bridge between the program and the algorithm or flowchart. Also works as a rough documentation, so the program of one developer can be understood easily when a pseudo code is written out. In industries, the approach of documentation is essential. And that's where a pseudo-code proves vital.
- The main goal of a pseudo code is to explain what exactly each line of a program should do, hence making the code construction phase easier for the programmer.

How to write a Pseudo-code:-

1. Arrange the sequence of tasks and write the pseudocode accordingly.
2. Start with the statement of a pseudo code which establishes the main goal or the aim.

Example:

```
This program will allow the user to check  
the number whether it's even or odd.
```

3. The way the if-else, for, while loops are indented in a program, indent the statements likewise, as it helps to comprehend the decision control and execution mechanism. They also improve the readability to a great extent.
4. Example:
- 5.
6. `if "1"`
7. `print response`
8. `"I am case 1"`

```
9.  
10. if "2"  
11.     print response  
12.     "I am case 2"
```

13. Use appropriate naming conventions. The human tendency follows the approach to follow what we see. If a programmer goes through a pseudo code, his approach will be the same as per it, so the naming must be simple and distinct.
14. Use appropriate sentence casings, such as CamelCase for methods, upper case for constants and lower case for variables.
15. Elaborate everything which is going to happen in the actual code. Don't make the pseudo code abstract.
16. Use standard programming structures such as 'if-then', 'for', 'while', 'cases' the way we use it in programming.
17. Check whether all the sections of a pseudo code is complete, finite and clear to understand and comprehend.
18. Don't write the pseudo code in a complete programmatic manner. It is necessary to be simple to understand even for a layman or client, hence don't incorporate too many technical terms.

Hardware and Software

The following table highlights the points that differentiate a hardware from a software.

Hardware	Software
It is the physical component of a computer system.	It is the programming language that makes hardware functional.
It has the permanent shape and structure, which cannot be modified.	It can be modified and reused, as it has no permanent shape and structure.
The external agents such as dust, mouse, insects, humidity, heat, etc. can affect the hardware (as it is tangible).	The external agents such as dust, mouse, insects, humidity, heat, etc. cannot affect (as it is not tangible).
It works with binary code (i.e., 1's to 0's) .	It functions with the help of high level language like COBOL, BASIC, JAVA, etc.
It takes in only machine language, i.e., lower level language.	It takes in higher level language, easily readable by a human being.
It is not affected by the computer bug or virus.	It is affected by the computer bug or virus.
It cannot be transferred from one place to other electronically.	It can transfer from one place to other electronically.
Duplicate copy of hardware cannot be created.	A user can create copies of a software as many as he wishes.

Computer languages:- There are mainly three different languages with the help of which we can develop computer programs. And they are

- Machine Level language
- Assembly Level Language and
- High-Level Language

Machine Level Language:- The computer can understand only the language of Digital Electronics. Digital Electronics deals with the presence and absence of voltages. Within the computer there are two logics can play their role. These logics are –

- **Positive Logic:** Here presence of voltage will be denoted by 1 and absence of voltage will be denoted by 0
- **Negative Logic :** Here presence of voltage will be denoted by 0 and absence of voltage will be denoted by 1

But obviously, the computer can follow any one of the logic at a time, not both the logics simultaneously. To make the computer understand, a program can be written using only 0s and 1s. The data can also be specified and represented using only 0s and 1s. Such a program is called Machine Language program. Machine language was the first in the evolution of computer programming languages. Computer directly understands a program written in the machine language. So as a result, the machine language program does not require any translator to convert from one form to another. In fact, even to this day, basically, computers understand only the 0s and 1s.

Assembly Level Language:- After machine level language, the next level of development in the evolution of computer languages was the Assembly Language. Machine level language uses only the binary language. But on the other hand, assembly language uses mnemonics or symbolic instructions in place of a sequence of 0s and 1s. As fewer examples, we can consider that to add register A and B in a particular computer, assembly language uses the mnemonic 'ADD B' in place of 10001111. In assembly language, we use symbolic names to denote addresses and data. A number of such examples are dealt with in the successive chapters. Thus writing a program in assembly language has advantages over writing the same in a machine language.

High Level Language:- High level language is the next development in the evolution of computer languages. Examples of some high-level languages are given below

- PROLOG (for "PROgramming LOGic");
- FORTRAN (for 'FORmula TRANslation');
- LISP (for "LIST Processing");
- Pascal (named after the French scientist Blaise Pascal).

High-level languages are like English-like language, with less words also known as keywords and fewer ambiguities. Each high level language will have its own syntax and keywords. The meaning of the word syntax is grammar.

Language Processors: Assembler, Compiler and Interpreter

Language Processors:- Assembly language is machine dependent yet mnemonics that are being used to represent instructions in it are not directly understandable by machine and high Level language is machine independent. A computer understands instructions in machine code, i.e. in the form of 0s and 1s. It is a tedious task to write a computer program directly in machine code. The programs are written mostly in high level languages like Java, C++, Python etc. and are called **source code**. This source code cannot be executed directly by the computer and must be converted into machine language to be executed. Hence, a special translator system software is used to translate the program written in high-level language into machine code is called **Language Processor** and the program after translated into machine code (object program / object code).

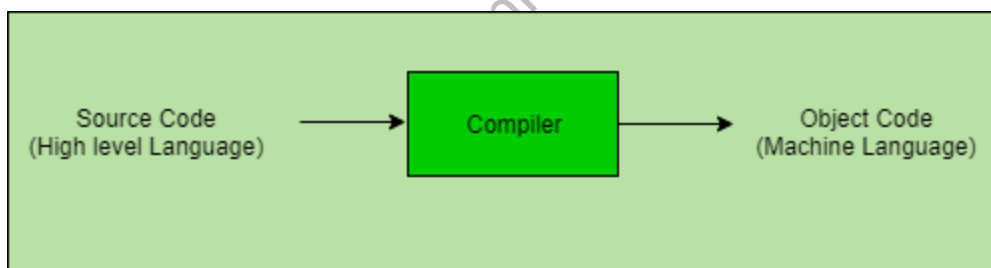
The language processors can be any of the following three types:

1. **Compiler:-**

The language processor that reads the complete source program written in high level language as a whole in one go and translates it into an equivalent program in machine language is called as a Compiler.

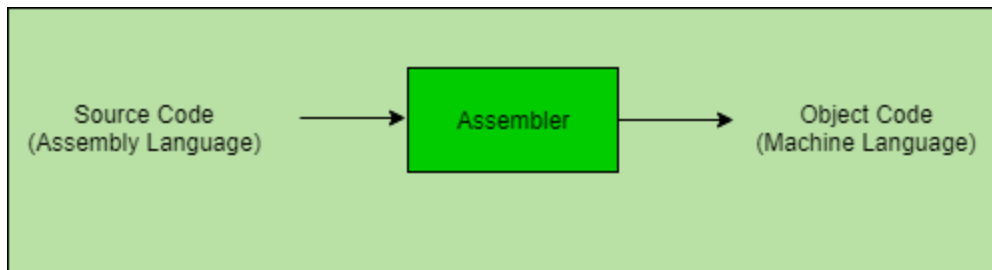
Example: C, C++, C#, Java

In a compiler, the source code is translated to object code successfully if it is free of errors. The compiler specifies the errors at the end of compilation with line numbers when there are any errors in the source code. The errors must be removed before the compiler can successfully recompile the source code again.>



2. **Assembler:-**

The Assembler is used to translate the program written in Assembly language into machine code. The source program is a input of assembler that contains assembly language instructions. The output generated by assembler is the object code or machine code understandable by the computer.



3. Interpreter:-

The translation of single statement of source program into machine code is done by language processor and executes it immediately before moving on to the next line is called an interpreter. If there is an error in the statement, the interpreter terminates its translating process at that statement and displays an error message. The interpreter moves on to the next line for execution only after removal of the error. An Interpreter directly executes instructions written in a programming or scripting language without previously converting them to an object code or machine code.

Example: Perl, Python and Matlab.

Difference between Compiler and Interpreter.

Compiler	Interpreter
A compiler is a program which converts the entire source code of a programming language into executable machine code for a CPU.	interpreter takes a source program and runs it line by line, translating each line as it comes to it.
Compiler takes large amount of time to analyze the entire source code but the overall execution time of the program is comparatively faster.	Interpreter takes less amount of time to analyze the source code but the overall execution time of the program is slower.
Compiler generates the error message only after scanning the whole program, so debugging is comparatively hard as the error can be present anywhere in the program.	Its Debugging is easier as it continues translating the program until the error is met
Generates intermediate object code.	No intermediate object code is generated.
Examples: C, C++, Java	Examples: Python, Perl

UNIT-III

A **computer network** is a system in which multiple computers are connected to each other to share information and resources.



Characteristics of a Computer Network

- Share resources from one computer to another.
- Create files and store them in one computer, access those files from the other computer(s) connected over the network.
- Connect a printer, scanner, or a fax machine to one computer within the network and let other computers of the network use the machines available over the network.

Following is the list of hardware's required to set up a computer network.

- Network Cables
- Distributors
- Routers
- Internal Network Cards
- External Network Cards

Network Cables

Network cables are used to connect computers. The most commonly used cable is Category 5 cable RJ-45.



Distributors

A computer can be connected to another one via a serial port but if we need to connect many computers to produce a network, this serial connection will not work.



The solution is to use a central body to which other computers, printers, scanners, etc. can be connected and then this body will manage or distribute network traffic.

Router

A router is a type of device which acts as the central point among computers and other devices that are a part of the network. It is equipped with holes called ports. Computers and other devices

are connected to a router using network cables. Now-a-days router comes in wireless modes using which computers can be connected without any physical cable.



Network Card

Network card is a necessary component of a computer without which a computer cannot be connected over a network. It is also known as the network adapter or Network Interface Card (NIC). Most branded computers have network card pre-installed. Network cards are of two types: Internal and External Network Cards.

Internal Network Cards

Motherboard has a slot for internal network card where it is to be inserted. Internal network cards are of two types in which the first type uses Peripheral Component Interconnect (PCI) connection, while the second type uses Industry Standard Architecture (ISA). Network cables are required to provide network access.



External Network Cards

External network cards are of two types: Wireless and USB based. Wireless network card needs to be inserted into the motherboard, however no network cable is required to connect to the network.



Universal Serial Bus (USB)

USB card is easy to use and connects via USB port. Computers automatically detect USB card and can install the drivers required to support the USB network card automatically.



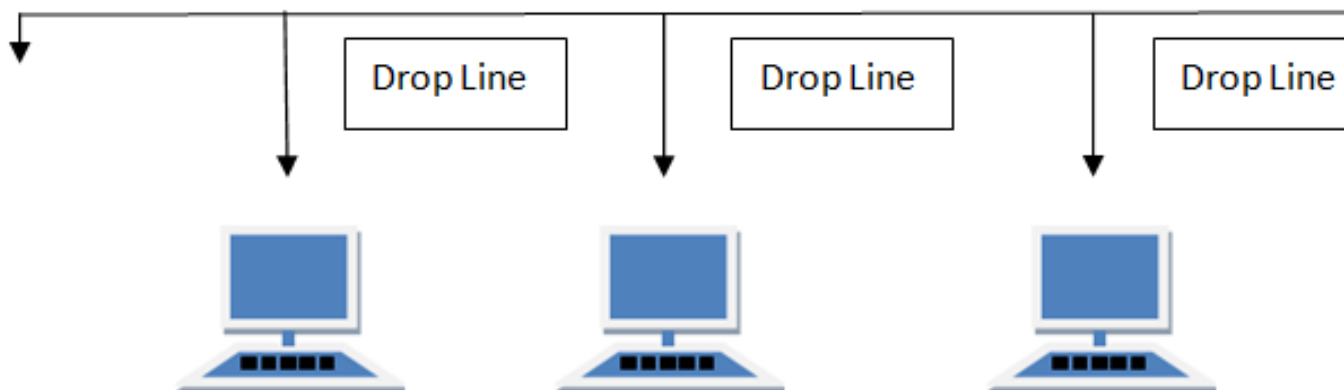
Types of Network Topology

Network Topology is the schematic description of a network arrangement, connecting various nodes(sender and receiver) through lines of connection.

BUS Topology

Bus topology is a network type in which every computer and network device is connected to single cable. When it has exactly two endpoints, then it is called **Linear Bus topology**.

Cable End



Features of Bus Topology

1. It transmits data only in one direction.
2. Every device is connected to a single cable

Advantages of Bus Topology

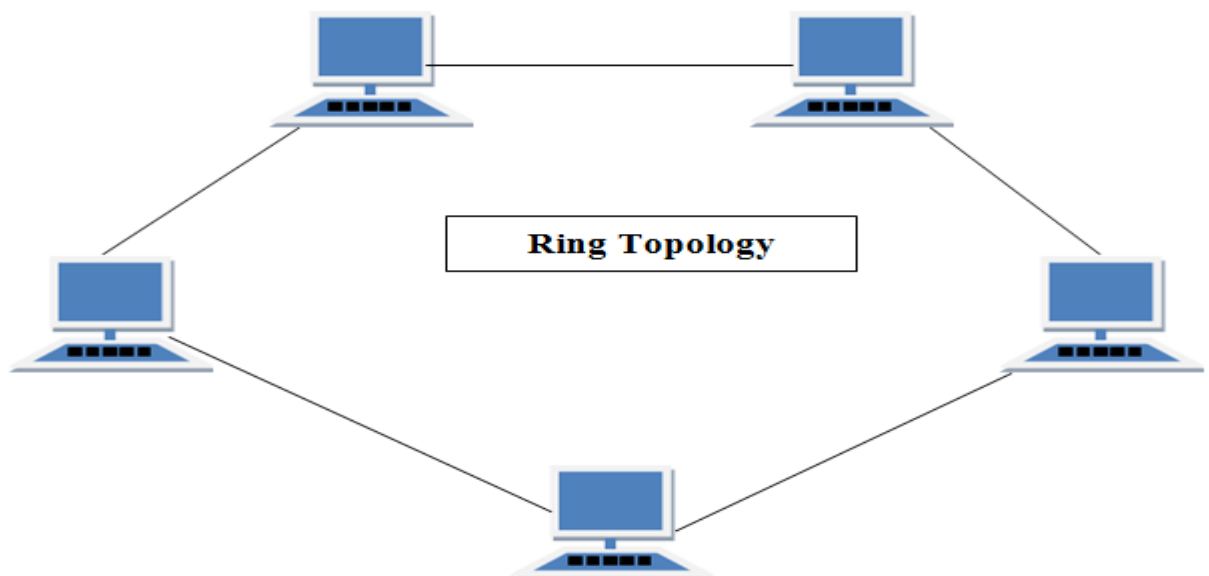
1. It is cost effective.
2. Cable required is least compared to other network topology.
3. Used in small networks.
4. It is easy to understand.
5. Easy to expand joining two cables together.

Disadvantages of Bus Topology

1. Cables fails then whole network fails.
2. If network traffic is heavy or nodes are more the performance of the network decreases.
3. Cable has a limited length.
4. It is slower than the ring topology.

RING Topology

It is called ring topology because it forms a ring as each computer is connected to another computer, with the last one connected to the first. Exactly two neighbours for each device.



Features of Ring Topology

1. A number of repeaters are used for Ring topology with large number of nodes, because if someone wants to send some data to the last node in the ring topology with 100 nodes, then the data will have to pass through 99 nodes to reach the 100th node. Hence to prevent data loss repeaters are used in the network.
2. The transmission is unidirectional, but it can be made bidirectional by having 2 connections between each Network Node, it is called **Dual Ring Topology**.
3. In Dual Ring Topology, two ring networks are formed, and data flow is in opposite direction in them. Also, if one ring fails, the second ring can act as a backup, to keep the network up.
4. Data is transferred in a sequential manner that is bit by bit. Data transmitted, has to pass through each node of the network, till the destination node.

Advantages of Ring Topology

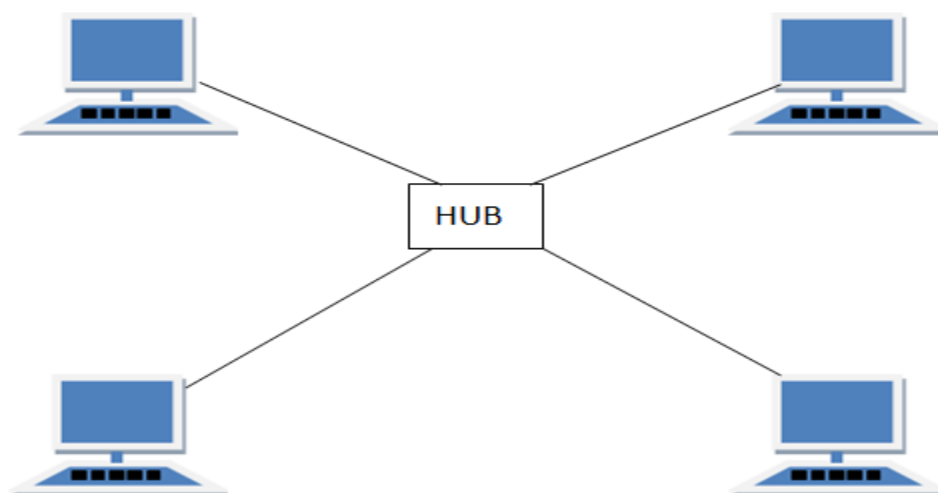
1. Transmitting network is not affected by high traffic or by adding more nodes, as only the nodes having tokens can transmit data.
2. Cheap to install and expand

Disadvantages of Ring Topology

1. Troubleshooting is difficult in ring topology.
2. Adding or deleting the computers disturbs the network activity.
3. Failure of one computer disturbs the whole network.

STAR Topology

In this type of topology all the computers are connected to a single hub through a cable. This hub is the central node and all others nodes are connected to the central node.



Features of Star Topology

1. Every node has its own dedicated connection to the hub.
2. Hub acts as a repeater for data flow.
3. Can be used with twisted pair, Optical Fibre or coaxial cable.

Advantages of Star Topology

1. Fast performance with few nodes and low network traffic.
2. Hub can be upgraded easily.
3. Easy to troubleshoot.
4. Easy to setup and modify.
5. Only that node is affected which has failed, rest of the nodes can work smoothly.

Disadvantages of Star Topology

1. Cost of installation is high.
2. Expensive to use.
3. If the hub fails then the whole network is stopped because all the nodes depend on the hub.
4. Performance is based on the hub that is it depends on its capacity

MESH Topology

It is a point-to-point connection to other nodes or devices. All the network nodes are connected to each other. Mesh has $\frac{n(n-1)}{2}$ physical channels to link n devices.

There are two techniques to transmit data over the Mesh topology, they are :

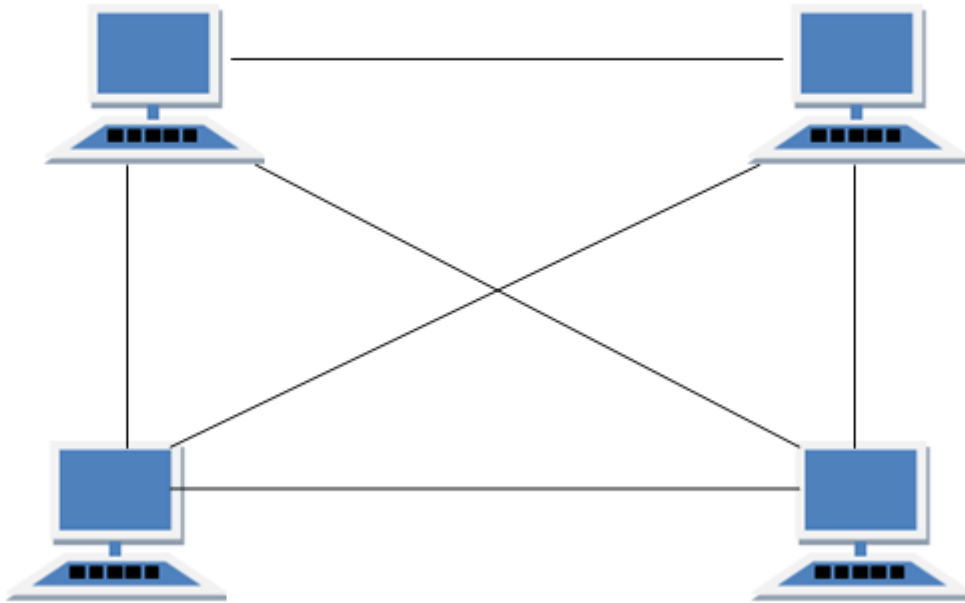
1. Routing
2. Flooding

MESH Topology: Routing

In routing, the nodes have a routing logic, as per the network requirements. Like routing logic to direct the data to reach the destination using the shortest distance. Or, routing logic which has information about the broken links, and it avoids those node etc. We can even have routing logic, to re-configure the failed nodes.

MESH Topology: Flooding

In flooding, the same data is transmitted to all the network nodes, hence no routing logic is required. The network is robust, and the its very unlikely to lose the data. But it leads to unwanted load over the network.



Types of Mesh Topology

1. **Partial Mesh Topology** : In this topology some of the systems are connected in the same fashion as mesh topology but some devices are only connected to two or three devices.
2. **Full Mesh Topology** : Each and every nodes or devices are connected to each other.

Features of Mesh Topology

1. Fully connected.
2. Robust.
3. Not flexible.

Advantages of Mesh Topology

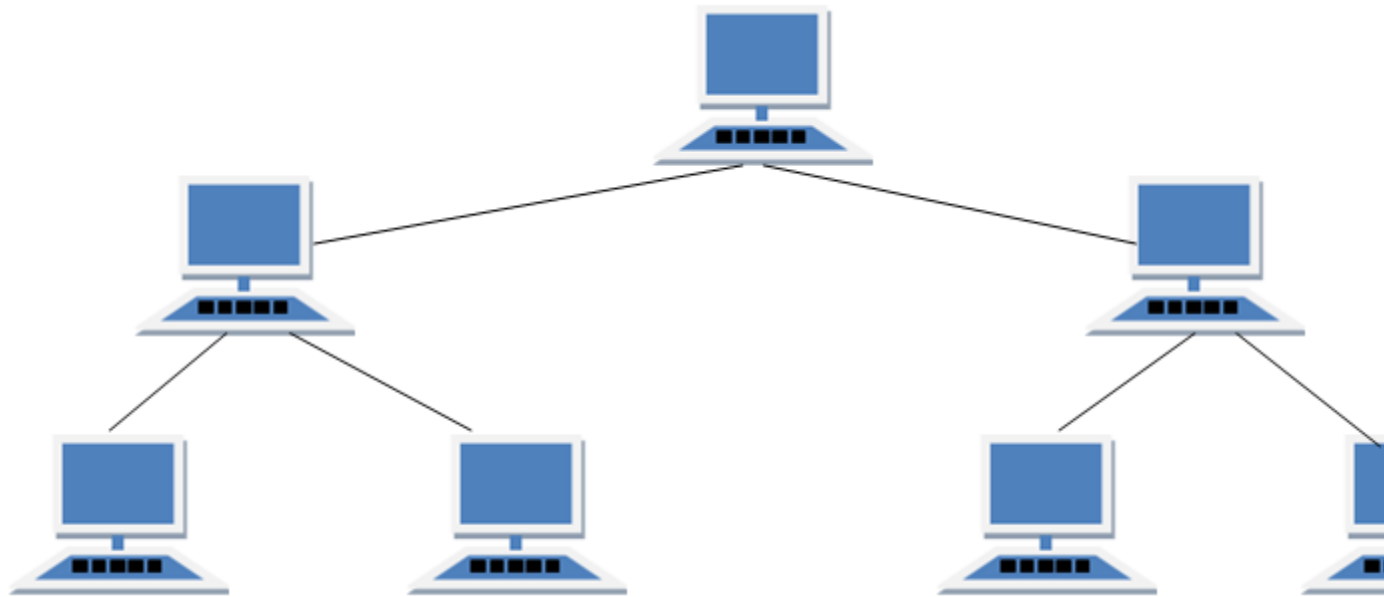
1. Each connection can carry its own data load.
2. It is robust.
3. Fault is diagnosed easily.
4. Provides security and privacy.

Disadvantages of Mesh Topology

1. Installation and configuration is difficult.
2. Cabling cost is more.
3. Bulk wiring is required.

TREE Topology

It has a root node and all other nodes are connected to it forming a hierarchy. It is also called hierarchical topology. It should at least have three levels to the hierarchy.



Features of Tree Topology

1. Ideal if workstations are located in groups.
2. Used in Wide Area Network.

Advantages of Tree Topology

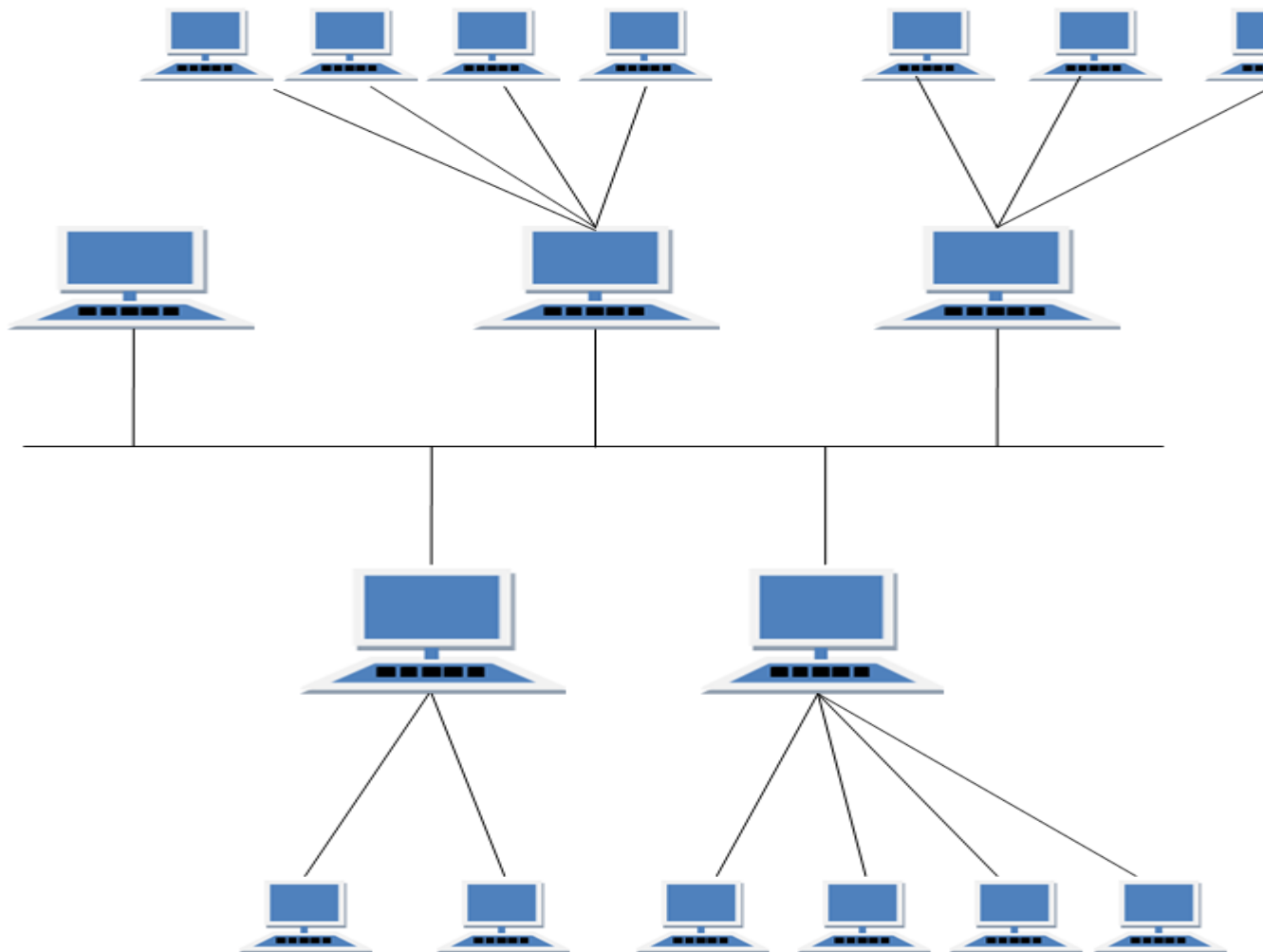
1. Extension of bus and star topologies.
2. Expansion of nodes is possible and easy.
3. Easily managed and maintained.
4. Error detection is easily done.

Disadvantages of Tree Topology

1. Heavily cabled.
2. Costly.
3. If more nodes are added maintenance is difficult.
4. Central hub fails, network fails.

HYBRID Topology

It is two different types of topologies which is a mixture of two or more topologies. For example if in an office in one department ring topology is used and in another star topology is used, connecting these topologies will result in Hybrid Topology (ring topology and star topology).



Features of Hybrid Topology

1. It is a combination of two or topologies
2. Inherits the advantages and disadvantages of the topologies included

Advantages of Hybrid Topology

1. Reliable as Error detecting and trouble shooting is easy.
2. Effective.
3. Scalable as size can be increased easily.
4. Flexible.

Disadvantages of Hybrid Topology

1. Complex in design.
2. Costly.

Types of Networks

Networks can be categorized depending on size, complexity, level of security, or geographical range. We will discuss some of the most popular topologies based on geographical spread.

PAN

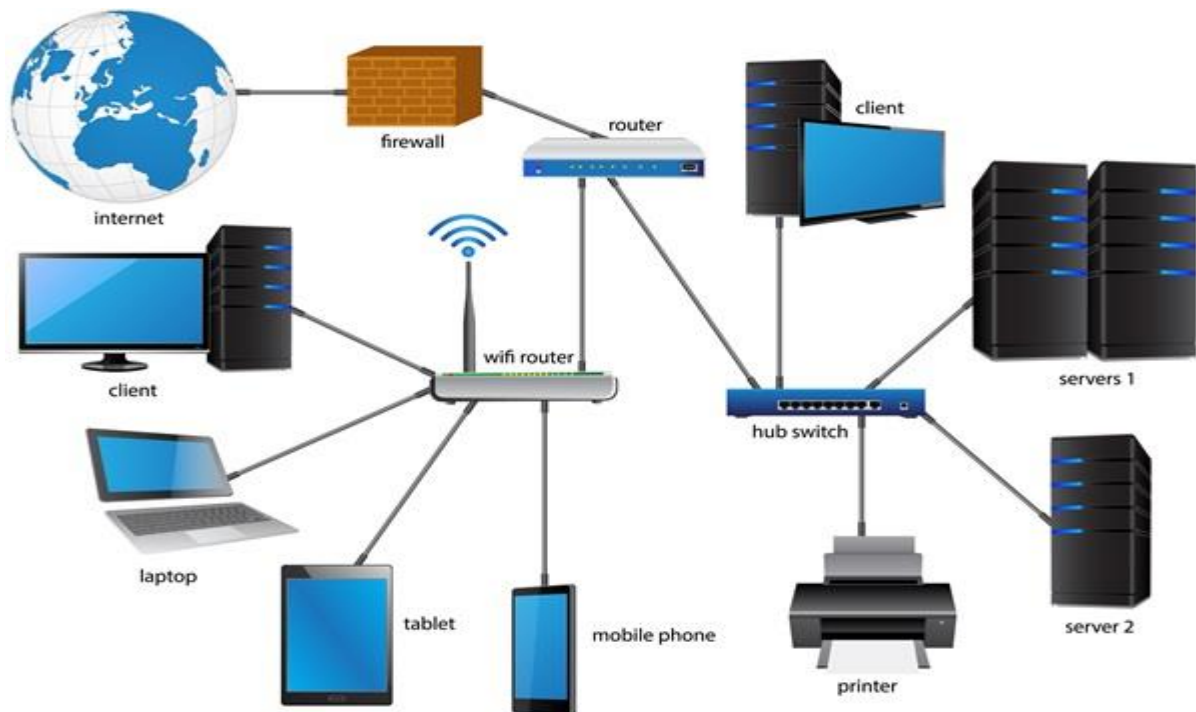
PAN is the acronym for Personal Area Network. PAN is the interconnection between devices within the range of a person's private space, typically within a range of 10 metres. If you have transferred images or songs from your laptop to mobile or from mobile to your friend's mobile using Bluetooth, you have set up and used a personal area network.



A person can connect her laptop, smart phone, personal digital assistant and portable printer in a network at home. This network could be fully Wi-Fi or a combination of wired and wireless.

LAN

LAN or Local Area Network is a wired network spread over a single site like an office, building or manufacturing unit. LAN is set up to when team members need to share software and hardware resources with each other but not with the outside world. Typical software resources include official documents, user manuals, employee handbook, etc. Hardware resources that can be easily shared over the network include printer, fax machines, modems, memory space, etc. This decreases infrastructure costs for the organization drastically.



A LAN may be set up using wired or wireless connections. A LAN that is completely wireless is called Wireless LAN or WLAN.

MAN

MAN is the acronym for Metropolitan Area Network. It is a network spread over a city, college campus or a small region. MAN is larger than a LAN and typically spread over several kilometres. Objective of MAN is to share hardware and software resources, thereby decreasing infrastructure costs. MAN can be built by connecting several LANs.

The most common example of MAN is cable TV network.

WAN

WAN or Wide Area Network is spread over a country or many countries. WAN is typically a network of many LANs, MANs and WANs. Network is set up using wired or wireless connections, depending on availability and reliability.

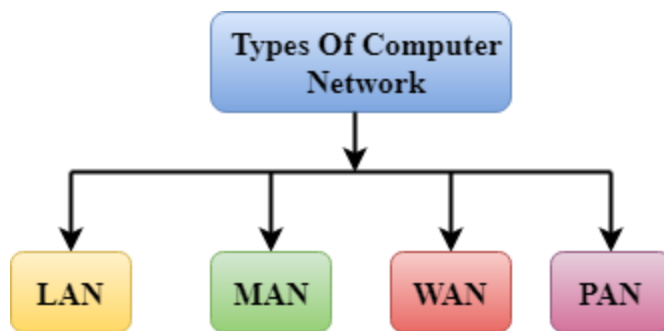


The most common example of WAN is the Internet.

Computer Network Types

A computer network is a group of computers linked to each other that enables the computer to communicate with another computer and share their resources, data, and applications.

A computer network can be categorized by their size. A **computer network** is mainly of **four types**:



- LAN(Local Area Network)
- PAN(Personal Area Network)
- MAN(Metropolitan Area Network)
- WAN(Wide Area Network)

LAN (Local Area Network)

- Local Area Network is a group of computers connected to each other in a small area such as building, office.
- LAN is used for connecting two or more personal computers through a communication medium such as twisted pair, coaxial cable, etc.
- It is less costly as it is built with inexpensive hardware such as hubs, network adapters, and ethernet cables.
- The data is transferred at an extremely faster rate in Local Area Network.
- Local Area Network provides higher security.



PAN (Personal Area Network)

- Personal Area Network is a network arranged within an individual person, typically within a range of 10 meters.
- Personal Area Network is used for connecting the computer devices of personal use is known as Personal Area Network.
- **Thomas Zimmerman** was the first research scientist to bring the idea of the Personal Area Network.
- Personal Area Network covers an area of **30 feet**.
- Personal computer devices that are used to develop the personal area network are the laptop, mobile phones, media player and play stations.



There are two types of Personal Area Network:

- Wired Personal Area Network
- Wireless Personal Area Network

Wireless Personal Area Network: Wireless Personal Area Network is developed by simply using wireless technologies such as WiFi, Bluetooth. It is a low range network.

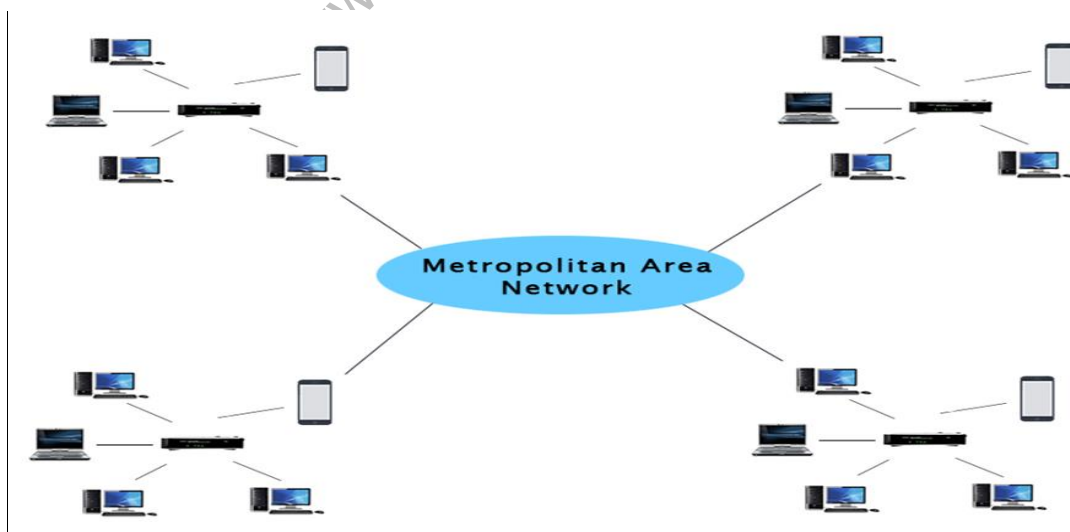
Wired Personal Area Network: Wired Personal Area Network is created by using the USB.

Examples Of Personal Area Network:

- **Body Area Network:** Body Area Network is a network that moves with a person. **For example**, a mobile network moves with a person. Suppose a person establishes a network connection and then creates a connection with another device to share the information.
- **Offline Network:** An offline network can be created inside the home, so it is also known as a **home network**. A home network is designed to integrate the devices such as printers, computer, television but they are not connected to the internet.
- **Small Home Office:** It is used to connect a variety of devices to the internet and to a corporate network using a VPN

MAN(Metropolitan Area Network)

- A metropolitan area network is a network that covers a larger geographic area by interconnecting a different LAN to form a larger network.
- Government agencies use MAN to connect to the citizens and private industries.
- In MAN, various LANs are connected to each other through a telephone exchange line.
- The most widely used protocols in MAN are RS-232, Frame Relay, ATM, ISDN, OC-3, ADSL, etc.
- It has a higher range than Local Area Network(LAN).

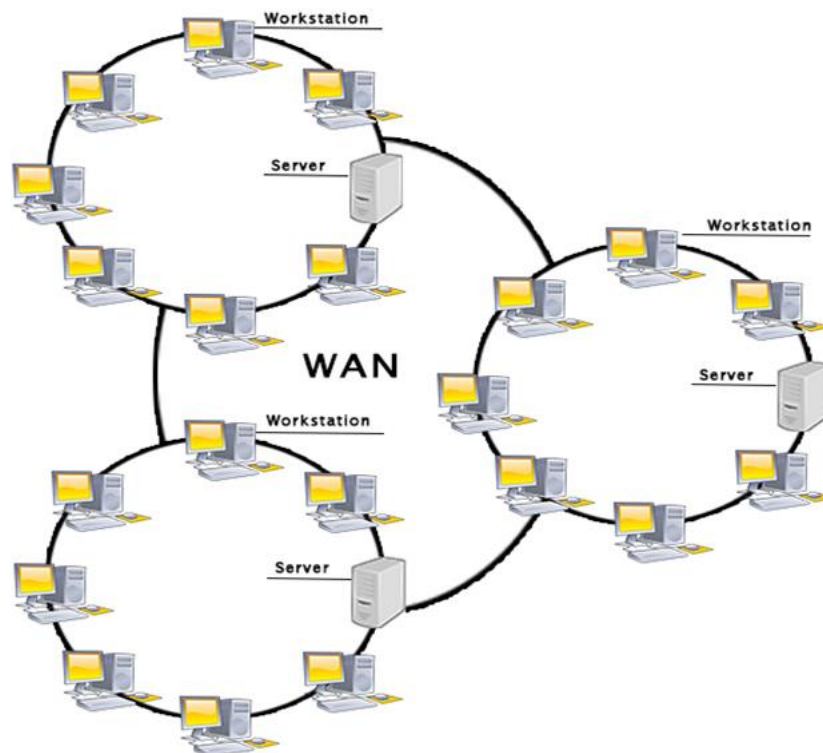


Uses Of Metropolitan Area Network:

- MAN is used in communication between the banks in a city.
- It can be used in an Airline Reservation.
- It can be used in a college within a city.
- It can also be used for communication in the military.

WAN(Wide Area Network)

- A Wide Area Network is a network that extends over a large geographical area such as states or countries.
- A Wide Area Network is quite bigger network than the LAN.
- A Wide Area Network is not limited to a single location, but it spans over a large geographical area through a telephone line, fibre optic cable or satellite links.
- The internet is one of the biggest WAN in the world.
- A Wide Area Network is widely used in the field of Business, government, and education.



Examples Of Wide Area Network:

- **Mobile Broadband:** A 4G network is widely used across a region or country.
- **Last mile:** A telecom company is used to provide the internet services to the customers in hundreds of cities by connecting their home with fiber.
- **Private network:** A bank provides a private network that connects the 44 offices. This network is made by using the telephone leased line provided by the telecom company.

Advantages Of Wide Area Network:

Following are the advantages of the Wide Area Network:

- **Geographical area:** A Wide Area Network provides a large geographical area. Suppose if the branch of our office is in a different city then we can connect with them through WAN. The internet provides a leased line through which we can connect with another branch.
- **Centralized data:** In case of WAN network, data is centralized. Therefore, we do not need to buy the emails, files or back up servers.
- **Get updated files:** Software companies work on the live server. Therefore, the programmers get the updated files within seconds.
- **Exchange messages:** In a WAN network, messages are transmitted fast. The web application like Face book, Whatsapp, Skype allows you to communicate with friends.
- **Sharing of software and resources:** In WAN network, we can share the software and other resources like a hard drive, RAM.
- **Global business:** We can do the business over the internet globally.
- **High bandwidth:** If we use the leased lines for our company then this gives the high bandwidth. The high bandwidth increases the data transfer rate which in turn increases the productivity of our company.

Disadvantages of Wide Area Network:

The following are the disadvantages of the Wide Area Network:

- **Security issue:** A WAN network has more security issues as compared to LAN and MAN network as all the technologies are combined together that creates the security problem.
- **Needs Firewall & antivirus software:** The data is transferred on the internet which can be changed or hacked by the hackers, so the firewall needs to be used. Some people can inject the virus in our system so antivirus is needed to protect from such a virus.
- **High Setup cost:** An installation cost of the WAN network is high as it involves the purchasing of routers, switches.
- **Troubleshooting problems:** It covers a large area so fixing the problem is difficult.

Network Devices (Hub, Repeater, Bridge, Switch, Router, Gateways and router)

1. Repeater – A repeater operates at the physical layer. Its job is to regenerate the signal over the same network before the signal becomes too weak or corrupted so as to extend the length to which the signal can be transmitted over the same network. An important point to be noted about repeaters is that they do not amplify the signal. When the signal becomes weak, they copy the signal bit by bit and regenerate it at the original strength. It is a 2 port device.

2. Hub:-A hub is basically a multiport repeater. A hub connects multiple wires coming from different branches, for example, the connector in star topology which connects different stations. Hubs cannot filter data, so data packets are sent to all connected devices. In other words, collision domain of all hosts connected through Hub remains one. Also, they do not have intelligence to find out best path for data packets which leads to inefficiencies and wastage.

Types of Hub

- **Active Hub**:- These are the hubs which have their own power supply and can clean, boost and relay the signal along the network. It serves both as a repeater as well as wiring center. These are used to extend maximum distance between nodes.
- **Passive Hub**:- These are the hubs which collect wiring from nodes and power supply from active hub. These hubs relay signals onto the network without cleaning and boosting them and can't be used to extend distance between nodes.

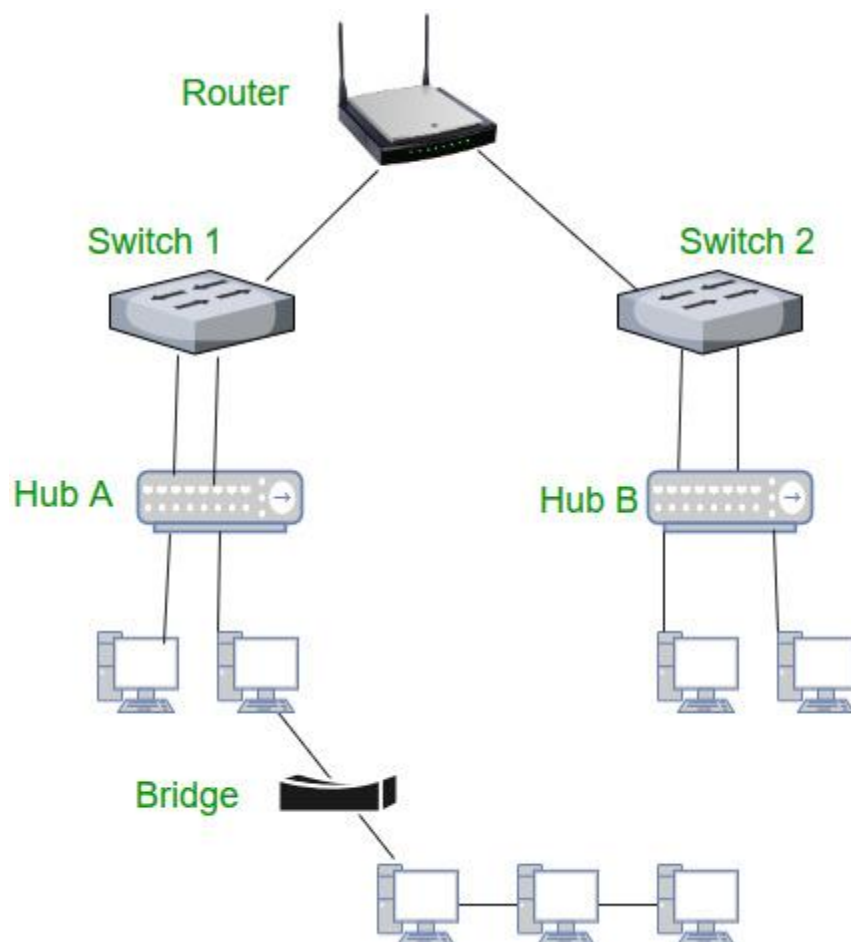
3. Bridge :-A bridge operates at data link layer. A bridge is a repeater, with add on functionality of filtering content by reading the MAC addresses of source and destination. It is also used for interconnecting two LANs working on the same protocol. It has a single input and single output port, thus making it a 2 port device.

Types of Bridges

- **Transparent Bridges**:- These are the bridge in which the stations are completely unaware of the bridge's existence i.e. whether or not a bridge is added or deleted from the network, reconfiguration of the stations is unnecessary. These bridges make use of two processes i.e. bridge forwarding and bridge learning.
- **Source Routing Bridges**:- In these bridges, routing operation is performed by source station and the frame specifies which route to follow. The host can discover frame by sending a special frame called discovery frame, which spreads through the entire network using all possible paths to destination.

4. Switch:-A switch is a multi port bridge with a buffer and a design that can boost its efficiency (large number of ports imply less traffic) and performance. Switch is data link layer device. Switch can perform error checking before forwarding data, that makes it very efficient as it does not forward packets that have errors and forward good packets selectively to correct port only. In other words, switch divides collision domain of hosts, but [broadcast domain](#) remains same.

5. Routers :-A router is a device like a switch that routes data packets based on their IP addresses. Router is mainly a Network Layer device. Routers normally connect LANs and WANs together and have a dynamically updating routing table based on which they make decisions on routing the data packets. Router divide broadcast domains of hosts connected through it.



6. Gateway :-A gateway, as the name suggests, is a passage to connect two networks together that may work upon different networking models. They basically work as the messenger agents

that take data from one system, interpret it, and transfer it to another system. Gateways are also called protocol converters and can operate at any network layer. Gateways are generally more complex than switch or router.

6. **Brouter** – It is also known as bridging router is a device which combines features of both bridge and router. It can work either at data link layer or at network layer. Working as router, it is capable of routing packets across networks and working as bridge, it is capable of filtering local area network traffic.

Types of networks

The **Network** allows computers to **connect and communicate** with different computers via any medium. LAN, MAN and WAN are the three major types of the network designed to operate over the area they cover. There are some similarities and dissimilarities between them. One of the major differences is the geographical area they cover, i.e. **LAN** covers the smallest area; **MAN** covers an area larger than LAN and **WAN** comprises the largest of all.

LAN (Local Area Network)

- Local Area Network is a group of computers connected to each other in a small area such as building, office.
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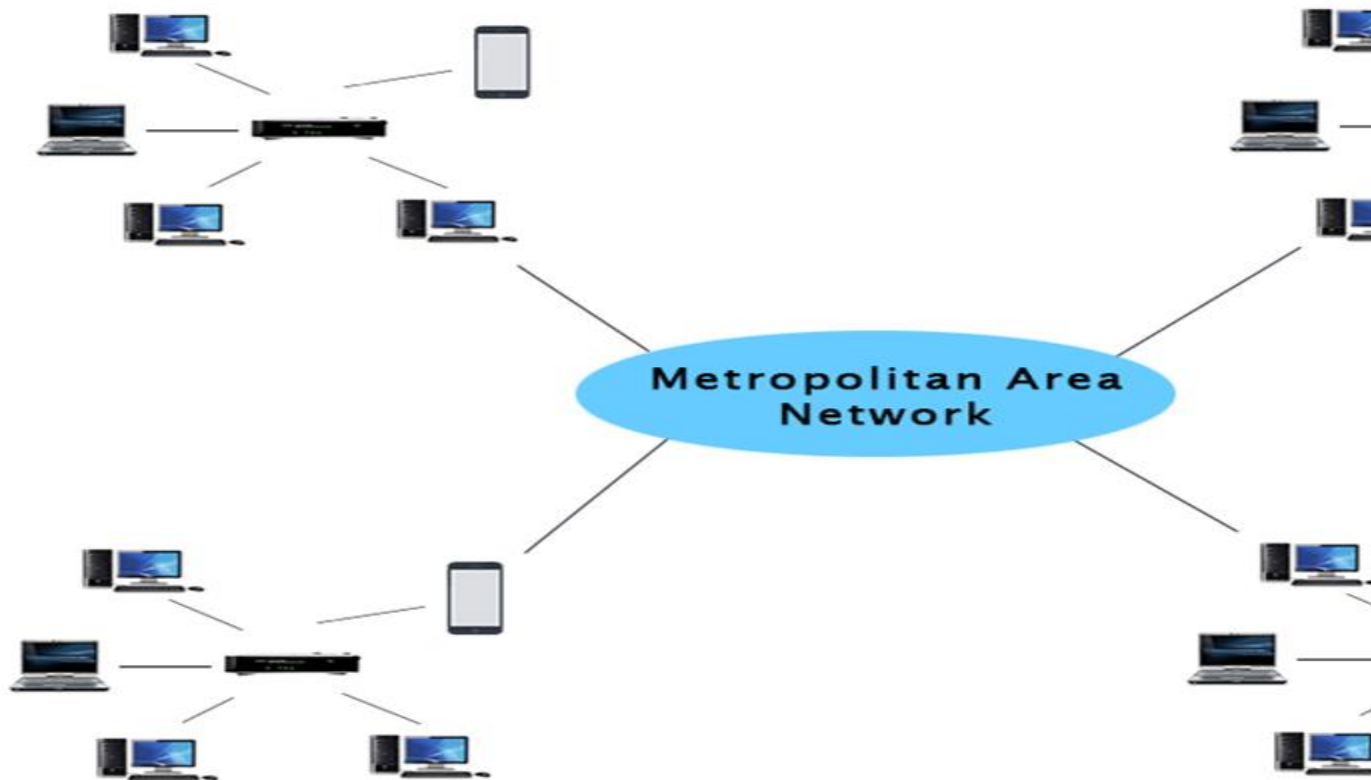
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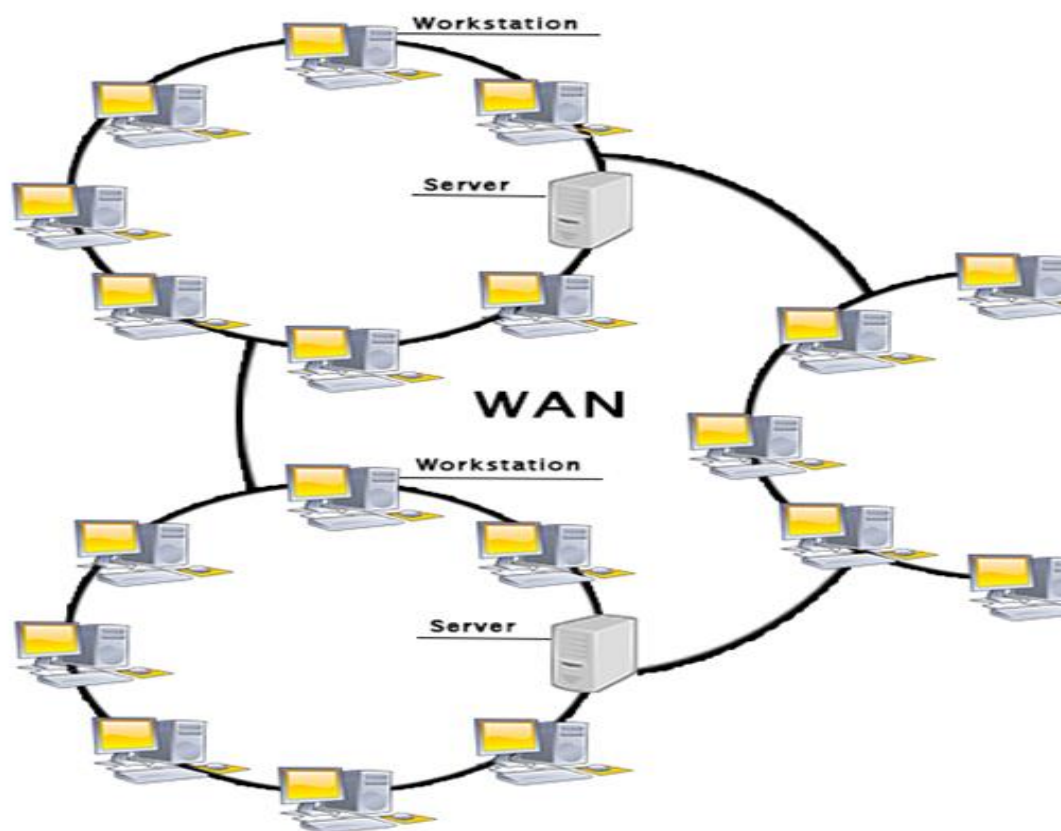


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Introduction of Operating System

An operating system acts as an intermediary between the user of a computer and computer hardware. The purpose of an operating system is to provide an environment in which a user can execute programs in a convenient and efficient manner.

An operating system is a software that manages the computer hardware. The hardware must provide appropriate mechanisms to ensure the correct operation of the computer system and to prevent user programs from interfering with the proper operation of the system.

Operating System – Definition:

- An operating system is a program that controls the execution of application programs and acts as an interface between the user of a computer and the computer hardware.
- A more common definition is that the operating system is the one program running at all times on the computer (usually called the kernel), with all else being application programs.
- An operating system is concerned with the allocation of resources and services, such as memory, processors, devices, and information. The operating system correspondingly includes programs to manage these resources, such as a traffic controller, a scheduler, memory management module, I/O programs, and a file system.

Functions of Operating system – Operating system performs three functions:

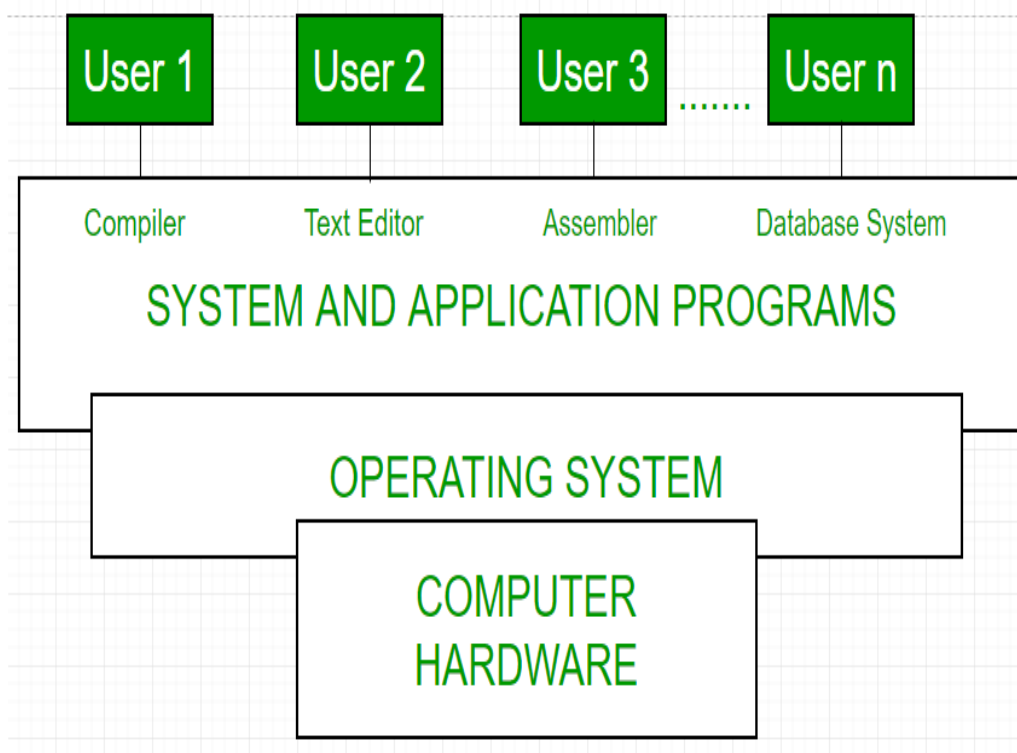
1. **Convenience:** An OS makes a computer more convenient to use.
2. **Efficiency:** An OS allows the computer system resources to be used in an efficient manner.
3. **Ability to Evolve:** An OS should be constructed in such a way as to permit the effective development, testing and introduction of new system functions at the same time without interfering with service.

Operating system as User Interface –

1. User
2. System and application programs
3. Operating system
4. Hardware

Every general-purpose computer consists of the hardware, operating system, system programs, and application programs. The hardware consists of memory, CPU, ALU, and I/O devices, peripheral device, and storage device. System program consists of compilers,

loaders, editors, OS, etc. The application program consists of business programs, database programs.



Every computer must have an operating system to run other programs. The operating system coordinates the use of the hardware among the various system programs and application programs for various users. It simply provides an environment within which other programs can do useful work.

The operating system is a set of special programs that run on a computer system that allows it to work properly. It performs basic tasks such as recognizing input from the keyboard, keeping track of files and directories on the disk, sending output to the display screen and controlling peripheral devices.

OS is designed to serve two basic purposes:

1. It controls the allocation and use of the computing System's resources among the various user and tasks.
2. It provides an interface between the computer hardware and the programmer that simplifies and makes feasible for coding, creation, debugging of application programs.

The Operating system must support the following tasks. The task are:

1. Provides the facilities to create, modification of programs and data files using an editor.
2. Access to the compiler for translating the user program from high level language to machine language.
3. Provide a loader program to move the compiled program code to the computer's memory for execution.

4. Provide routines that handle the details of I/O programming.

I/O System Management

The module that keeps track of the status of devices is called the I/O traffic controller. Each I/O device has a device handler that resides in a separate process associated with that device. The I/O subsystem consists of

- A memory Management component that includes buffering caching and spooling.
- A general device driver interface.

Drivers for specific hardware devices.

Assembler

The input to an assembler is an assembly language program. The output is an object program plus information that enables the loader to prepare the object program for execution. At one time, the computer programmer had at his disposal a basic machine that interpreted, through hardware, certain fundamental instructions. He would program this computer by writing a series of ones and Zeros (Machine language), place them into the memory of the machine.

Compiler

The High-level languages- examples are FORTRAN, COBOL, ALGOL and PL/I are processed by compilers and interpreters. A compiler is a program that accepts a source program in a “high-level language “and produces a corresponding object program. An interpreter is a program that appears to execute a source program as if it was machine language. The same name (FORTRAN, COBOL, etc.) is often used to designate both a compiler and its associated language.

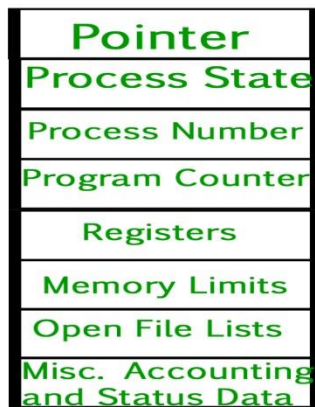
Loader

A Loader is a routine that loads an object program and prepares it for execution. There are various loading schemes: absolute, relocating and direct-linking. In general, the loader must load, relocate and link the object program. The loader is a program that places programs into memory and prepares them for execution. In a simple loading scheme, the assembler outputs the machine language translation of a program on a secondary device and a loader places it in the core. The loader places into memory the machine language version of the user’s program and transfers control to it. Since the loader program is much smaller than the assembler, those make more core available to the user’s program.

Process Table and Process Control Block (PCB)

While creating a process the operating system performs several operations. To identify these process, it must identify each process, hence it assigns a process identification number (PID) to each process. As the operating system supports multi-programming, it needs to keep track of all the processes. For this task, the process control block (PCB) is used to track the process’s execution status. Each block of memory contains information about the process state, program counter, stack pointer, status of opened files, scheduling algorithms, etc. All these information is required and must be saved when the process is switched from one state to another. When the process made transitions from one state to another, the operating system must update information in the process’s PCB.

A process control block (PCB) contains information about the process, i.e. registers, quantum, priority, etc. The process table is an array of PCB's, that means logically contains a PCB for all of the current processes in the system.



Process Control Block

- **Pointer** – It is a stack pointer which is required to be saved when the process is switched from one state to another to retain the current position of the process.
- **Process state** – It stores the respective state of the process.
- **Process number** – Every process is assigned with a unique id known as process ID or PID which stores the process identifier.
- **Program counter** – It stores the counter which contains the address of the next instruction that is to be executed for the process.
- **Register** – These are the CPU registers which includes: accumulator, base, registers and general purpose registers.
- **Memory limits** – This field contains the information about memory management system used by operating system. This may include the page tables, segment tables etc.
- **Open files list** – This information includes the list of files opened for a process.

There are many operations that can be performed on processes. Some of these are process creation, process preemption, process blocking, and process termination. These are given in detail as follows:

PROCESS OPERATIONS

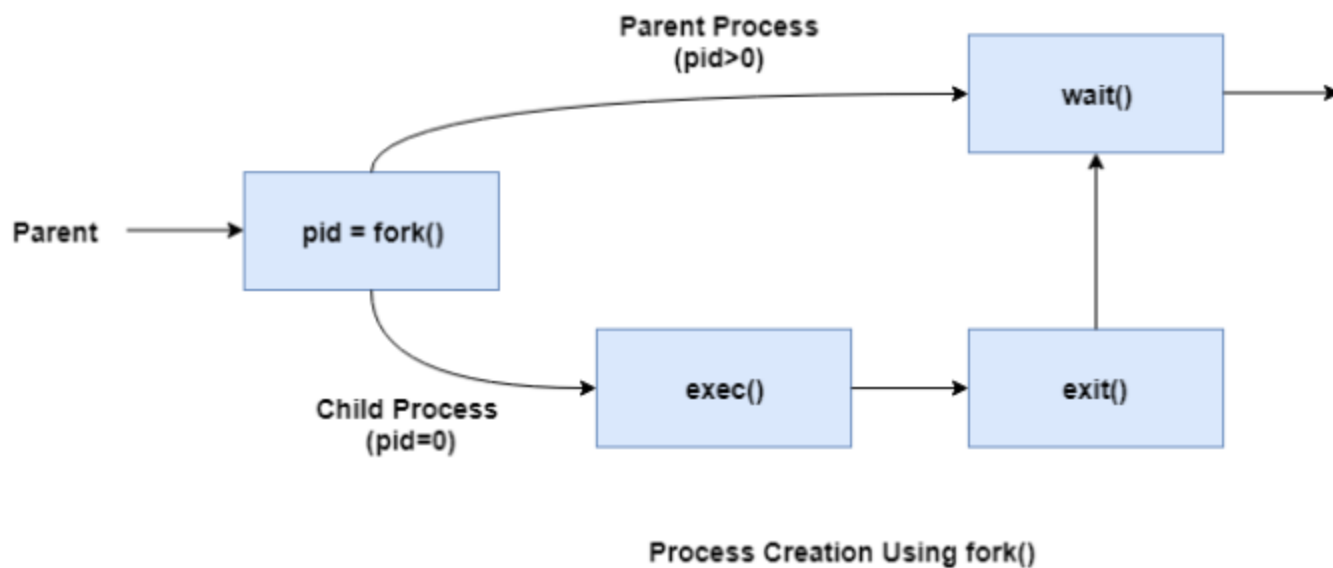
Process Creation

Processes need to be created in the system for different operations. This can be done by the following events:

- User request for process creation
- System initialization
- Execution of a process creation system call by a running process
- Batch job initialization

A process may be created by another process using `fork()`. The creating process is called the parent process and the created process is the child process. A child process can have only one parent but a parent process may have many children. Both the parent and child processes have the same memory image, open files, and environment strings. However, they have distinct address spaces.

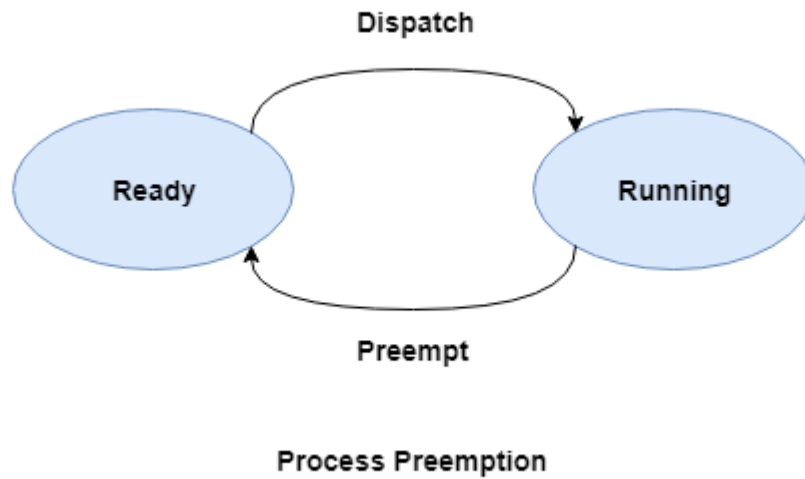
A diagram that demonstrates process creation using `fork()` is as follows:



Process Preemption

An interrupt mechanism is used in preemption that suspends the process executing currently and the next process to execute is determined by the short-term scheduler. Preemption makes sure that all processes get some CPU time for execution.

A diagram that demonstrates process preemption is as follows:

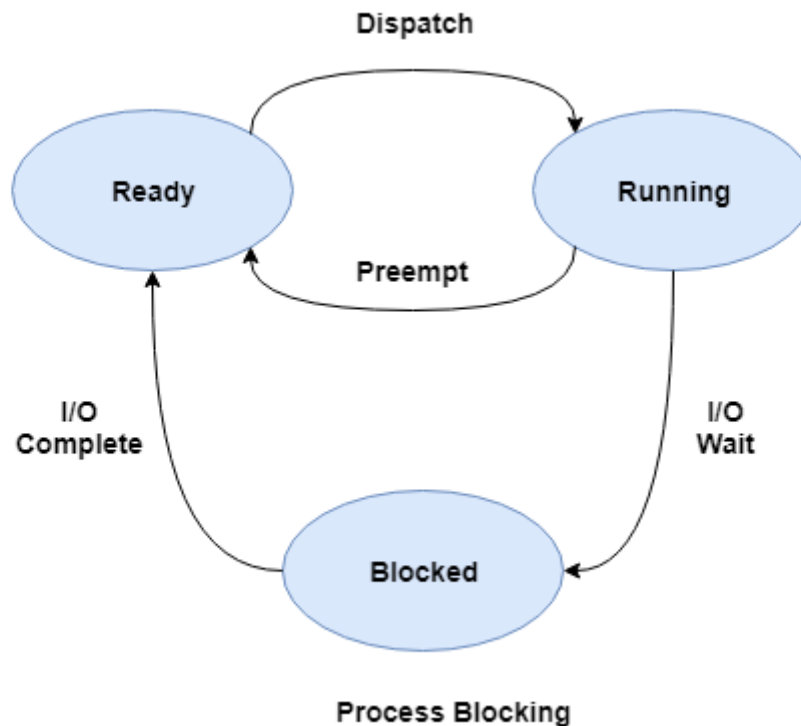


Process Blocking

The process is blocked if it is waiting for some event to occur. This event may be I/O as the I/O events are executed in the main memory and don't require the processor. After the event is complete, the process again goes to the ready state.

A diagram that demonstrates process blocking is as follows:

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Process Termination

After the process has completed the execution of its last instruction, it is terminated. The resources held by a process are released after it is terminated.

A child process can be terminated by its parent process if its task is no longer relevant. The child process sends its status information to the parent process before it terminates. Also, when a parent process is terminated, its child processes are terminated as well as the child processes cannot run if the parent processes are terminated.

Definition

The process scheduling is the activity of the process manager that handles the removal of the running process from the CPU and the selection of another process on the basis of a particular strategy.

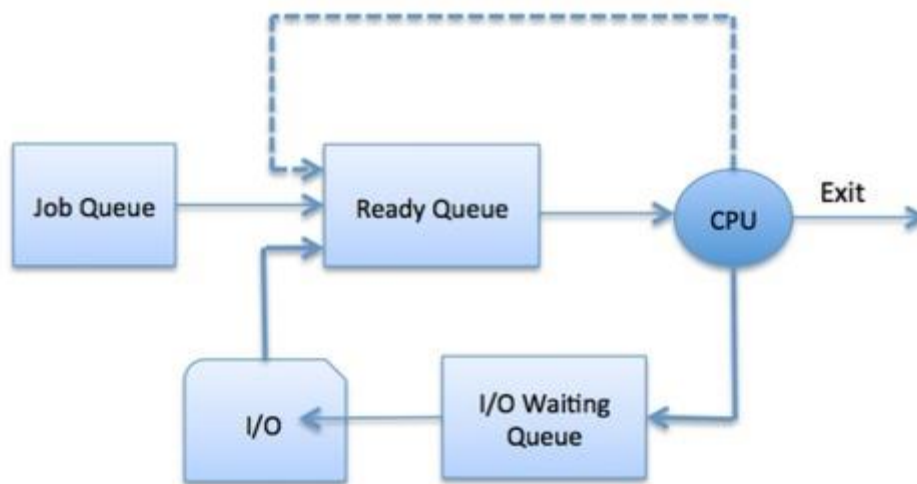
Process scheduling is an essential part of a Multiprogramming operating systems. Such operating systems allow more than one process to be loaded into the executable memory at a time and the loaded process shares the CPU using time multiplexing.

Process Scheduling

The OS maintains all PCBs in Process Scheduling Queues. The OS maintains a separate queue for each of the process states and PCBs of all processes in the same execution state are placed in the same queue. When the state of a process is changed, its PCB is unlinked from its current queue and moved to its new state queue.

The Operating System maintains the following important process scheduling queues –

- **Job queue** – This queue keeps all the processes in the system.
- **Ready queue** – This queue keeps a set of all processes residing in main memory, ready and waiting to execute. A new process is always put in this queue.
- **Device queues** – The processes which are blocked due to unavailability of an I/O device constitute this queue.



The OS can use different policies to manage each queue (FIFO, Round Robin, Priority, etc.). The OS scheduler determines how to move processes between the ready and run queues which can only have one entry per processor core on the system; in the above diagram, it has been merged with the CPU.

Schedulers

Schedulers are special system software which handle process scheduling in various ways. Their main task is to select the jobs to be submitted into the system and to decide which process to run. Schedulers are of three types –

- Long-Term Scheduler
- Short-Term Scheduler
- Medium-Term Scheduler

Long Term Scheduler

It is also called a **job scheduler**. A long-term scheduler determines which programs are admitted to the system for processing. It selects processes from the queue and loads them into memory for execution. Process loads into the memory for CPU scheduling.

The primary objective of the job scheduler is to provide a balanced mix of jobs, such as I/O bound and processor bound. It also controls the degree of multiprogramming. If the degree of multiprogramming is stable, then the average rate of process creation must be equal to the average departure rate of processes leaving the system.

On some systems, the long-term scheduler may not be available or minimal. Time-sharing operating systems have no long term scheduler. When a process changes the state from new to ready, then there is use of long-term scheduler.

Short Term Scheduler

It is also called as **CPU scheduler**. Its main objective is to increase system performance in accordance with the chosen set of criteria. It is the change of ready state to running state of the process. CPU scheduler selects a process among the processes that are ready to execute and allocates CPU to one of them.

Short-term schedulers, also known as dispatchers, make the decision of which process to execute next. Short-term schedulers are faster than long-term schedulers.

Medium Term Scheduler

Medium-term scheduling is a part of **swapping**. It removes the processes from the memory. It reduces the degree of multiprogramming. The medium-term scheduler is in-charge of handling the swapped out-processes.

A running process may become suspended if it makes an I/O request. A suspended processes cannot make any progress towards completion. In this condition, to remove the process from memory and make space for other processes, the suspended process is moved to the secondary storage. This process is called **swapping**, and the process is said to be swapped out or rolled out. Swapping may be necessary to improve the process mix.

Comparison among Scheduler

S.N.	Long-Term Scheduler	Short-Term Scheduler	Medium-Term Scheduler
1	It is a job scheduler	It is a CPU scheduler	It is a process swapping scheduler.
2	Speed is lesser than short term	Speed is fastest among other	Speed is in between both short

	scheduler	two	and long term scheduler.
3	It controls the degree of multiprogramming	It provides lesser control over degree of multiprogramming	It reduces the degree of multiprogramming.
4	It is almost absent or minimal in time sharing system	It is also minimal in time sharing system	It is a part of Time sharing systems.
5	It selects processes from pool and loads them into memory for execution	It selects those processes which are ready to execute	It can re-introduce the process into memory and execution can be continued.

Command interpreter

A command interpreter is the part of a computer operating system that understands and executes commands that are entered interactively by a human being or from a program. In some operating systems, the command interpreter is called the shell.

A command interpreter allows the user to interact with a program using commands in the form of text lines. It was frequently used until the 1970's. However, in modern times many command interpreters are replaced by graphical user interfaces and menu-driven interfaces.

Purpose of Command Interpreters

Command interpreters serve many purposes and are more useful than graphical user interfaces in some cases. Details about these cases are given as follows:

- Command interpreters have a large range of commands and queries available for different operations. Also, it is much faster to type than to click as is done using graphical user interfaces..
- There are some systems that don't have enough resources to support graphical user interfaces. In those cases, command interpreters can be used.
- Scientists and engineers often used command interpreters in scientific environments. Technically advanced users also prefer command interpreters as compared to graphical user interfaces.
- People with visual disabilities use command interpreters as they cannot work with graphical user interfaces. Commands and instructions can be displayed using braille displays in command interpreters.

Modern use of Command Interpreters

Many advanced users use powerful command interpreters even though graphical user interfaces are more common. Some of the systems where command interpreters are used are:

- PHP has a shell for interactive use which is called php-cli.
- Ruby has command shell for interactive use.
- Some Linux distributions have the bash implementation of the Unix shell.
- Junos and Cisco IOS routers are configured using command line interpreters.
- Windows has Windows Command Prompt with a CLI environment.

An operating system is the fundamental basis of all other application programs. Operating system is an intermediary between the users and the hardware.

Operating system controls and coordinates the use of hardware among application programs. The major services of an operating system are –

- Memory management
- Disk access
- Creating user interface
- Managing the different programs operating parallel
- Likewise, it controls and manage the hardware's working

Applications of Operating System

Following are the major *applications* of an operating system –

- An operating system is accountable for the formation and deletion of files and directories.
- An operating system manages the process of deletion, suspension, resumption, and synchronization.
- An operating system manages memory space by allocation and de-allocation.
- An operating system stores, organizes, and names and protects the existing files.
- Further, an operating system manages all the components and devices of the computers system including modems, printers, plotters, etc.
- In case, if any device fails, the operating system detects and notify.
- An operating system protects from destruction as well as from unauthorized use.
- An operating system facilitates the interface to user and hardware.

Popular operating systems

Types of Operating System:-Following are the major types of operating system

- Disk Operating System (DOS)
- Windows Operating System
- Unix Operating System

Let us now discuss each operating system in detail.

Disk Operating System:-

MS-DOS is one of the oldest and widely used operating system. DOS is a set of computer programs, the major functions of which are file management, allocation of system resources, providing essential features to control hardware devices.

DOS commands can be typed in either upper case or lower case.

Features of DOS

Following are the significant features of DOS

- It is a single user system.
- It controls program.
- It is machine independence.
- It manages (computer) files.
- It manages input and output system.
- It manages (computer) memory.
- It provides command processing facilities.
- It operates with Assembler.

Types of DOS Commands

Following are the major types of DOS Command –

- **Internal Commands** – Commands such as DEL, COPY, TYPE, etc. are the internal commands that remain stored in computer memory.
- **External Commands** – Commands like FORMAT, DISKCOPY, etc. are the external commands and remain stored on the disk.

Windows Operating System:-

The operating system window is the extension of the disk operating system.

It is the most popular and simplest operating system; it can be used by any person who can read and understand basic English, as it does not require any special training.

However, the Windows Operating System requires DOS to run the various application programs initially. Because of this reason, DOS should be installed into the memory and then window can be executed.

Elements of Windows OS

Following are the significant element of Windows Operating System (WOS) –

- Graphical User Interface
- Icons (pictures, documents, application, program icons, etc.)
- Taskbar
- Start button
- Windows explorer
- Mouse button
- Hardware compatibility
- Software compatibility
- Help, etc.

Versions of Windows Operating System

Following are the different versions of Windows Operating System –

Version	Year	Version	Year
Window 1.01	1985	Windows XP Professional x64	2005
Windows NT 3.1	1993	Windows Vista	2007
Windows 95	1995	Windows 7	2009
Windows 98	1998	Windows 8	2012
Windows 2000	2000	Windows 10	2015
Windows ME	2000	Windows Server 2016	2016

Windows XP	2001		
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UNIX Operating System:-

The Unix Operating System is the earliest operating system developed in 1970s. Let us consider the following points relating to the Unix Operating System –

- It is an operating system that has multitasking features.
- It has multiuser computer operating systems.
- It runs practically on every sort of hardware and provides stimulus to the open source movement.
- It has comparative complex functionality and hence an untrained user cannot use it; only the one who has taken training can use this system.
- Another drawback of this system is, it does not give notice or warn about the consequences of a user's action (whether user's action is right or wrong).

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