FUNDAMENTAL OF COMPUTERS
&
EMERGING TECHNOLOGIES

KCA-101

Contents of Unit-2

- Operating System: Definition
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What is an 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 conveniently and efficiently.

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.

QUIZ 2.1

What is an operating system?

A. Interface between the hardware and application programs
B. Collection of programs that manages hardware resources
C. System service provider to the application programs
D. All of the mentioned

The main memory accommodates _____

A. CPU
B. User Processes
C. Operating System
D. All of the mentioned

Functions of Operating System

Important functions of an Operating System

1. Memory Management
2. Processor Management
3. Device Management
4. File Management
5. Security
6. Job Accounting
7. Error Detection
8. Coordination between other software and users

Memory Management

Memory management is the functionality of an operating system which handles or manages primary memory and moves processes back and forth between main memory and disk during execution. Memory management keeps track of each and every memory location, regardless of either it is allocated to some process, or it is free. It checks how much memory is to be allocated to processes. It decides which process will get memory at what time. It tracks whenever some memory gets freed or unallocated and correspondingly it updates the status.

Processor Management: A program in execution is called a process. In case of multiprogramming environment system gets multiple programs for execution and operating system has to decide which program should be send to CPU for execution and for how much time. This process is called as process scheduling in which operating system decide which process needs to get into the CPU for execution and how much time span is required. Assigning and de-assigning of process is charge of operating system. CPU can execute one single process at a time, so its selection is done by operating system. Operating system use a separate program to hold the status of processor to provide information about is it free or busy in process execution. Traffic controller is used to keep processor's status information. In case of processor management operating system perform the activities

- It keeps the track of processor status and processor itself. (The program which is responsible for this task is called as traffic controller)
- Allocates the processor or CPU to a Process.
- Deallocates the processor or CPU by a process.

Device Management

There are several resources controlled by the operating system which can be supposed of as devices, some of these are physical devices for example tapes and some are taken as virtual or abstract devices for example files. In case if there are multiple users of the system then the system may require to first request the device to confirm exclusive use of it. After implementation of the task for which the device was required will release it. Operating system performs the following activates to manage the devices

- It decides that which process and when gets the device for how much time.
- It holds track of all the devices, I/O controller is used to perform this task.
- It allocates the devices in convenient and efficient manner.
- Deallocate the devices which are no longer required for a task.

File Management

A file system is organized into directories for efficient or easy navigation and usage. These directories may contain other directories and other files. An Operating System carries out the following file management activities. It keeps track of where information is stored, user access settings and status of every file, and more… These facilities are collectively known as the file system.

Security

The operating system uses password protection to protect user data and similar other techniques. it also prevents unauthorized access to programs and user data.

Job accounting

Operating system Keeps track of time and resources used by various tasks and users, this information can be used to track resource usage for a particular user or group of users.

Error detecting aids

The operating system is constantly required to be aware of possible errors. The errors can occur in memory, CPU, I/O devices or in the user program. Operating system must take the proper action to ensure correct and reliable computing against each type of error.

Coordination between other software and users

Operating systems also coordinate and assign interpreters, compilers, assemblers, and other software to the various users of the computer systems.

Operating System Services

Operating System Services

An operating system provides certain services to programs and the users of those programs.

1. **Program Execution**: The system must be capable to load the program into main memory for its execution. The program must be capable to end its execution.
2. **I/O Operations**: A program may require I/O for its execution, these I/O can be a file or device. For specific device may be a specific function is required. For the concern of protection and efficiency user usually cannot directly control the I/O devices. Therefor operating system should provide some means to do I/O operations.

3. **Communication:** In many cases process need to exchange information with another process. This communication can occur in two major ways. First one tack places between processes executing on the same computer, second one take places between processes executing on the different computers that are connected via a computer network. Communication can be implemented using shared memory or by message passing technique in which packets of information are moved between processes by the operating system.

QUIZ 2.2

Which of the following is not an important functions of an operating System?

A. Memory Management
B. File Management
C. Virus Protection
D. Processor Management

In OS, Memory management refers to management of?

A. Primary Memory
B. Main Memory
C. Secondary Memory
D. Both A and B

In multiprogramming environment, the OS decides which process gets the processor when and for how much time. This function is called _____.

A. process scheduling
B. process rescheduling
C. traffic controller
D. Processor Management

Keeps tracks of processor and status of process. The program responsible for this task is known as?

A. track manager
B. processor controller
C. traffic manager
D. traffic controller

What does I/O controller do?

A. Keeps tracks of primary memory
B. Keeps tracks of all devices
C. Keeps tracks of processes
D. All of the above

What does file system do?

A. Keeps track of information
B. Keeps track of location
C. Keeps track of information status
D. All of the above

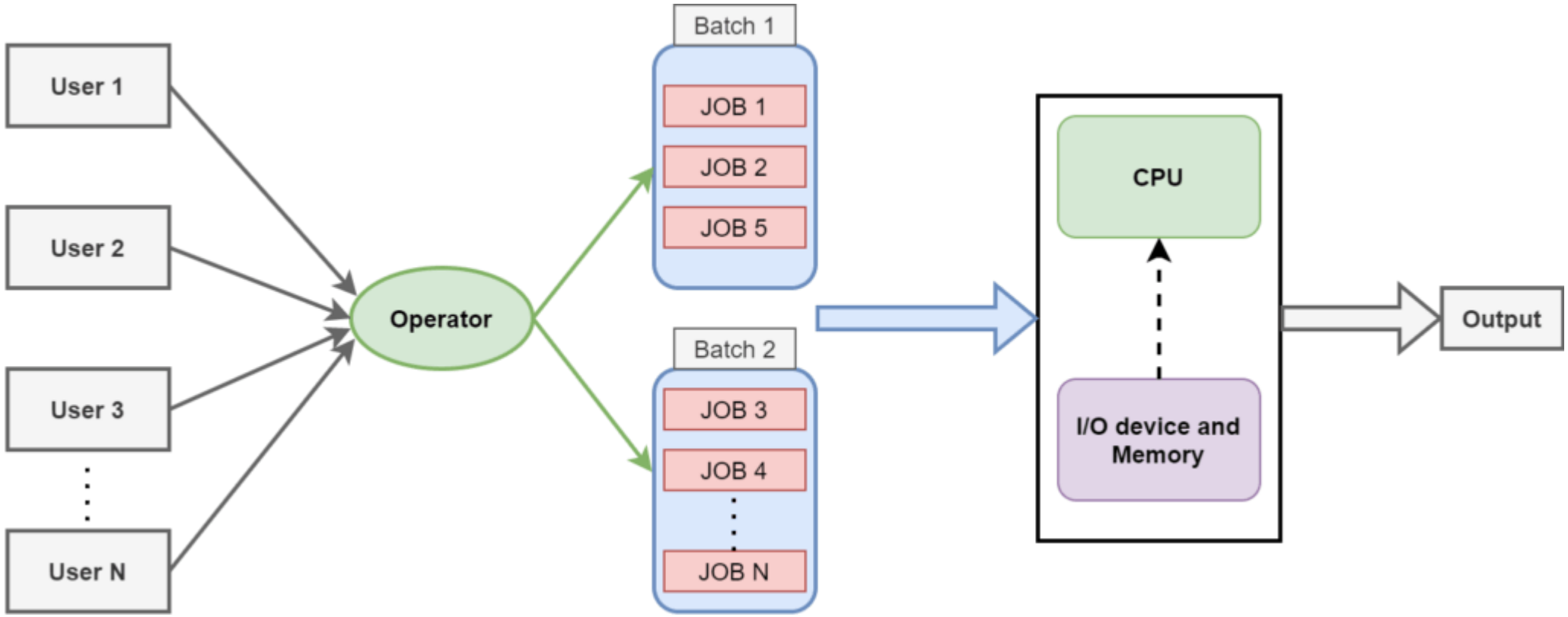
Types of Operating System

Types of Operating Systems

- Batch Operating System: Sequence of jobs in a program on a computer without manual interventions.
- Time-sharing Operating System allows many users to share computer resources. (Max utilization of the resources).
- Distributed Operating System: Manages a group of different computers and makes appear to be a single computer.
- Network Operating System: computers running in different operating systems can participate in a common network (It is used for security purposes).
- Real-time Operating System: used where any or all the jobs have strict time constraints.

Batch Operating System

This type of operating system does not interact with the computer directly. There is an operator which takes similar jobs having the same requirement and group them into batches. It is the responsibility of the operator to sort jobs with similar needs.



Advantages of Batch Operating System:

- It is very difficult to guess or know the time required for any job to complete. Processors of the batch systems know how long the job would be when it is in queue
- Multiple users can share the batch systems
- The idle time for the batch system is very less
- It is easy to manage large work repeatedly in batch systems

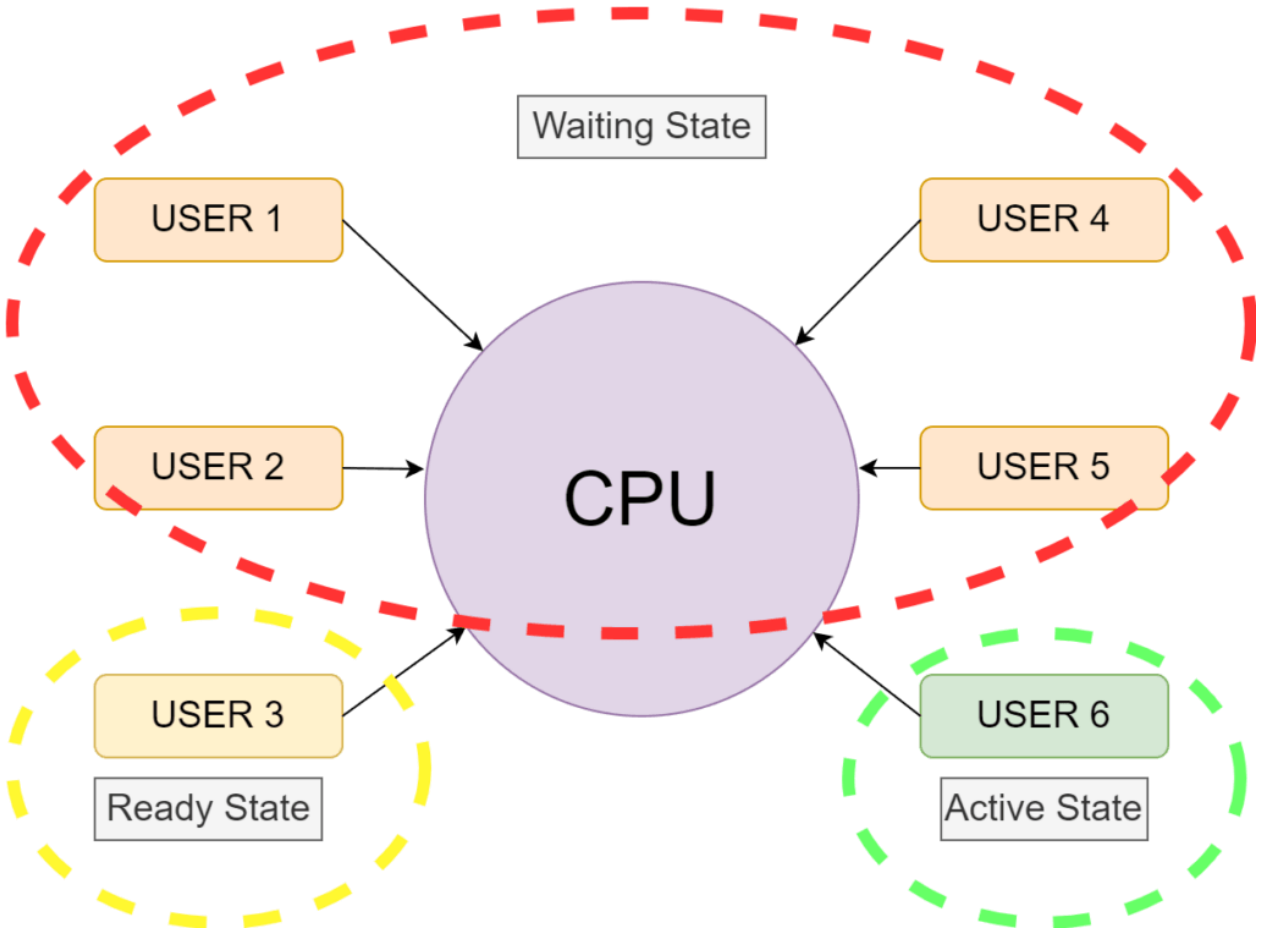
Disadvantages of Batch Operating System:

- The computer operators should be well known with batch systems
- Batch systems are hard to debug
- It is sometimes costly
- The other jobs will have to wait for an unknown time if any job fails

Examples of Batch based Operating System: Payroll System, Bank Statements, etc.

Time-Sharing Operating Systems

Each task is given some time to execute so that all the tasks work smoothly. Each user gets the time of CPU as they use a single system. These systems are also known as Multitasking Systems. The task can be from a single user or different users also. The time that each task gets to execute is called time slice or quantum. After this time interval is over OS switches over to the next task.



Advantages of Time-Sharing OS

- It has a quick response time.
- CPU idle time is reduced.
- Each task is assigned a certain time limit.
- Reduced likelihood of program duplication improves reaction time.
- User-friendly and simple to use.

Disadvantages of Time-Sharing OS

- It uses a lot of resources.
- Hardware with high quality is required.
- It has difficulty with consistency.
- A security and integrity problem with user programs and data.

Examples of Time-Sharing OS are Multics, Unix, etc.

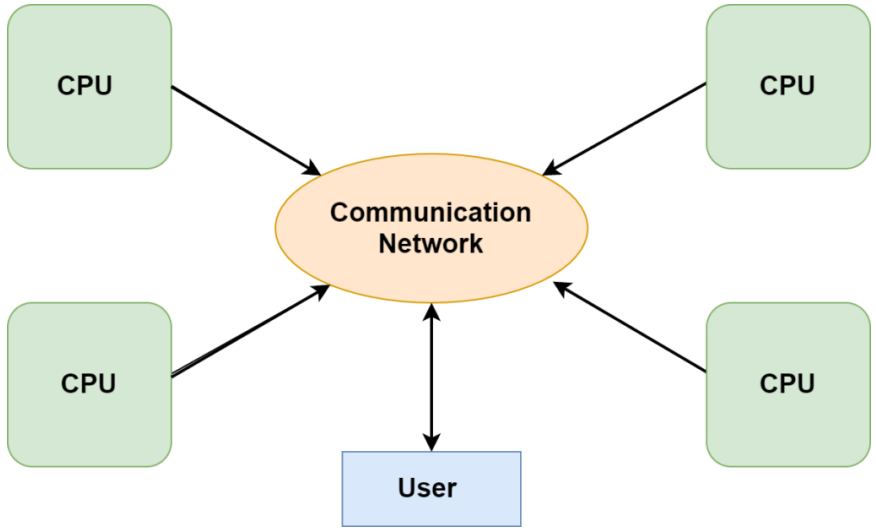
QUIZ 2.3

1. Which of the following operating system does not interact with the computer directly, in fact in this operating system each user prepares his job in an offline device and submits it to the computer?
    A. Batch Operating system
    B. Multitasking Operating System
    C. Time-sharing Operating System
    D. Distributed Operating System
2. Which of the following is not a feature of the batch Operating system?
    A. Large turnaround time
    B. It is very easy to debug the program in this operating system
    C. Other pending jobs are affected due to a lack of protection schemes

Distributed Operating System

Distributed Operating System is an operating system that runs over different independent, networked, communicating computers. Here are also the users who earn the benefit of the shared resources but in a different way. There is no centralized memory or resources. Different components are located in various systems or computers in the network.The individual components or systems of the network are nodes. Each computer or user will compute or handle the task assigned to him and share them in the distribution channel. This allows the user to access the data and resources in one system from another. All the computers are connected through LAN/WAN and communicate between them.

Examples of Distributed Operating System are- LOCUS, Solaris, OSF/1 etc.



Advantages of Distributed Operating System:

- Failure of one will not affect the other network communication, as all systems are independent from each other
- Electronic mail increases the data exchange speed
- Since resources are being shared, computation is highly fast and durable
- Load on host computer reduces
- These systems are easily scalable as many systems can be easily added to the network
- Delay in data processing reduces

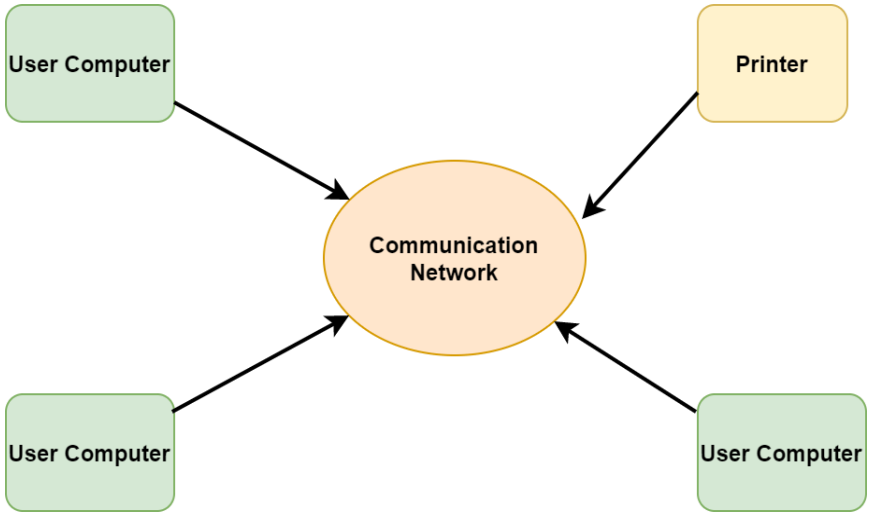
Disadvantages of Distributed Operating System:

- Failure of the main network will stop the entire communication
- To establish distributed systems the language which is used are not well defined yet
- These types of systems are not readily available as they are very expensive. Not only that the underlying software is highly complex and not understood well yet

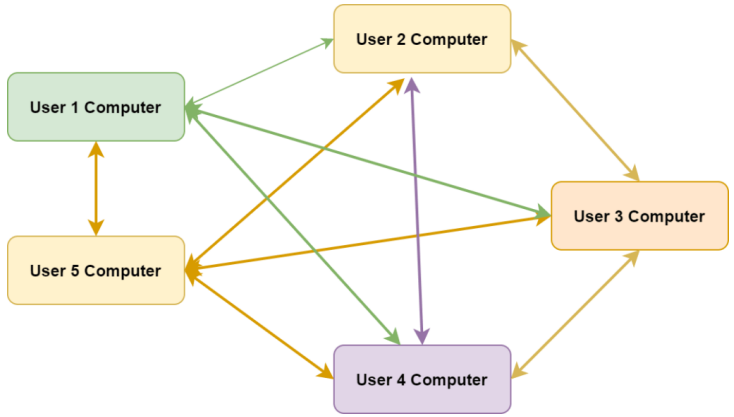
Network Operating System

A network operating system (NOS) is software that connects multiple devices and computers on the network and allows them to share resources on the network. NOS manage relationship between network resources and users.
Two primary parts of NOS: Client & Server.

Examples of Network Operating System are Microsoft Windows Server 2003, Microsoft Windows Server 2008, UNIX, Linux, Mac OS X, Novell NetWare, and BSD, etc.

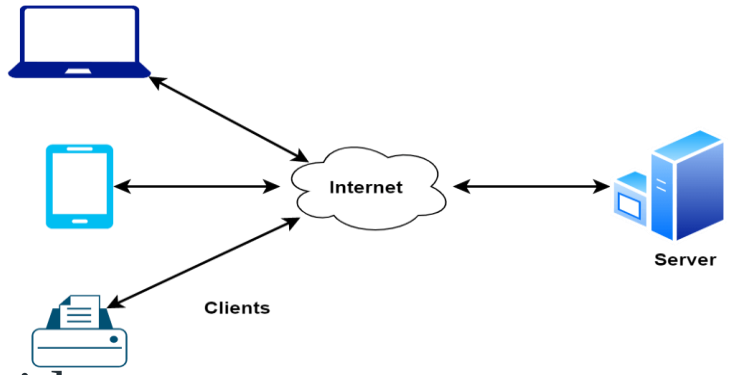


Types of Network operating systems



Peer to Peer

Peer-to-peer network operating systems allow sharing resources and files with small-sized networks and having fewer resources. In general, peer-to-peer network operating systems are used on LAN.



Client/server

Client-server network operating systems provide users access to resources through the central server. This NOS is too expensive to implement and maintain. This operating system is good for the big networks which provide many services.

Advantages of Network Operating System

- Highly stable centralized servers
- Security concerns are handled through servers
- New technologies and hardware up-gradation are easily integrated into the system
- Server access is possible remotely from different locations and types of systems

Disadvantages of Network Operating System

- Servers are costly
- User has to depend on a central location for most operations
- Maintenance and updates are required regularly

Difference between Network operating systems & Distributed Operating System

Network OS	Distributed OS
Connects multiple computers on a network to share resources.	Joins multiple computers over a bus and make them work as a single computer.
Runs on a server, and every devices that're connected with network can have their own individual operating system.	Each machine connected to the network bus must have same operating system.
Easy to install and economical.	Very costly and complex to install.
Helps to share the user credentials as well as manages data, and security related resources.	Shares the resources to run a task.
Less reliable because every device is connected with the main server. In case of failure of the central server, all processes will stop working.	More reliable because there's nothing like central system. In case of failure of a device, processing will not stop.

Real-Time Operating System

Process Time: Time taken by a system to process the task
Response Time: Time interval between input and output by the system.
Real-time systems: A system in which process time and response time is very small. This controls the environment and outcome of those affects a lot. There's no user GUI in this type of operating system. Moreover, the real-time operating system works with strict time-bound and deadlines.. If not provide output in fixed time interval means system fail. **Applications of RTOS**: Scientific Work, Robotics, Traffic Control System etc. **Examples** of RTOS are MTS, Lynx, QNX

Two types of Real-Time Operating System

1. **Hard Real-Time Systems:** These OSs are meant for applications where time constraints are very strict and even the shortest possible delay is not acceptable. Military, Avionics applications fall in this category
2. **Soft Real-Time Systems:** These OSs are for applications where for time-constraint is less strict. Digital audio or multimedia systems fall in this category

Advantages of Real Time OS

- **Less Downtime:** RTOS makes sure that the system consumes more resources. As a result, a system using RTOS experiences very less downtime
- **Task Management:** A real time operating system typically takes less amount of time to shift from one task to another.
- **Efficiency:** A real time operating system focusses on one application at a given time. Most often this application will be the one which is already running. All others on queue will be kept in waiting stage. Thus, the critical tasks can be processed on time within the given deadline for achieving the exact results needed.
- **Availability:** Due to the fact that a RTOS exhibits maximum results, it is a system which is available 24/7.
- **Reliability:** Real time operating systems, especially those which are of hard RTOS are completely free of errors. It ensures a better way of handling errors.

Disadvantages of Real Time OS

- **Limited Tasks:** Although a RTOS is capable of concentrating on targeted applications, that is not the same with multitasking. They are designed to run only few of the tasks. Therefore, it is not recommended for systems that require multi-tasking.
- **Program Crashes:** Program crashes can be frequently experienced while using a real time operating system.
- **Complex Algorithms:** Complex algorithms are behind a RTOS interface. It will be difficult for a normal user to write these algorithms. Only an expert developer will be able to write and understand them.
- **Device driver and interrupt signals:** It needs specific device drivers and interrupts signals to respond earliest to interrupts.
- **Task Focus:** RTOS focusses on one application at a given time. This is mainly done to maintain accuracy and reduce errors. All other applications those are of low priority needs to be on waiting. There is no time limit in how much time they will be on standby.

QUIZ-2.4

1. Which of the following Operating systems use multiple central processors to serve multiple real-time applications and multiple users?
    A. Batch Operating system
    B. Multitasking Operating System
    C. Time-sharing Operating System
    D. Distributed Operating System
2. Which of the following Operating systems runs on a server and provides the server the capability to manage data, users, groups, etc?
    A. Batch Operating system
    B. Network operating system
    C. Mobile Operating system
    D. Real-time Operating system
3. In which real-time Operating system, secondary storage is limited or missing and the data is stored in ROM?
    A. Hard real-time systems
    B. The soft real-time system

Examples of Operating Systems

- Windows (GUI-based, PC)
- GNU/Linux (Personal, Workstations, ISP, File and print server, Three-tier client/Server)
- macOS (Macintosh), used for Apple’s personal computers and workstations (MacBook, iMac).
- Android (Google’s Operating System for smartphones/tablets/smartwatches)
- iOS (Apple’s OS for iPhone, iPad, and iPod Touch)

Command-Based Operating System

Command-Based Operating System or Command Line Interface (CLI)

In computers, a command is a specific order from a user to the computer's operating system or to an application to perform a service, such as "Show me all my files" or "Run this program for me." Operating systems such as DOS that do not have a graphical user interface (GUI) offer a simple command line interface in

CLI permits users to put in writing commands associate degree exceedingly in terminal or console window to interact with an operating system. CLI is a platform or medium wherever users answer a visible prompt by writing a command and get the response from the system, for this users have to be compelled to kind command or train of command for performing the task. CLI is suitable for pricey computing wherever input exactitude is the priority.

Advantages & Disadvantages of CLI

Advantages	Disadvantages
This type of interface needs much less memory (RAM) in order to use compared to other types of user interfaces	Commands have to be typed precisely. If there is a spelling error the command will fail

GUI-Based Operating System

CLI	GUI
CLI is difficult to use.	Whereas it is easy to use.
It consumes low memory.	While consuming more memory.
In CLI we can obtain high precision.	While in it, low precision is obtained.
CLI is faster than GUI.	The speed of GUI is slower than CLI.
CLI operating system needs only a keyboard.	While GUI operating system needs both a mouse and keyboard.
CLI's appearance can not be modified or changed.	While its appearance can be modified or changed.
In CLI, input is entered only at a command prompt.	While in GUI, the input can be entered anywhere on the screen.
In CLI, the information is shown or presented to the user in plain text and files.	While in GUI, the information is shown or presented to the user in any form such as: plain text, videos, images, etc.

CLI	GUI
In CLI, there are no menus provided.	While in GUI, menus are provided.
There are no graphics in CLI.	While in GUI, graphics are used.
CLI do not use any pointing devices.	While it uses pointing devices for selecting and choosing items.
In CLI, spelling mistakes and typing errors are not avoided.	Whereas in GUI, spelling mistakes and typing errors are avoided.
Some command-line environments provide multi-tasking but it is complicated to see several things on one screen.	GUI enables a user to easily observe and operate various things at once.
CLI enables a user to simply script a series of instructions to carry out a task or execute a program.	GUI does not provide the facility to script a sequence of commands.

Computer Network

What is Computer Network?

- A computer network is a system that connects numerous independent computers in order to share information (data) and resources. The integration of computers and other different devices allows users to communicate more easily.
- A computer network is a collection of two or more computer systems that are linked together. A network connection can be established using either cable or wireless media. Hardware and software are used to connect computers and tools in any network.
- A computer network consists of various kinds of nodes. Servers, networking hardware, personal computers, and other specialized or general-purpose hosts can all be nodes in a computer network. Hostnames and network addresses are used to identify them.

Basic Characteristics of Computer Networks

1. Fault Tolerance
2. Scalability
3. Quality of Service (QoS)
4. Security

Fault Tolerance is the ability to

- Continue working without despite failures or continue operating without interruption when one or more of its component fail.
- Ensure no loss of service by ensuring minimizing downtime (time during which a m/c esp. computer is out of action)

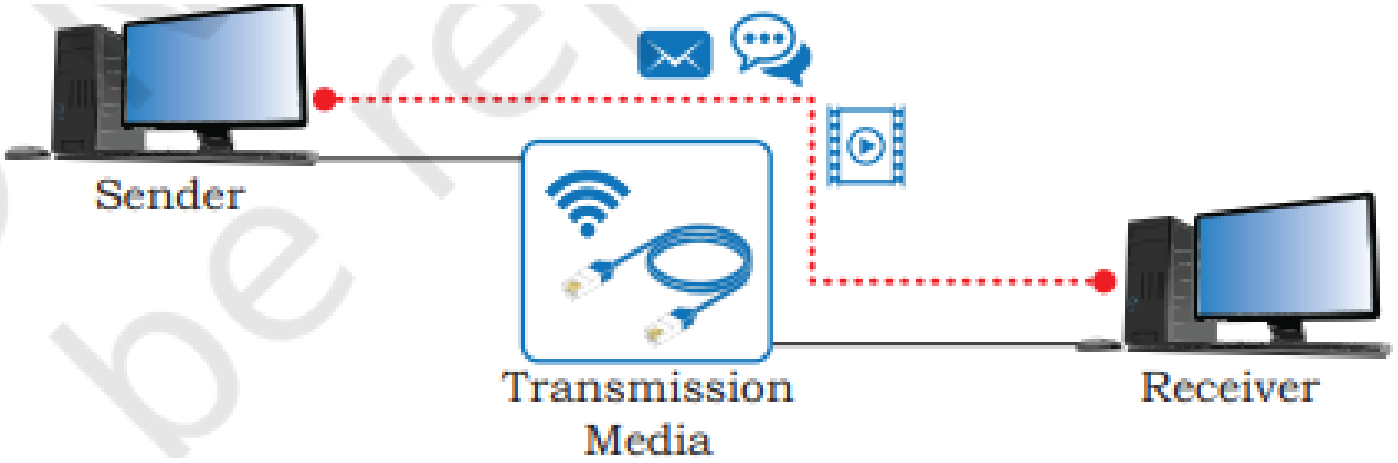
Scalability: It is the ability to grow based on the needs and have good performance after growth. The best example of scalability is The Internet itself, now also many new users are connecting through the internet and communicating with other devices, but our network is working properly. This is what scalability is.

Quality of Service (QoS): Quality of Service (QoS) refers to the ability to set priorities and manage data traffic and reduce data loss, delay, etc.

Security: Security is the ability to prevent unauthorized access, misuse, or forgery. Also, it is the ability to provide confidentiality, integrity and availability.

Data Communication

Data communications means exchange of data between two devices via some form of transmission medium such as a wired or wireless. These are sender, receiver, communication medium, the message to be communicated, and certain rules called protocols to be followed during communication. The communication media is also called transmission media



Sender: A sender is a computer or any such device which is capable of sending data over a network. It can be a computer, mobile phone, smartwatch, walkietalkie, video recording device, etc.

Receiver: A receiver is a computer or any such device which is capable of receiving data from the network. It can be any computer, printer, laptop, mobile phone, television, etc. In computer communication, the sender and receiver are known as nodes in a network.

Communication media: It is the path through which the message travels between source and destination. It is also called medium or link which is either wired or wireless. For example, a television cable, telephone cable, ethernet cable, satellite link, microwaves, etc.

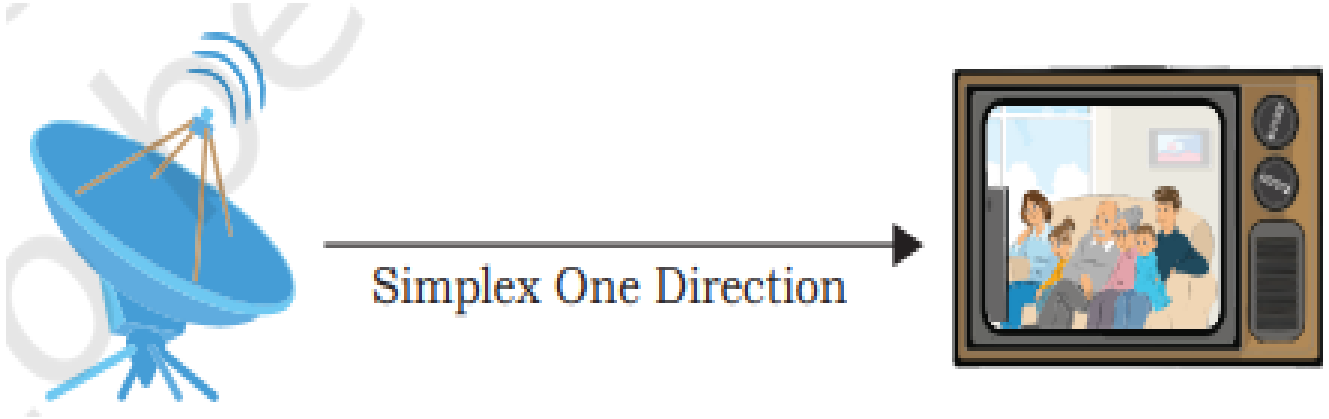
Types of Data Communication

Data communication happens in the form of signals between two or more computing devices or nodes. The transfer of data happens over a point-to-point or multipoint communication channel. Data communication between different devices are broadly categorized into 3 types:

- Simplex communication
- Half-duplex communication
- Full-duplex communication

Simplex Communication

It is a one way or unidirectional communication between two devices in which one device is sender and other one is receiver. Devices use the entire capacity of the link to transmit the data. It is like a one-way street where vehicles can move in only one direction. For example, data entered through a keyboard or audio sent to a speaker are one-way communications.

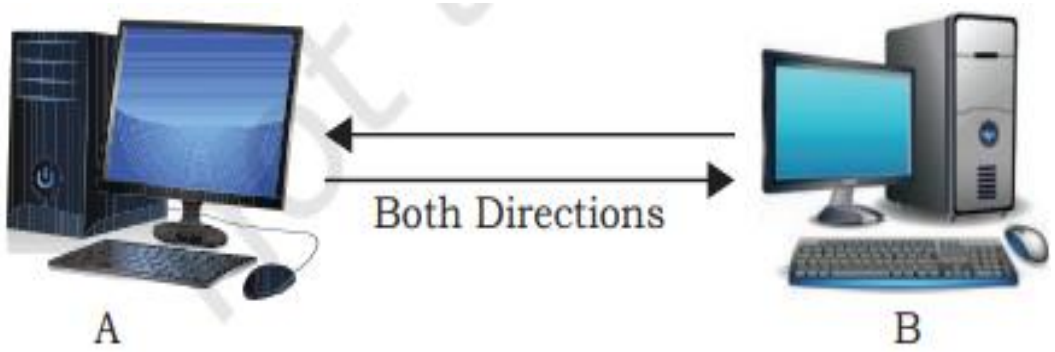


Half-duplex Communication

It is two way or bidirectional communication between two devices in which both the devices can send and receive data or control signals in both directions, but not at the same time, While one device is sending data, the other one will receive and vice-versa. It is like sharing a one-way narrow bridge among vehicles moving in both directions. Vehicles cannot pass the bridge simultaneously. Application of such type of communication can be found in walkie-talkie where one can press the push-to-talk button and talk

Full-duplex Communication

It is two way or bidirectional communication in which both devices can send and receive data simultaneously, This type of communication channel is employed to allow simultaneous communication, for example, in our cell phones and landline telephones. The capacity of the transmission link is shared between the signals going in both directions. This can be done either by using two physically separate simplex lines — one for sending and other for receiving, or the capacity of the single channel is shared between the signals travelling in different directions.



Classification of Computer Network

Network Classification

The Network allows computers to connect and communicate with different computers via any medium. Three major types of networks designed to operate over the area they cover are:

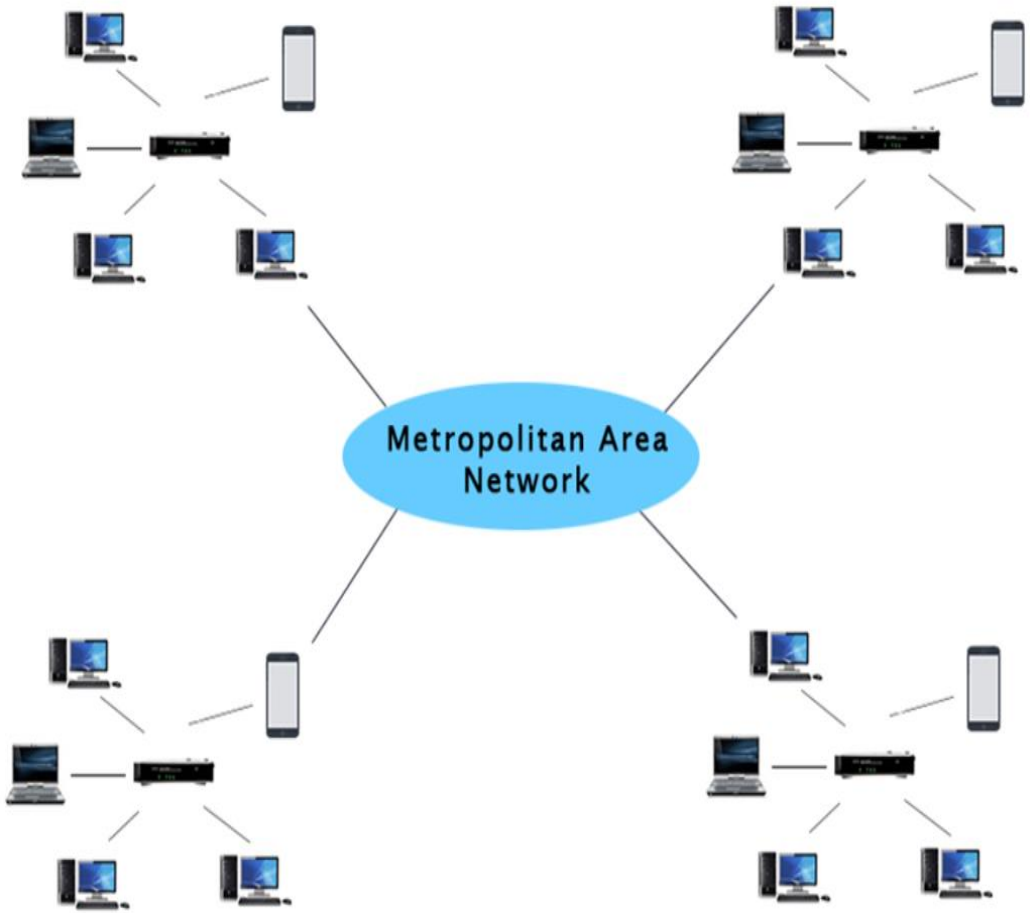
- Local Area Network (LAN)
- Metropolitan Area Network (MAN)
- Wide Area Network (WAN)

Local Area Network (LAN)

- LAN is usually privately owned and links the devices in a single office, building or campus of up to few kilometers in size.
- LAN typically used transmission technology consisting of single cable to which all machines are connected.
- Traditional LANs run at speeds of 10 to 100 Mbps (but now much higher speeds can be achieved).

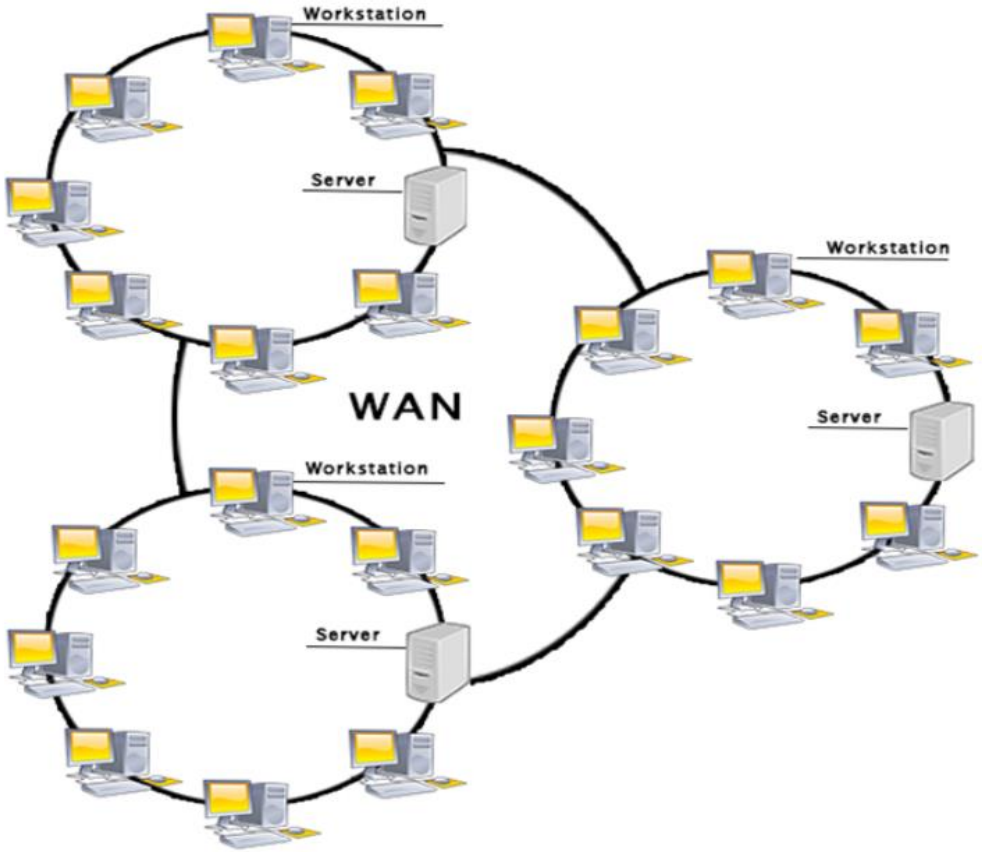
Metropolitan Area Network (MAN)

- MAN is designed to extend over the entire city.
- It may be a single network as a cable TV network, or it may be means of connecting a number of LANs into a larger network so that resources may be shared.
- MAN is wholly owned and operated by a private company or may be a service provided by a public company.
- The main reason for distinguishing MANs as a special category is that a standard has been adopted for them.



Wide Area Network (WAN)

- WAN provides long-distance transmission of data, voice, image and information over large geographical areas that may comprise a country, continent or even the whole world.
- In contrast to LANs, WANs may utilize public, leased or private communication devices, usually in combinations, and can therefore span an unlimited number of miles.



Network Topologies

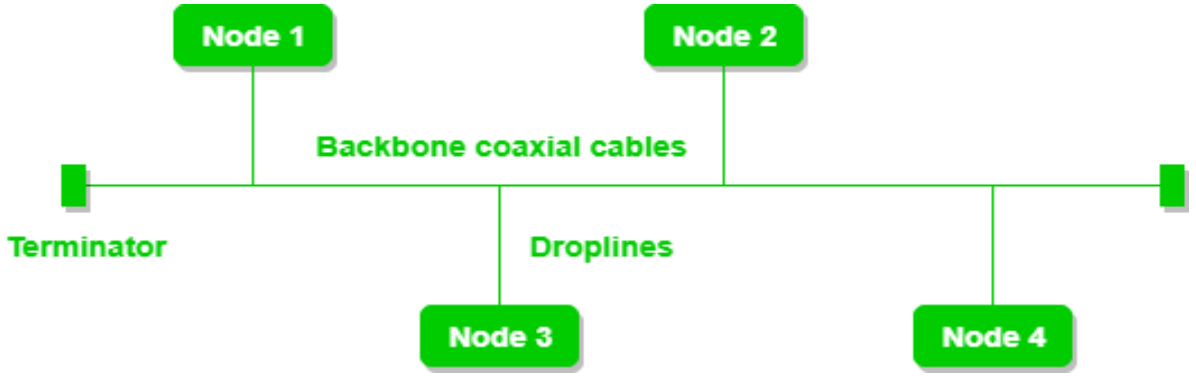
Network Topologies

The way to arrange or connect patterns of computers/ nodes/ devices used in the network is known as Network Topology. Common types of Network Topologies are:

1. Bus Topology
2. Ring Topology
3. Star Topology
4. Mesh Topology
5. Hybrid Topology

Bus Topology

- Bus topology is a type of network setup where each computer and network device is connected to a ***single cable*** or backbone.
- Bus topology is unidirectional and data is transferred from one end to another in a single direction.
- At each end of the bus there is a ***terminator***, which absorbs any signal, preventing reflection of signal from the endpoints.
- If the terminator is not present, the endpoint acts like a mirror and reflects the signal back causing interference and other problems.



Advantages of Bus Topology

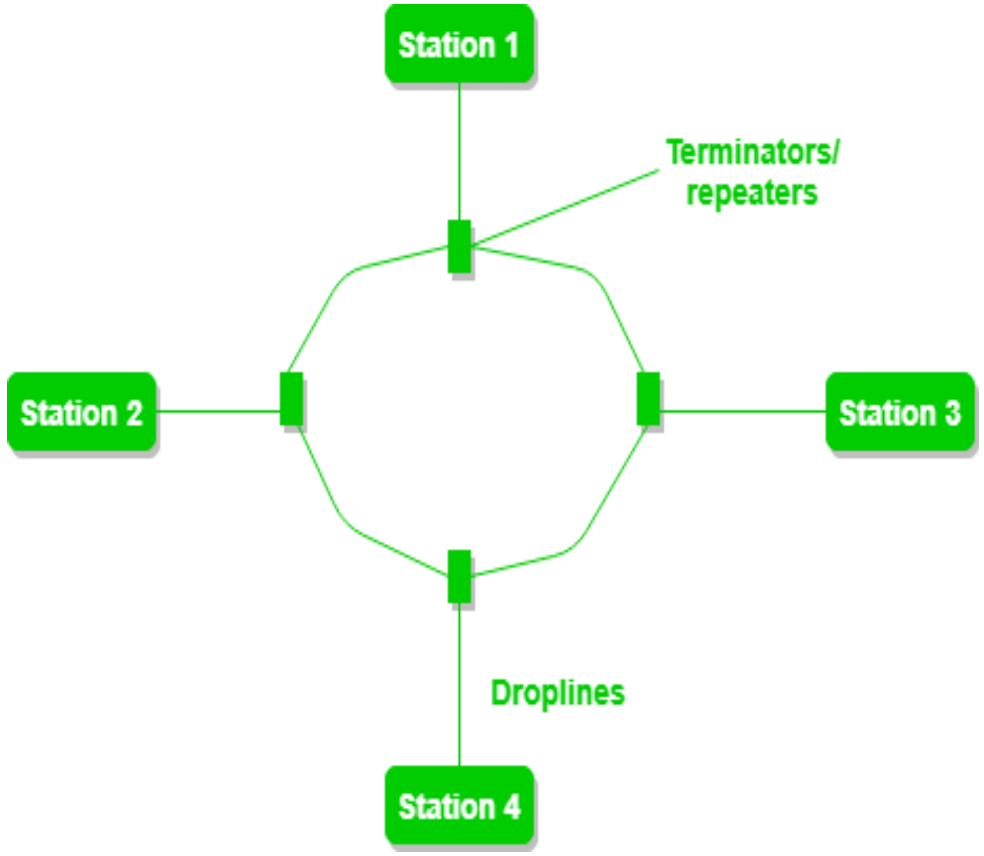
- If N devices are connected to each other in a bus topology, then the number of cables required to connect them is 1, known as backbone cable, and N drop lines are required.
- It's the easiest network topology for connecting computers or peripherals in a linear fashion.
- The cost of the cable is less compared to other topologies, but it is used to build small networks.

Disadvantages of Bus Topology

- Terminators are required for both ends of the main cable.
- Additional devices slow the network down.
- If the network traffic is heavy, it increases collisions in the network.
- If a main cable is damaged, the network fails or splits into two.

Ring Topology

- Ring topology is like a bus topology, but with connected ends.
- The node that receives the message from the previous computer will retransmit to the next node.
- The data flows in one direction, i.e.., it is unidirectional, but it can be made bidirectional by having 2 connections between each Network Node, it is called Dual Ring Topology.



Advantages of Ring Topology

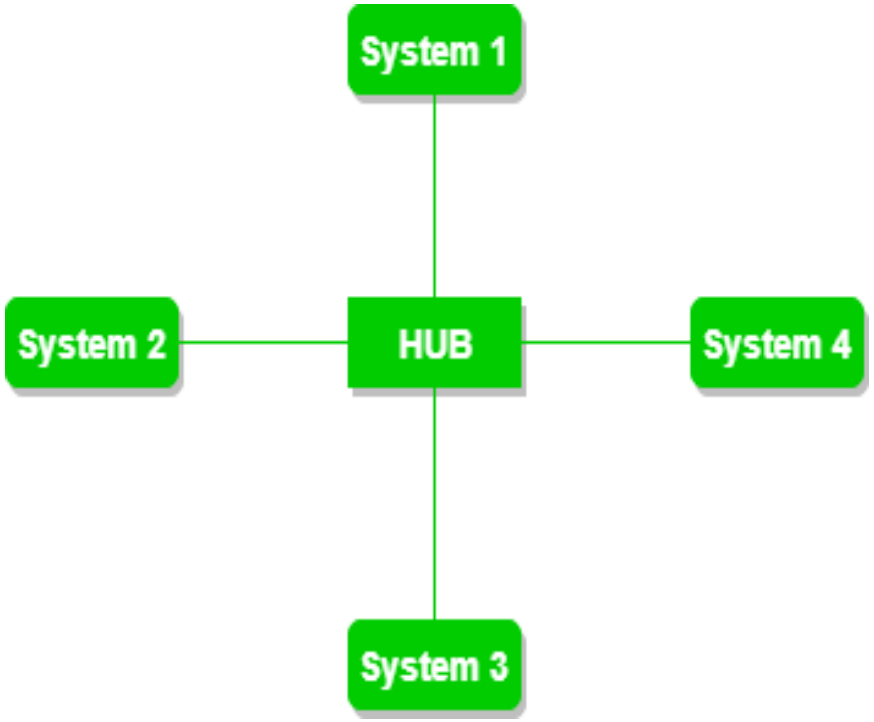
- The data transmission is high-speed.
- The possibility of collision is minimum in this type of topology.
- Cheap to install and expand.
- It is less costly than a star topology.

Problems with Ring Topology

- The failure of a single node in the network can cause the entire network to fail.
- Troubleshooting is difficult in this topology.
- The addition of stations in between or the removal of stations can disturb the whole topology.
- Less secure.

Star Topology

- In Star topology, all the components of network are connected to the central device called “hub” which may be a hub or a switch.
- All workstations are connected to central device with a point-to-point connection. So it can be said that every computer is indirectly connected to every other node by the help of “hub”.
- All the data on the star topology passes through the central device before reaching the intended destination.
- Hub acts as a junction to connect different nodes present in Star Network, and at the same time it manages and controls whole of the network.
- Central device can also communicate with other hubs of different network.



Advantages of Star Topology

- If N devices are connected to each other in a star topology, then the number of cables required to connect them is N. So, it is easy to set up.
- Each device requires only 1 port i.e., to connect to the hub, therefore the total number of ports required is N.
- It is Robust. If one link fails only that link will affect and not other than that.
- Easy to fault identification and fault isolation.
- Star topology is cost-effective as it uses inexpensive coaxial cable.

Problems with Star Topology

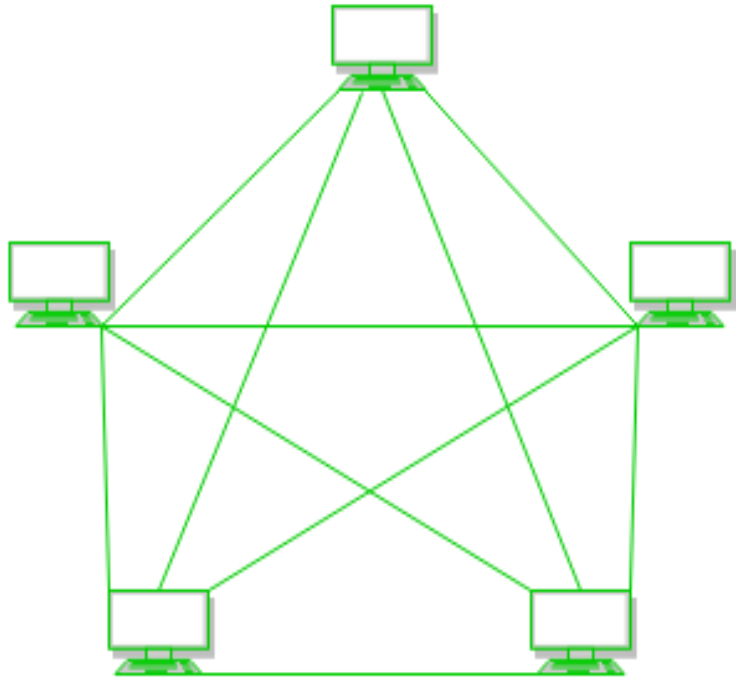
- If the concentrator (hub) on which the whole topology relies fails, the whole system will crash down.
- The cost of installation is high.
- Performance is based on the single concentrator i.e., hub.

Mesh Topology

- Mesh technology is an arrangement of the network in which computers are interconnected with each other through various redundant connections.
- There are multiple paths from one computer to another computer.
- It does not contain the switch, hub or any central computer which acts as a central point of communication.
- Mesh topology can be formed by using the formula:

Number of cables = (n*(n-1))/2;

Where n is the number of nodes that represents the network.



Advantages of Mesh Topology

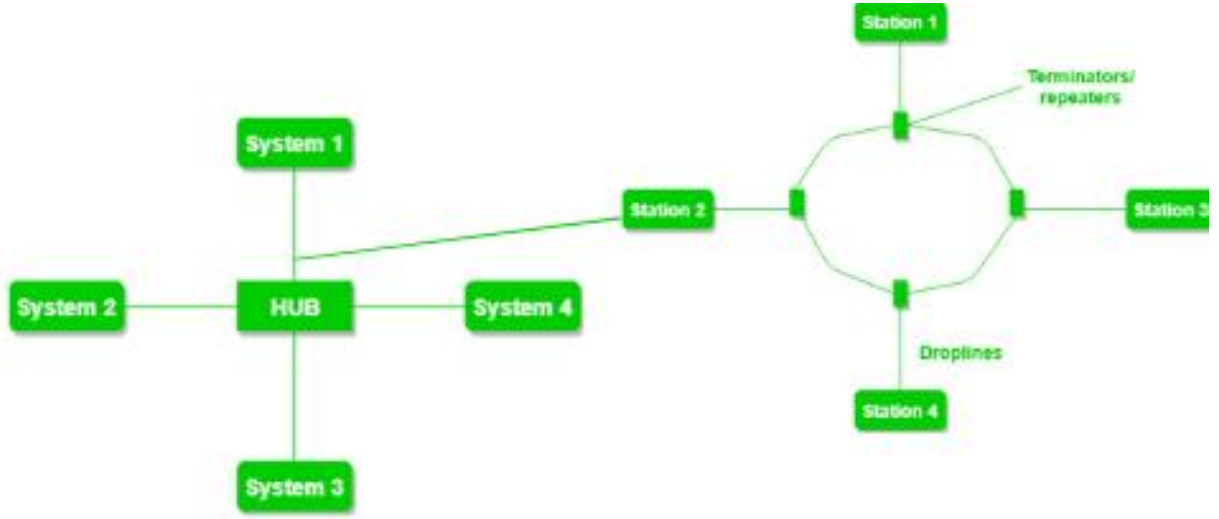
- Communication is very fast between the nodes.
- It is robust.
- The fault is diagnosed easily. Data is reliable because data is transferred among the devices through dedicated channels or links.
- Provides security and privacy.

Problems with Mesh Topology

- Installation and configuration are difficult.
- The cost of cables is high as bulk wiring is required, hence suitable for a smaller number of devices.
- The cost of maintenance is high.

Hybrid Topology

This topological technology is the combination of all the various types of topologies we have studied above. It is used when the nodes are free to take any form. It means these can be individuals such as Ring or Star topology or can be a combination of various types of topologies seen above. Each individual topology uses the protocol that has been discussed earlier.



Advantages of Hybrid Topology

- This topology is **very flexible**.
- The size of the network can be easily expanded by **adding new devices.**

Problems with Hybrid Topology

- It is challenging **to design the architecture** of the Hybrid Network.
- **Hubs** used in this topology are **very expensive.**
- The infrastructure cost is very high as a hybrid network **requires a lot of cabling and network devices**.

S.NO.	Star Topology	Bus Topology
1.	Star topology is a topology in which all devices are connected to a central hub.	Bus topology is a topology where each device is connected to a single cable which is known as the backbone.
2.	In star topology, if the central hub fails then the whole network fails.	In a Bus topology, the failure of the network cable will cause the whole network to fail.
3.	In star topology, there is a non-linear arrangement of nodes in a network.	In a bus topology, there is a linear arrangement of nodes in a network.
4.	Management of high traffic and performance of the network is highly dependent on the capacity of the central hub.	Bus topology can not effectively manage a terminator's high amount of traffic as if there is high traffic then the performance of the network is affected.
5.	Star topology does not have any terminator.	Bus topology has a terminators at both ends of the network.
6.	Star topology has a high implementation cost because of the central hub and extra wires required for connection.	Bus topology is less expensive than a star topology.
7.	Data transmission is faster in a star topology.	In a Bus topology, the data is transmitted slower as compared to a star topology.
8.	In star topology the communication between nodes is done through a central hub, a message from the sender node reaches the central hub first then it is transmitted to the receiver node.	In a Bus topology, the data from a sender device to a receiver device is sent directly.
9.	Expansion is easier.	Expansion of network i.e., addition of new node is difficult.
10.	Less chances of data collision in star topology.	High chances of data collision in bus topology.

Network Devices

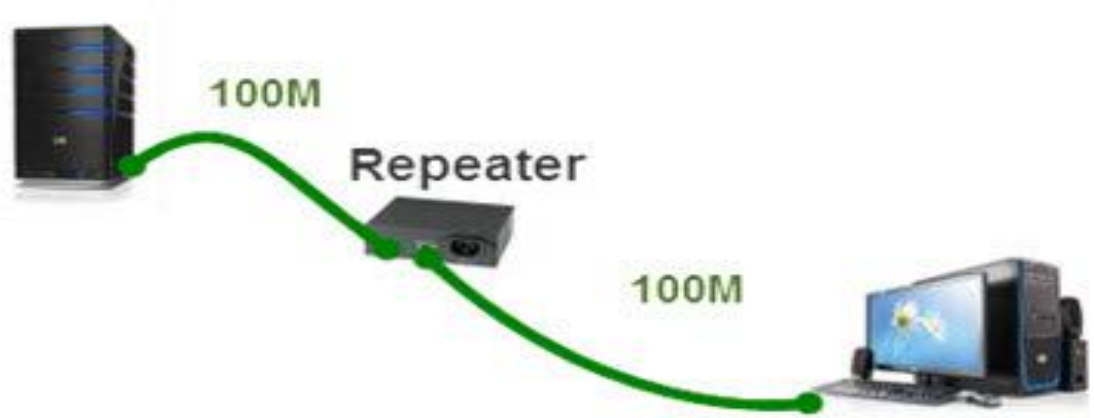
Network Devices: Network devices, also known as networking hardware, are physical devices that allow hardware on a computer network to communicate and interact with one another.

Common network device list:

1. Repeater
2. Hub
3. Switch
4. Router
5. Bridge
6. Gateway

Repeater

A repeater is an electronic device that amplifies the signal it receives. You can think of repeater as a device which receives a signal and retransmits it at a higher level or higher power so that the signal can cover longer distances, more than 100 meters for standard LAN cables. Repeaters work on the Physical layer.



Advantages of Repeaters

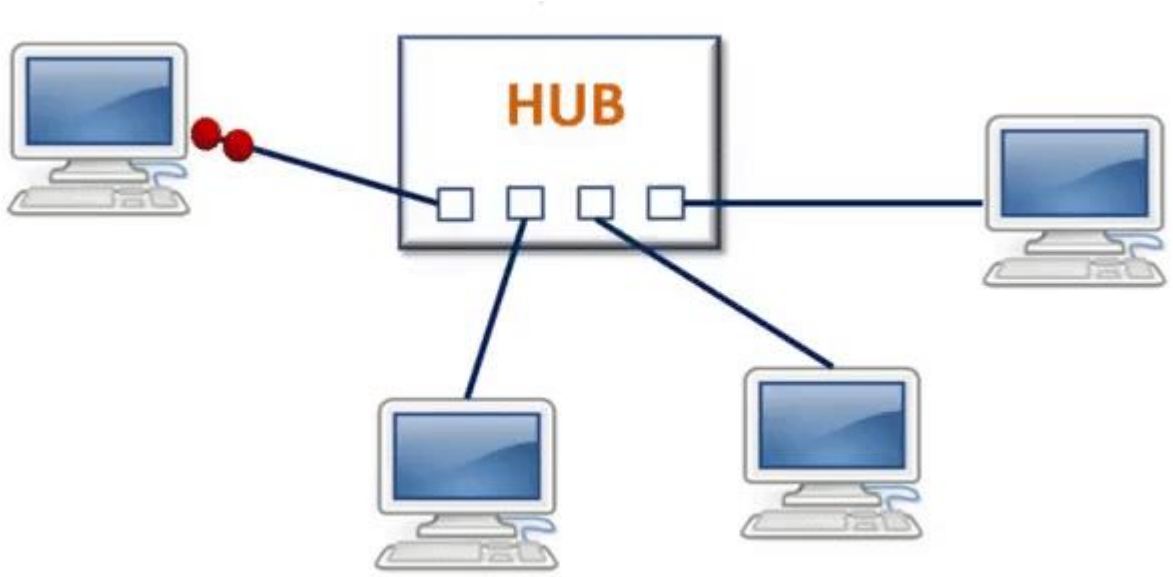
- Repeaters are simple to install and can easily extend the length or the coverage area of networks.
- They are cost effective.
- Repeaters don’t require any processing overhead. The only time they need to be investigated is in case of degradation of performance.
- They can connect signals using different types of cables.

Disadvantages of Repeaters

- Repeaters cannot connect dissimilar networks.
- They cannot differentiate between actual signal and noise.
- They cannot reduce network traffic or congestion.
- Most networks have limitations upon the number of repeaters that can be deployed.

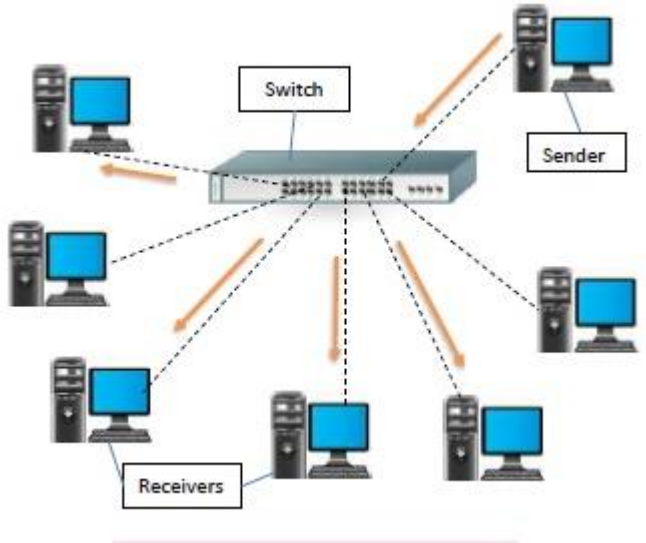
Hub

A hub is one of the simplest networking devices that connects several computers or other network devices when referring to networking (network devices hub). **In layman's terms, a hub is a hardware device that allows multiple devices or connections to connect to a computer.**



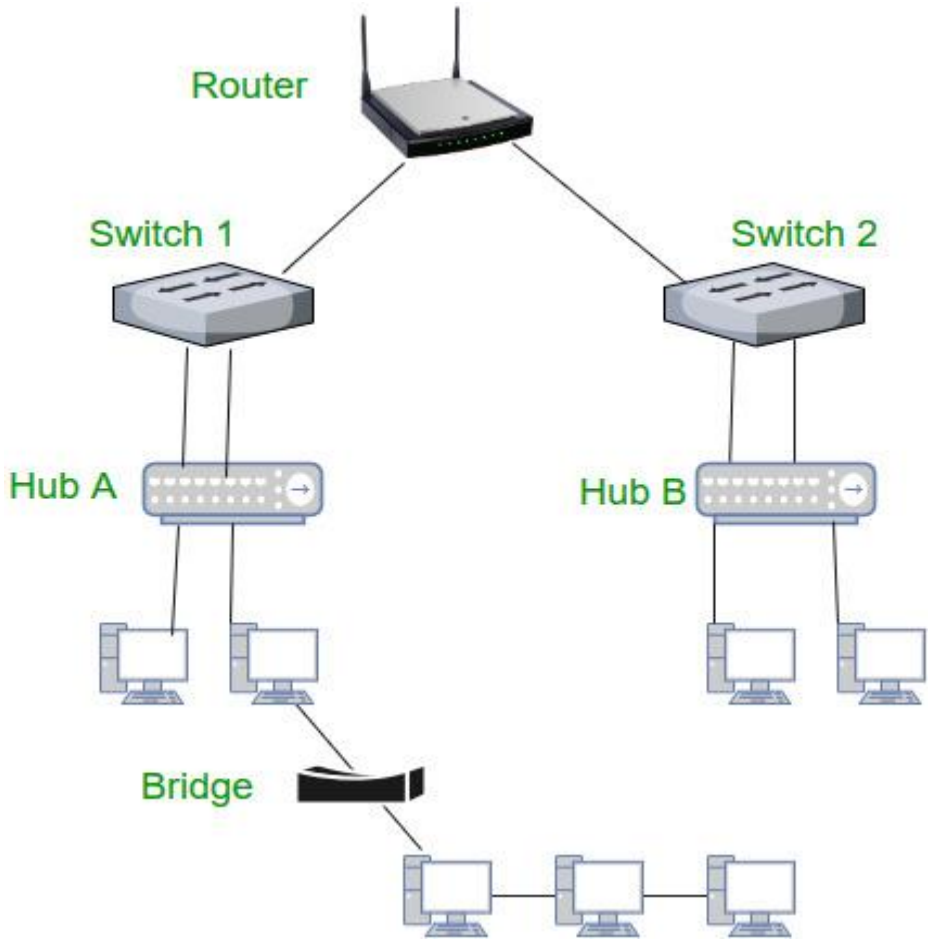
Switch

Switch is a network device that has multiple ports, used to connect computer devices and create a network. It works on layer 2 (data-Link layer) of the OSI model and has multiple switching ports. A switch can learn the physical addresses of the devices that are connected to it, store these physical addresses (called MAC address) in its table. It works on star topology because all devices are connected to the central node. Data from the source is first arrived at the switch and then transferred to the destination device.



Routers

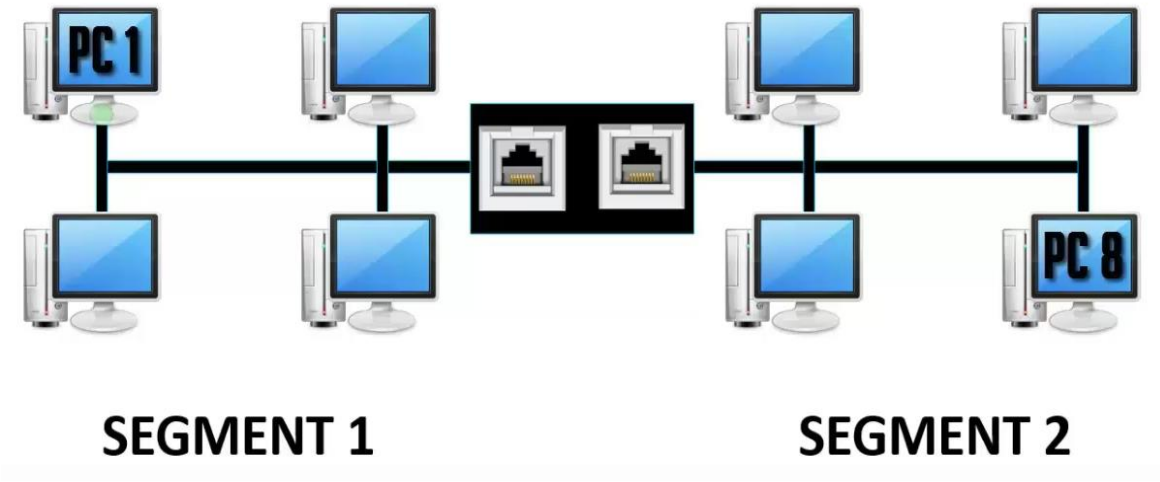
A router is a device like a switch that routes data packets based on their IP addresses. The router is mainly a Network Layer device. Routers normally connect LANs and WANs and have a dynamically updating routing table based on which they make decisions on routing the data packets. The router divides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



Bridge

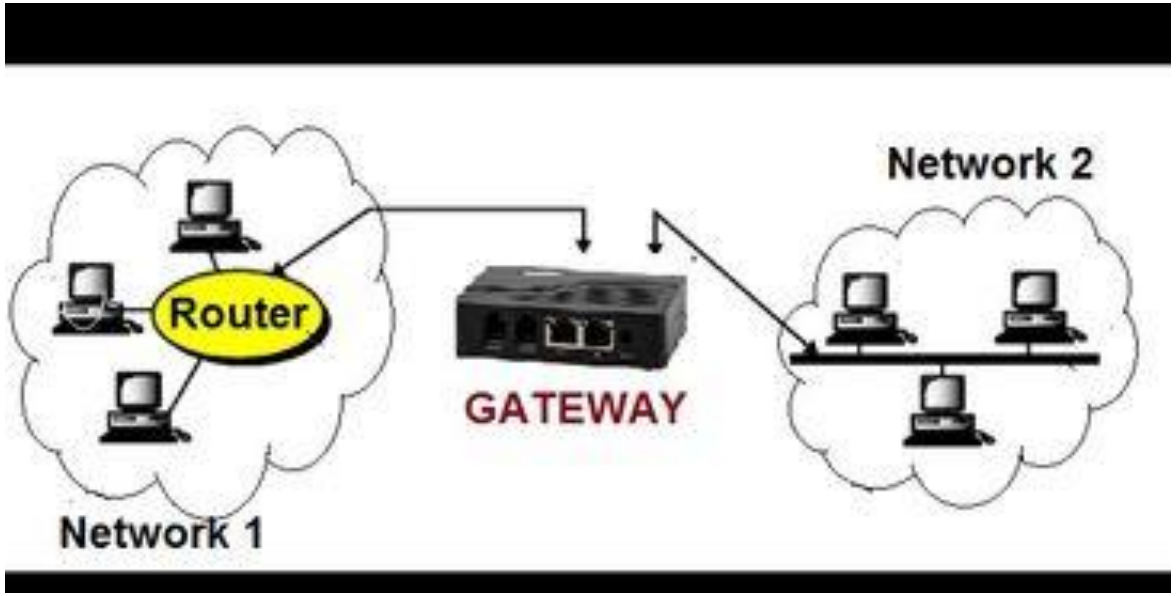
Bridges are used to connect two or more hosts or network segments together. The basic role of bridges in network architecture is storing and forwarding frames between the different segments that the bridge connects. They use hardware Media Access Control (MAC) addresses for transferring frames.

Bridges work only at the Physical and Data Link layers of the OSI model. Bridges are used to divide larger networks into smaller sections by sitting between two physical network segments and managing the flow of data between the two.

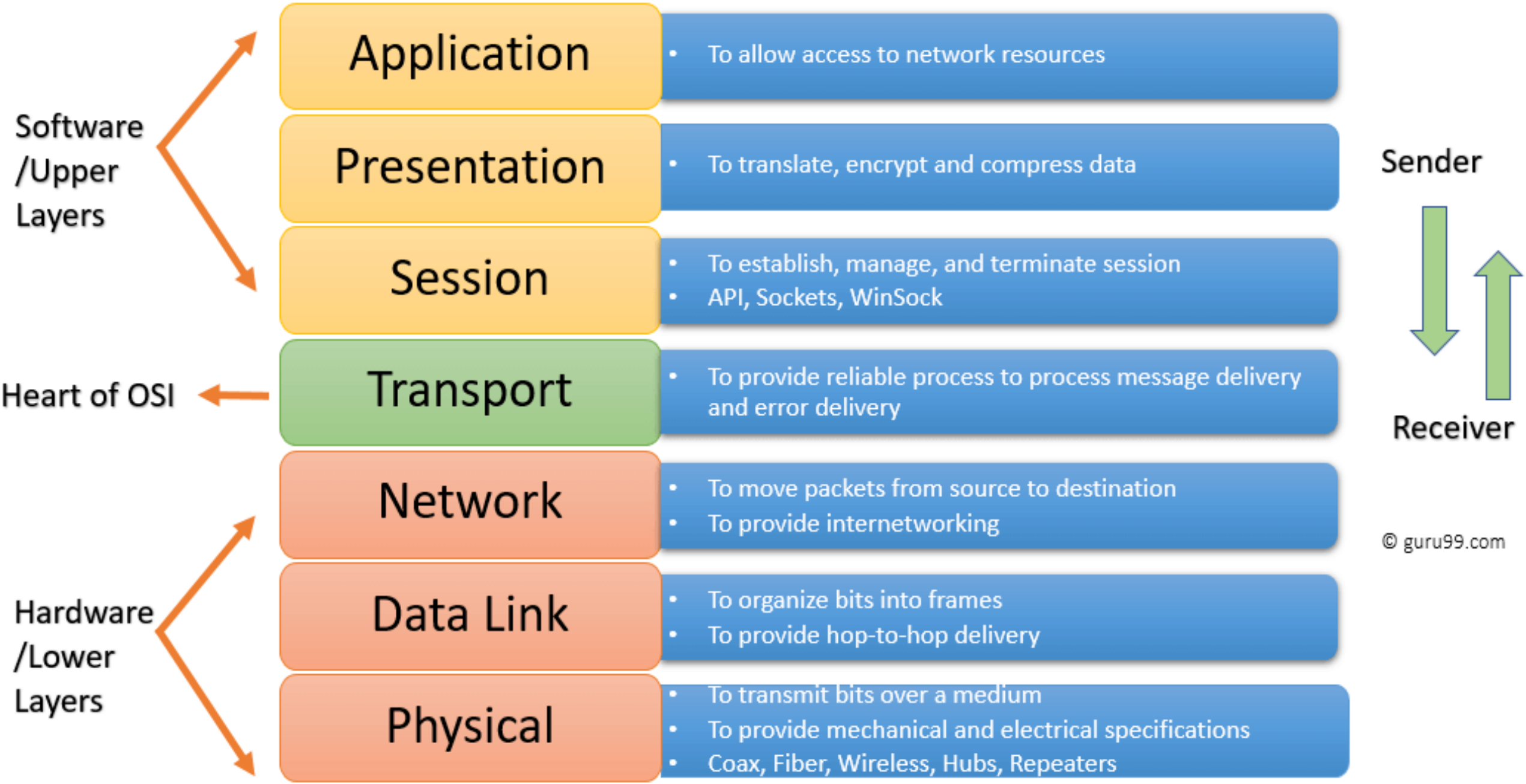


Gateway

A gateway, as the name suggests, is a passage to connect two networks that may work upon different networking models. They work as 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 switches or routers. A gateway is also called a protocol converter.



OSI Model
(Open System Interconnection)


Application
To allow access to network resources
Presentation
To translate, encrypt and compress data
Session
To establish, manage, and terminate session
API, Sockets, WinSock
Transport
To provide reliable process to process message delivery and error delivery
Network
To move packets from source to destination
To provide internetworking
Data Link
To organize bits into frames
To provide hop-to-hop delivery
Physical
To transmit bits over a medium
To provide mechanical and electrical specifications
Coax, Fiber, Wireless, Hubs, Repeaters
Software /Upper Layers
Heart of OSI
Hardware /Lower Layers
Sender
Receiver
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Physical Layer

- The lowest layer of the OSI reference model is the physical layer.
- It is responsible for the actual physical connection between the devices.
- The physical layer contains information in the form of **bits.**
- It is responsible for transmitting individual bits from one node to the next.
- Hub, Repeater, Modem, Cables are Physical Layer devices.
- Functions: Bit rate control, Physical Topologies, Transmission Mode

Data Link Layer

- At the data link layer, directly connected nodes are used to perform node-to-node data transfer where data is packaged into frames.
- The data link layer also corrects errors that may have occurred at the physical layer.
- The data link layer encompasses two sub-layers of its own. The first, media access control (MAC), provides flow control and multiplexing for device transmissions over a network. The second, the logical link control (LLC), provides flow and error control over the physical medium as well as identifies line protocols.
- Switch & Bridge are Data Link Layer devices.

Network Layer

- The network layer is responsible for receiving frames from the data link layer and delivering them to their intended destinations among based on the addresses contained inside the frame.
- The network layer finds the destination by using logical addresses, such as IP (internet protocol).
- Network layer is implemented by networking devices such as routers.
- Routers are a crucial component used to quite literally route information where it needs to go between networks.

Transport Layer

- Transport layer provides services to application layer and takes services from network layer.
- The data in the transport layer is referred to as Segments.
- It is responsible for the End-to-End Delivery of the complete message.
- The transport layer also provides the acknowledgement of the successful data transmission and re-transmits the data if an error is found.
- It regulates the size, sequencing, and ultimately the transfer of data between systems and hosts.

Session Layer

This layer is responsible for establishment of connection, maintenance of sessions, authentication and also ensures security.

Presentation Layer

- Presentation layer is also called the **Translation layer**.
- The data from the application layer is extracted here and manipulated as per the required format to transmit over the network.

The functions of the presentation layer are :

1. **Translation:** For example, ASCII to EBCDIC.
2. **Encryption/ Decryption:** Data encryption translates the data into another form or code.
3. **Compression:** Reduces the number of bits that need to be transmitted on the network.

Application Layer

- The very top of the OSI Reference Model stack of layers, we find Application layer which is implemented by the network applications. These applications produce the data, which has to be transferred over the network. This layer also serves as a window for the application services to access the network and for displaying the received information to the user.

  Ex: Application – Browsers, Skype Messenger etc.

- Application Layer is also called as Desktop Layer.

OSI model is a tool used by IT professionals to actually model or trace the actual flow of how data transfers in networks

Example: The simplest example of communication flow through the OSI Model is an email application. When a sender clicks “Send” on an email application, the message is sent to the presentation layer using a defined protocol (SMTP for outgoing email). The presentation layer compresses the data and sends the message to the session layer, which opens a session for communication between the sender’s device and the outgoing server. The message is sent to the transport layer where data is segmented, and then the network layer breaks the segments into packets. Then, the packets are sent from the network layer to the data link layer, where packets are further broken down into frames. The frames are sent to the physical layer where data is converted to bitstreams of ones and zeros and transferred across a medium such as wireless connections or cables.

When the message reaches the recipient, the process is reversed. Data is sent from the physical layer to the application layer, where data is converted from the bitstream ones and zeros to the message available in the recipient’s email client. When a message is sent back to the sender, the process is repeated, and communication flows down to layer 1 from layer 7 and back up the OSI Model when it reaches the recipient’s device.


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