BBA

Computer & IT Applications - I

UNIT 3

What is an Operating System?

An **Operating System** is a System software that manages all the resources of the computing device.

- Acts as an interface between the software and different parts of the computer or the computer hardware.
- Manages the overall resources and operations of the computer.
- Controls and monitors the execution of all other programs that reside in the computer, which also includes application programs and other system software of the computer.
- Examples of Operating Systems are Windows, Linux, macOS, Android, iOS, etc.

Operating System Goals:

- Run user applications and simplify problem-solving for users.
- Ensure the computer system is user-friendly and easy to navigate.
- Optimize the use of computer hardware for efficiency

What is an Operating System Used for?

- **As a platform for Application programs:** It provides a platform, on top of which, other programs, called application programs can run.
- **Managing Input-Output unit: It** also allows the computer to manage its own resources such as memory, monitor, keyboard, printer, etc. Management of these resources is required for effective and fair utilization.
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- **Multitasking:** It manages memory and allows multiple programs to run in their own space and even communicate with each other through shared memory.
- **Manages memory and Files:** It manages the computer's main memory and second storage. Additionally, it allows and deallocates memory to all tasks and applications.
- **Provides Security:** It helps to maintain the system and applications safe through the authorization process. Thus, the OS provides security to the system.

Operating System Structures

The "Operating System Structures" listed here, are fundamental parts of an operating system (OS) that work together to manage hardware, software, and user interactions efficiently.

- **Process Management:** Manages running programs (processes), including creation, scheduling, and termination for efficient CPU use.
- **Main Memory Management:** Allocates and tracks RAM usage for processes, using techniques like paging and virtual memory.
- **File Management:** Organizes, creates, deletes, and manages access to files on storage devices.
- **I/O System Management:** Coordinates data transfer between devices (e.g., keyboards, printers) and the system using drivers.
- **Secondary Storage Management:** Manages disks (e.g., HDDs, SSDs) for data storage, retrieval, and space allocation.
- **Networking:** Handles communication between computers, managing protocols and data transfer.
- **Protection System:** Secures resources by controlling access and authenticating users.
- **Command-Interpreter System:** Provides a user interface (e.g., command line) to interpret and execute user commands.

Objectives of Operating Systems

Let us now see some of the objectives of the operating system, which are mentioned below.

- **Convenient to use:** One of the objectives is to make the computer system more convenient to use in an efficient manner.
- **User Friendly:** To make the computer system more interactive with a more convenient interface for the users.
- **Easy Access:** To provide easy access to users for using resources by acting as an intermediary between the hardware and its users**.**
- **Management of Resources:** For managing the resources of a computer in a better and faster way.
- **Controls and Monitoring:** By keeping track of who is using which resource, granting resource requests, and mediating conflicting requests from different programs and users.
- **Fair Sharing of Resources:** Providing efficient and fair sharing of resources between the users and programs.

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)

Types of Operating System (OS)

Following are the popular types of OS (Operating System):

1. Batch Operating System
2. Multitasking/Time Sharing OS
3. Multiprocessing OS
4. Real Time OS
5. Distributed OS
6. Network OS
7. Mobile OS

1. Batch Operating System

Some computer processes are very lengthy and time-consuming. To speed the same process, a job with a similar type of needs are batched together and run as a group.The user of a batch operating system never directly interacts with the computer. In this type of OS, every user prepares his or her job on an offline device like a punch card and submit it to the computer operator.

2. Multi-Tasking/Time-sharing Operating systems

Time-sharing operating system enables people located at a different terminal(shell) to use a single computer system at the same time. The processor time (CPU) which is shared among multiple users is termed as time sharing.

3. Real time OS

A real time operating system time interval to process and respond to inputs is very small. Examples: Military Software Systems, Space Software Systems are the Real time OS example.

4. Distributed Operating System

Distributed systems use many processors located in different machines to provide very fast computation to its users.

5. Network Operating System

Network Operating System runs on a server. It provides the capability to serve to manage data, user, groups, security, application, and other networking functions.

6. Mobile OS

Mobile operating systems are those OS which is especially that are designed to power smartphones, tablets, and wearables devices.Some most famous mobile operating systems are Android and iOS, but others include BlackBerry, Web, and watchOS.

Difference between Multiprogramming, multitasking, multithreading and multiprocessing

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1. **Multiprogramming -** Multiprogramming is known as keeping multiple programs in the main memory at the same time ready for execution.
2. **Multiprocessing -** A computer using more than one CPU at a time.
3. **Multitasking -** Multitasking is nothing but multiprogramming with a Round-robin scheduling algorithm.
4. **Multithreading** is an extension of multitasking.

Feature	Multiprogramming	Multitasking	Multithreading	Multiprocessing
Definition	Running multiple programs on a single CPU	Running multiple tasks (applications) on a single CPU	Running multiple threads within a single task (application)	Running multiple processes on multiple CPUs (or cores)
Resource Sharing	Resources (CPU, memory) are shared among programs	Resources (CPU, memory) are shared among tasks	Resources (CPU, memory) are shared among threads	Each process has its own set of resources (CPU, memory)
Scheduling	Uses round-robin or priority-based	Uses priority-based or	Uses priority-based or time-	Each process can have its own

	scheduling to allocate CPU time to programs	time-slicing scheduling to allocate CPU time to tasks	slicing scheduling to allocate CPU time to threads	scheduling algorithm
Memory Management	Each program has its own memory space	Each task has its own memory space	Threads share memory space within a task	Each process has its own memory space
Context Switching	Requires a context switch to switch between programs	Requires a context switch to switch between tasks	Requires a context switch to switch between threads	Requires a context switch to switch between processes
Inter-Process Communication (IPC)	Uses message passing or shared memory for IPC	Uses message passing or shared memory for IPC	Uses thread synchronization mechanisms (e.g., locks, semaphores) for IPC	Uses inter-process communication mechanisms (e.g., pipes, sockets) for IPC

OR

What is multiprogramming?

In multiprogramming, one computer can run more than one program simultaneously. This allows for more efficiency and better use of resources.

Nevertheless, because each program has its own memory space, it may also increase the risk of errors and crashes.

What is multitasking?

Multitasking is when a single computer runs multiple programs at once, but only one program runs at a time. Each program gets some of the CPU's processing power while another program waits in line to get its turn. As a result, more resources are used efficiently, but error and crash risks are increased because multiple programs access memory space

simultaneously. Multitasking is the ability to do more than one thing at once. It is often used to refer to the ability to perform multiple tasks simultaneously but can also be used to describe the ability to switch between tasks quickly and efficiently.

What is multithreading?

Multithreading is Multiprocessing in computer runs multiple programs at once, but only one program runs at a time on each processor core (or thread). Each core gets some processing power from the CPU while another core waits in line to get its turn. The use of multiple threads simultaneously allows for more efficient resource use but also increases the risk of Multiprocessing Rashes.

What is multiprocessing?

Multiprocessing is when two or more computers work together to create a single system that appears as one computer to the user. This is also known as distributed processing. What is parallel processing? Parallel processing occurs when a single computer runs two or more applications simultaneously, but the work application runs on each processor core (or thread).

Difference between multiprogramming, multitasking, multithreading, and multiprocessing

Characteristics	**Multi-programming**	**Multitasking**	**Multi-threading**	**Multiprocessing**
Definition:	Multiprogramming refers to the practice of running many applications in parallel inside the same physical memory	Multitasking is the practice of working on many things at once.	Each thread is a small, independently executing process inside a larger process. Multithreading is the name for this approach.	Multiprocessing describes a system with more than one processor and can thus run many sets of instructions simultaneously.
Description	In computer programming, multiprogramming is a technique for maximising processor usage by allowing several processes to be run simultaneously. As a result of	Multithreading is a form of multitasking involving more than one thread of execution in a program, each of which shares some common process space and variables with other threads. When two or more	Multiprogramming was developed to allow simultaneous execution of programs on early computers with small amounts of memory. Multitasking expanded on this early idea, allowing multiple programs to execute simultaneously with	Multithreading is similar to multitasking but allows multiple threads within a single program instead of between various programs. Multiprocessing allows more than one CPU (central

	multitasking, an operating system can run several programs concurrently by sharing the computer's resources.	processors are used in a computer system, this is called multiprocessing.	complete memory protection, allowing unused memory space to be used by another program when needed.	processing unit) to work together as if they were one machine
Number of CPU:	One CPU is used.	One CPU is used.	Use one or more than one CPU.	More than one CPU is used.
Job processing time:	The tasks are taking longer to process.	Time commitment is not very much.	The time required to do a work is very standard.	Job processing times have been reduced.
Number of processes being executed:	One process is executed at a time.	One by one, the job is executed.	Many independent processes are occurring simultaneously	More than one process is executed
Economical:	Yes, it is economical,	Yes, it is economical,	Yes, it is economical,	No, it is not that much economical
Throughput:	There is a decrease in throughput.	Moderate throughput.	Average throughput.	Maximum throughput has been reached.
Efficiency:	Least	Moderate	Moderate	Maximum

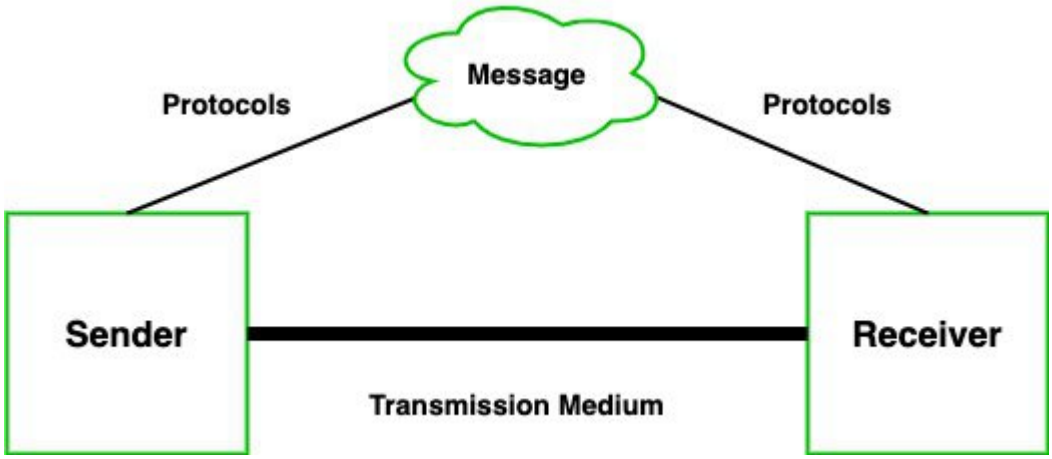
Data Communication - Definition, Components, Types, Channels

Transferring data over a transmission medium between two or more devices, systems, or places is known as data communication. Nowadays, computing and telecommunications depend heavily on this data transmission, which makes a variety of applications conceivable, including email, video chatting, the Internet, and many more things.

Components of Data Communication

A communication system is made up of the following components:

1. **Message:** A message is a piece of information that is to be transmitted from one person to another. It could be a text file, an audio file, a video file, etc.
2. **Sender:** It is simply a device that sends data messages. It can be a computer, mobile, telephone, laptop, video camera, or workstation, etc.
3. **Receiver:** It is a device that receives messages. It can be a computer, telephone mobile, workstation, etc.
4. **Transmission Medium / Communication Channels:** Communication channels are the medium that connect two or more workstations. Workstations can be connected by either wired media or wireless media.
5. **Set of rules (Protocol):** When someone sends the data (The sender), it should be understandable to the receiver also otherwise it is meaningless. For example, Sonali sends a message to Chetan. If Sonali writes in Hindi and Chetan cannot understand Hindi, it is a meaningless conversation.



Therefore, there are some set of rules (protocols) that is followed by every computer connected to the internet and they are:

- **TCP(Transmission Control Protocol)**: It is responsible for dividing messages into packets on the source computer and reassembling the received packet at the destination or recipient computer. It also makes sure that the packets have the information about the source of the message data, the destination of the message data, the sequence in which the message data should be re-assembled, and checks if the message has been sent correctly to the specific destination.
- **IP(Internet Protocol)**: Do You ever wonder how computer determines which packet belongs to which device. What happens if the message you sent to your friend is received by your father? Scary Right. Well! IP is responsible for handling the address of the destination computer so that each packet is sent to its proper destination.

Type of data communication

As we know that data communication is communication in which we can send or receive data from one device to another. The data communication is divided into three types:

1. **Simplex Communication:** It is one-way communication or we can say that unidirectional communication in which one device only receives and another device only sends data and devices uses their entire capacity in transmission. For example, IoT, entering data using a keyboard, listening music using a speaker, etc.
2. **Half Duplex communication:** It is a two-way communication, or we can say that it is a bidirectional communication in which both the devices can send and receive data but not at the same time. When one device is sending data then another device is only receiving and vice-versa. For example, walkie-talkie.
3. **Full-duplex communication:** It is a two-way communication or we can say that it is a bidirectional communication in which both the devices can send and receive data at the same time. For example, mobile phones, landlines, etc.

Communication Channels

Communication channels are the medium that connects two or more workstations. Workstations can be connected by either wired media or wireless media. It is also known as a transmission medium. The transmission medium or channel is a link that carries messages between two or more devices. We can group the communication media into two categories:

- Guided media transmission
- Unguided media transmission

1. **Guided Media:** In this transmission medium, the physical link is created using wires or cables between two or more computers or devices, and then the data is transmitted using these cables in terms of signals. Guided media transmission of the following types:

1. Twisted pair cable: It is the most common form of wire used in communication. In a twisted-pair cable, two identical wires are wrapped together in a double helix. The twisting of the wire reduces the crosstalk. It is known as the leaking of a signal from one wire to another due to which signal can corrupt and can cause network errors. The twisting protects the wire from internal crosstalk as well as external forms of signal interference. Types of Twisted Pair Cable :

- **Unshielded Twisted Pair (UTP):** It is used in computers and telephones widely. As the name suggests, there is no external shielding so it does not protects from external interference. It is cheaper than STP.
- **Shielded Twisted Pair (STP):** It offers greater protection from crosstalk due to shield. Due to shielding, it protects from external interference. It is heavier and costlier as compare to UTP.

2. Coaxial Cable: It consists of a solid wire core that is surrounded by one or more foil or wire shields. The inner core of the coaxial cable carries the signal and the outer shield provides the ground. It is widely used for television signals and also used by large corporations in building security systems. Data transmission of this cable is better but expensive as compared to twisted pair.

3. Optical fibers: Optical fiber is an important technology. It transmits large amounts of data at very high speeds due to which it is widely used in internet cables. It carries data as a light that travels inside a thin glass fiber. The fiber optic cable is made up of three pieces:

1. **Core:** Core is the piece through which light travels. It is generally created using glass or plastic.
2. **Cladding:** It is the covering of the core and reflects the light back to the core.
3. **Sheath:** It is the protective covering that protects fiber cable from the environment.

2. Unguided Media: The unguided transmission media is a transmission mode in which the signals are propagated from one device to another device wirelessly. Signals can wave through the air, water, or vacuum. It is generally used to transmit signals in all directions. Unguided Media is further divided into various parts :

1. Microwave: Microwave offers communication without the use of cables. Microwave signals are just like radio and television signals. It is used in long-distance communication. Microwave transmission consists of a transmitter, receiver, and atmosphere. In microwave communication, there are parabolic antennas that are mounted on the towers to send a beam to another antenna. The higher the tower, the greater the range.

2. Radio wave: When communication is carried out by radio frequencies, then it is termed radio waves transmission. It offers mobility. It is consists of the transmitter and the receiver. Both use antennas to radiate and capture the radio signal.

3. Infrared: It is short-distance communication and can pass through any object. It is generally used in TV remotes, wireless mouse, etc.

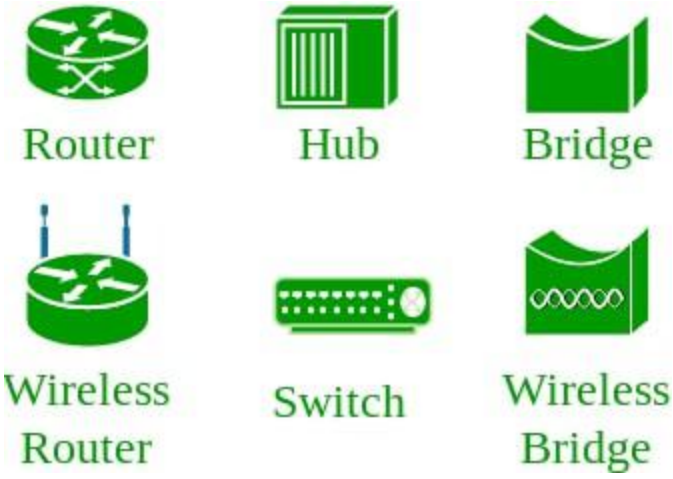
Important Concepts

- **Network:** A group of connected computers and devices that can communicate and share data with each other.
- **Node:** Any device that can send, receive, or forward data in a network. This includes laptops, mobiles, printers, earbuds, servers, etc.

- **Networking Devices:** Devices that manage and support networking functions. This includes routers, switches, hubs, and access points.
- **Transmission Media:** The physical or wireless medium through which data travels between devices.
- **Wired media:** Ethernet cables, optical fiber.
- **Wireless media:** Wi-Fi, Bluetooth, infrared
- **Service Provider Networks:** Networks offered by external providers that allow users or organizations to lease network access and capabilities. This includes internet providers, mobile carriers, etc.

Network Devices

An interconnection of multiple devices, also known as hosts, that are connected using multiple paths for the purpose of sending/receiving data or media. Computer networks can also include multiple devices/mediums which help in the communication between two different devices; these are known as Network devices and include things such as routers, switches, hubs, and bridges.



Network Devices

Various Network devices are:

1. Router
- Connects multiple networks (like home network to the internet).
- Directs data packets to their correct destination.

2. Switch
- Connects devices within a network (like computers in an office).
- Forwards data only to the specific device it is meant for.

3. Hub
- Basic device that connects multiple devices in a network.
- Sends data to all devices (less efficient than a switch).

4. Bridge

- Connects and filters traffic between two networks or segments.
- Helps reduce network traffic.

5. Gateway

- Connects two different types of networks.
- Translates data between different protocols.

6. Access Point (AP)

- Provides wireless connectivity to devices.
- Extends a wired network into a Wi-Fi network.

7. Modem

- Converts digital data from a computer into signals for phone/cable lines and vice versa.
- Provides internet access.

8. Firewall

- Monitors and controls incoming and outgoing network traffic.
- Provides security by blocking unauthorized access.

What is network?

A network is a collection of interconnected devices that communicate with each other to sh are resources, data, and services. It can include computers, servers, printers, and other d evices linked by communication channels, either wired or wireless. Essentially, a network all ows multiple devices to exchange information and collaborate effectively.

Types of Network

Networks can be classified into several types based on their size, purpose, and technology, including Personal Area Network (PAN), Local Area Network (LAN), Metropolitan Area Netw ork (MAN), and Wide Area Network (WAN).

1. Personal Area Network (PAN)

- **Definition**: A PAN is a small network designed for personal devices within a short ran ge, typically around 10 meters (33 feet).
- **Examples**: Bluetooth connections between smartphones and headphones, or connec ting a laptop to a printer.
- **Characteristics**: High-
  speed communication, low cost, and easy maintenance. It is primarily used for conne cting personal devices like smartphones, tablets, and wearables.

2. Local Area Network (LAN)

- **Definition**: A LAN connects computers and devices within a limited geographical area , such as a home, school, or office building.

- **Examples**: Wi-Fi networks in homes or wired networks in offices.
- **Characteristics**: High data transmission speeds, low cost, and easy maintenance. LAN typically use Ethernet or WiFi technology and can cover distances up to 2 kilometers.

3. Metropolitan Area Network (MAN)

- **Definition**: A MAN covers a larger geographical area than a LAN, typically spanning a city or a large campus.
- **Examples**: Networks connecting multiple buildings in a university or a city-wide Wi-Fi network.

Characteristics: High speed data transmission, often using optical fiber connections. MANs are suitable for connecting multiple LANs within a specific area.

4. Wide Area Network (WAN)

- **Definition**: A WAN connects networks over large geographical distances, often spanning countries or continents.
- **Examples**: The Internet is the largest WAN, connecting millions of devices worldwide

Characteristics: Lower data transmission speeds compared to LANs and MANs, and often requires leased telecommunication lines. WANs are used for connecting multiple LANs and MANs.

5. Campus Area Network (CAN)

- **Definition**: A CAN is larger than a LAN but smaller than a MAN, typically used in educational institutions or corporate campuses.
- **Examples**: Networks connecting several buildings within a university or a corporate office complex.
- **Characteristics**: Uses Ethernet technology and covers a few kilometers, allowing for high-speed data transmission.

These types of networks serve different purposes and are essential for facilitating communication and resource sharing in various environments. Understanding these classifications helps in selecting the appropriate network type for specific needs.

Types of Network Topology

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A network topology is the arrangement of devices (nodes) and connections (links) in a computer network. It shows how computers, servers, and other devices are connected and how data flows between them. There are two main types of topology:

- **Physical Topology:** The actual physical layout of cables and devices.
- **Logical Topology:** How data moves across the network, regardless of physical layout.

Note: *Choosing the right topology is important because it affects the performance, cost, reliability, and security of the network.*

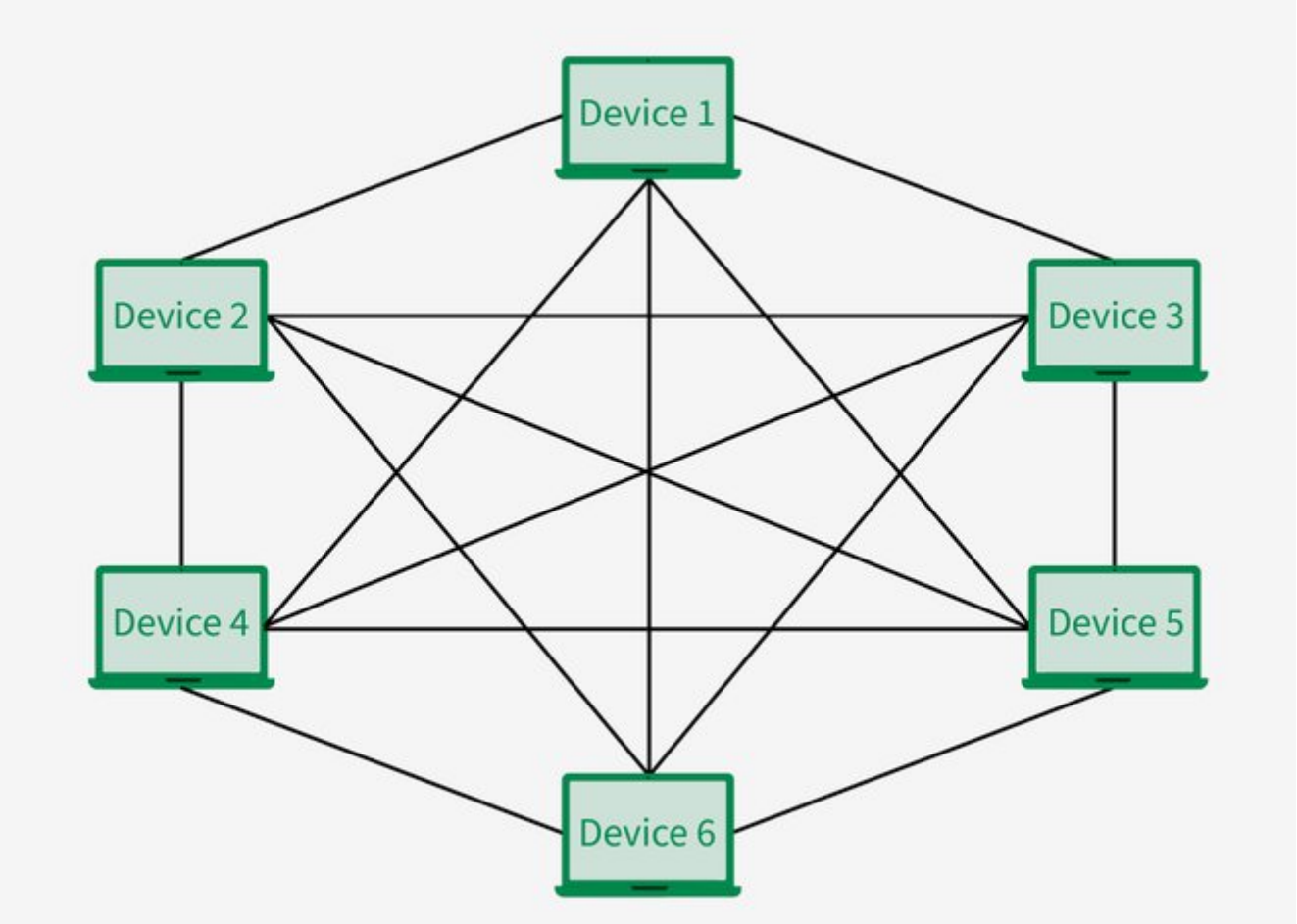
Point to Point Topology

Point-to-point topology is a type of topology that works on the functionality of the sender and receiver. It is the simplest communication between two nodes, in which one is the sender and the other one is the receiver. Point-to-Point provides high bandwidth.

Point-to-point Topology

Mesh Topology

In a mesh topology, every device is connected to another device via a particular channel. Every device is connected to another via dedicated channels. These channels are known as links. In Mesh Topology, the protocols used are AHCP (Ad Hoc Configuration Protocols), DHCP (Dynamic Host Configuration Protocol), etc.



Mesh Topology

- Suppose, the N number of devices are connected with each other in a mesh topology, the total number of ports that are required by each device is N−1*N*−1. In Figure , there are 6 devices connected to each other, hence the total number of ports required by each device is 5. The total number of ports required = N * (N-1)= N * (N-1).
- Suppose, N number of devices are connected with each other in a mesh topology, then the total number of dedicated links required to connect them is NC2*NC*2 i.e. N * (N-1)/2N * (N-1)/2. In Figure, there are 6 devices connected to each other, hence the total number of links required is 6 * 5/2 = 156 * 5/2 = 15.

Advantages of Mesh Topology

- Communication is very fast between the nodes.
- Mesh Topology 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.

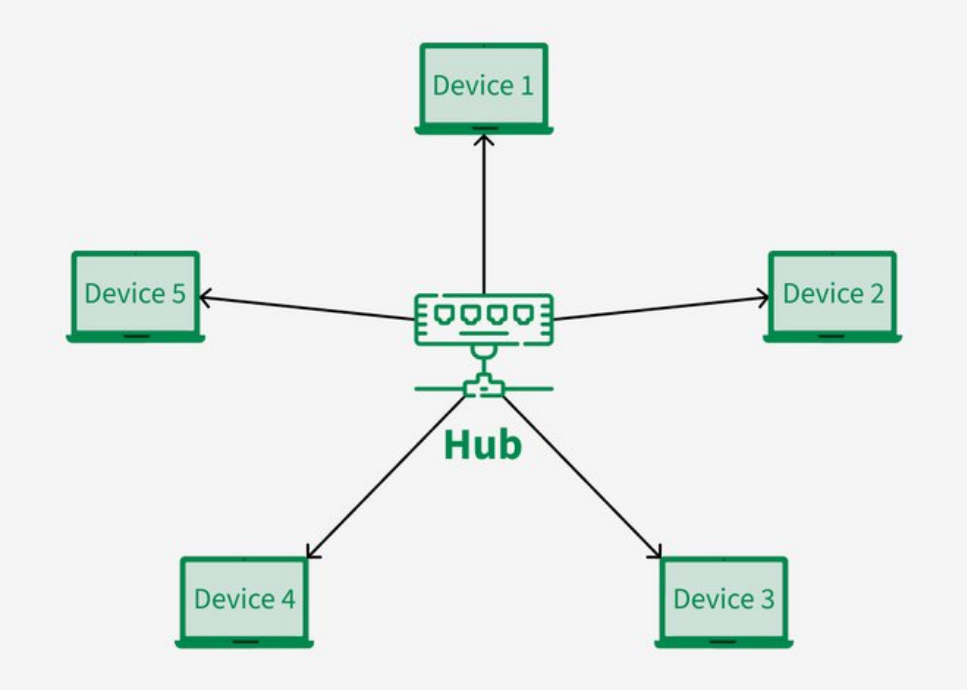
Disadvantages of Mesh Topology

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

Note: *A common example of mesh topology is the internet backbone, where various internet service providers are connected to each other via dedicated channels. This topology is also used in military communication systems and aircraft navigation systems.*

Star Topology

In Star Topology, all the devices are connected to a single hub through a cable. This hub is the central node and all other nodes are connected to the central node. The hub can be passive in nature i.e., not an intelligent hub such as broadcasting devices, at the same time the hub can be intelligent known as an active hub. Active hubs have repeaters in them.



Star Topology

Note: *Here, Coaxial cables or RJ-45 cables are used to connect the computers & many popular Ethernet LAN protocols are used as CD(Collision Detection), CSMA (Carrier Sense Multiple Access), etc.*

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.

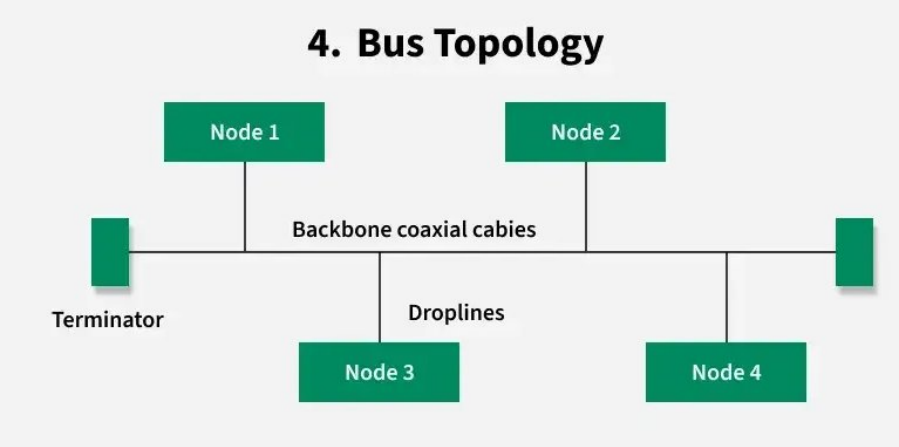
Disadvantages of Star Topology

- 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.

Note: *A common example of star topology is a local area network (LAN) in an office where all computers are connected to a central hub. This topology is also used in wireless networks where all devices are connected to a wireless access point.*

Bus Topology

Bus Topology is a network type in which every computer and network device is connected to a single cable. It is bi-directional. It is a multi-point connection and a non-robust topology because if the backbone fails the topology crashes. In Bus Topology, various MAC (Media Access Control) protocols are followed by LAN ethernet connections like TDMA, Pure Aloha, CDMA, Slotted Aloha, etc.



Bus Topology

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.
- Coaxial or twisted pair cables are mainly used in bus-based networks that support up to 10 Mbps.

- The cost of the cable is less compared to other topologies, but it is used to build small networks.
- Bus topology is familiar technology as installation and troubleshooting techniques are well known.
- CSMA is the most common method for this type of topology.

Disadvantages of Bus Topology

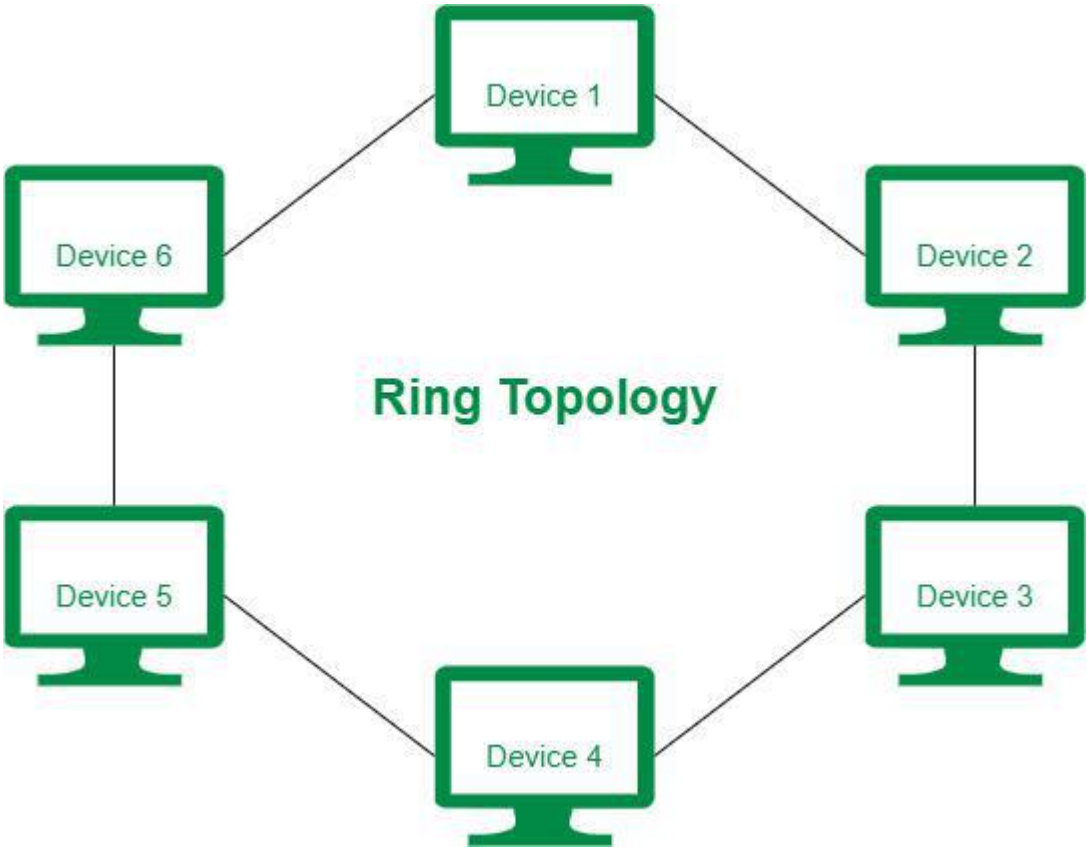
- A bus topology is quite simpler, but still, it requires a lot of cabling.
- If the common cable fails, then the whole system will crash down.
- If the network traffic is heavy, it increases collisions in the network. To avoid this, various protocols are used in the MAC layer known as Pure Aloha, Slotted Aloha, CSMA/CD, etc.
- Adding new devices to the network would slow down networks.
- Security is very low.

Note: *A common example of bus topology is the Ethernet LAN, where all devices are connected to a single coaxial cable or twisted pair cable. This topology is also used in cable television networks.*

Ring Topology

In a Ring Topology, it forms a ring connecting devices with exactly two neighboring devices. A number of repeaters are used for Ring topology with a 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.

In-Ring Topology, the Token Ring Passing protocol is used by the workstations to transmit the data where, Token passing is a network access method in which a token is passed from one node to another node & Token is a frame that circulates around the network.



Ring Topology

Note: *Here, data flows in one direction, but it can be made bidirectional by having 2 connections between each Network Node, it is called Dual Ring Topology.*

Operations of Ring Topology

- One station is known as a monitor station which takes all the responsibility for performing the operations.
- To transmit the data, the station has to hold the token. After the transmission is done, the token is to be released for other stations to use.
- When no station is transmitting the data, then the token will circulate in the ring.

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.

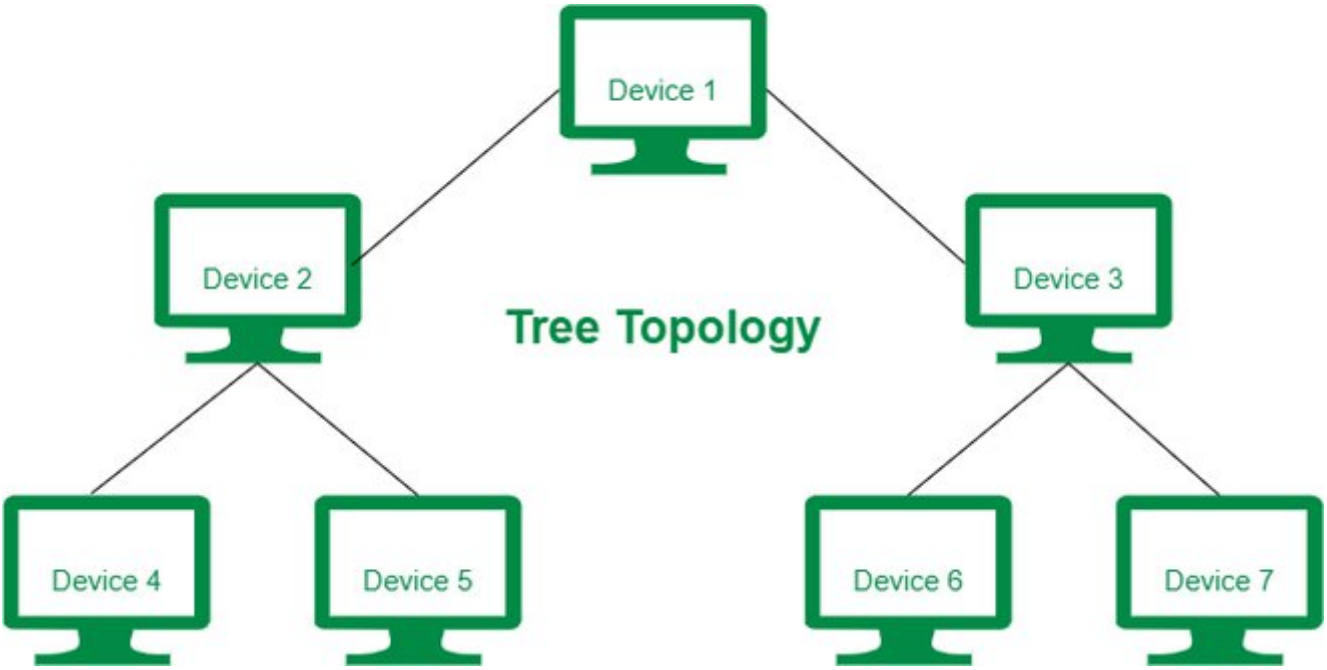
Disadvantages of Ring Topology

- The failure of a single node in the network can cause the entire network to fail.
- Troubleshooting is difficult in this topology.
- Less secure.

Tree Topology

Tree topology is the variation of the Star topology. This topology has a hierarchical flow of data. In Tree Topology, protocols like DHCP and SAC (Standard Automatic Configuration) are used.

- Here, various secondary hubs are connected to the central hub which contains the repeater.
- This data flow from top to bottom i.e. from the central hub to the secondary and then to the devices or from bottom to top i.e. devices to the secondary hub and then to the central hub.
- It is a multi-point connection and a non-robust topology because if the backbone fails the topology crashes.



Tree Topology

Advantages of Tree Topology

- It allows more devices to be attached to a single central hub thus it decreases the distance that is traveled by the signal to come to the devices.
- It allows the network to get isolated and also prioritize from different computers.
- We can add new devices to the existing network.

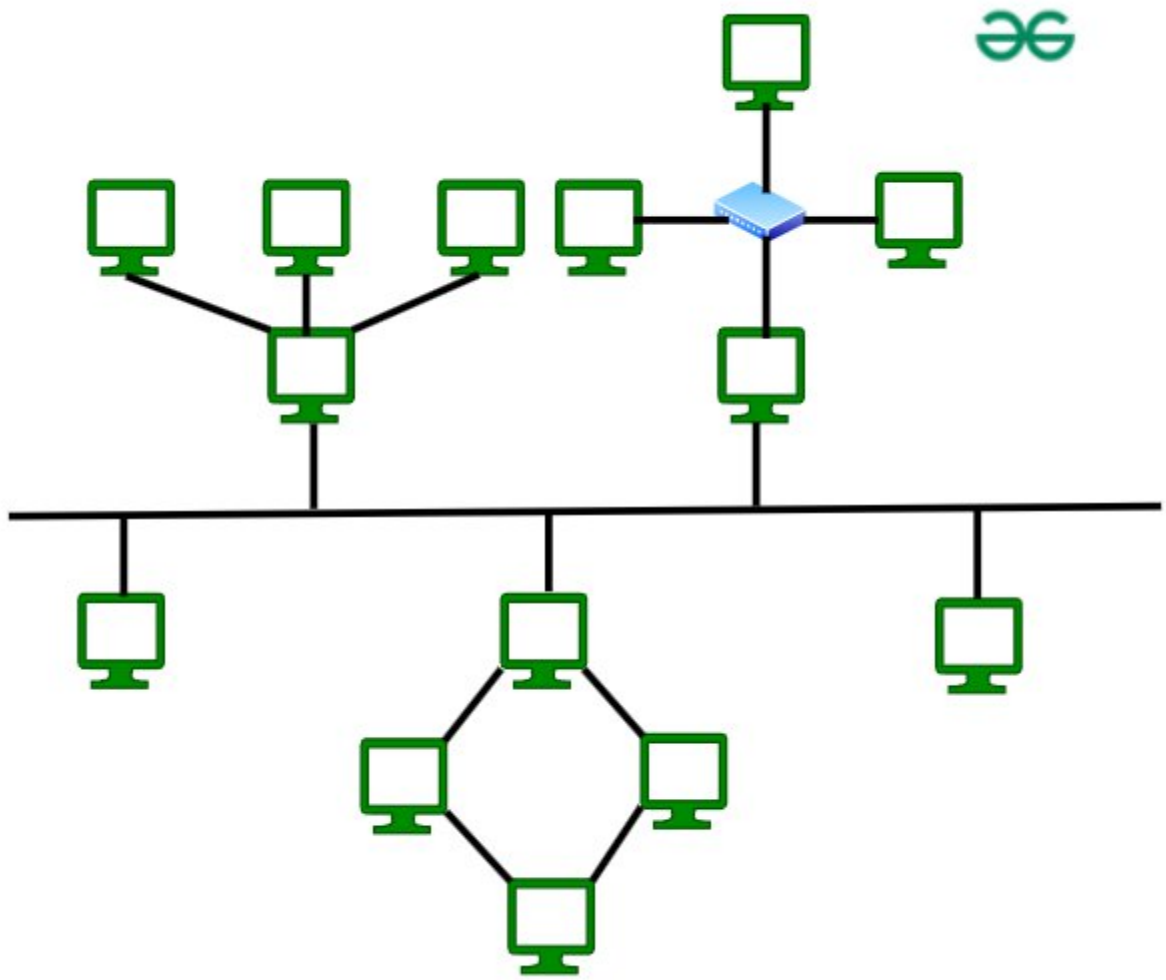
Disadvantages of Tree Topology

- If the central hub gets fails the entire system fails.
- The cost is high because of the cabling.
- If new devices are added, it becomes difficult to reconfigure.

Note: *A common example of a tree topology is the hierarchy in a large organization. CEO is the root, who is connected to the different departments(child nodes) of the company, managers overseeing different teams (grandchild nodes) & team members (leaf nodes) are at the bottom of the hierarchy.*

Hybrid Topology

Hybrid Topology is the combination of all the various types of topologies we have studied above. Hybrid Topology 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.



Hybrid Topology

Advantages of Hybrid Topology

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

Disadvantages of Hybrid Topology

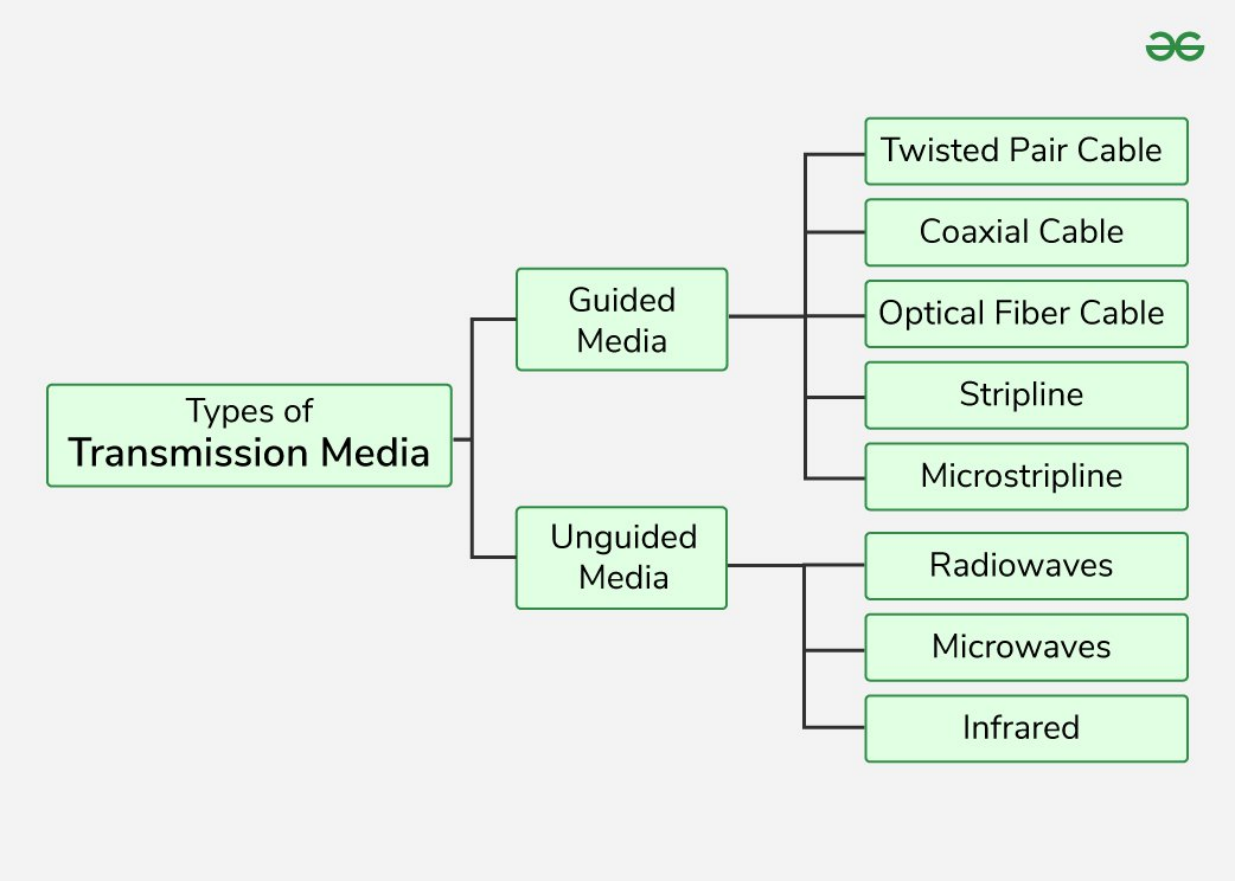
- It is challenging to design the architecture of the Hybrid Network.
- Hubs used in this topology are very expensive.
- The infrastructure cost is very high as a hybrid network requires a lot of cabling and network devices .

Note: A common example of a hybrid topology is a university campus network. The network may have a backbone of a star topology, with each building connected to the backbone through a switch or router. Within each building, there may be a bus or ring topology connecting the different rooms and offices.

Transmission Media in Computer Networks

Transmission media is the physical medium through which data is transmitted from one device to another within a network. These media can be wired or wireless. The choice of medium depends on factors like distance, speed, and interference. In this article, we will discuss the transmission media and it's types in detail.

Transmission Media is broadly classified into the following types:



Types of Transmission Media

1. Guided Media

Guided Media is also referred to as Wired or Bounded transmission media. Signals being transmitted are directed and confined in a narrow pathway by using physical links. There are 3 major types of Guided Media: Twisted Pair, Coaxial and Optical Fiber Cables

Features:

- High Speed
- Secure
- Used for comparatively shorter distances

1.1 Twisted Pair Cable

It consists of 2 separately insulated conductor wires twisted about each other. Generally, several such pairs are bundled together in a protective sheath. They are the most widely used Transmission Media. Twisted Pair is of two types:

(a) Unshielded Twisted Pair (UTP): UTP consists of two insulated copper wires twisted around one another. This type of cable has the ability to block interference and does not depend on a physical shield for this purpose. It is used for telephonic applications.

Unshielded Twisted Pair Unshielded Twisted Pair

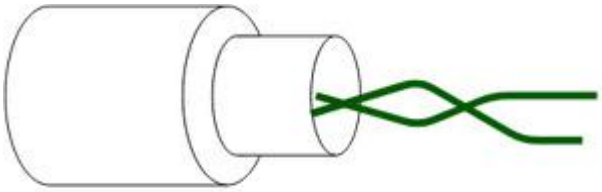
Advantages:

- Least expensive
- Easy to install
- High-speed capacity

Disadvantages:

- Lower capacity and performance in comparison to STP
- Short distance transmission due to attenuation

(b) Shielded Twisted Pair (STP): Shielded Twisted Pair (STP) cable consists of a special jacket (a copper braid covering or a foil shield) to block external interference. It is used in fast data rate Ethernet and in voice and data channels of telephone lines.



Shielded Twisted Pair Shielded Twisted Pair

Advantages:

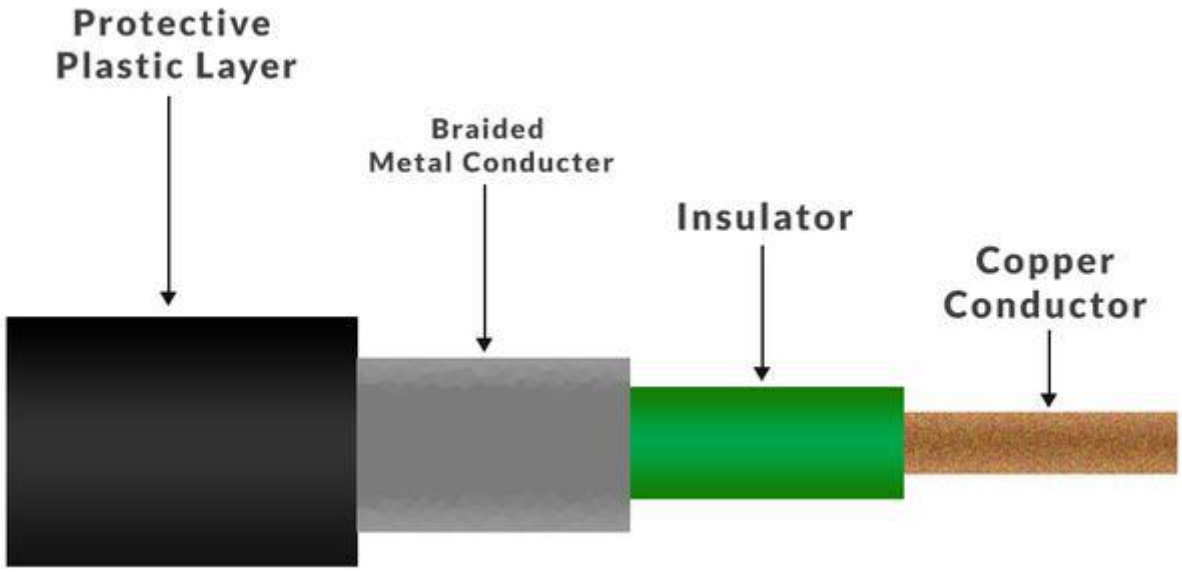
- Better performance at a higher data rate in comparison to UTP
- Eliminates crosstalk
- Comparatively faster

Disadvantages:

- Comparatively difficult to install and manufacture
- More expensive
- Bulky

1.2 Coaxial Cable

Coaxial cable has an outer plastic covering containing an insulation layer made of PVC or Teflon and 2 parallel conductors each having a separate insulated protection cover.
The coaxial cable transmits information in two modes: Baseband mode(dedicated cable bandwidth) and Broadband mode(cable bandwidth is split into separate ranges). Cable TVs and analog television networks widely use Coaxial cables.



Coaxial Cable

Advantages:

- Coaxial cables has high bandwidth .
- It is easy to install.
- Coaxial cables are more reliable and durable.
- Less affected by noise or cross-talk or electromagnetic inference.
- Coaxial cables support multiple channels

Disadvantages:

- Coaxial cables are expensive.
- The coaxial cable must be grounded in order to prevent any crosstalk.
- As a Coaxial cable has multiple layers it is very bulky.
- There is a chance of breaking the coaxial cable and attaching a “t-joint” by hackers, this compromises the security of the data.

1.3 Optical Fiber Cable

Optical Fibre Cable uses the concept of total internal reflection of light through a core made up of glass. The core is surrounded by a less dense glass or plastic covering called the

coating. It is used for the transmission of large volumes of data. The cable can be unidirectional or bidirectional. The WDM (Wavelength Division Multiplexer) supports two modes, namely unidirectional and bidirectional mode.

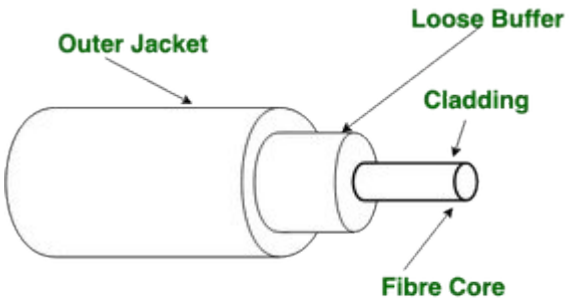


Figure of Optical Fibre Cable

Advantages:

- Increased capacity and bandwidth
- Lightweight
- Less signal attenuation
- Immunity to electromagnetic interference
- Resistance to corrosive materials

Disadvantages:

- Difficult to install and maintain
- High cost

Applications:

- **Medical Purpose:** Used in several types of medical instruments.
- **Defence Purpose:** Used in transmission of data in aerospace.
- **For Communication:** This is largely used in formation of internet cables.
- **Industrial Purpose:** Used for lighting purposes and safety measures in designing the interior and exterior of automobiles.

2.1 Radio Waves

Radio waves are easy to generate and can penetrate through buildings. The sending and receiving antennas need not be aligned. Frequency Range: 3KHz - 1GHz3KHz - 1GHz. AM and FM radios and cordless phones use Radio waves for transmission.

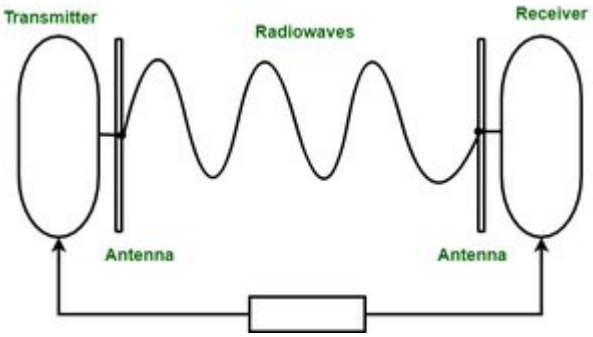
Types of Radio Waves:

- Short Wave: AM Radio

- VHF (Very High Frequency): FM Radio/TV
- UHF (Ultra High Frequency): TV

Radio Wave Components:

- Transmitter: Responsible for encoding the signal.
- Receiver: Responsible for decoding the signal.



Radiowave

2.2 Microwaves

It is a line of sight transmission i.e. the sending and receiving antennas need to be properly aligned with each other. The distance covered by the signal is directly proportional to the height of the antenna. Frequency Range:1GHz - 300GHz. Micro waves are majorly used for mobile phone communication and television distribution.

Advantages:

- Cheaper than using cables
- Freedom from land acquisition
- Ease of communication in difficult terrains
- Communication over oceans

Disadvantages:

- Insecure communication.
- Out of phase signal.
- Susceptible to weather conditions.
- Bandwidth is limited.
- High cost of design, implementation, and maintenance.

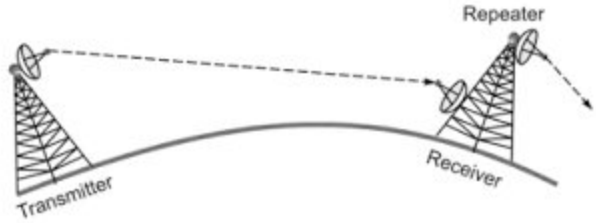


Fig: Microwave Transmission

Microwave Transmission

2.3 Infrared

Infrared waves are used for very short distance communication. They cannot penetrate through obstacles. This prevents interference between systems. Frequency Range:300GHz - 400THz. It is used in TV remotes, wireless mouse, keyboard, printer, etc.

Difference between Radio Waves, Micro Waves, and Infrared Waves

Basis	Radiowave	Microwave	Infrared wave
Direction	These are omni-directional in nature.	These are unidirectional in nature.	These are unidirectional in nature.
Penetration	At low frequency, they can penetrate through solid objects and walls but high frequency they bounce off the	At low frequency, they can penetrate through solid objects and walls. at high frequency, they	They cannot penetrate through any solid object and walls.

Basis	Radiowave	Microwave	Infrared wave
	obstacle.	cannot penetrate.	
Frequency range	Frequency range: 3 KHz to 1GHz.	Frequency range: 1 GHz to 300 GHz.	Frequency range: 300 GHz to 400 GHz.
Security	These offers poor security.	These offers medium security.	These offers high security.
Attenuation	Attenuation is high.	Attenuation is variable.	Attenuation is low.
Government License	Some frequencies in the radio-waves require government license to use these.	Some frequencies in the microwaves require government license to use these.	There is no need of government license to use these waves.
Usage Cost	Setup and usage Cost is moderate.	Setup and usage Cost is high.	Usage Cost is very less.
Communication	These are used in long distance communication.	These are used in long distance communication.	These are not used in long distance communication.