

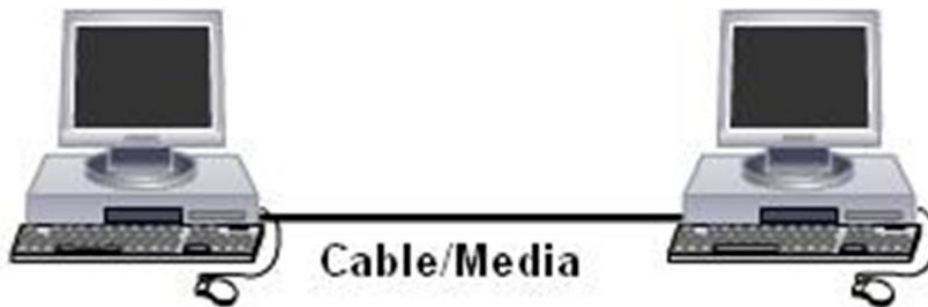


Computer Networking

By: Rahul Gupta
mail: rhlgupta091@gmail.com

What is Networking?

Connections between two or more computers or devices with each other through any transmission media for the purpose of sharing information, application program and resources is called “Network” and this process is called “Networking”.



“Collection of two or more than two computers or devices is called Network.”

“Sharing of resources between two or more than two computers or devices is called Networking.”

“Network means not only computers, it can any device like as Television & Mobile etc.”

“Concept of Networking does not change even if there are two computers or million computers connected.”

ADVANTAGES OF NETWORK:

- Speed
- Cost
- Security
- Centralized Software Management
- Resource Sharing
- Electronic Mail
- Flexible Access

DISADVANTAGES OF NETWORK:

- Server faults stop applications being available
- Network faults can cause loss of data.
- Network fault could lead to loss of resources
- User work dependent upon network
- System open to hackers
- Decisions tend to become centralised
- Could degrade in performance
- Resources could be located too far from users
- Difficult to manage large Network

Requirement to Network Data Communication:

- Sender
- Receiver
- Media
 - Guided Media (Wired)
 - Un-guided Media (Wireless)
- Message
- Protocols

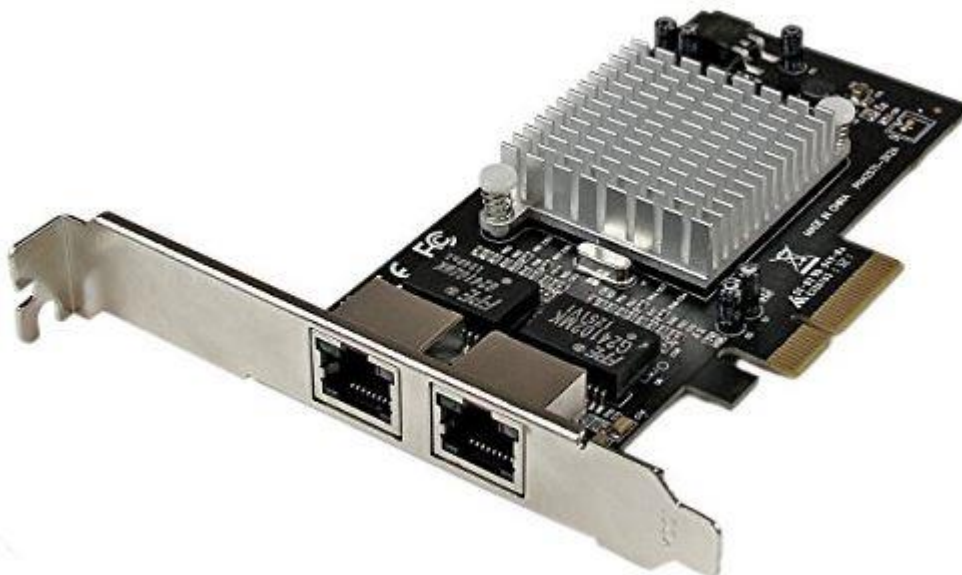
Networking Devices

Network devices are components used to connect computers or other electronic devices together so that they can share files or resources like printers or fax machines.

- **NIC:** Network Interface Card is also called LAN Card, Ethernet Card, Network Interface Unit (NIU) and Network Adapter. It is networking device that is used to connect two computers in a network using wired or wireless connection. Every NIC has unique 48-bit hexa-decimal address that is called MAC (Media Access Control) Address or Hardware Address.

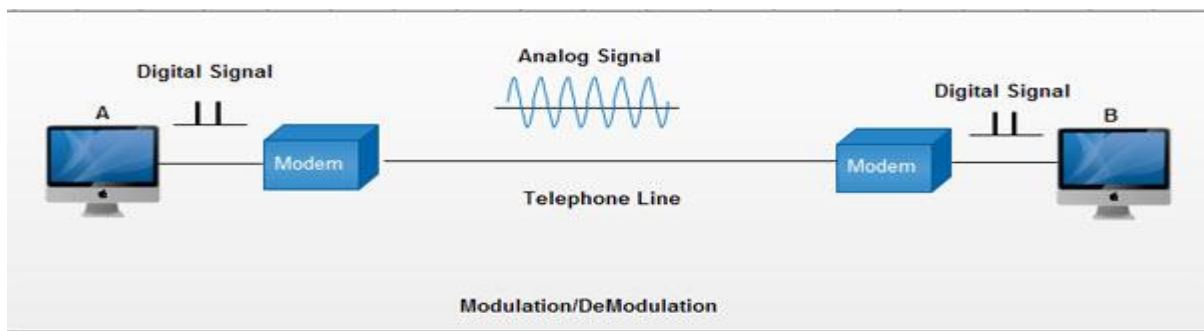
24-Bit : Vendor ID

24-Bit : Serial No. of Product



- **MODEM:** Modems are used for data transfer from one computer network to another computer network through telephone lines. The computer network works in digital mode, while analog technology is used for carrying messages across phone lines.

Modulator converts information from digital mode to analog mode at the transmitting end and demodulator converts the same from analog to digital at receiving end. The process of converting analog signals of one computer network into digital signals of another computer network so they can be processed by a receiving computer is referred to as digitizing.



When an analog facility is used for data communication between two digital devices called Data Terminal Equipment (DTE), modems are used at each end. DTE can be a terminal or a computer.

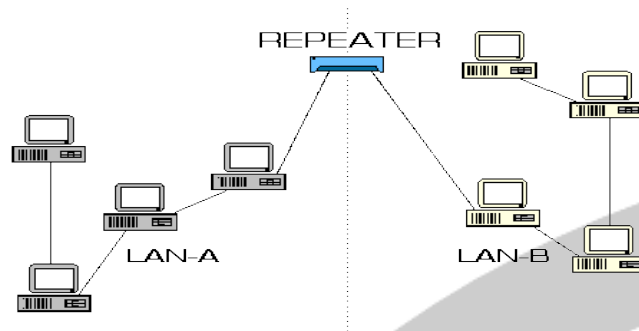
- **Hub:** a hub is the most basic networking device that connects multiple computers or other network devices together. Unlike a network switch or router, a network hub has no routing tables or intelligence on where to send information and broadcasts all network data across each connection. Most hubs can detect basic network errors such as collisions, but having all information broadcast to multiple ports can be a security risk and cause bottlenecks. In the past, network hubs were popular because they were cheaper than a switch or router. Today, switches do not cost much more than a hub and are a much better solution for any network.



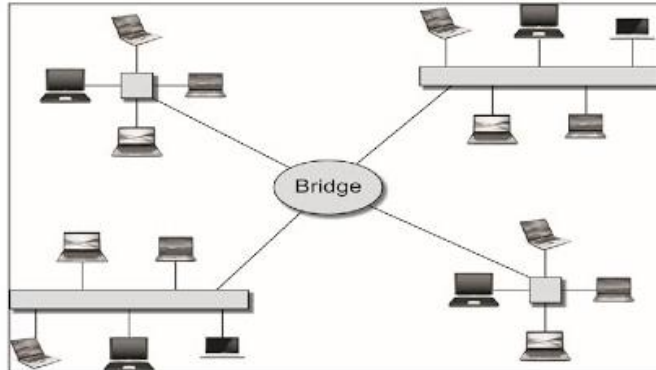
- **Switches:** Switch is also a networking device that looks like a hub with multiple ports but it does not work like multiport repeater. It is an intelligent device. A switch in an Ethernet-based LAN reads incoming TCP/IP data packets/frames containing destination information as they pass into one or more input ports. The destination information in the packets is used to determine which output ports will be used to send the data on to its intended destination.



- **Repeaters:** A network device used to regenerate or replicate a signal. Repeaters are used in transmission systems to regenerate analog or digital signals distorted by transmission loss. A repeater operates at the physical layer. An important point to be noted about repeaters is that they do not amplify the signal. When the signal becomes weak, they copy the signal bit by bit and regenerate it at the original strength. It is a 2-port device.



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



- **Router:** A router is a device that routes data packets based on their IP addresses. Router is mainly a Network Layer device that connects different networks. Routers normally connect LANs and WANs together. A Router also decides the best and shortest possible path, if multiple paths exist between source and destination.



Types of Network

Computer network can be classified according to their geographical area and their uses.

Depending upon the geographical area covered by a network, it is classified as:

- Local area network(LAN)
- Wide area network(WAN)
- Personal area network(PAN)
- Metropolitan area network(MAN)
- Campus Area Network (CAN)
- Home Area Network(HAN)
- Wireless Local Area Network (WLAN)

Depending upon the purpose by a network, it is classified as:

- Storage area network(SAN)
- Enterprise private network(EPN)
- Virtual private network(VPN)

Local Area Network (LAN)

A LAN is a small and privately-owned network to provide local connectivity within a small region. "A region" refers to the same office, the same building, the same company and in the same schools. It provides different services like document management, sharing resources, workgroup scheduling, e-mail and fax communications services and other VOIP and unified communication. Some common LAN protocols are Ethernet, Asynchronous Transfer Mode (ATM), Token Ring and Fiber Distributed Data Interface (FDDI).

Characteristics of a LAN include:

- Limited geographic operation up to 10 Km
- High speed data transfer rates
- Full time connectivity to local services
- Generally lower in cost than a WAN
- It uses mainly bus, ring and star topology
- LAN support a variety of transmission medium such as Ethernet, fiber, wireless etc
- Requires little wiring, typically a single cable connecting to each device

There are basically two types of Local Area Networks:

1. ARCNet
2. Ethernet

1. ARCNET (Attached Resource Computer NETwork):

ARCNET is one of the oldest, simplest, and least expensive types of Local-Area Network protocol, similar in purpose to Ethernet or Token Ring. ARCNET was the first widely available networking system for microcomputers and became popular in the 1980s for office automation tasks. ARCNet was introduced by Data-point Corporation in 1977.

A special advantage of ARCNET is that it permits various types of transmission media - twisted-pair wire, coaxial cable, and fiber optic cable - to be mixed on the same network. The specification is ANSI 878.1. It can have up to 255 nodes per network.

A new specification, called ARCNet Plus, will support data rates of 20 Mbps

2. Ethernet:

Ethernet is a family of computer networking technologies for local area networks commercially introduced in 1980. Standardized in IEEE 802.3, Ethernet has largely replaced competing wired local area network technologies. Ethernet uses a bus or star topology Network and supports data transfer rates of 10 Mbps.

Ethernet Network uses the CSMA/CD access method to handle simultaneous demands. It is one of the most widely implemented LAN standards. A newer version of Ethernet Network, called 100Base-T (or Fast Ethernet), supports data transfer rates of 100 Mbps.

And the newest version, Gigabit Ethernet supports data rates of 1 gigabit (1,000 megabits) per second. Ethernet is a physical and data link layer technology for local area networks (LANs). Ethernet Network was invented by engineer Robert Metcalfe.

Advantages and Disadvantages of LAN

Advantages:

- Lower in cost
- Sharing of Resources
- High Speed
- Security

Disadvantages:

- When number of nodes become increases then performance became decrease.
- Area covered is limited.

Wide Area Network (WAN)

A WAN is used to transmit data and information over large geographical distances which may even span entire countries and continents. A WAN can contain multiple smaller networks, such as LANs or MANs. The Internet is a WAN, and connects computers all around the world together.

Communication between networks is called internetworking. WAN may use advanced technologies such as Asynchronous Transfer Mode (ATM), Frame Relay, and Synchronous Optical Network (SONET). WAN may be managed by multiple administration.

Advantages and Disadvantages of WAN

Advantages:

- large geographical area

Disadvantages

- Complicated and complex
- High cost
- Required high performance devices
- low security
- WANs use very expensive network equipment.

Classification of WAN:

- Internet (Public Network)
- Intranet (Private Network)
- Extranet (Private + Public Network)

Internet:

Internet is a global or public network. Internet is the example of Wide Area Network (WAN), which is a group of Local Area Network (LAN) that covers broad area environments in which company offices are in different cities, states, or countries or on different continents.

We use internet web application (HTTP, FTP) that provides the information anywhere in the world on the internet.

Intranet:

An Intranet is a private network that includes a LAN, MAN & WAN. That is basically a Company Network.

Extranet:

Extranet is a public and private network. It is an extended intranet like as Bank.

Personal Area Network (PAN)

PAN is used to transmit data and information very shorter distances which control by a single person within a single building. PAN has connectivity range up to 10 meters. PAN may include wireless computer keyboard and mouse, Bluetooth enabled headphones, wireless printers, mobile, tablet, IPAD and TV remotes. For example, Internet hotspot which may contain up to 8 devices connected with a single hotspot.

Advantages and Disadvantages of PAN**Advantages**

- PANs are efficient, cost-effective and convenient.
- security because it is control by single person

Disadvantages:

- Shorter distance up to 10 meters only
- Data rate is low compare to other network

Metropolitan Area Network (MAN)

A MAN is a network designed to extend over an entire city. The MAN range of between 10 to 50 miles. This is a network which is larger than a LAN but smaller than a WAN.

A MAN may be single network [like a cable television network] or may be formed by connecting a large number of LANs [like a company using a MAN to connect to the LANs in all of its offices throughout a city].

Advantages and Disadvantages of MAN

Advantages:

- It is wider area than a LAN
- It is a large network connectedness, information can be disseminated more widely, rapidly and significantly.

Disadvantages:

- Data rate is slow compare to LAN
- Cost is higher than LAN, required more devices and cables to covered large area.
- It is difficult to manage.

Campus Area Network (CAN)

Campus Area Network is larger than a LAN, but smaller than an MAN. It area cover a university, large school or small business. It is controlled by the campus tenant/ owner: an enterprise, university, government etc. The range of CAN is measured 1Km to 5Km.

Advantages and Disadvantages of CAN

Advantages:

- Cost-effective
- It can be wireless or wired network
- Multi-departmental network access
- Managed-service available
- High Bandwidth

Disadvantages:

- Difficult to managed.

Home area Network (HAN)

A Home area network (HAN) is a type of computer network that operate within a small area typically a home or small office. It connects home digital devices, such as PCs, mobile phones, tablets, smart watch, entertainment technology, thermostats, home security systems and smart appliances, into a common network. With the increasing availability of Internet service and affordable PCs, more people are networking their multiple PCs and network-capable devices to use a single broadband outlet, usually through a cable or DSL provider.

Advantages and Disadvantages of HAN

Advantages:

- Resource Sharing: - Network resources can easily share between devices like internet sharing.
- Easy to manage: - It is managed by single person.
- High Security: - Only know person can use resources.
- Easy Accessible

Disadvantages:

- If backbone network damaged than whole network become halt
- Lack of Wi-fi Password: - If wireless security very weak than hacker can use resources or damaged resources.
- Health: - The wave generated from wi-fi devices can harm brain.

Wireless Local Area Network (WLAN)

A wireless LAN or WLAN is a wireless local area network to communication over short distances using radio wave. Areas may range from a single room to an entire campus. The backbone of this network usually cables, with one or more wireless access points connecting the wireless users to the wired network. A WLAN can be built using any of several different wireless network protocols, most commonly either Wi-Fi or Bluetooth. Wireless LANs can contain many different kinds of devices including.

- mobile phones
- laptop and tablet computers

- Internet audio systems
- game consoles
- Internet-enabled home appliances

Advantages and Disadvantages of WLAN

Advantages:

- Portable: - A nodes can communicate without restriction within radio coverage.
- Planning: - wireless networks allow for communication without planning. Wired networks need wiring plans.
- Installation is quick and easy, and can eliminate the need of cable through walls / ceiling and wall / ceiling.
- Easier to provide connectivity in areas that are difficult to lay cable.

Disadvantages:

- Low Bandwidth due to interference.
- WLAN adapters costlier than ethernet adapters.
- Security is difficult to maintain.
- Increase in nodes reduce the data transfer rate.
- A device is operated within range of radio wave.

Storage Area Network (SAN)

A Storage Area Network (SAN) is a specialized, high-speed network joining servers and storage, including disks, disk arrays, tapes, etc. It provides block-level storage that can be accessed by the applications running on any networked servers. It consists of hosts, switches, storage elements, and storage devices that are interconnected with various technologies, topologies, and protocols.

A storage area network is typically assembled using three principle components: cabling, host bus adapters (HBA) and switches.

Advantages and Disadvantages of SAN

Advantages:

- Scalability: - It can add multiple device without limit of a handful of disks that are attach to a system
- Performance: - Data transmitted to and from a SAN is on its own private network partitioned off from user traffic, backup traffic and other SAN traffic. that why performance is not affected.

- Uptime: - SAN systems require no reboots to add new disks, to replace disks or to configure RAID groups.
- Versatile: - A SAN can be single entity, a master grouping of several SANs and can include SANs in remote locations.
- It provides long distance connectivity.
- Disaster Recovery: - A SAN is a reliable and fast data recovery solution.

Disadvantages:

- It is expensive to implement.
- Require high level of skill to maintain and troubleshoot problems.

Enterprise Private Network (EPN)

An enterprise private network is a network build by an enterprise/company to interconnect disparate offices to each other in a secure way over a network e.g., production offices, head offices etc. An enterprise private network is mainly build for sharing computer resources.

Advantages of EPN

- Security: - Their all communications are secure because they are encrypted.
- Sharing: - They shared their resource, for cost cutting.
- Centralize: - All offices of company connected to each other they sharing their message to each other very easily.
- It helps in business continuity.

Virtual Private Network (VPN)

A virtual private network (VPN) is a network technology that creates a secure connection over a public network like Internet or a private network owned by a service provider. Big company, institutions, and government agencies use VPN technology to enable remote users to securely connect to a private network. for example, A company employee go for meeting out of country and urgently need company resources to access, then he can access resource by using VPN.

Educational institutions use VPNs to connect campuses that can be distributed across the country or around the world.

The most common types of VPNs are remote-access VPNs and site-to-site VPNs.

A remote-access VPN allows users to establish secure connections with a remote computer network using a laptop or desktop computer connected to the Internet.

A site-to-site VPN allows offices to establish secure connections with each other over a public network such as the Internet.

Advantages and Disadvantages of VPN

Advantages:

- **Cost:** - It is inexpensive way to build a private network, because it uses internet for communication between sites is a cost-effective alternative to expensive leased private lines and telephone charges associated with long distance are reduced.
- **Security:** - Virtual private networks uses higher level of secure communication when compared to other remote methods of communication.
- **Scalability:** - Virtual private networks are very flexible in terms of growing with the company and adding new users to the network.
- **Mobility:** - It allow users to get connected with their company resources from anywhere in world using a public network.

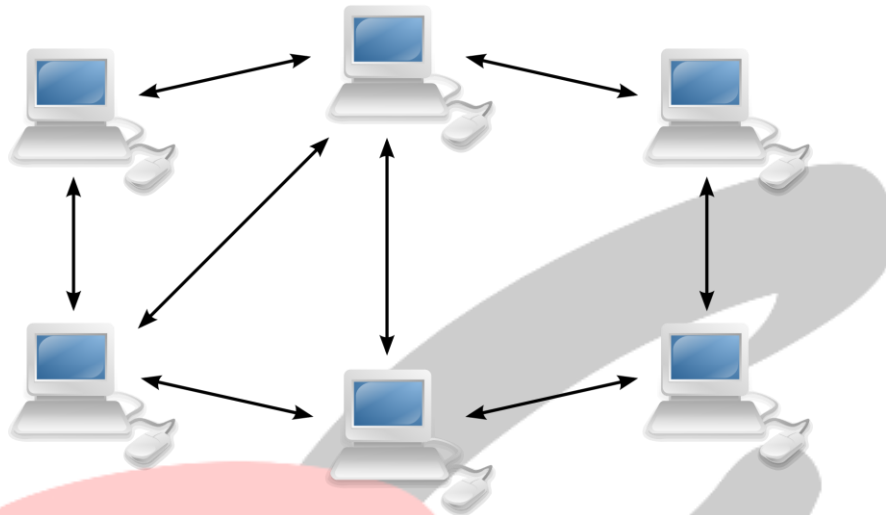
Disadvantages:

- **Bandwidth:** - Bandwidth is major drawback of VPN, because public network very slow compare to Leased line.
- **VPN security** must have configured properly otherwise it easy for hacker to compromise the company resources.

Network Architecture

- **Peer to Peer Network:**

In peer-to-peer networking there are no dedicated servers or hierarchy among the computers. All the computers are equal and therefore known as peers. Normally each computer serves as Client/Server and there is no one assigned to be an administrator responsible for the entire network.



- Peer to peer is a type of architecture in which nodes are interconnected with each other and share resources with each other without the central controlling server.
- P2P system allows us to construct such a distributed system or a application in which all resources and data is contributed by the hosts over the network.
- P2P system allows us to be sharing of data at very large scale without the use of any server whose job is to manage the scaling it means that scaling of data can be done without a server.
- P2P are used in File-sharing, web-caching and providing information to user. Bit torrent is an example of P2P applications which use P2P architecture.

Advantages of Peer to Peer:

- It is easy to install.
- All resources are shared by all nodes with each other without a server.
- Central dependency is eliminated.
- It is more reliable.
- Cost of building and maintaining this p2p network is less as compared to other network.

Disadvantages of Peer to Peer:

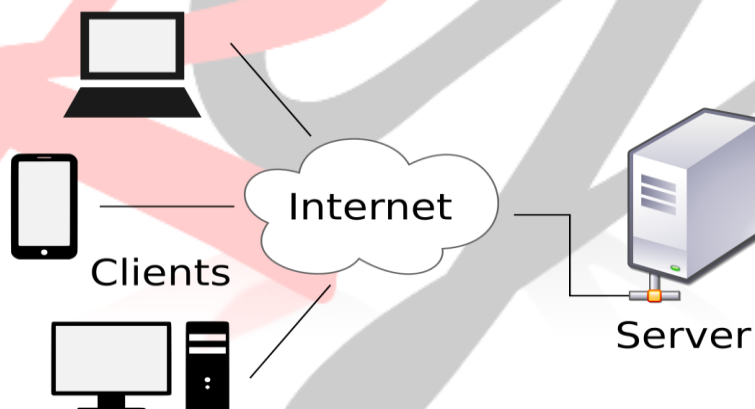
- As we know there is not central server so that network cannot be administrated for example we cannot filter the files being shared by the nodes with each other.
- Security is another issue in this network as malware can easily be transmitted across the network.
- Because of no centralized server we cannot make a backup of system every node has to make backup of its own data in his system.
- Transferring of sensitive data through the p2p is not recommended.

- **Client/Server Network:**

The term Client/server refers to the concept of sharing the work involved in processing data between the client computer and the most powerful server computer.

The client/server network is the most efficient way to provide:

- Databases and management of applications such as Spread sheets, Accounting, Communications and Document management.
- Network management.
- Centralized file storage.



- The application is modelled as a set of services that are provided by servers and a set of clients that use these services.
- Clients know of servers but servers need not know of clients.
- Clients and servers are logical processes.

Types of Client-Server Architecture

- **2-tier:** The three application layers are mapped onto two computer systems which are the client and the server.

Client can be

- ✓ Thin client or
- ✓ Fat client

- **3-tier:** The three application layers are mapped onto three logically separate processes that executes on different processors

What is Fat & Thin Client

A **fat client** (also called heavy, rich or thick client) is a computer (client) in client server architecture or networks that typically provides rich functionality independent of the central server

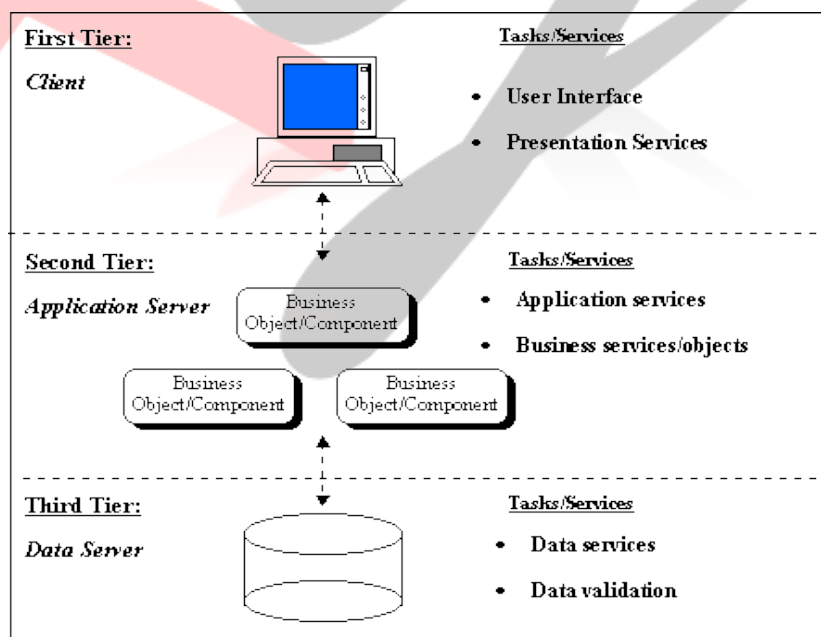
Example: SMTP, FTP, DNS Server

A **thin client** (sometimes also called a lean, zero or slim client) is a computer or a program or an application that depends heavily on another computer (its server) to fulfill its computational roles.

Example: MS Outlook, Remote Desktop

3-Tier Architecture

- Each of the application layers may execute on a separate processor.
- Allows for better performance than a thin-client model and is simpler to manage than a fat-client model.
- A more scalable architecture - as demands increase, extra servers can be added.



2-Tier Architecture:

- The Two-tier architecture is divided into two parts:
- Client Application (Client Tier)
- Database (Data Tier)

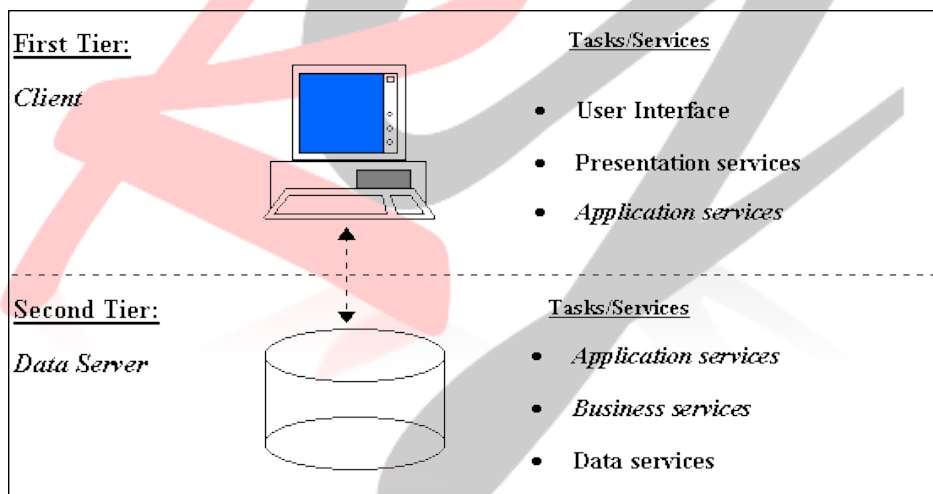
For e.g.: On client application side the code is written for saving the data in the SQL server database. Client sends the request to server and it process the request & send back with data. The main problem of two tier architecture is the server cannot respond multiple request same time, as a result it causes a data integrity issue.

Advantages:

- ✓ Easy to maintain and modification is bit easy
- ✓ Communication is faster

Disadvantages:

- ✓ In two tier architecture application performance will be degrade upon increasing the users.
- ✓ Cost-ineffective



Advantage of Client-Server Architecture:

- Centralization
- Proper Management
- Back-up and Recovery possible
- Upgradation and Scalability in Client-server set-up
- Accessibility
- Security
- Servers can play different roles for different clients

Disadvantage of Client-Server Architecture:

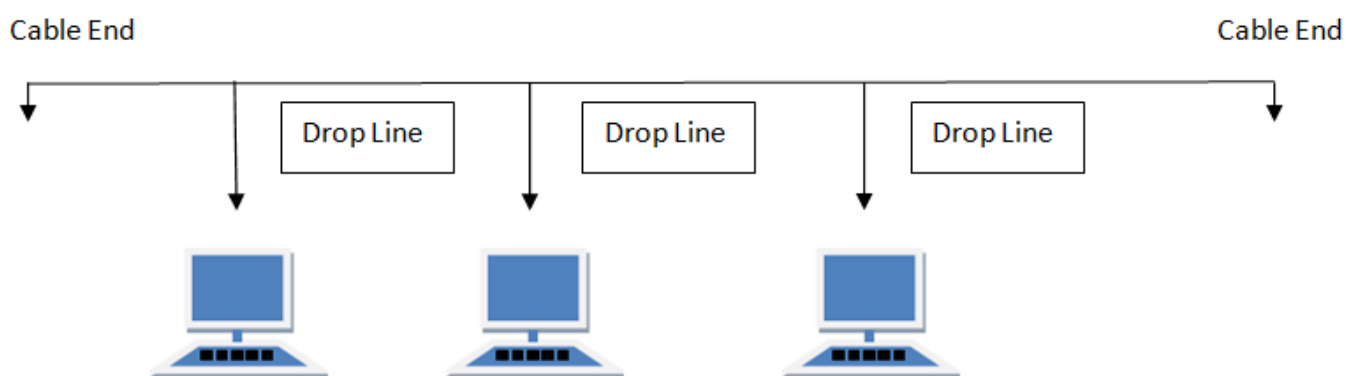
- Congestion in Network: Too many requests from the clients may lead to congestion, which rarely takes place in P2P network. Overload can lead to breaking-down of servers. In peer-to-peer, the total bandwidth of the network increases as the number of peers increase.
- Client-Server architecture is not as robust as a P2P and if the server fails, the whole network goes down. Also, if you are downloading a file from server and it gets abandoned due to some error, download stops altogether. However, if there would have been peers, they would have provided the broken parts of file.
- Cost: It is very expensive to install and manage this type of computing.
- You need professional IT people to maintain the servers and other technical details of network.

Network Topology

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

- **BUS Topology**

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



Features of Bus Topology:

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

Advantages of Bus Topology:

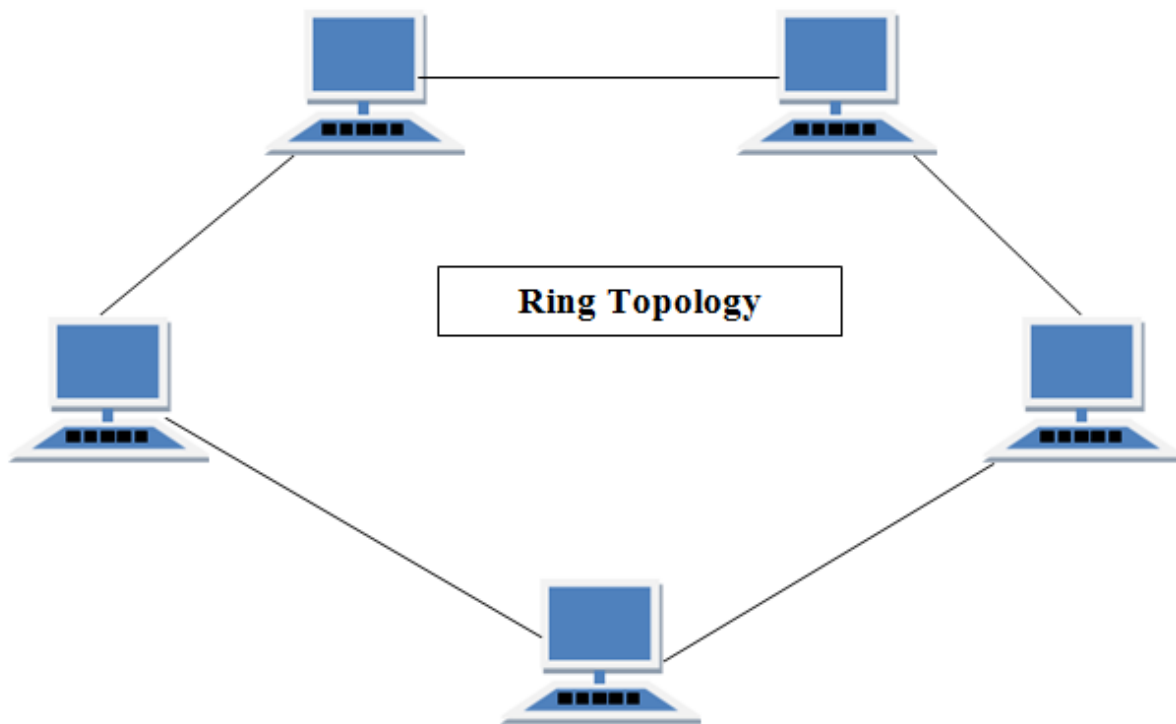
- It is cost effective.
- Cable required is least compared to other network topology.
- Used in small networks.
- It is easy to understand.
- Easy to expand joining two cables together.

Disadvantages of Bus Topology:

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

- **RING Topology**

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



Features of Ring Topology:

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

Advantages of Ring Topology:

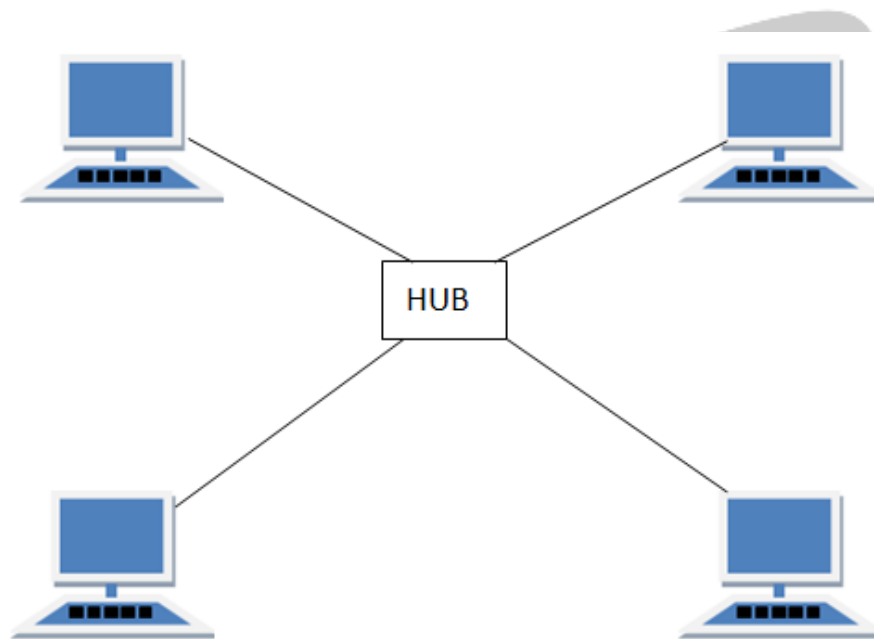
- Transmitting network is not affected by high traffic or by adding more nodes, as only the nodes having tokens can transmit data.
- Cheap to install and expand

Disadvantages of Ring Topology:

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

- **STAR Topology**

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



Features of Star Topology:

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

Advantages of Star Topology:

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

Disadvantages of Star Topology:

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

- **MESH Topology**

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

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

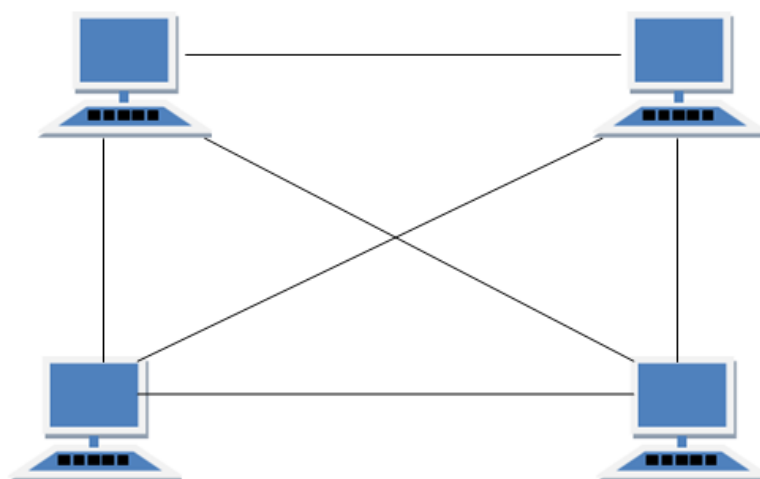
- Routing
- Flooding

Routing:

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

Flooding:

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



Types of Mesh Topology:

Partial Mesh Topology: In this topology, some of the systems are connected in the same fashion as mesh topology but some devices are only connected to two or three devices.

Full Mesh Topology: Each and every nodes or devices are connected to each other.

Features of Mesh Topology:

- Fully connected.
- Robust.
- Not flexible.

Advantages of Mesh Topology:

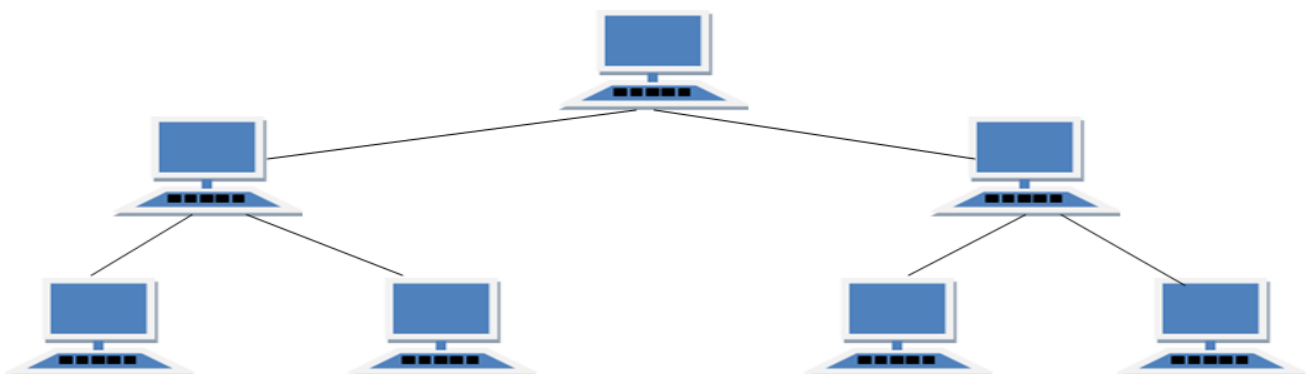
- Each connection can carry its own data load.
- It is robust.
- Fault is diagnosed easily.
- Provides security and privacy.

Disadvantages of Mesh Topology:

- Installation and configuration is difficult.
- Cabling cost is more.
- Bulk wiring is required.

- **TREE Topology**

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



Features of Tree Topology:

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

Advantages of Tree Topology

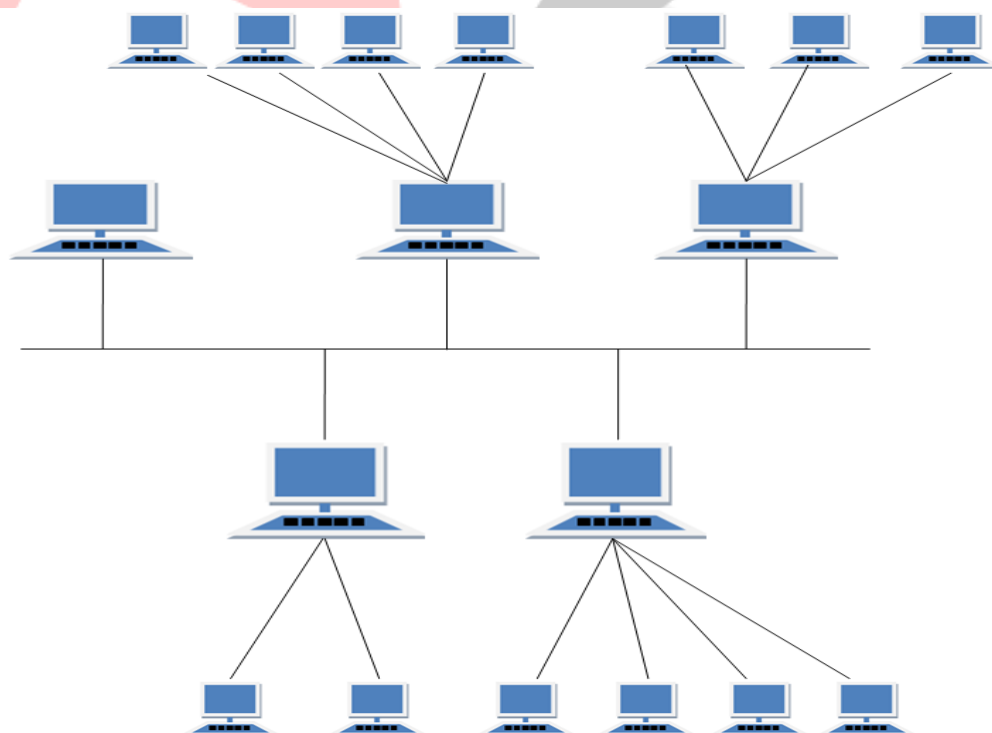
- Extension of bus and star topologies.
- Expansion of nodes is possible and easy.
- Easily managed and maintained.
- Error detection is easily done.

Disadvantages of Tree Topology:

- Heavily cabled.
- Costly.
- If more nodes are added maintenance is difficult.
- Central hub fails, network fails.

- **HYBRID Topology**

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



Features of Hybrid Topology:

- It is a combination of two or topologies
- Inherits the advantages and disadvantages of the topologies included

Advantages of Hybrid Topology:

- Reliable as Error detecting and troubleshooting is easy.
- Effective.
- Scalable as size can be increased easily.
- Flexible.

Disadvantages of Hybrid Topology:

- Complex in design.
- Costly.

Transmission Media

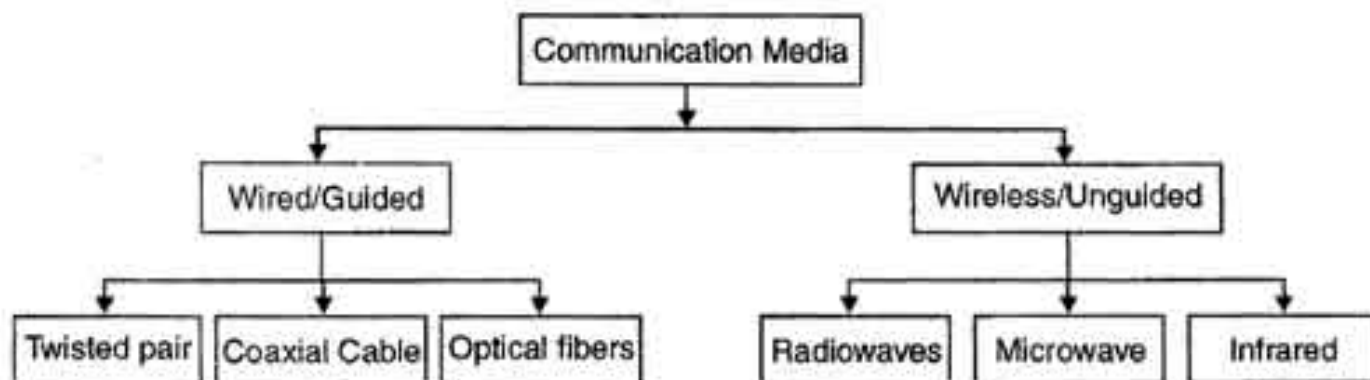
Transmission media is a pathway that carries the information from sender to receiver. We use different types of cables or waves to transmit data. Data is transmitted normally through electrical or electromagnetic signals.

- An electrical signal is in the form of current.
- An electromagnetic signal is series of electromagnetic energy pulses at various frequencies.
- signals can be transmitted through copper wires, optical fibers, atmosphere, water and vacuum
- Transmission media is also called Communication channel.

Types of Transmission Media

Transmission media is broadly classified into two groups:

- Wired or Guided Media or Bound Transmission Media
- Wireless or Unguided Media or Unbound Transmission Media



Wired or Guided Media or Bound Transmission Media

Bound transmission media are the cables that are tangible or have physical existence and are limited by the physical geography.

- Popular bound transmission media in use are twisted pair cable, co-axial cable and fiber optical cable.
- Each of them has its own characteristics like transmission speed, effect of noise, physical appearance, cost etc.

Wireless or Unguided Media or Unbound Transmission Media

Unbound transmission media are the ways of transmitting data without using any cables. These media are not bounded by physical geography. This type of transmission is called Wireless communication.

- Nowadays wireless communication is becoming popular.
- Wireless LANs are being installed in office and college campuses.
- This transmission uses Microwave, Radio wave, Infra red are some of popular unbound transmission media.

Transmission Media Factors

Bandwidth: It refers to the data carrying capacity of a channel or medium. Higher bandwidth communication channels support higher data rates.

Radiation: It refers to the leakage of signal from the medium due to undesirable electrical characteristics of the medium.

Noise Absorption: It refers to the susceptibility of the media to external electrical noise that can cause distortion of data signal.

Attenuation: It refers to loss of energy as signal propagates outwards. The amount of energy lost depends on frequency. Radiations and physical characteristics of media contribute to attenuation.

Guided Media

Twisted Pair Cable

- A transmission medium consisting of pairs of twisted copper wires.
- We can transmit 1 Mbps over short distances (less than 100m).
- They are mainly used to transmit analog signals, but they can be used for digital signals.

Types of Twisted Pair Cable

Unshielded Twisted Pair (UTP)

Shielded Twisted Pair (STP)

Unshielded Twisted Pair

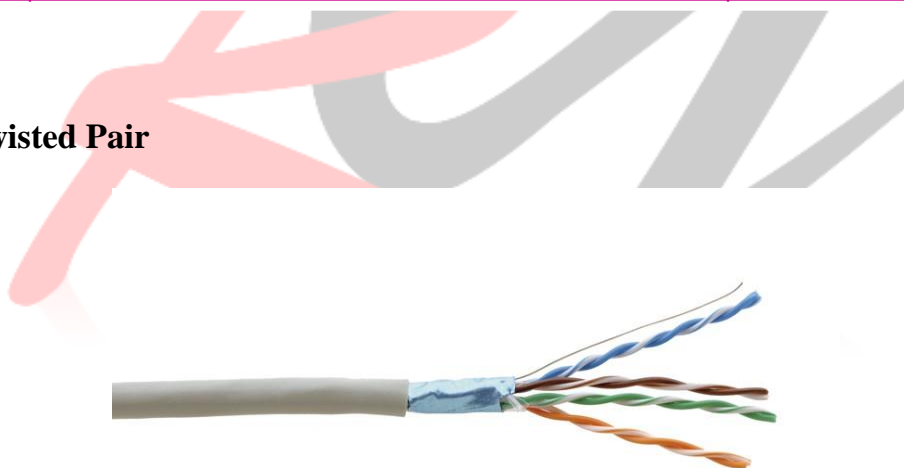


- Unshielded twisted pair (UTP) cables are widely used in the computer and telecommunications industry as Ethernet cables and telephone wires.
- In an UTP cable, conductors which form a single circuit are twisted around each other in order to cancel out electromagnetic interference (EMI) from external sources. Unshielded means no additional shielding like meshes or aluminum foil, which add bulk, are used.
- UTP cables are often groups of twisted pairs grouped together with color coded insulators, the number of which depends on the purpose.

Categories of unshielded twisted-pair cables

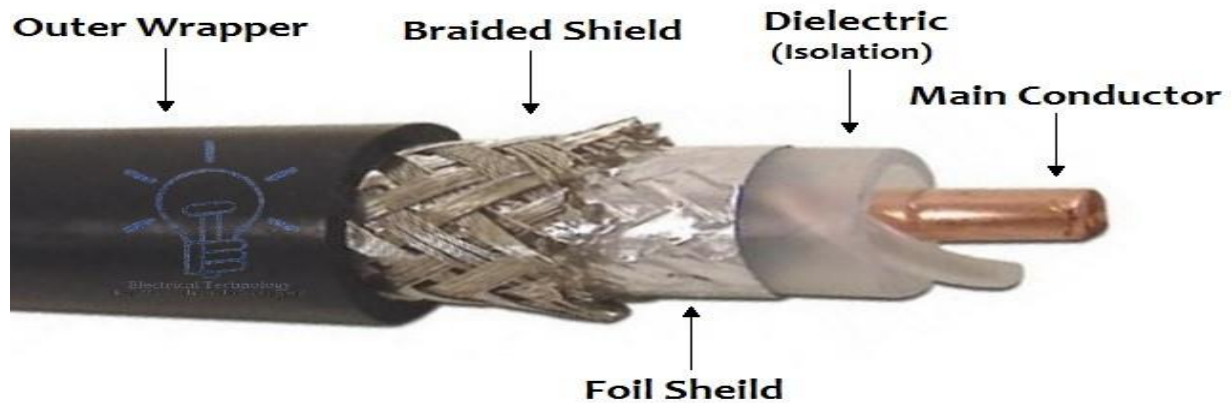
<i>Category</i>	<i>Specification</i>	<i>Data Rate (Mbps)</i>	<i>Use</i>
1	Unshielded twisted-pair used in telephone	< 0.1	Telephone
2	Unshielded twisted-pair originally used in T-lines	2	T-1 lines
3	Improved CAT 2 used in LANs	10	LANs
4	Improved CAT 3 used in Token Ring networks	20	LANs
5	Cable wire is normally 24 AWG with a jacket and outside sheath	100	LANs
5E	An extension to category 5 that includes extra features to minimize the crosstalk and electromagnetic interference	125	LANs
6	A new category with matched components coming from the same manufacturer. The cable must be tested at a 200-Mbps data rate.	200	LANs
7	Sometimes called SSTP (shielded screen twisted-pair). Each pair is individually wrapped in a helical metallic foil followed by a metallic foil shield in addition to the outside sheath. The shield decreases the effect of crosstalk and increases the data rate.	600	LANs

Shielded Twisted Pair



- Shielded twisted pair (STP) cable was originally designed by IBM for token ring networks that include two individual wires covered with a foil shielding, which prevents electromagnetic interference, thereby transporting data faster.
- STP is similar to unshielded twisted pair (UTP); however, it contains an extra foil wrapping or copper braid jacket to help shield the cable signals from interference. STP cables are costlier when compared to UTP, but has the advantage of being capable of supporting higher transmission rates across longer distances.

Coaxial Cable

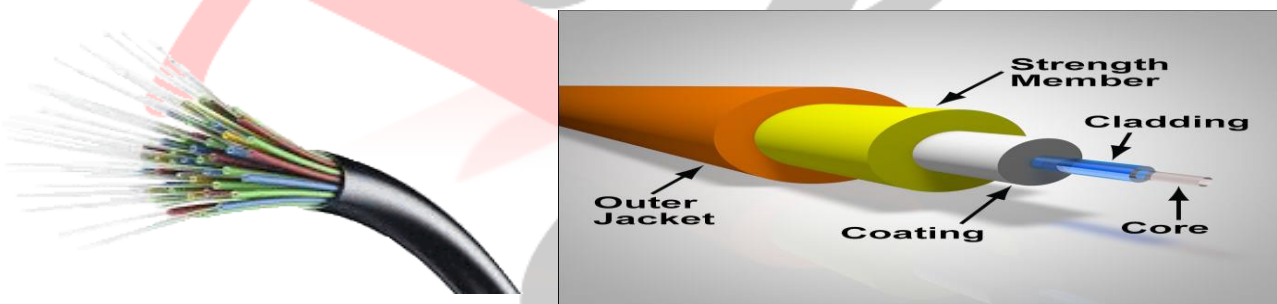


Coaxial Cable

Coaxial consists of a core made of solid copper surrounded by insulation, a braided metal shielding, and an outer cover.

- This media is used in base band and broadband transmission.
- Coaxial cables do not produce external electric and magnetic fields and are not affected by them.
- This makes them ideally suited, although more expensive, for transmitting signals.

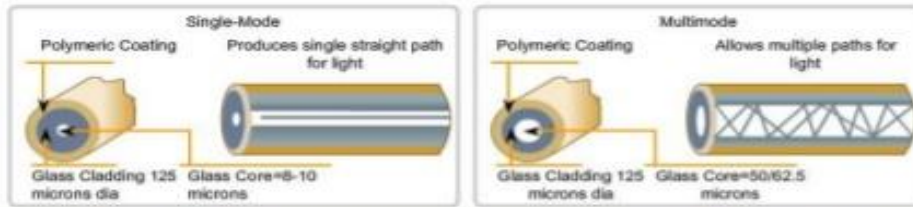
Optical Fiber Cable



Optical fiber consists of a glass core, surrounded by a glass cladding with slightly lower refractive index.

- In most networks fiber-optic cable is used as the high-speed backbone, and twisted wire and coaxial cable are used to connect the backbone to individual devices.
- Mode of propagation in optical fiber cable:
 - Single Mode
 - Multi Mode

Single mode vs. Multimode Fibers



Single-Mode	Multimode
<ul style="list-style-type: none"> • Small core • Less dispersion • Carry a single ray of light, usually generated from a laser. • Employ for long distance applications (100Km) • Uses as Backbone and distances of several thousands meters. 	<ul style="list-style-type: none"> • Larger core than single mode cable. • Allows greater dispersion and therefore, loss of signal. • Used for shorter distance application, but shorter than single-mode (up to 2Km) • It uses LED source that generates differtes angles along cable. • Often uses in LANs or small distances such as campus networks.

Dr Ajay N Phirkas

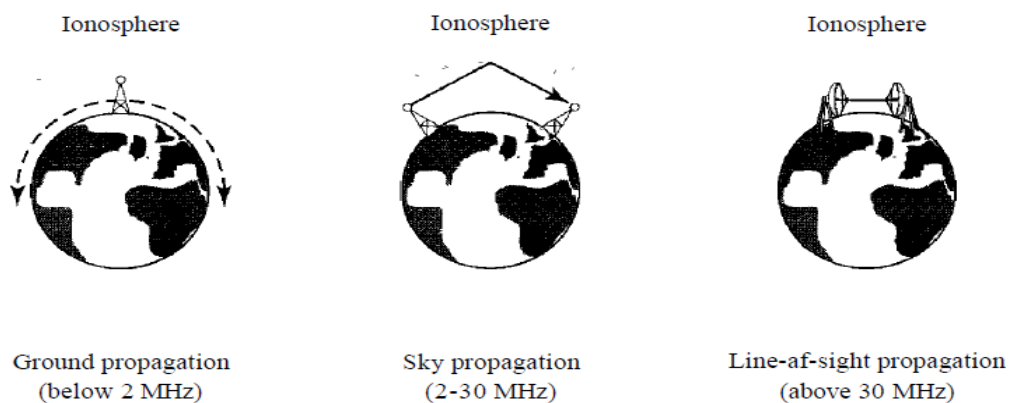


Un-guided Media

Types of un-guided media

Unguided signals can travel from source to destination in several ways:

- Ground propagation
- Sky propagation
- Line-of-sight propagation

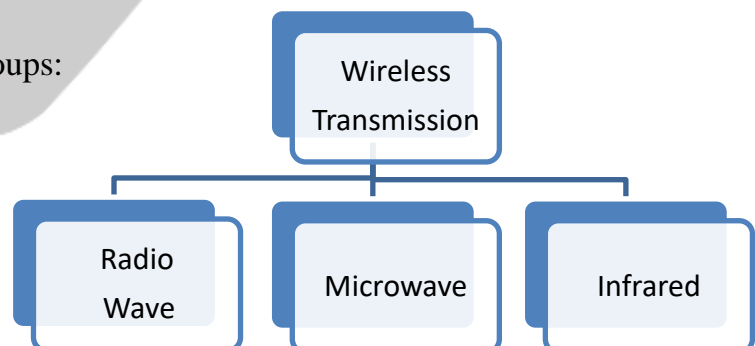


- In ground propagation, radio waves travel through the lowest portion of the atmosphere, hugging the earth/data.
- In sky propagation, higher-frequency radio waves radiate upward into the ionosphere where they are reflected back to the earth.
- In line-of-sight propagation, very high-frequency signals are transmitted in straight lines directly from antenna to antenna.

Wave types

Wireless transmission divided into three groups:

1. Radio waves
2. Micro waves
3. Infrared



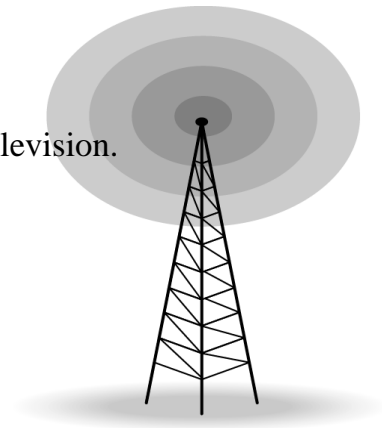
Radio waves

Radio waves are used for multicast communications, such as radio and television.

They can penetrate through walls.

Highly regulated. Use Omni directional antennas

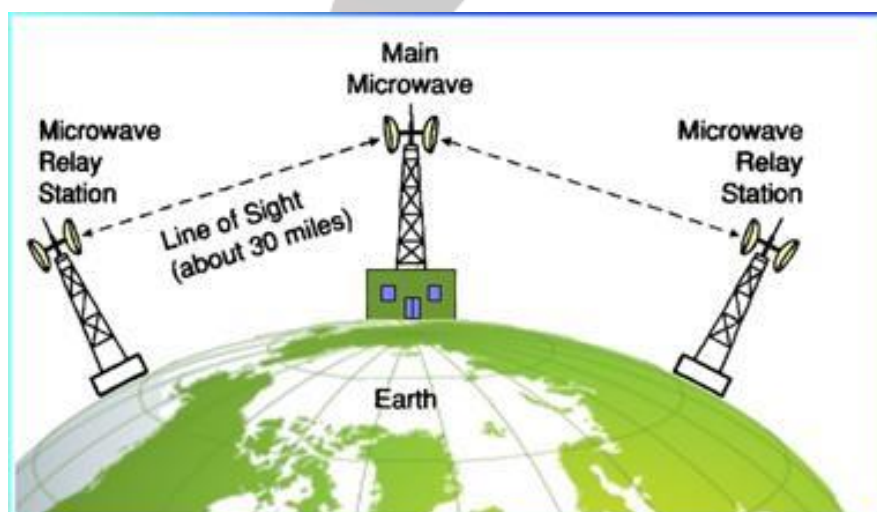
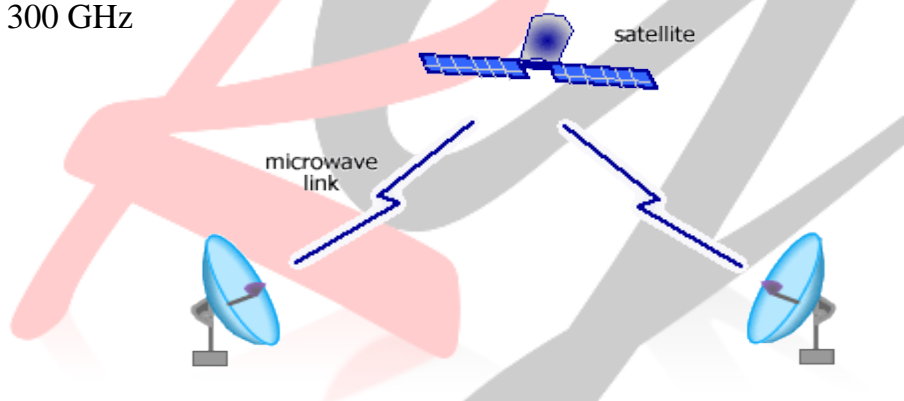
Frequencies between 3 kHz and 1GHz



Micro waves

Microwaves are used for unicast communication such as cellular telephones, satellite networks, and wireless LANs.

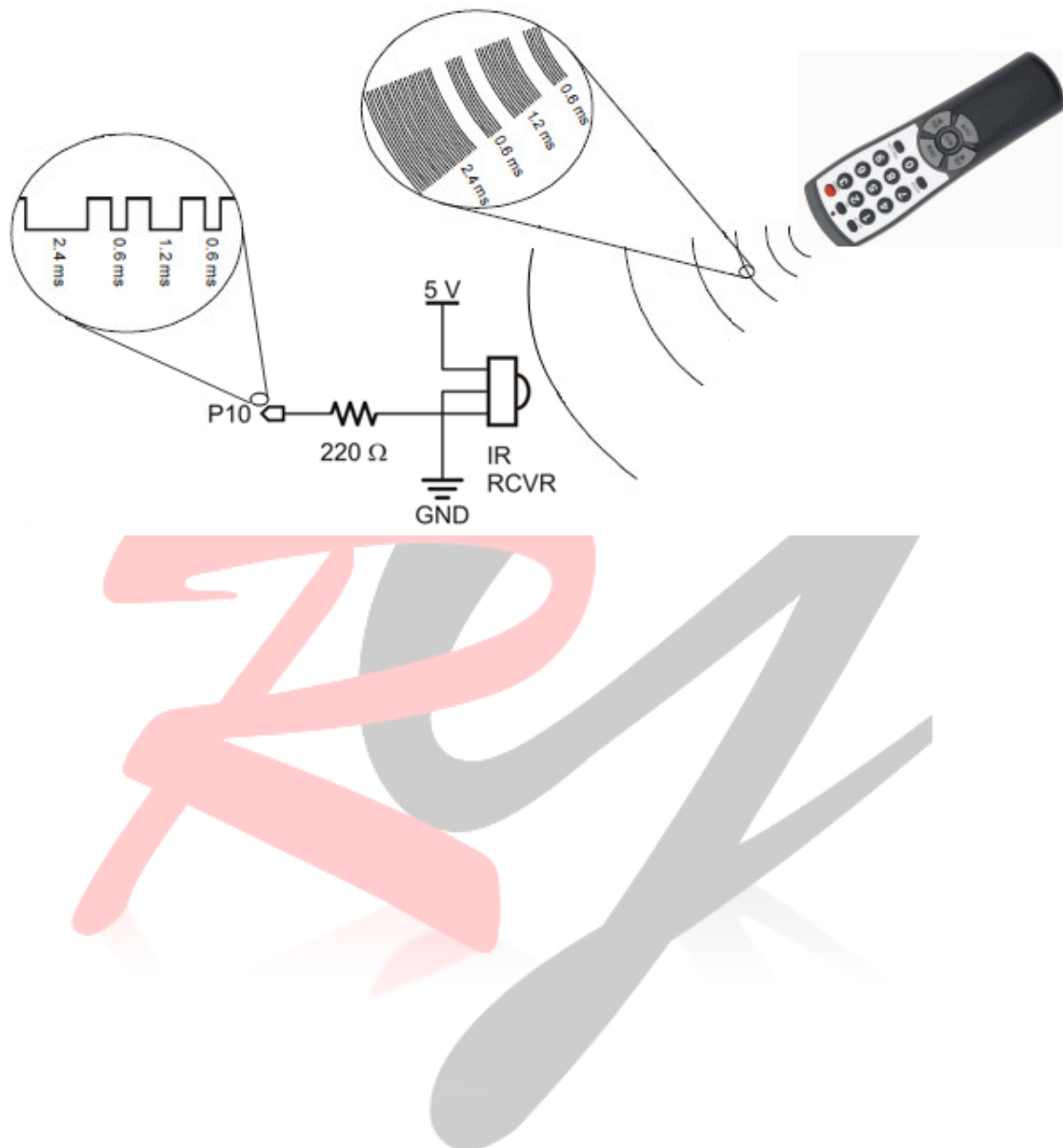
- Higher frequency ranges cannot penetrate walls.
- Use directional antennas - point to point line of sight communications.
- 1 and 300 GHz



Infrared

Infrared signals can be used for short- range communication in a closed area.

- using line-of-sight propagation
- 300 GHz to 400 THz

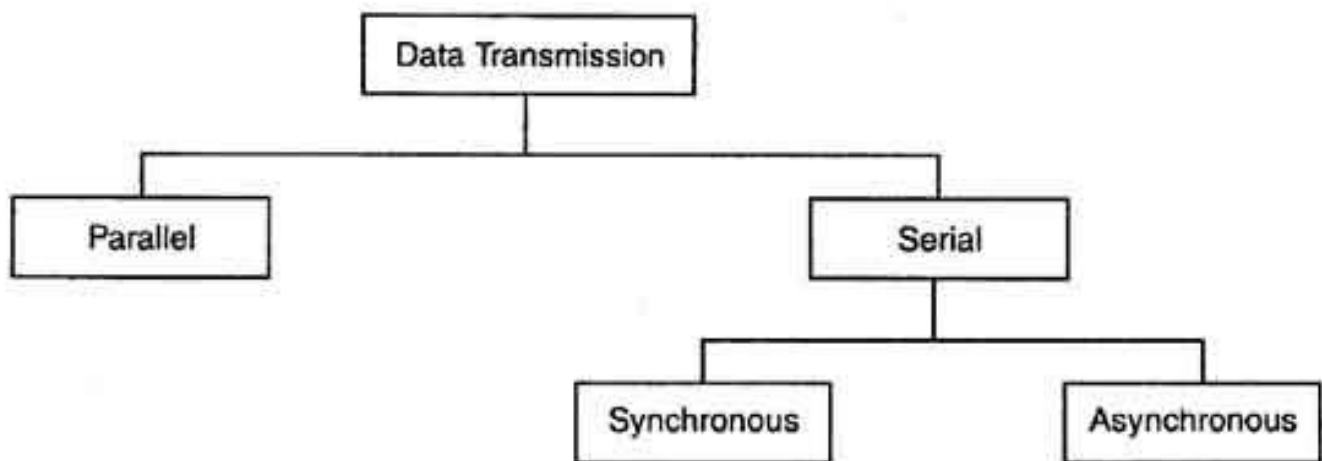


Data Transmission

Data transmission refers to the movement of data in form of bits between two or more digital devices.

This transfer of data takes place via some form of transmission media (for example; coaxial cable, fiber optics etc.)

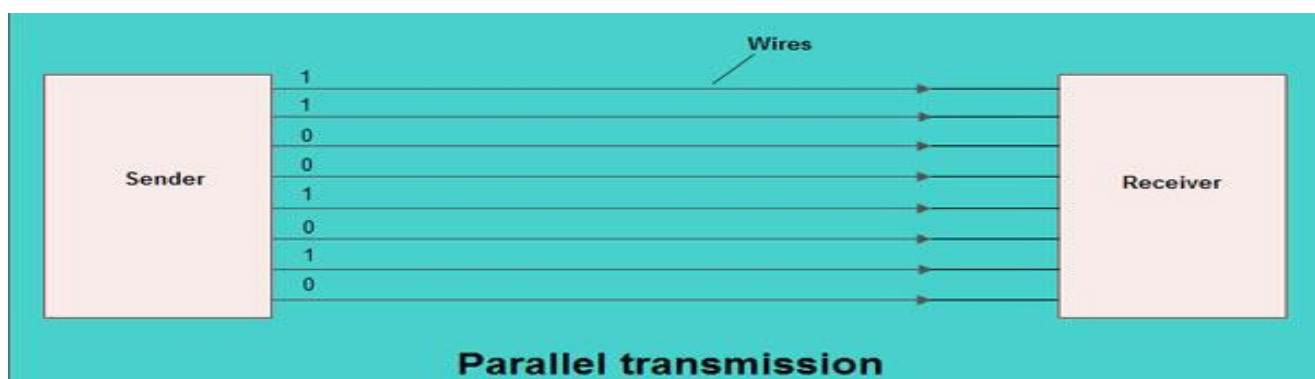
Types of Data Transmission



Parallel transmission

- ▶ In parallel transmission, all the bits of data are transmitted simultaneously on separate communication lines.
- ▶ In order to transmit n bits, n wires or lines are used. Thus each bit has its own line.
- ▶ All n bits of one group are transmitted with each clock pulse from one device to another i.e. multiple bits are sent with each clock pulse.
- ▶ Parallel transmission is used for short distance communication.

As shown in the fig, eight separate wires are used to transmit 8 bit data from sender to receiver.



Advantage and Disadvantage of parallel transmission

Advantages:

- ▶ It is speedy way of transmitting data as multiple bits are transmitted simultaneously with a single clock pulse.

Disadvantages:

- ▶ It is costly method of data transmission as it requires n lines to transmit n bits at the same time.

Serial Transmission

- ▶ In serial transmission, the various bits of data are transmitted serially one after the other.
- ▶ It requires only one communication line rather than n lines to transmit data from sender to receiver.
- ▶ Thus all the bits of data are transmitted on single line in serial fashion.
- ▶ In serial transmission, only single bit is sent with each clock pulse.
- ▶ These conversion devices convert the parallel data into serial data at the sender side so that it can be transmitted over single line.
- ▶ On receiver side, serial data received is again converted to parallel form so that the internal circuitry of computer can accept it.
- ▶ Serial transmission is used for long distance communication.

Advantage and Disadvantage of Serial transmission

Advantage:

- ▶ Use of single communication line reduces the transmission line cost by the factor of n as compared to parallel transmission.

Disadvantage:

- ▶ Use of conversion devices at source and destination end may lead to increase in overall transmission cost.
- ▶ This method is slower as compared to parallel transmission as bits are transmitted serially one after the other.

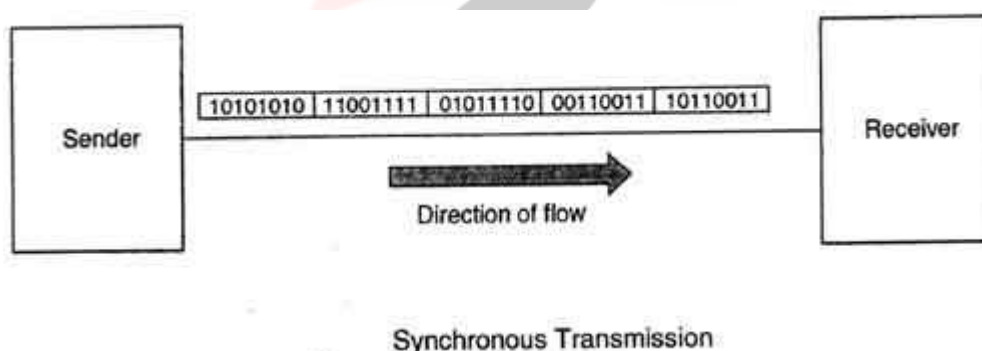
Types of Serial Transmission

- ▶ There are two types of serial transmission-synchronous and asynchronous both these transmissions use '*Bit synchronization*'
- ▶ *Bit Synchronization* is a function that is required to determine when the beginning and end of the data transmission occurs.
- ▶ *Bit synchronization* helps the receiving computer to know when data begin and end during a transmission. Therefore bit synchronization provides timing control.

Synchronous Transmission

- ▶ Synchronous transmission does not use start and stop bits.
- ▶ In this method bit stream is combined into longer frames that may contain multiple bytes.
- ▶ There is no gap between the various bytes in the data stream
- ▶ In the absence of start & stop bits, bit synchronization is established between sender & receiver by 'timing' the transmission of each bit.
- ▶ Since the various bytes are placed on the link without any gap, it is the responsibility of receiver to separate the bit stream into bytes so as to reconstruct the original information.
- ▶ In order to receive the data error free, the receiver and sender operates at the same clock frequency.

Synchronous transmission is used for high speed communication between computers.



Advantage and Disadvantage of Synchronous transmission

Advantage:

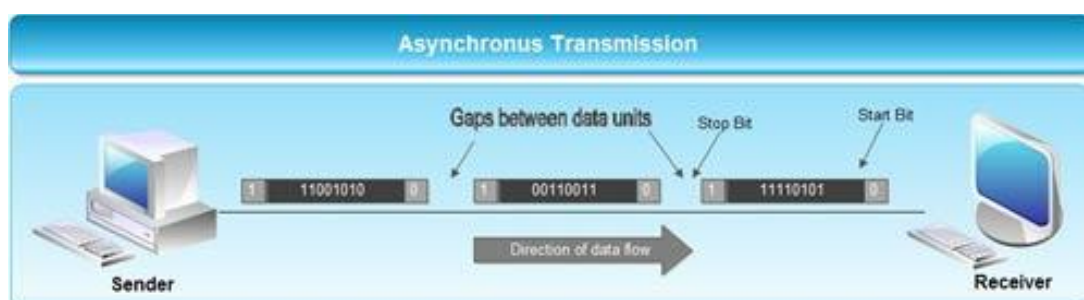
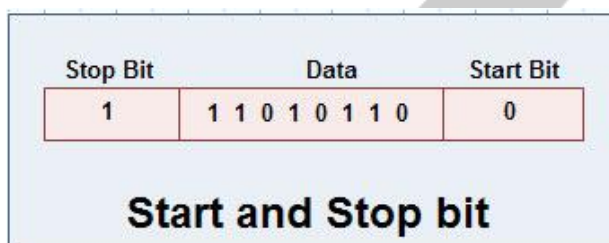
- ▶ This method is faster as compared to asynchronous as there are no extra bits (start bit & stop bit) and also there is no gap between the individual data bytes.

Disadvantage:

- ▶ It is costly as compared to asynchronous method. It requires local buffer storage at the two ends of line to assemble blocks and it also requires accurately synchronized clocks at both ends. This lead to increase in the cost.
- ▶ The sender and receiver have to operate at the same clock frequency. This requires proper synchronization which makes the system complicated.

Asynchronous Transmission

- ▶ Asynchronous transmission sends only one character at a time where a character is either a letter of the alphabet or number or control character i.e. it sends one byte of data at a time.
- ▶ Bit synchronization between two devices is made possible using start bit and stop bit.
- ▶ Start bit indicates the beginning of data i.e. alerts the receiver to the arrival of new group of bits. A start bit usually 0 is added to the beginning of each byte.
- ▶ Stop bit indicates the end of data i.e. to let the receiver know that byte is finished, one or more additional bits are appended to the end of the byte. These bits, usually 1s are called stop bits.
- ▶ Addition of start and stop increase the number of data bits. Hence more bandwidth is consumed in asynchronous transmission.
- ▶ Asynchronous transmission is well suited for keyboard type-terminals and paper tape devices. The advantage of this method is that it does not require any local storage at the terminal or the computer as transmission takes place character by character.
- ▶ Asynchronous transmission is best suited to Internet traffic in which information is transmitted in short bursts. This type of transmission is used by modems.



Advantages of Asynchronous transmission

- ▶ This method of data transmission is cheaper in cost as compared to synchronous e.g. If lines are short, asynchronous transmission is better, because line cost would be low and idle time will not be expensive.
- ▶ In this approach each individual character is complete in itself, therefore if character is corrupted during transmission, its successor and predecessor character will not be affected.
- ▶ It is possible to transmit signals from sources having different bit rates.
- ▶ The transmission can start as soon as data byte to be transmitted becomes available.
- ▶ Moreover, this mode of data transmission is easy to implement.

Disadvantages of asynchronous transmission

- ▶ This method is less efficient and slower than synchronous transmission due to the overhead of extra bits and insertion of gaps into bit stream.
- ▶ Successful transmission inevitably depends on the recognition of the start bits. These bits can be missed or corrupted.

Comparison between Serial and Parallel transmission

Sr. No.	Factor	Serial	Parallel
1.	Number of bits transmitted at one clock pulse	One bit	n bits
2.	No. of lines required to transmit n bits	One line	n lines
3.	Speed of data transfer	Slow	Fast
4.	Cost of transmission	Low as one line is required	Higher as n lines are required.
5.	Application	Long distance communication between two computers	Short distance communication. like computer to printer.

Comparison between Asynchronous and Synchronous

Sr. No.	Factor	Asynchronous	Synchronous
1.	Data send at one time	Usually 1 byte	Multiple bytes
2.	Start and Stop bit	Used	Not used
3.	Gap between Data units	Present	Not present
4.	Data transmission speed	Slow	Fast
5.	Cost	Low	High

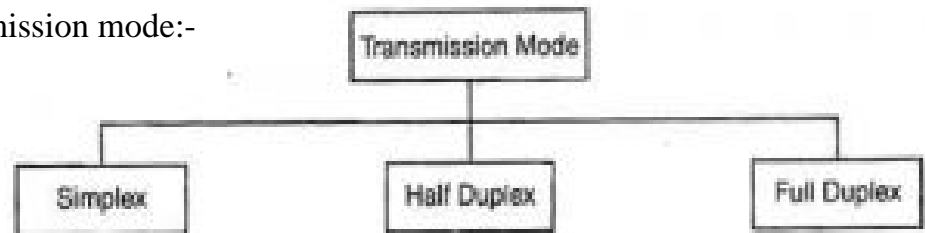
Transmission Mode

Transmission mode means transferring of data between two devices. It is also known as communication mode. Buses and networks are designed to allow communication to occur between individual devices that are interconnected.

Types of Transmission Mode

There are three types of transmission mode:-

- Simplex Mode
- Half-Duplex Mode
- Full-Duplex Mode



Simplex Mode

In Simplex mode, the communication is unidirectional, as on a one-way street. Only one of the two devices on a link can transmit, the other can only receive. The simplex mode can use the entire capacity of the channel to send data in one direction.

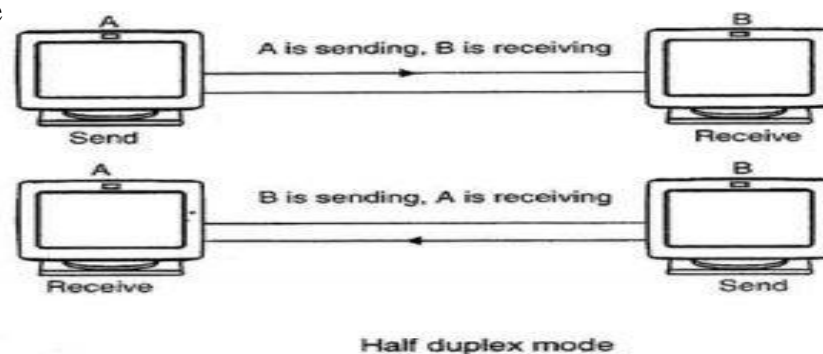
Example: Television, Radio, Keyboards and Monitors.



Half-Duplex Mode

In half-duplex mode, each station can both transmit and receive, but not at the same time. When one device is sending, the other can only receive, and vice versa. The half-duplex mode is used in cases where there is no need for communication in both direction at the same time.

Example: Walkie-Talkie



Full-Duplex Mode

In full-duplex mode, both stations can transmit and receive simultaneously. Full-duplex mode is used when communication in both direction is required all the time. The capacity of the channel, however must be divided between the two directions.

Example: Telephone, Mobile.

