Computer Network and Internet

Computer Network :-

→ A set of computers connected together to share information is known as computer Network.

Types of Network :-

Usually there are 3 types of Network.
  i) LAN (Local Area Network)
  ii) MAN (Metropolitan Area Network)
 iii) WAN (Wide Area Network)

LAN :-

→ LAN refers to a group of computers that all belong to the same organization and that are linked within a small geographic area using network.

→ Data transfer speeds over a local area network can reach up to 10 Mbps to 10 Gbps.

→ It is limited in size, typically a few hundred meters.

→ It is usually used within an office building or home.

MAN :-

→ It is larger then LAN.

→ It usually spans a city or a large campus.

→ It is optimized for a larger geographical area then a LAN, ranging from several blocks of buildings to entire cities.

→ It acts as a high speed network to allow sharing of regional resources.

WAN :-

→ WAN covers a large geographic area such as country, continent or even whole of the world.

→ A WAN is two or more LANs connected together. The LANs can be many miles apart

→ It may transmit data over leased high speed phone lines or wireless links such as satellites.

→ The most popular WAN is the Internet

LAN

LAN1

MAN

LAN2

LAN3

LAN1

LAN2

WAN

MAN1

LAN4

MAN2
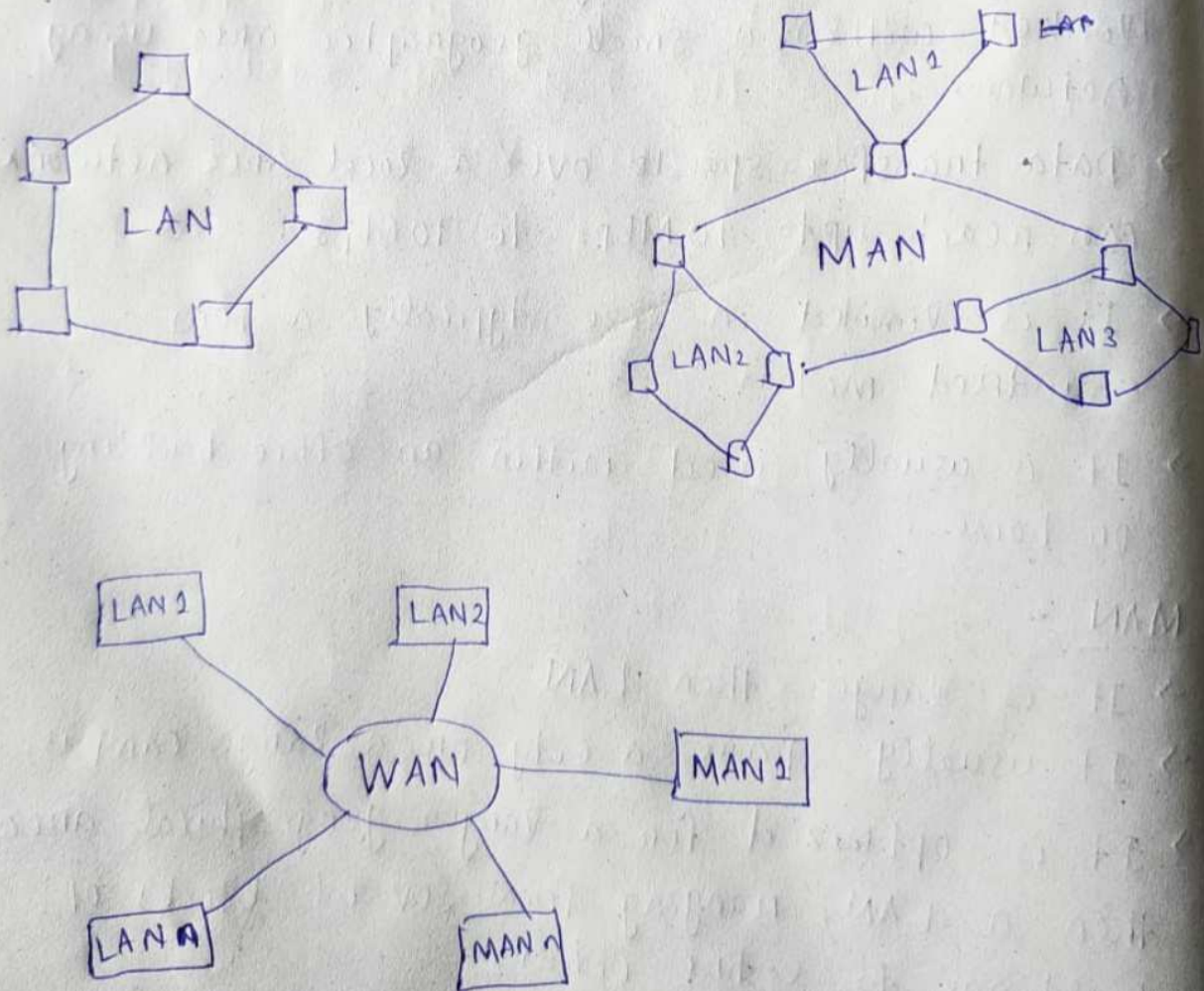
Data Transmission mode defines the direction of the flow of information between two communication devices. It is also called Data Communication or Directional Mode. It specifies the direction of the flow of information from one place to another in a computer network.

The data transmission modes can be characterized in the following three types based on the direction of exchange of information:

1. Simplex

2. Half-Duplex

3. Full Duplex

1. Simplex

Simplex is the data transmission mode in which the data can flow only in one direction, i.e., the communication is unidirectional. In this mode, a sender can only send data but can not receive it. Similarly, a receiver can only receive data but can not send it.

Direction of flow at all time

| Sender | → | Receiver |
| Device 1 | | Device 2 |

Simplex Mode
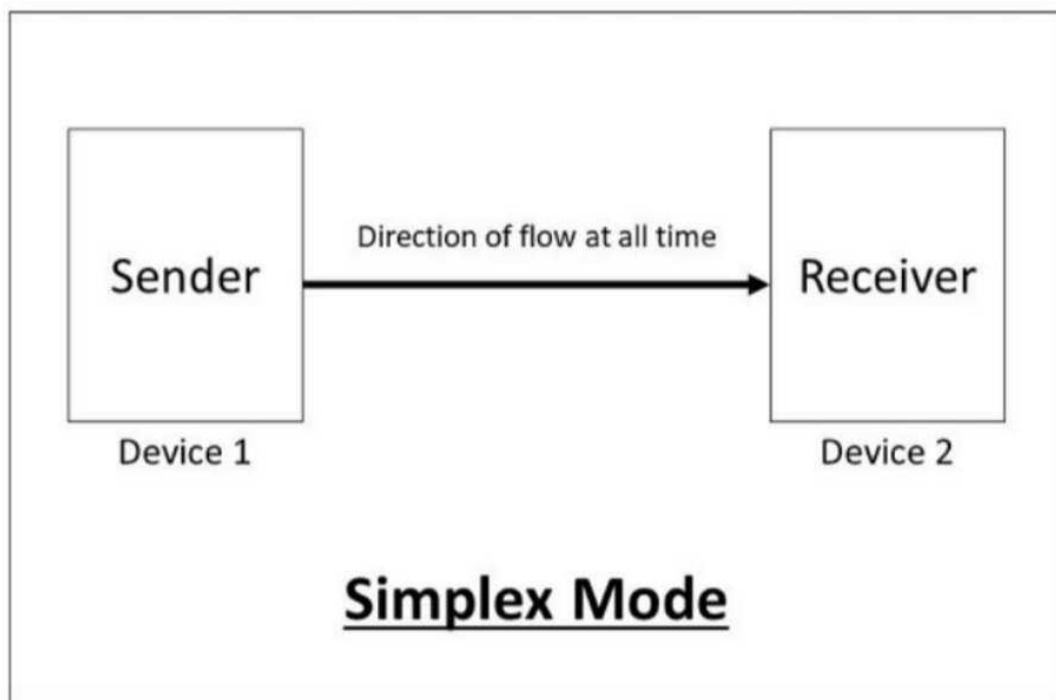
2. Half-Duplex

Half-Duplex is the data transmission mode in which the data can flow in both directions but in one direction at a time. It is also referred to as Semi-Duplex. In other words, each station can both transmit and receive the data but not at the same time. When one device is sending the other can only receive and vice-versa.

Half-Duplex Mode
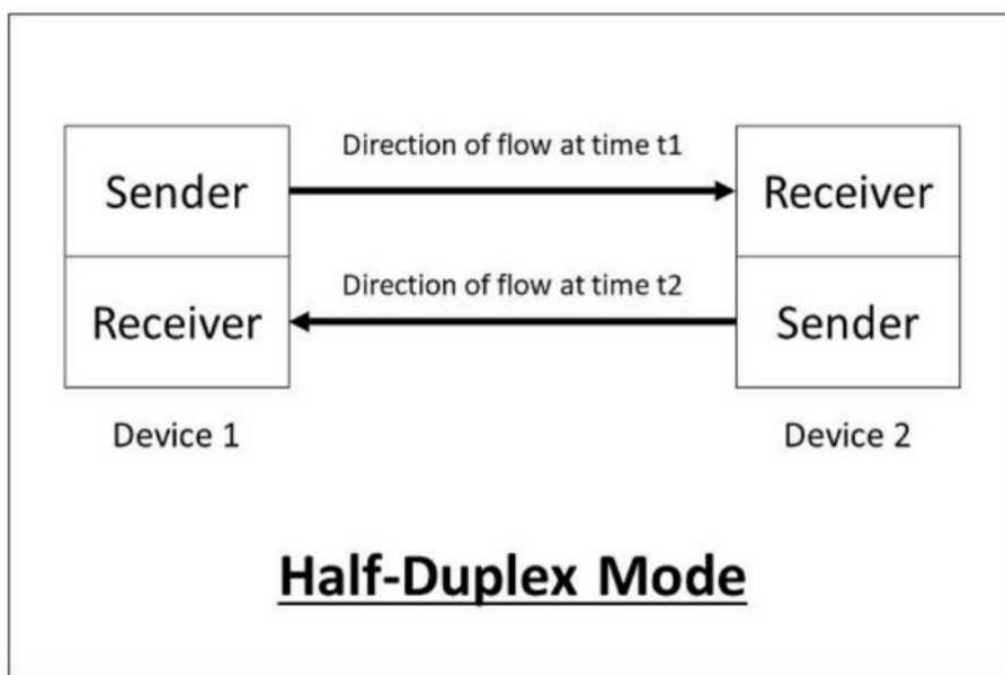
3. Full-Duplex

Full-Duplex is the data transmission mode in which the data can flow in both directions at the same time. It is bi-directional in nature. It is two-way communication in which both the stations can transmit and receive the data simultaneously.
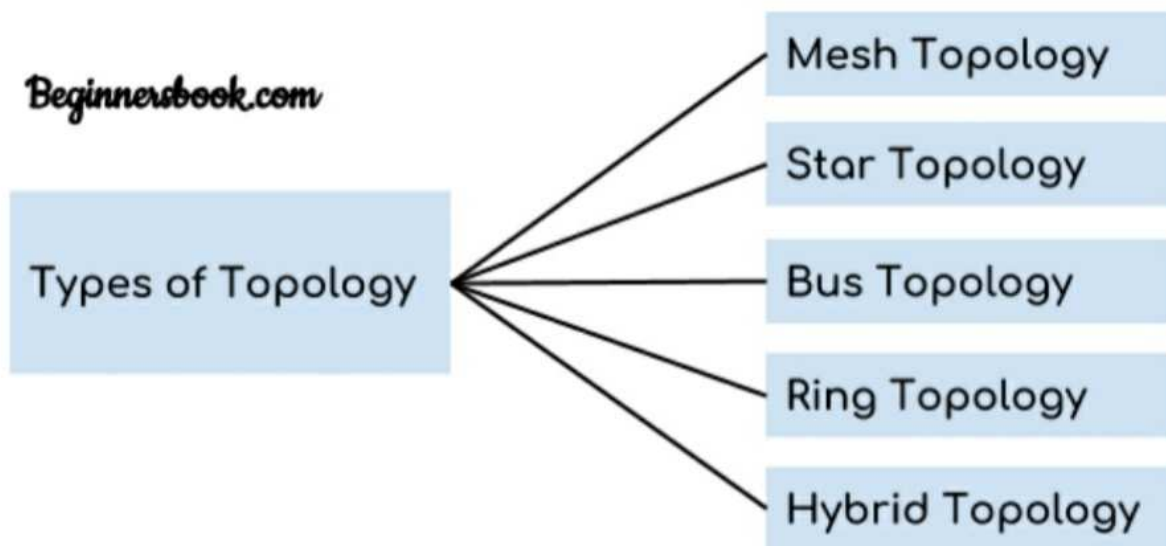

Full-Duplex Mode
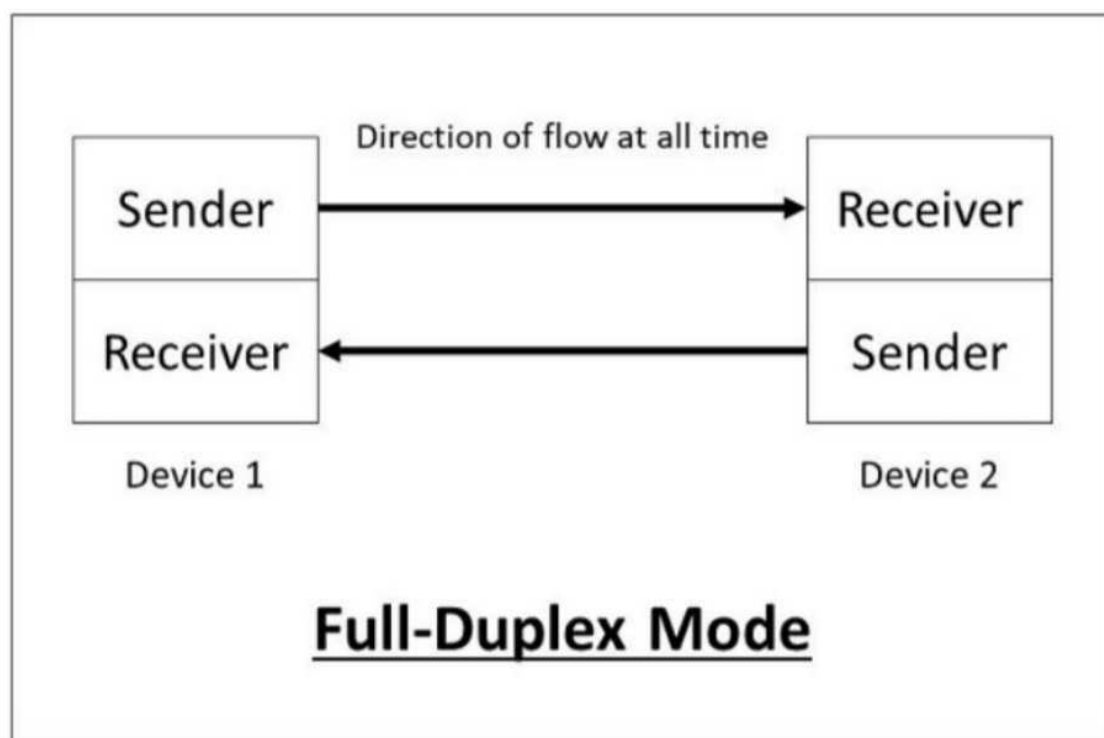
Network Topology refers to layout of a network. How different nodes in a network are connected to each other and how they communicate is determined by the network's topology.
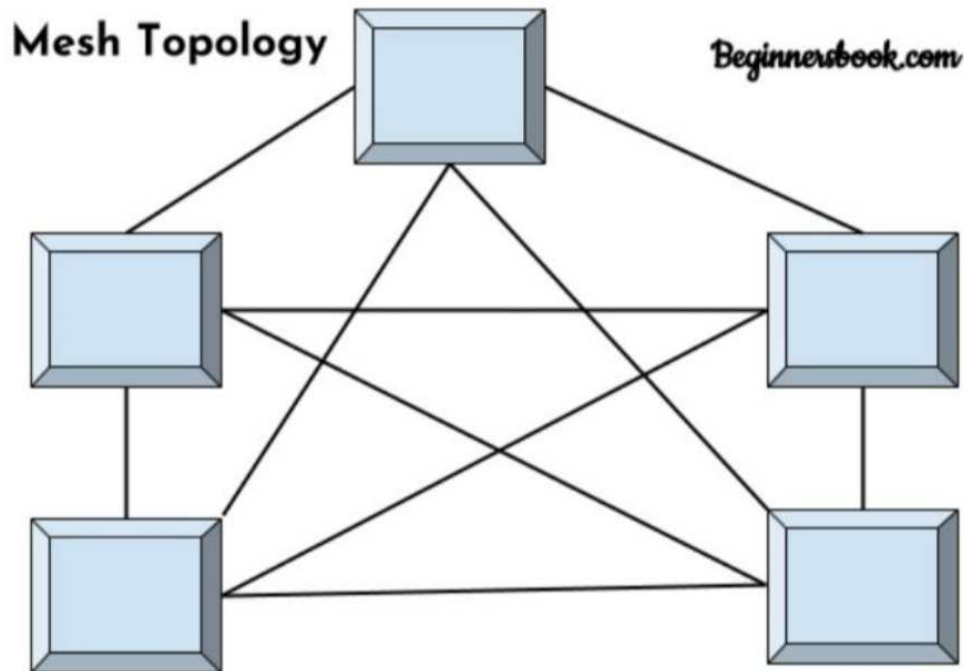
Types of Topology

There are five types of topology in computer networks:

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Types of Topology → Mesh Topology, Star Topology, Bus Topology, Ring Topology, Hybrid Topology

1. Mesh Topology

2. Star Topology

3. Bus Topology

4. Ring Topology

5. Hybrid Topology

Mesh Topology

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In mesh topology each device is connected to every other device on the network through a dedicated point-to-point link. When we say dedicated it means that the link only carries data for the two connected devices only. Lets say we have n devices in the network then each device must be connected with (n-1) devices of the network. Number of links in a mesh topology of n devices would be n(n-1)/2.

Advantages of Mesh topology

1. No data traffic issues as there is a dedicated link between two devices which means the link is only available for those two devices.
2. Mesh topology is reliable and robust as failure of one link doesn't affect other links and the communication between other devices on the network.
3. Mesh topology is secure because there is a point to point link thus unauthorized access is not possible.
4. Fault detection is easy.

Disadvantages of Mesh topology

1. Amount of wires required to connected each system is tedious and headache.

2. Since each device needs to be connected with other devices, number of I/O ports required must be huge.

3. Scalability issues because a device cannot be connected with large number of devices with a dedicated point to point link.

Star Topology

Star Topology

Hub

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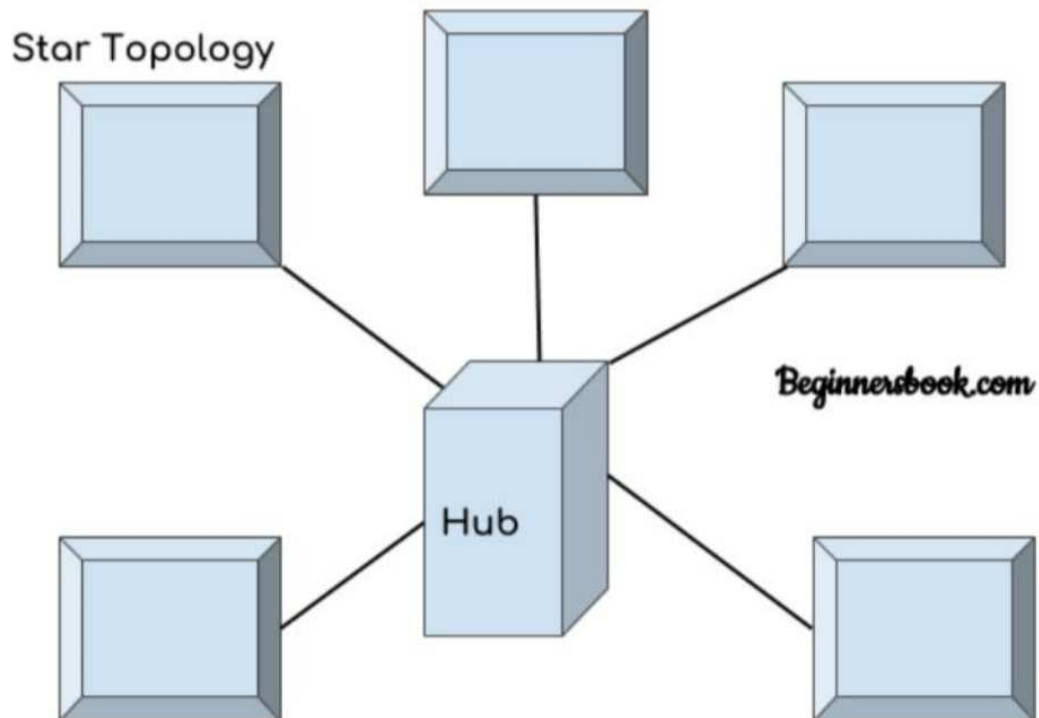
In star topology each device in the network is connected to a central device called hub. Unlike Mesh topology, star topology doesn't allow direct communication between devices, a device must have to communicate through hub. If one device wants to send data to other device, it has to first send the data to hub and then the hub transmit that data to the designated device.

Advantages of Star topology

1. Less expensive because each device only need one I/O port and needs to be connected with hub with one link.
2. Easier to install
3. Less amount of cables required because each device needs to be connected with the hub only.
4. Robust, if one link fails, other links will work just fine.
5. Easy fault detection because the link can be easily identified.

Disadvantages of Star topology

1. If hub goes down everything goes down, none of the devices can work without hub.
2. Hub requires more resources and regular maintenance because it is the central system of star topology.

Bus Topology
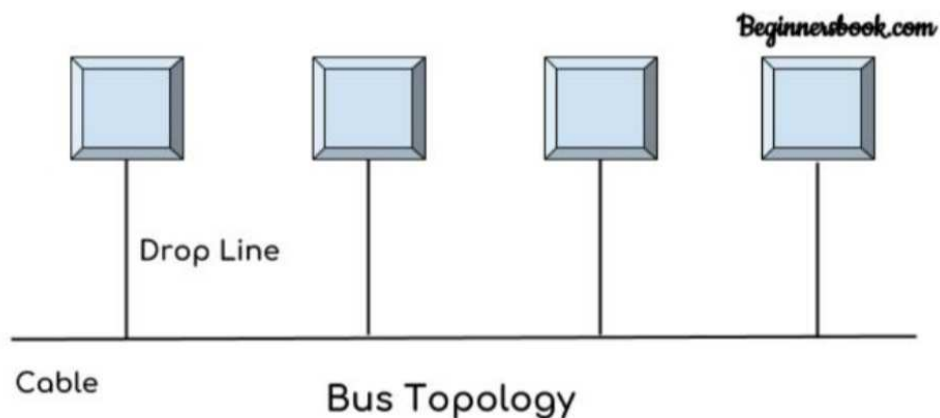
Bus Topology

In bus topology there is a main cable and all the devices are connected to this main cable through drop lines. There is a device called tap that connects the drop line to the main cable. Since all the data is transmitted over the main cable, there is a limit of drop lines and the distance a main cable can have.
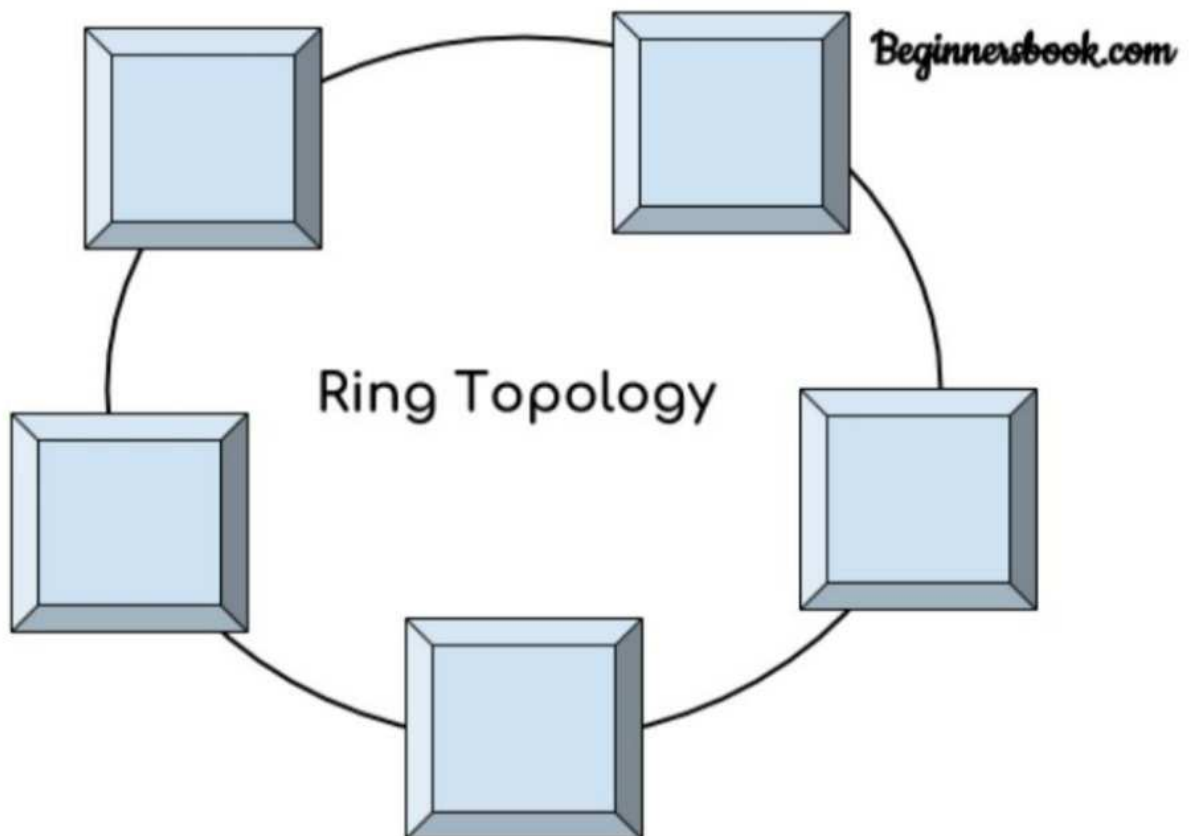
Advantages of bus topology

1. Easy installation, each cable needs to be connected with backbone cable.
2. Less cables required than Mesh and star topology

Disadvantages of bus topology

1. Difficultly in fault detection.

2. Not scalable as there is a limit of how many nodes you can connect with backbone cable.

Ring Topology

Ring Topology

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In ring topology each device is connected with the two devices on either side of it. There are two dedicated point to point links a device has with the devices on the either side of it. This structure forms a ring thus it is known as ring topology. If a device wants to send data to another device then it sends the data in one direction, each device in ring topology has a repeater, if the received data is intended for other device then repeater forwards this data until the intended device receives it.
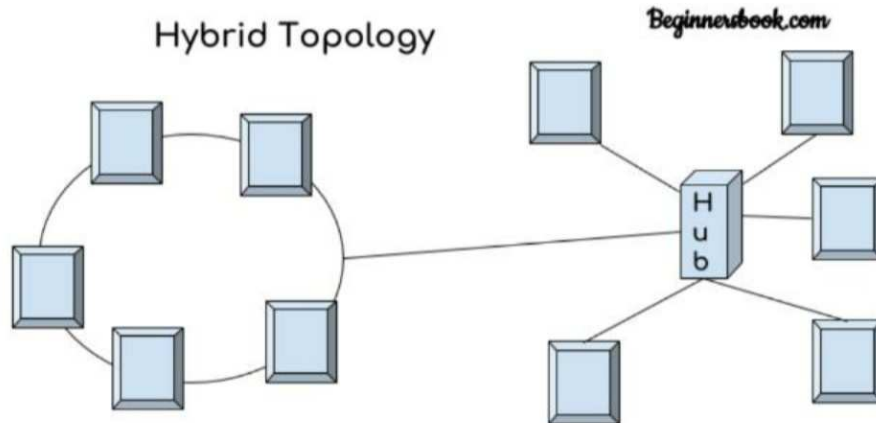
Advantages of Ring Topology

1. Easy to install.
2. Managing is easier as to add or remove a device from the topology only two links are required to be changed.

Disadvantages of Ring Topology

1. A link failure can fail the entire network as the signal will not travel forward due to failure.
2. Data traffic issues, since all the data is circulating in a ring.

Hybrid topology

Hybrid Topology

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A combination of two or more topology is known as hybrid topology. For example a combination of star and mesh topology is known as hybrid topology.

Advantages of Hybrid topology

1. We can choose the topology based on the requirement for example, scalability is our concern then we can use star topology instead of bus technology.
2. Scalable as we can further connect other computer networks with the existing networks with different topologies.

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Disadvantages of Hybrid topology

1. Fault detection is difficult.

2. Installation is difficult.

3. Design is complex so maintenance is high thus expensive.

What are network devices?

Network devices, or networking hardware, are physical devices that are required for communication and interaction between hardware on a computer network.

Types of network devices

Here is the common network device list:

- Hub

- Switch

- Router

- Bridge

- Gateway

- Modem

- Repeater

Hub

Hub is a centralized device that connects multiple devices in a single LAN network. When Hub receives the data signals from a connected device on any of its port, except that port, it forwards those signals to all other connected devices from the remaining ports. Usually, Hub has one or more uplink ports that are used to connect it with another Hub.

There are two types of the Hub.

Passive Hub: - It forwards data signals in the same format in which it receives them. It does not change the data signal in any manner.

Active Hub: - It also works same as the passive Hub works. But before forwarding the data signals, it amplifies them. Due to this added feature, the active Hub is also known as the repeater.

What Is a Switch in Networking?

In a network, a switch is a hardware device that filters and forwards network packets from one networking device (switch, router, computer, server, etc.) to another. It is widely used in local area networks (LANs) to send each incoming message frame by looking at the physical device address, known as the Media Access Control address (MAC address).

functions of switches:

- Connect multiple hosts: Normally, a switch provides a large number of ports for cable connections, allowing for star topology routing. It is usually used to connect multiple PCs to the network.
- Forwards a message to a specific host: Like a bridge, a switch uses the same forwarding or filtering logic on each port. When any host on the network or a switch sends a message to another host on the same network or the same switch, the switch receives and decodes the frames to read the physical (MAC) address portion of the message.

- Manage traffic: A switch in networking can manage traffic either coming into or exiting the network and can connect devices like computers and access points with ease.

- Keep electrical signal undistorted: When a switch forwards a frame, it regenerates an undistorted square electrical signal.

- Increase LAN bandwidth: A switch divides a LAN into multiple collision domains with independent broadband, thus greatly increasing the bandwidth of the LAN.

Router

The router connects the different network segments. It switches the data packets between those networks which are either located in the different logical segments or built with the different network layer protocols.

When a router receives a data packet on any of its interface, it checks the destination address of that packet and based on that destination address, it forwards that data packet from the interface which is connected with the destination address.

To forward a data packet to its destination, router keeps the records of connected networks. These records are maintained in a database table known as the routing table. Routing table can be built statically or dynamically.

Basically routers are used: -

→ To connect different network segments.

→ To connect different network protocols such as IP and IPX.

→ To connect several smaller networks into a large network (known as the Internetwork)

→ To break a large network into smaller networks (Known as the Subnets. Usually created to improve the performance or manageability.)

→ To connect two different media types such as UTP and Fiber optical.

→ To connect two different network architectures such as Token Ring and Ethernet.

→ To connect LAN network with Telco company' office (Known as the DTE device).

→ To access DSL services (known as the DSL Router).

Bridge

Bridge is used to divide a large network into smaller segments. Basic functions of the Bridge are the following: -

➡ Breaking a large network into smaller segments.

➡ Connecting different media types. Such as connects UTP with the fiber optic.

➡ Connecting different network architectures. Such as connects Ethernet with the Token ring.
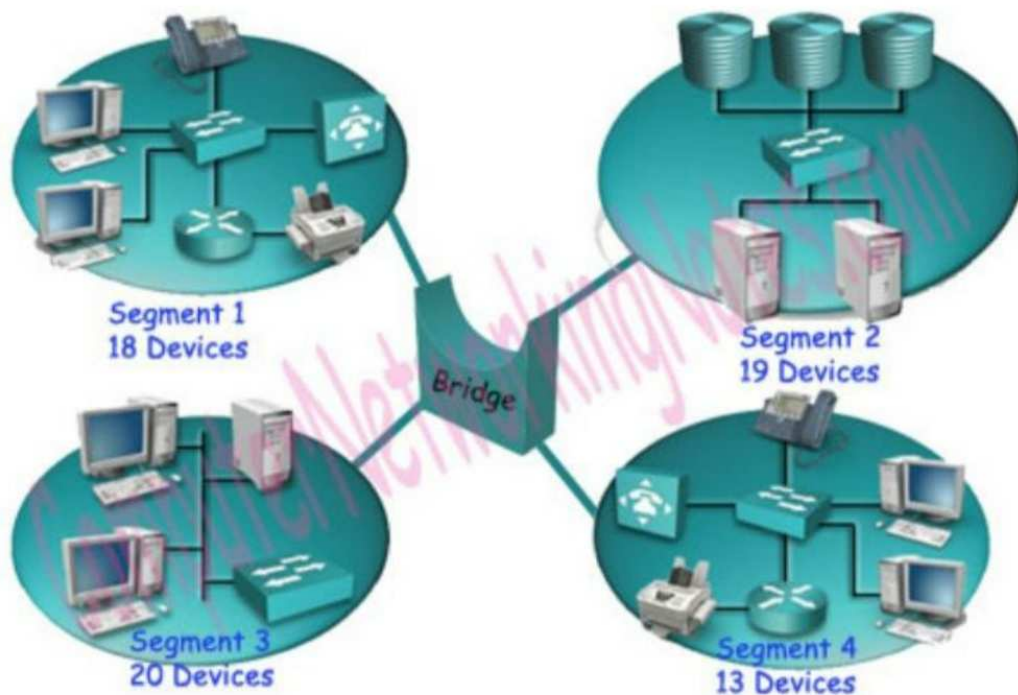
A Bridge can connect two different types of media or network architecture, but it cannot connect two different types of network layer protocol such as TCP/IP or IPX. Bridge requires the same network layer protocol in all segments.

There are three types of Bridge:-

Local Bridge: - This Bridge connects two LAN segments directly. In Ethernet Implementation, it is known as the Transparent Bridge. In Token Ring network, it is called the Source-Routed Bridge.

Remote Bridge: - This Bridge connects with another Bridge over the WAN link.

Wireless Bridge: - This Bridge connects with another Bridge without using wires. It uses radio signals for the connectivity.

In OSI Layers /TCP-IP networking models, the functionalities of the Bridges are defined in the physical layer and data link layer.

Definition...

- A gateway is a network element that acts as an entrance point to another network. For example an access gateway is a gateway between telephony network and other network such as internet.

- A gateway is generally a work station or server. It is a two-way path between networks. It is used to connect different types of networks.

- Gateway is a work station by which we can make out connection between external network and internal network.

- Gateway belongs to transport layer and application layer of the OSI model.

Working…

- Gateways connect the two networks even if the protocols are different. So protocol conversion is also done by gateways

- It simply stripped off the old protocol and assigns new protocol to the packets, so it is also called protocol translator

- Gateways are the simple junctions between two network architectures. They repackage and convert data going from one environment to another so that one environment can understand the other environments data

- A gateway links two systems which have different communication protocols, different language and different architecture

- Gateways never filter out the data. So it passes bad packets too.

- Gateways are task specific. So they are dedicated to a particular type of transfer. They often referred to by their particular task name.

- Example:- Windows NT server to SNA gateway.

- LANs may have component called gateways, which assists in transferring from one LAN to another LAN.

- Because it takes it time for protocol conversion, it is little bit slower.

Benefits of GATEWAY...

- Used to expand the network.

- Gateway is a server so it provides some security.

- We can connect two different types of networks.

- Protocol conversion is done.

- Effectively handles the traffic problems.

- And also establishes connections between internal network and external network.

Modem

In simple language, a Modem is the device that is used to connect with the Internet. Technically, it is the device that enables the digital data to be transmitted over the telecommunication lines.

A Telco company uses entirely different data transmission technology from the technology that a PC uses for the data transmission. A modem understands both technologies. It changes the technology that a PC uses, in the technology which Telco Company understands.

It enables communication between the PC (Known as the DTE device) and the Telecom company' office (Known as the DCE device).
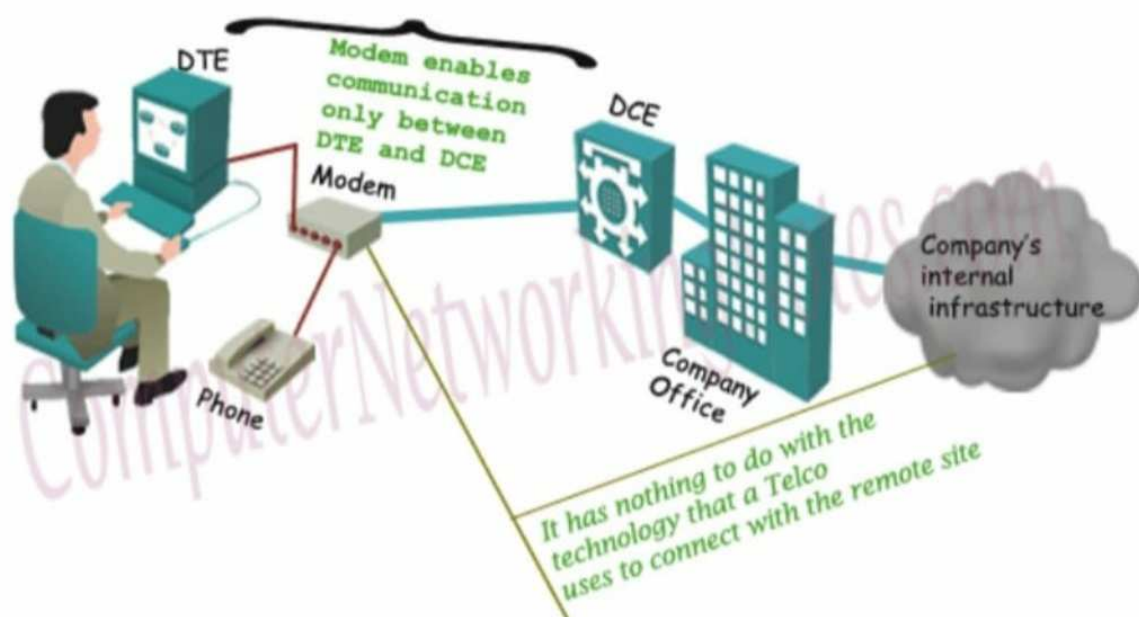
Repeater

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

Network Interface Card (NIC)

In the list of the networking devices, NIC stands on the first place. Without this device, networking cannot be done. This is also known as network adapter card, Ethernet Card and LAN card. NIC allows a networking device to communicate with the other networking device.

NIC converts the data packets between two different data transmission technologies. A PC uses parallel data transmission technology to transmit the data between its internal parts while the media that provides connectivity between different PCs uses serial data transmission technology.

A NIC converts parallel data stream into the serial data stream and the serial data stream into the parallel data stream.
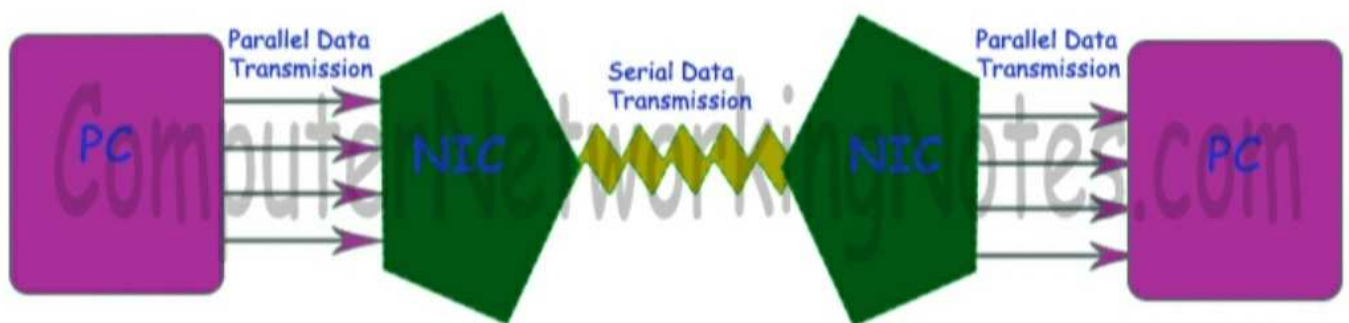
Typically all modern PCs have the integrated NICs in the motherboards. If additional NICs are required, they are also available as add-on devices separately.

Connection Types

There exist several ways to connect to the internet. Following are these connection types available:

1. Dial-up Connection
2. ISDN
3. DSL
4. Cable TV Internet connections
5. Satellite Internet connections
6. Wireless Internet Connections

Dial-up Connection

Dial-up connection uses telephone line to connect PC to the internet. It requires a modem to setup dial-up connection. This modem works as an interface between PC and the telephone line.
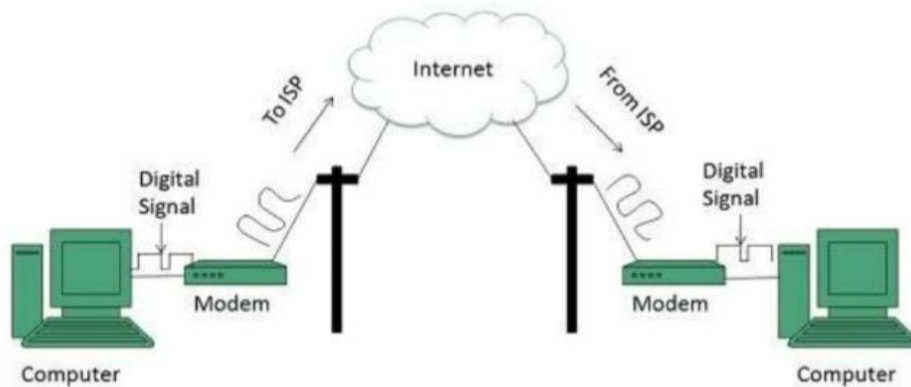
There is also a communication program that instructs the modem to make a call to specific number provided by an ISP.

Dial-up connection uses either of the following protocols:

1. Serial Line Internet Protocol (SLIP)
2. Point to Point Protocol (PPP)

The following diagram shows the accessing internet using modem:

ISDN

ISDN is acronym of **Integrated Services Digital Network.** It establishes the connection using the phone lines which carry digital signals instead of analog signals.

There are two techniques to deliver ISDN services:

1. Basic Rate Interface (BRI)

2. Primary Rate Interface (PRI)

Key points:

- The BRI ISDN consists of three distinct channels on a single ISDN line: t1o 64kbps B (Bearer) channel and one 16kbps D (Delta or Data) channels.

- The PRI ISDN consists of 23 B channels and one D channels with both have operating capacity of 64kbps individually making a total transmission rate of 1.54Mbps.

The following diagram shows accessing internet using ISDN connection:
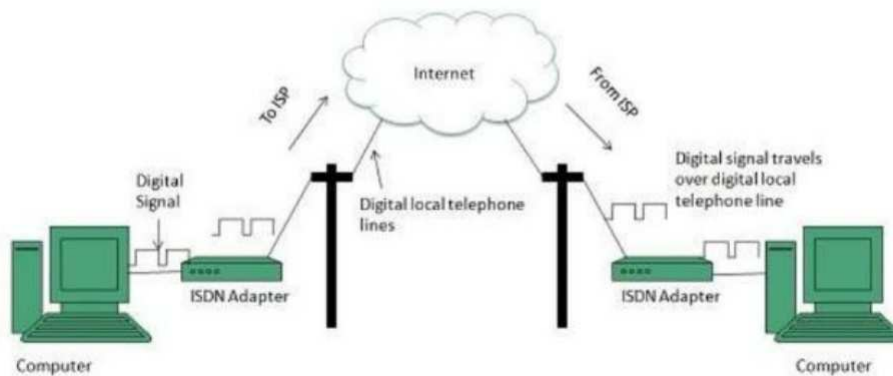
DSL

DSL is acronym of **Digital Subscriber Line.** It is a form of broadband connection as it provides connection over ordinary telephone lines.

Following are the several versions of DSL technique available today:

1. Asymmetric DSL (ADSL)

2. Symmetric DSL (SDSL)

3. High bit-rate DSL (HDSL)

4. Rate adaptive DSL (RDSL)

5. Very high bit-rate DSL (VDSL)

6. ISDN DSL (IDSL)

All of the above mentioned technologies differ in their upload and download speed, bit transfer rate and level of service.

The following diagram shows that how we can connect to internet using DSL technology:

Internet Access Using DSL Modem
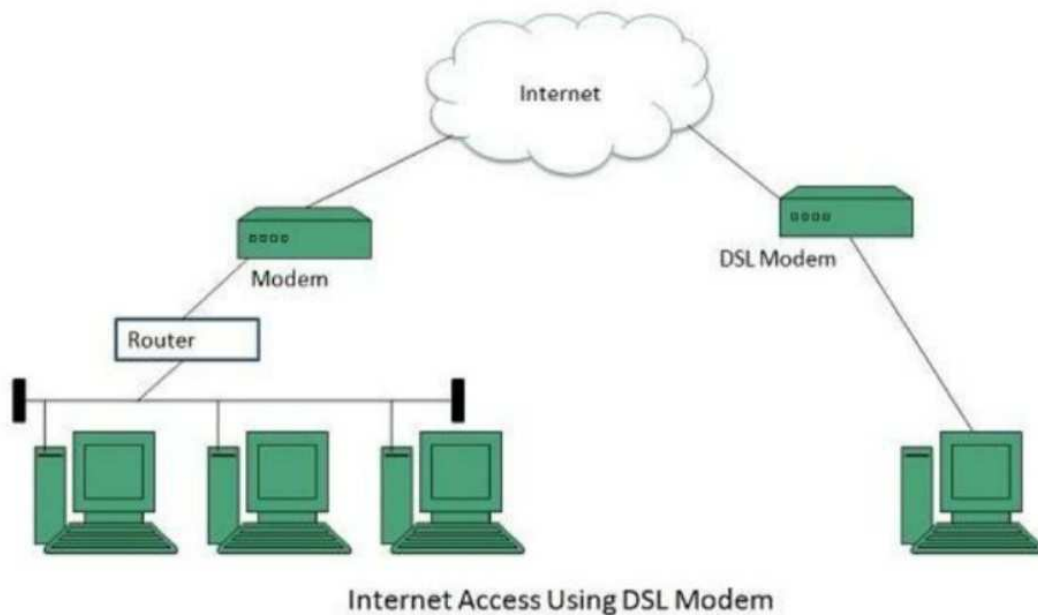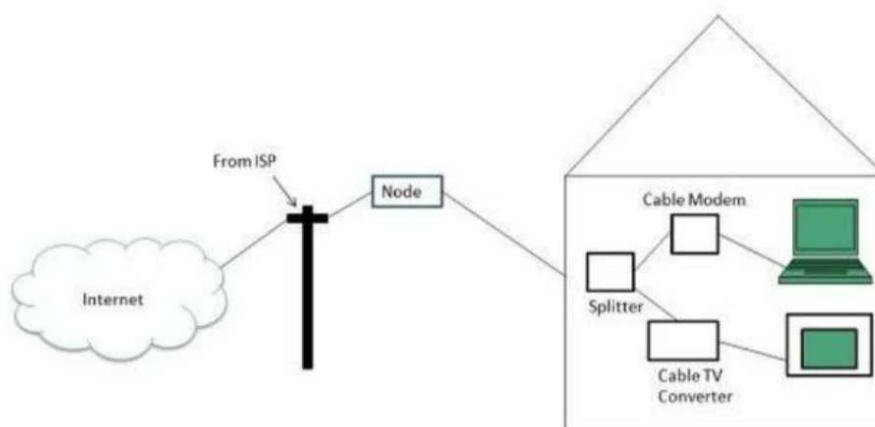
Cable TV Internet Connection

Cable TV Internet connection is provided through Cable TV lines. It uses coaxial cable which is capable of transferring data at much higher speed than common telephone line.

Key Points:

- A cable modem is used to access this service, provided by the cable operator.

- The Cable modem comprises of two connections: one for internet service and other for Cable TV signals.

- Since Cable TV internet connections share a set amount of bandwidth with a group of customers, therefore, data transfer rate also depends on number of customers using the internet at the same time.

The following diagram shows that how internet is accessed using Cable TV connection:

Satellite Internet Connection

Satellite Internet connection offers high speed connection to the internet. There are two types of satellite internet connection: one way connection or two way connection.

In one way connection, we can only download data but if we want to upload, we need a dialup access through ISP over telephone line.

In two way connection, we can download and upload the data by the satellite. It does not require any dialup connection.

The following diagram shows how internet is accessed using satellite internet connection:
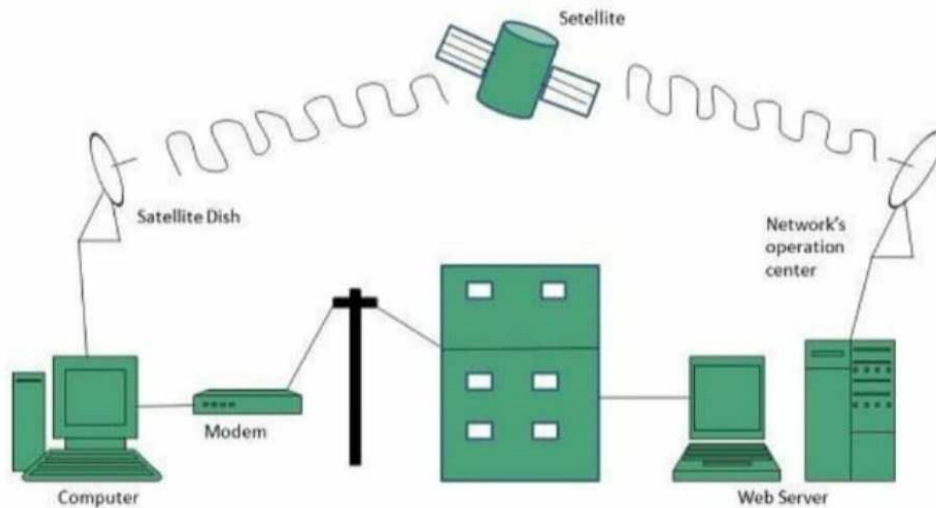
Wireless Internet Connection

Wireless Internet Connection makes use of radio frequency bands to connect to the internet and offers a very high speed. The wireless internet connection can be obtained by either WiFi or Bluetooth.

Key Points:

- Wi Fi wireless technology is based on IEEE 802.11 standards which allow the electronic device to connect to the internet.

- Bluetooth wireless technology makes use of short-wavelength radio waves and helps to create personal area network (PAN).

ISP

Stands for "Internet Service Provider." An ISP provides access to the Internet. Whether you're at home or work, each time you connect to the Internet, your connection is routed through an ISP.

Types of ISPs

Access ISPs — Employ a variety of technologies to facilitate consumers' connection to their network. These technologies may include broadband or dialup. Always-on types of broadband connections comprise cable, fiber optic service (FiOS), DSL (Digital Subscriber Line) and satellite. A number of access providers also provide email and hosting services.

Mailbox ISPs — Offer email mailbox hosting services and email servers to send, receive and store email. Many mailbox ISPs are also access providers.

Hosting ISPs — Offer email, File Transfer Protocol (FTP), web-hosting services, virtual machines, clouds and physical servers.

Transit ISPs —Provide large amounts of bandwidth needed to connect hosting ISPs and access ISPs together.

Virtual ISPs (VISP) — Purchase services from other ISPs to allow customers Internet access.

Free ISPs (free nets) – Provide service free of charge and often display advertisements while users are connected.

Factors to consider while choosing ISP

- Bandwidth (speed)
- Cost (setup and service fee)
- Availability (reach)
- Reliability (down time)
- Convenience (mobility, etc)

Services of ISPs

- Internet Access
- Domain Name Registration
- Domain Hosting
- Dial-up Access
- Leased Line Access

Examples of ISPs

- MTN
- Airtel
- UTL
- Infocom
- Smile
- Roke Telecom