Computer Network: Introduction to Networking, Computer Network, Internet,

The Network edge: end system, clients, server,

Connection-oriented and Connectionless service, Network core, Network access and Physical media, ISPs and Back bone

A computer network is an interconnection of various computers to share software, hardware, resources and data through a communication medium between them.

Any Computer Networking communication need a sender, a receiver and a communication medium, protocols and operating system to establish networking and to transfer signal or Data from sender to the receiver.

A networks model describes the organization of various computers in a network for using resources.

Networks provide the benefits of *exchanging information or Data, sharing resources, reducing system costs, increased reliability and flexible working environment*.

Chronology of significant computer-network developments

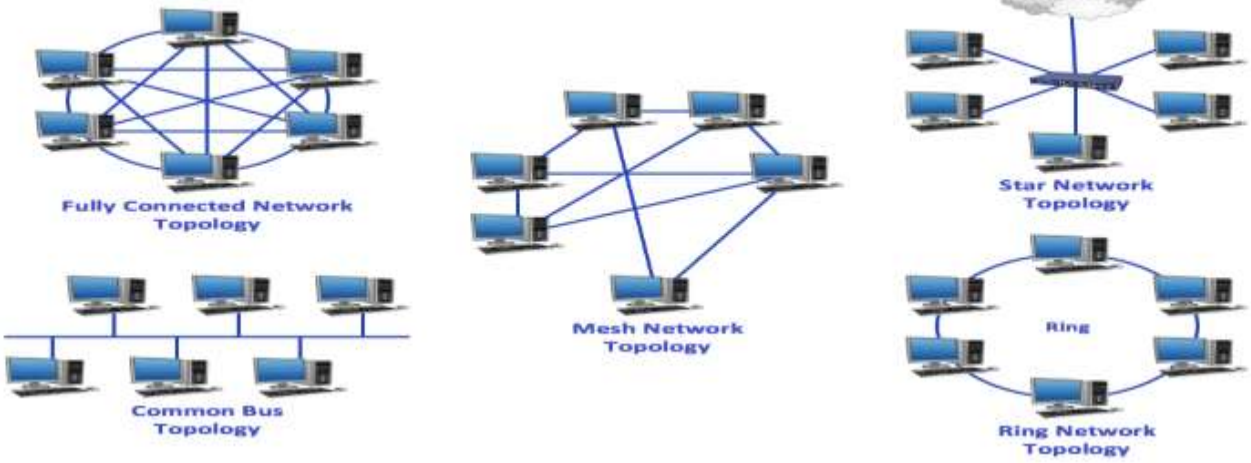
- late **1950s**, early networks of computers included the U.S. military radar system
- In **1960**, the commercial airline reservation system went online with two connected mainframes.
- **1965**, Western Electric introduced the first widely used telephone switch that implemented true computer control.
- **1969**, the first four nodes of the ARPANET were connected using 50 kbit/s circuits
- In **1972**, commercial services using X.25 were deployed
- **1973**, Robert Metcalfe wrote a formal memo at Xerox PARC describing Ethernet,
- **1995**, the transmission speed capacity for Ethernet increased from 10 Mbit/s to 100 Mbit/s
- **1998**, Ethernet supported transmission speeds of a Gigabit. Subsequently, higher speeds of up to 100 Gbit/s were added (as of **2016**)

Computer Network Classification

The local area network communication can be constructed by using server based model or peer to peer model. In peer to peer networks, the individual clients share data and resources but no one computer is treated as server.
LAN : Local area network is the small network that cover a small area of Network.
MAN : Metropolitan area networks are created by combining various local area networks.
WAN : Wide area networks are the biggest networks that provide connectivity across the globe.

Computer Network topology

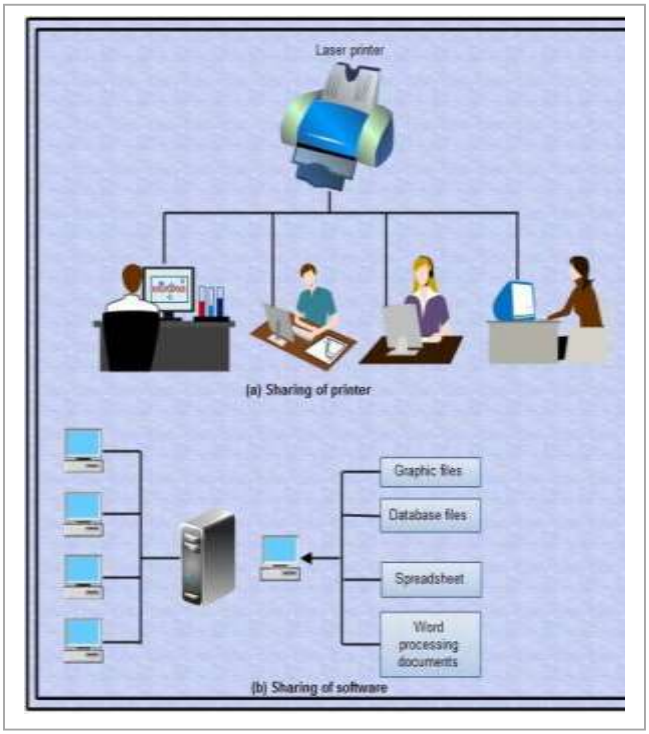
The physical arrangement of computers in a communication network is called as topology.
S**tar** topology: every system on the network is connected to a central controller called Hub and all the data is transmitted through this. Star topology is very easy to install and configure.
Bus topology: a single cable acts as a backbone of the communication network and all the nodes or computers are attached to it by using T connectors.
Ring Topology : Failure of one computer disturbs the whole network.
Mesh 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.
Fully Connected Network Topology : All devices or nodes are connected to each other.



Uses of Computer Networks

The computer networks are playing an important role in providing services to large organizations as well as to the individual common man.

• Many organizations have a large number of computers in operation. These computers may be within the same building, campus, city or different cities. Even though the computers are located in different locations, the organizations can track of inventories, monitor productivity, do the ordering and billing etc.



• The computer networks are useful to the organizations in the following ways:

1. Resource and Information sharing e.g. printer, software, file, video etc.
2. Data Protection: *For providing high reliability.*
3. Cost effective.
4. Communication and Collaboration: *It can provide a powerful communication medium.*
5. Security System
6. E-Commerce
7. Mobile Users

1. Resource and Information sharing

• It allows resources(e.g. printers, files) or same devices sharing to *anyone on the network irrespective of the physical location* of the resource and the user.

• Show in Fig (a) and (b) which shows a printer being shared and different information being shared.

•Information sharing is the exchange of data between various organizations, people, and technologies. Different information and data can be shared like the file, videos, etc.

2. Data Protection: *High reliability due to alternative sources of data*

• It provides high reliability by having alternative sources of data. For e.g. all files could be replicated on more than one machines, so *if one of them is unavailable due to hardware failure or any other reason, the other copies can be used.*

• The aspect of high reliability is very important for military, banking, air traffic control, nuclear reactor safety and many other applications where continuous operations are a must even if there are hardware or software failures.

3. Cost effectivie

• Computer networking is an important financial aspect for organizations because it saves money.

• Organizations can use separate personal computer one per user instead of using mainframe computer which are expensive.

• The organizations can use the workgroup model **(peer to peer)** in *which all the PCs are networked together and each one can have the access to the other for communicating or sharing purpose.*

• The organization, if it wants security for its operation, it can go in for the **domain model** in which there is a server and clients. All the clients can communicate and access data through the server. The whole arrangement is called as **client -server model.**

4. Communication medium: *Communication and Collaboration*

• A computer network provides a powerful communication medium among widely separated employees.

• Using network it is easy for two or more employees, *who are separated by geographical locations to work on a report, document or R and D simultaneously i.e. on -line.*

Networks **for People:**

• Starting in 1990s, the computer networks began to start delivering services to the private individuals at home.

• The computer networks offer the following services to an individual person:

1. Access to remote information
2. Person to person communication
3. Interactive entertainment.

1. Remote Access: *Access to remote information*- Access to remote information involves interaction between a person and a remote database. Access to remote information comes in many forms like:

(i) Home shopping, paying telephone, electricity bills, e-banking, on line share market etc.

(ii) Newspaper is. On-line and is personalized, digital library consisting of books, magazines, scientific journals etc.

(iii) World wide web which contains information. about the arts, business, cooking, government, health, history, hobbies, recreation, science, sports etc.

2. Person to person communication: Person to person communication includes:

(i) Electronic-mail (e-mail)

(ii) Real time e-mail i.e. video conferencing allows remote users to communicate with no delay by seeing and hearing each other. Video-conferencing is being used for remote school, getting medical opinion from distant specialists etc.

(iii) Worldwide newsgroups in which one person posts a message and all other subscribers to the newsgroup can read it or give their feedbacks.

3. Interactive entertainment: Interactive entertainment includes:

(i) Multiuser real-time simulation games.

(ii) Video on demand.

(iii) Participation in live TV programs likes quiz, contest, discussions etc.

In short, the ability to merge information, communication and entertainment will surely give rise to a massive new industry based on computer networking.

What is Real-time TV program and Live TV program?

5. Security

(i) Surveillance System

(ii) Security alarm system

(iii) Location tracker system

(iv) SMS system

(v) Realtime Geographical Information System

6. E-commerce:- Computer Network is also used in E-commerce where users can pay bills, transfer cash, buy good, etc using the computer.

7. Mobile Users :- Computer Network is used in the mobile device like telephone, Smartphone, tablets, etc for communication, the internet, file sharing, etc.

Network Model : *organization of various computers in a network for using resources.*

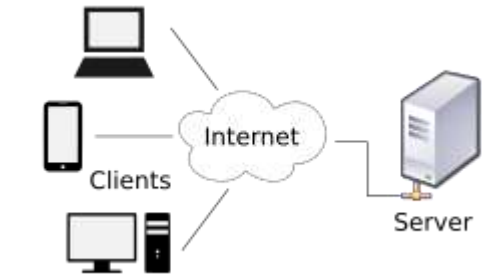
***Client Server Model**

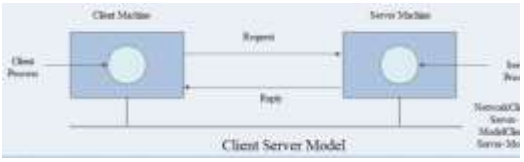
Client or Host or service requester : The *individual workstations or pc* in the network are called as clients which request for services.

Server or service providers: The *central computer or stable/static host* which is more powerful than the clients and which allows the clients to access its software and database is called as the server.

The **client–server model** is a distributed application structure but centralized system that partitions *tasks or workloads between the providers of a resource or service, called servers, and service requesters, called clients*. Often clients and servers communicate over a computer network on separate hardware, but both client and server may reside in the same system.

A server host runs one or more server programs which share their resources with clients. A client does not share any of its resources, but requests a server's content or service function. Clients therefore initiate communication sessions with servers which await incoming requests. *Examples of computer applications that use the client–server model are Email, network printing, network antivirus, and the World Wide Web.*





***P2P Model:**

Peer-to-peer (P2P) computing or networking is a distributed application architecture that partitions *tasks or workloads between peers or nodes*. Peers are equally privileged, equipotent participants in the application. They are said to form a peer-to-peer network of nodes. *Peers make a portion of their resources, such as processing power, disk storage or network bandwidth, directly available to other network participants, without the need for central coordination by servers or stable hosts.* Peers are both suppliers and consumers of resources, in contrast to the traditional client-server model in which the consumption and supply of resources is divided.

A peer-to-peer (P2P) network is created when two or more PCs or devices are connected and share their resources without communicating with a separate server computer. In peer to peer networking architecture, each computer (workstation) has equivalent capabilities and responsibilities. Each PC acts as an independent workstation that stores data on its own hard drive but which can share it with all other PCs on the network. *Computers connecting with each other in a workgroup can share files, printers, and internet access.*

The Network edge: end system, clients, server

An **edge** device is a device which provides an entry point into enterprise or service provider core **networks**. Examples include routers, routing switches,

End System

The computers that are connected to a computer network are sometimes referred to as **end systems**. They are labeled **end systems** because they sit at the edge of the network. The **end** user always interacts with the **end systems**. **End systems** are the devices that provide information or services

Clients

A **client** is a piece of **computer** hardware or software that accesses a service made available by a server. The server is often (but not always) on another **computer** system, in which case the **client** accesses the service by way of a network.

There are mostly following types of clients

- Thick or Fat Clients
- Thin Clients

Thin Clients	Thick Clients
- Easy to deploy as they require no extra or specialized software installation - Needs to validate with the server after data capture - If the server goes down, data collection is halted as the client needs constant communication with the server - Cannot be interfaced with other equipment (in plants or factory settings for example) - Clients run only and exactly as specified by the server - More downtime -Portability in that all applications are on the server so any workstation can access - Opportunity to use older, outdated PCs as clients - Reduced security threat	- More expensive to deploy and more work for IT to deploy - Data verified by client not server (immediate validation) - Robust technology provides better uptime - Only needs intermittent communication with server - More expensive to deploy and more work for IT to deploy - Require more resources but less servers - Can store local files and applications - Reduced server demands - Increased security issues

Server

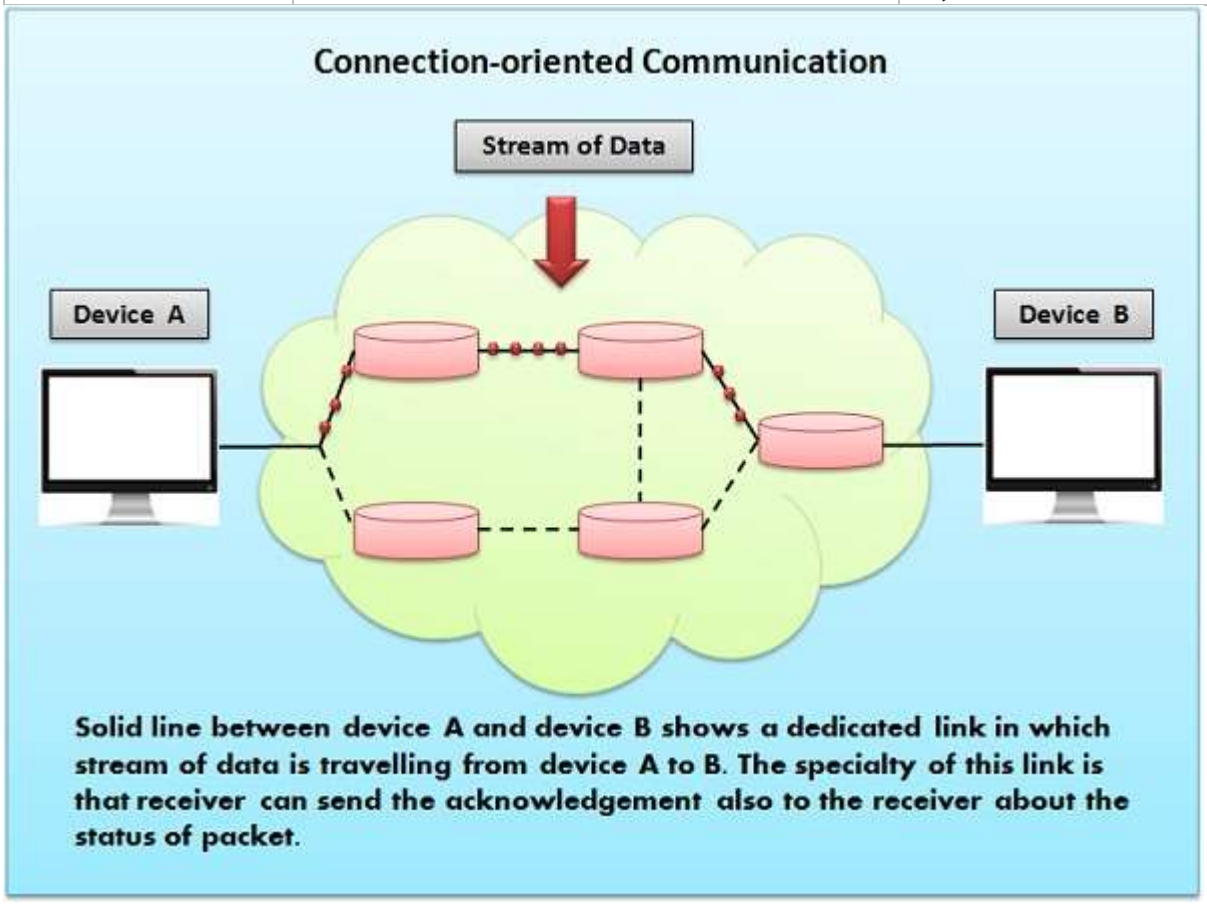
A server is a computer program that provides services to other computer programs (and their users) in the same or other computers. The computer that a server program runs in is also frequently referred to as a server.

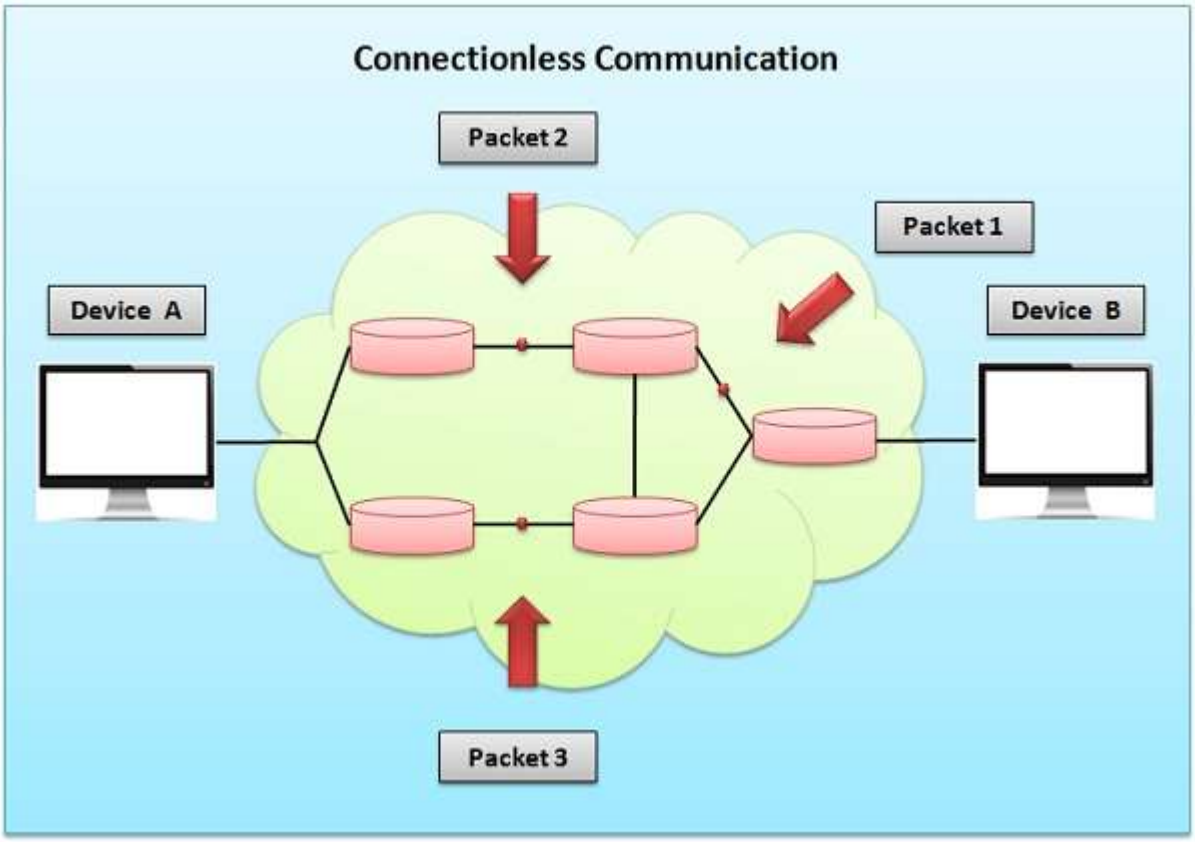
Types: webserver, mail server, proxy servers

Connection-oriented and Connection-less service

ATTRIBUTES	CONNECTION-ORIENTED SERVICE	CONNECTION-LESS SERVICE
Prior Connection Requirement	Necessary	Not required
Reliability	Ensures reliable transfer of data.	Not guaranteed.
Congestion	Unlikely	Occur likely.
Transferring mode	It can be implemented using circuit switching and virtual circuit.	It is implemented using packet switching.
Lost data retransmission	Feasible	Practically, not possible.
Suitability	Suitable for long and steady communication.	Suitable for bursty Transmission.
Signalling	Used for connection establishment.	There is no concept of signalling.

Packet forwarding	Packets sequentially travel to their destination node and follows the same route.	Packets reach the destination randomly without following the same route.
Delay	There is a delay in transfer of information, but once the connection is established faster delivery can be achieved.	Because to the absence of connection establishment phase, the transmission is faster.
Resource Allocation	Need to be allocated.	No prior allocation of the resource is required.
Bandwidth required	High	Less
Switching	Circuit Switching	Packet Switching
Example	Telephone system	Video Streaming, Online Gaming
Protocol	TCP	IP, UDP



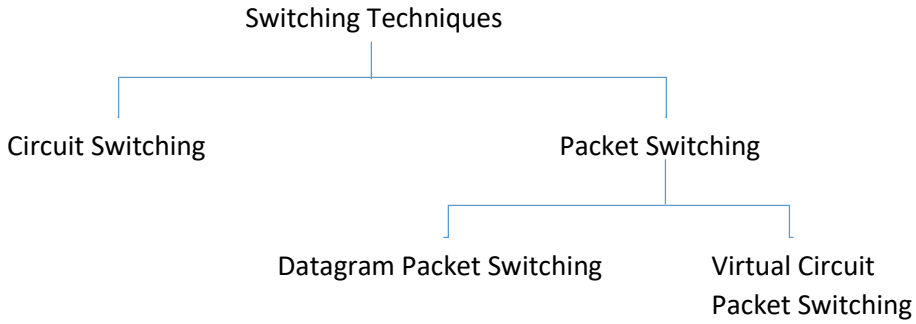


Network core

A **core network**, which offers numerous services to the customers who are interconnected by the access **network**. Example: in telecommunication **network's core**, direct telephone calls over the public-switched telephone **network**.

→ It means the approach to moving data through a network of links and switches.

→ Switching Types



→ In **circuit switched network**, the resources needed along a path (buffer, link transmission rate) to provide for communication between the end systems are reserved for the duration of the communication session between the end systems.

→ It reserves a constant transmission rate in the network's links for the duration of the communication. Since bandwidth has been reserved for this sender-to-receiver. Connection, the sender can transfer the data to the receiver at the guaranteed constant rate.

→ In **packed switched network**, the resources are not reserved for a sessions message use the resources on demand, and as a consequence may have to wait (i.e. queue) for access to a communication link.

→ The packet is sent into the network without reserving and bandwidth if one of the links is busy because other packets need to be transmitted over the link at the same time, our packet will have to wait in a buffer at the sending side of the transmission link, and suffer a delay.

There are two approaches in packet switched network

1. **Datagram Network**
   - Any network that forwards the packets according to the destination address is called a datagram network.
   - The routers in the internet forwards packets according to the destination address. Hence, internet is datagram network.
2. **Virtual Circuit Network**
   - Any network that forwards the packets according to virtual circuit identifier (fixed route) is called a virtual circuit network.
   - Preplanned route established before packets sent.
   - Examples are X25, Frame relay, ATM technologies.

Attribute	Circuit Switching	Datagram Packet Switching	VC Switching
Path type	Dedicated path	No Dedicated path	No Dedicated path
Path established	Path established for entire conversion	Route established for each packet	Route established for entire conversion
Delay	Call Setup Delay	Packet Transmission Delay	Both Call Setup and Transmission Delay
Overload	Overload may block call setup	Overload increases packet delay	Overload increases call setup and packet delay
speed and code conversion	No speed and code conversion	Speed and Code conversion	Speed and Code conversion
Bandwidth	Fixed Bandwidth	Dynamic Bandwidth	Dynamic Bandwidth
Overhead bits	No overhead bits after call setup	Overhead bits in each packet	Overhead bits in each packet
Resource reservation	Yes	No	Yes
Reliability	More	Less	More than Datagram
Wastage of Resources	More	Less	More than Datagram

Network Access

1. **Residential Access: point-to-point access**
   a. **Dialup via modem**
      - up to 56Kbps direct access to router (often less)
      - Can't surf and phone at same time: can't be "always on"
   b. **DSL: digital subscriber line**
      - deployment: telephone company (typically)
      - up to 1 Mbps upstream (today typically < 256 kbps)
      - up to 8 Mbps downstream (today typically < 1 Mbps)

- dedicated physical line to telephone central office csitn

c. Cable

- Cable internet access make the use of cable TV company's existing infrastructure
- Both the fiber and co-axial cable are employed, it is also called hybrid fiber coax (HFC)
- Requires cable modem, which connects to the home PC through Ethernet port.

d. Wireless Network

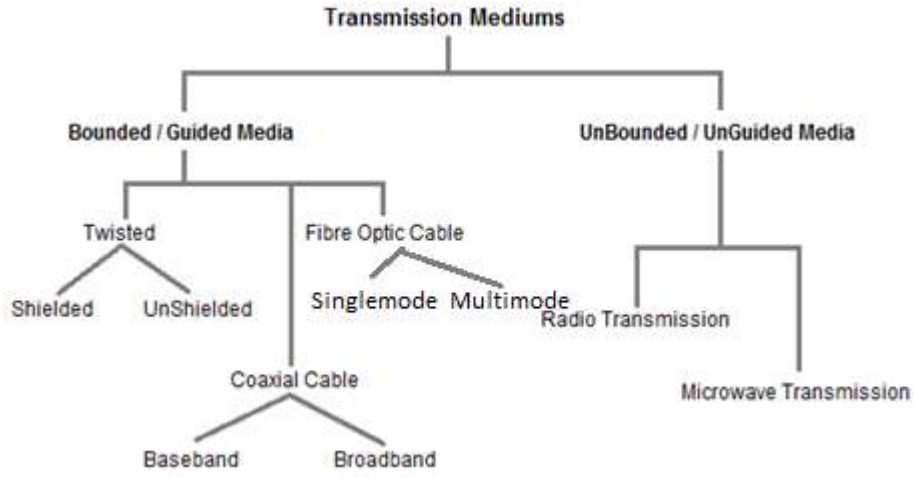
- Wireless LAN (Wi-Fi): IEEE 802.11
- Wide Area Wireless Access e.g.:- 3G, GPRS.
- WiMAX
- Intel WiMAX 2009
- k/a IEEE 802.16 is a long distance derivation of the 802.11 WiFi protocol speed 5-10 Mbps.

2. Company Access: Local Area Networks (LAN)

Ethernet:

- 10 Mbs, 100Mbps, 1Gbps, 10Gbps Ethernet
- modern configuration: end systems connect into Ethernet switch

Physical Medias or Transmission Medias



Transmission medium is the means through which we send our data from one place to another. The first layer (physical layer) of Communication Networks OSI Seven layer model is dedicated to the transmission media, we will study the OSI Model later.

Factors to be considered while choosing Transmission Medium

- Transmission Rate
- Cost and Ease of Installation
- Resistance to Environmental Conditions
- Distances
- Coverage areas or Network type

Bounded/Guided Transmission Media

It is the transmission media in which signals are confined to a specific path using wire or cable. The types of Bounded/ Guided are discussed below.

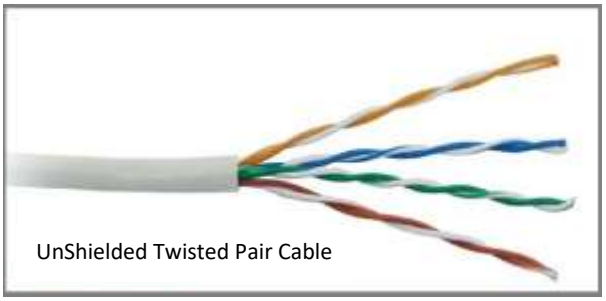
Twisted Pair Cable

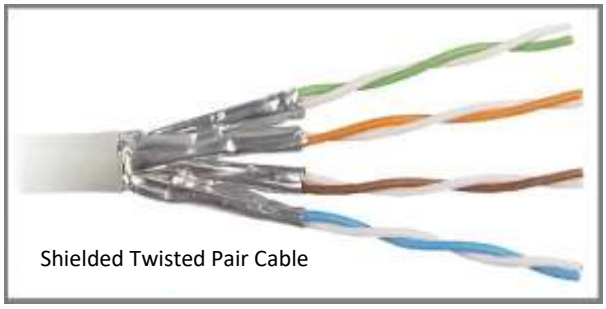
This cable is the most commonly used and is cheaper than others. It is lightweight, cheap, can be installed easily, and they support many different types of network. Some important points :

- Its frequency range is 0 to 3.5 kHz.
- Typical attenuation is 0.2 dB/Km @ 1kHz.
- Typical delay is 50 µs/km.
- Repeater spacing is 2km.

Twisted Pair is of two types :

- **Unshielded Twisted Pair (UTP)**
- **Shielded Twisted Pair (STP)**


UnShielded Twisted Pair Cable


Shielded Twisted Pair Cable

*** Unshielded Twisted Pair Cable :** It is the most common type of telecommunication when compared with Shielded Twisted Pair Cable which consists of two conductors usually copper, each with its own colour plastic insulator. Identification is the reason behind coloured plastic insulation.

UTP cables consist of 2 or 4 pairs of twisted cable. Cable with 2 pair use **RJ-11** connector and 4 pair cable use **RJ-45** connector.

Advantages :

- Installation is easy
- Flexible
- Cheap
- It has high speed capacity,
- 100 meter limit
- Higher grades of UTP are used in LAN technologies like Ethernet.

It consists of two insulating copper wires (1mm thick). The wires are twisted together in a helical form to reduce electrical interference from similar pair.

Disadvantages :

- Bandwidth is low when compared with Coaxial Cable
- Provides less protection from interference.

* **Shielded Twisted Pair Cable :** This cable has a metal foil or braided-mesh covering which encases each pair of insulated conductors. Electromagnetic noise penetration is prevented by metal casing. Shielding also eliminates crosstalk

It has same attenuation as unshielded twisted pair. It is faster than unshielded and coaxial cable. It is more expensive than coaxial and unshielded twisted pair.

Advantages :

- Easy to install
- Performance is adequate
- Can be used for Analog or Digital transmission
- Increases the signaling rate
- Higher capacity than unshielded twisted pair
- Eliminates crosstalk

Disadvantages :

- Difficult to manufacture
- Heavy

Coaxial Cable

Coaxial is called by this name because it contains two conductors that are parallel to each other. Copper is used in this as center conductor which can be a solid wire or a standard one. It is surrounded by PVC installation, a sheath which is encased in an outer conductor of metal foil, braid or both.

Outer metallic wrapping is used as a shield against noise and as the second conductor which completes the circuit. The outer conductor is also encased in an insulating sheath. The outermost part is the plastic cover which protects the whole cable.

Here the most common coaxial standards.

- 50-Ohm RG-7 or RG-11 : used with thick Ethernet.
- 50-Ohm RG-58 : used with thin Ethernet
- 75-Ohm RG-59 : used with cable television
- 93-Ohm RG-62 : used with ARCNET.

There are two **types** of Coaxial cables :

BaseBand : This is a 50 ohm (Ω) coaxial cable which is used for digital transmission. It is mostly used for LAN's. Baseband transmits a single signal at a time with very high speed. The major drawback is that it needs amplification after every 1000 feet.

BroadBand : This uses analog transmission on standard cable television cabling. It transmits several simultaneous signal using different frequencies. It covers large area when compared with Baseband Coaxial Cable.

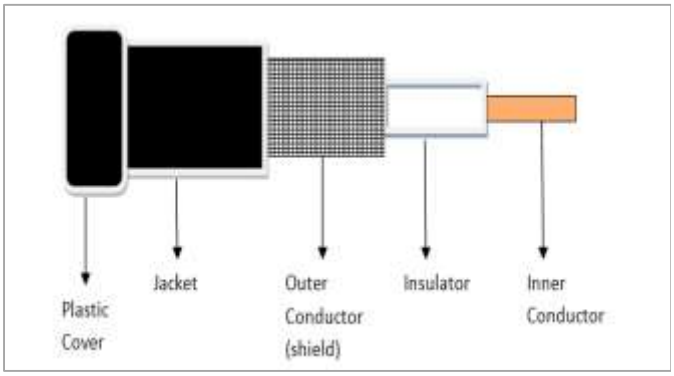


Fig.:- Coaxial Cable

Advantages :

- Bandwidth is high
- Used in long distance telephone lines.
- Transmits digital signals at a very high rate of 10Mbps.
- Much higher noise immunity
- Data transmission without distortion.
- The can span to longer distance at higher speeds as they have better shielding when compared to twisted pair cable

Disadvantages :

- Single cable failure can fail the entire network.
- Difficult to install and expensive when compared with twisted pair.
- If the shield is imperfect, it can lead to grounded loop.

Fiber Optic Cable

These are similar to coaxial cable. It uses electric signals to transmit data. At the center is the glass core through which light propagates.

In multimode fibers, the core is 50microns, and In single mode fibers, the thickness is 8 to 10 microns.

The core in fiber optic cable is surrounded by glass cladding with lower index of refraction as compared to core to keep all the light in core. This is covered with a thin plastic jacket to protect the cladding. The fibers are grouped together in bundles protected by an outer shield.

Fiber optic cable has bandwidth more than **2 gbps (Gigabytes per Second)**

Advantages :

- Provides high quality transmission of signals at very high speed.
- These are not affected by electromagnetic interference, so noise and distortion is very less.
- Used for both analog and digital signals.

Disadvantages :

- It is expensive
- Difficult to install.
- Maintenance is expensive and difficult.
- Do not allow complete routing of light signals.

Types of Fiber Optic Cable:

i. **Single Mode (Mono Mode):** For longer distance and LASER is used as light source.
ii. **Multi Mode:** For shorter distance and LED is used as light source.

Fig. Fiber Optic Cable

UnBounded/UnGuided Transmission Media

Unguided or wireless media sends the data through air (or water), which is available to anyone who has a device capable of receiving them. Types of unguided/ unbounded media are discussed below :

- Radio Transmission
- MicroWave Transmission

Radio Transmission

Its frequency is between **3 kHz to 300GHz**. It is simple to install and has high attenuation. These waves are used for multicast communications. The prime purpose of radio is to convey information from one place to another through the intervening media (i.e., air, space, nonconducting materials) without wires.

Applications: Radios, Televisions

Types of Propogation

Radio Transmission utilizes different types of propagation :

- **Troposphere :** The lowest portion of earth's atmosphere extending outward approximately 30 miles from the earth's surface. Clouds, jet planes, wind is found here.
- **Ionosphere :** The layer of the atmosphere above troposphere, but below space. Contains electrically charged particles.

Microwave Transmission

It travels at high frequency **300MHz – 300 GHz** than the radio waves. It requires the sender to be inside of the receiver. It operates in a system with a low gigahertz range. It is mostly used for unicast communication.

There are 2 types of Microwave Transmission :

1. Terrestrial Microwave
2. Satellite Microwave

Advantages of Microwave Transmission

- Used for long distance telephone communication

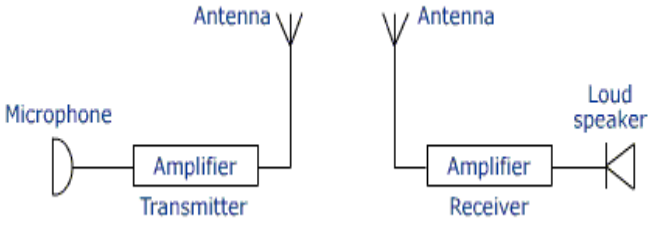


Fig. **Radio Transmission**

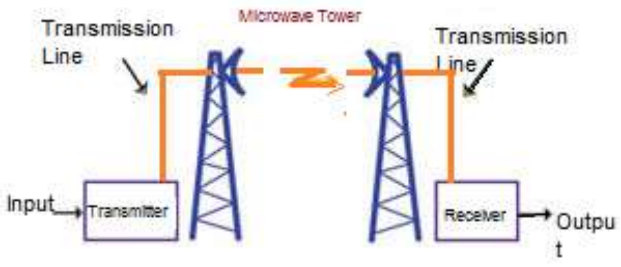


Fig. Microwave Transmission

- Carries 1000's of voice channels at the same time

Disadvantages of Microwave Transmission

- It is Very costly

Applications: Telecom, Radar, GPS, Satellite

Terrestrial Microwave

For increasing the distance served by terrestrial microwave, repeaters can be installed with each antenna .The signal received by an antenna can be converted into transmittable form and relayed to next antenna as shown in below figure. It is an example of telephone systems all over the world

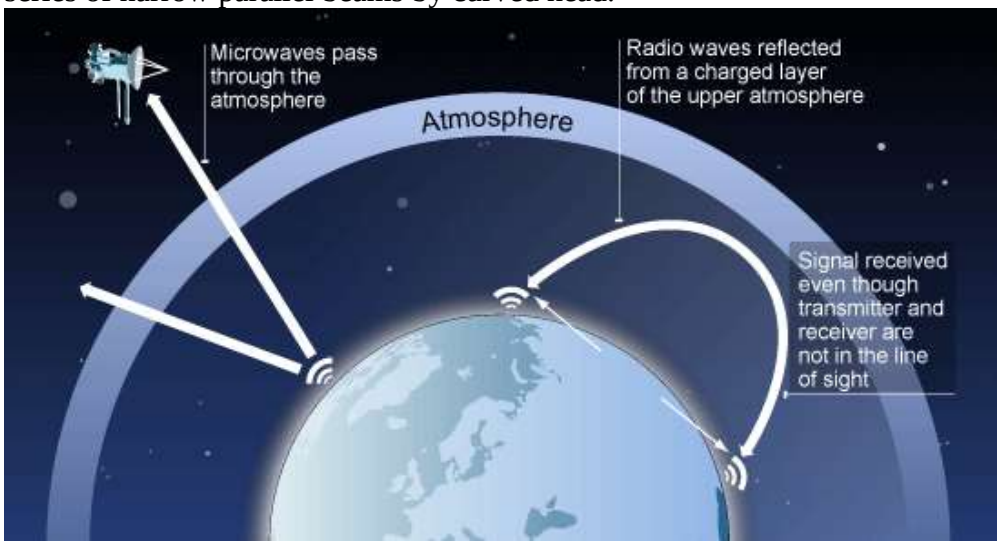
There are two types of antennas used for terrestrial microwave communication :

1. Parabolic Dish Antenna

In this every line parallel to the line of symmetry reflects off the curve at angles in a way that they intersect at a common point called focus. This antenna is based on geometry of parabola.

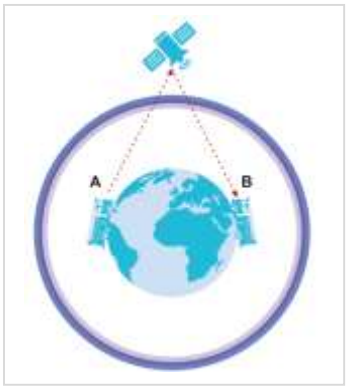
2. Horn Antenna

It is a like gigantic scoop. The outgoing transmissions are broadcast up a stem and deflected outward in a series of narrow parallel beams by curved head.



(a) Microwaves and radio waves in the atmosphere (b)A mobile phone mast - an example of a microwave transmitter

Satellite Microwave



This is a microwave relay station which is placed in outer space. The satellites are launched either by rockets or space shuttles carry them.

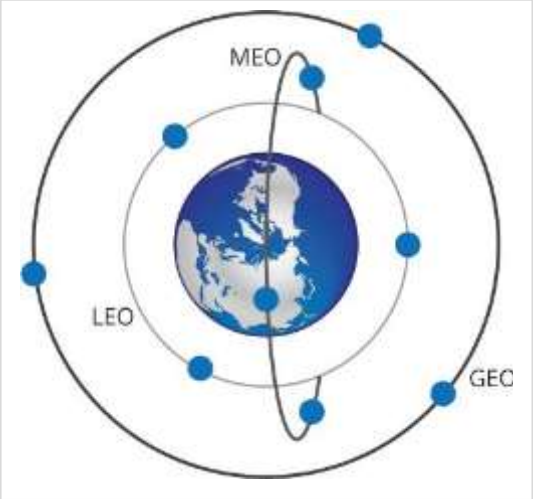
These are positioned 3600KM above the equator with an orbit speed that exactly matches the rotation speed of the earth. As the satellite is positioned in a geo-synchronous orbit, it is stationery relative to earth and always stays over the same point on the ground. This is usually done to allow ground stations to aim antenna at a fixed point in the sky.

If two users on the opposite side of the world want to communicate, the radio wave cannot use line of sight propagation, because it travels in a straight line and will not go around the curve of the earth. So, the solution for contacting somebody who's over the curved horizon is to put a satellite up, and the satellite will receive the signal from the radio caller, and then transmit it in another straight line, line of sight, to the person receiving it at the other end.

Features of Satellite Microwave :

- ✓ Bandwidth capacity depends on the frequency used.
- ✓ Satellite microwave deployment for orbiting satellite is difficult.

Communications satellites usually have one of three primary types of orbit, while other orbital classifications are used to further specify orbital details.



- Geostationary satellites have a *geostationary orbit* (**GEO**), which is ***35,786 KM (22,236 mi)*** from Earth's surface. This orbit has the special characteristic that the apparent position of the satellite in the sky when viewed by a ground observer does not change, the satellite appears to "stand still" in the sky. This is because the satellite's orbital period is the same as the rotation rate of the Earth. The advantage of this orbit is that ground antennas do not have to track the satellite across the sky, they can be fixed to point at the location in the sky the satellite appears.
- *Medium Earth orbit* (**MEO**) satellites are closer to Earth. Orbital altitudes range from ***2,000 to 35,786 KM*** **(1,243 to 22,236 mi**) above Earth.
- The region below medium orbits is referred to as *low Earth orbit* (**LEO**), and is about ***160 to 2,000 KM*** **(99 to 1,243 mi)** above Earth.

Advantages of Satellite Microwave :

- Transmitting station can receive back its own transmission and check whether the satellite has transmitted information correctly.
- A single microwave relay station which is visible from any point.

Disadvantages of Satellite Microwave :

- Satellite manufacturing cost is very high
- Cost of launching satellite is very expensive
- Transmission highly depends on whether conditions, it can go down in bad weather

What is the difference between Radio Waves and Microwaves?

• **Microwaves** are a sub-class of radio waves.

• The frequency of **radio waves** can take values from 3 KHz - to - 300 GHz, but **microwaves** are defined to have frequencies ranging from 300 MHz – to - 300 GHz.

• **Radio waves** in general have long distance communication capabilities, but **microwaves** do not have these abilities.

• **Radio waves** are mostly used in the communication field whereas **microwaves** are used in industries and astronomy.

Comparison of Transmission Medias

BASIS FOR COMPARISON	GUIDED MEDIA	UNGUIDED MEDIA
Basic	The signal requires a physical path for transmission.	The signal is broadcasted through air or sometimes water.
Alternative name	It is called wired communication or bounded transmission media.	It is called wireless communication or unbounded transmission media.
Direction	It provides direction to signal for travelling.	It does not provide any direction.
Types	Twisted pair cable, coaxial cable and fibre optic cable.	Radio wave, microwave and infrared.

Medium	Attenuation	Electromagnetic Interface	Security	Cost
Unshielded Twisted Pair	High	High	Low	Low
Shielded Twisted Pair	High	Moderate	Low	Moderate
Coaxial Cable	Moderate	Moderate	Low	Moderate
Fibre Optic Cable	Low	Low	High	High
Radio Waves	Low to High	High	Low	Moderate
Microwave Transmission	Can be higher or lower or moderate	High	Moderate	High
Satellite Communication	Can be higher or lower or moderate	High	Moderate	Very High

ISP

An ISP (Internet service provider) is a company that provides individuals and other companies access to the Internet and other related services such as Web site building and virtual hosting.

Features

When shopping for an ISP, make sure they include these basic features:

- **E-mail accounts.** Look for ISPs that offer the best packages on e-mail accounts, including features and number of e-mail aliases.
- **Customer service and support.** While many ISP companies are still mom-and-pop shops, look for a provider that can provide the service and support that your business needs. Always consider the worst case scenario, and be sure you have someone you can contact if there are problems.
- **High-speed access.** You can connect to the Internet in a number of different ways, including dialup, DSL, cable, and even wireless. Over the past decade, thousands of miles of fiber-optic cable have been installed all across the country, allowing more businesses and households to connect to the Internet at a much faster speed. Wireless options are also increasing, and more businesses are including that feature as part of their Internet service package.
- **Advanced spam-blocking features.** A few years ago, spam blocking features cost extra, but these days they are more likely to be part of the basic features package.

In addition to the regular services, some ISP's offer additional value-added services, including:

- **Domain name registration.** Many ISPs will include the cost of registering a domain name into their access or hosting packages. Prices for domain name registrations and automatic renewals will also vary, so make sure you get the best price available.
- **Web hosting.** Your ISP and your Web host don't have to be one and the same, but you may be able to save money and simplify your bookkeeping by getting both services from one place.

If you find yourself getting overwhelmed by the myriad ISP options available, consider retaining a technology consultant. A little time and money spent now may save you lots of money in the future. Whether you do it yourself and hire a consultant, the time to do your research and due diligence is now — not once you're locked in to an unfavorable long-term contract.

Different types of ISP connections

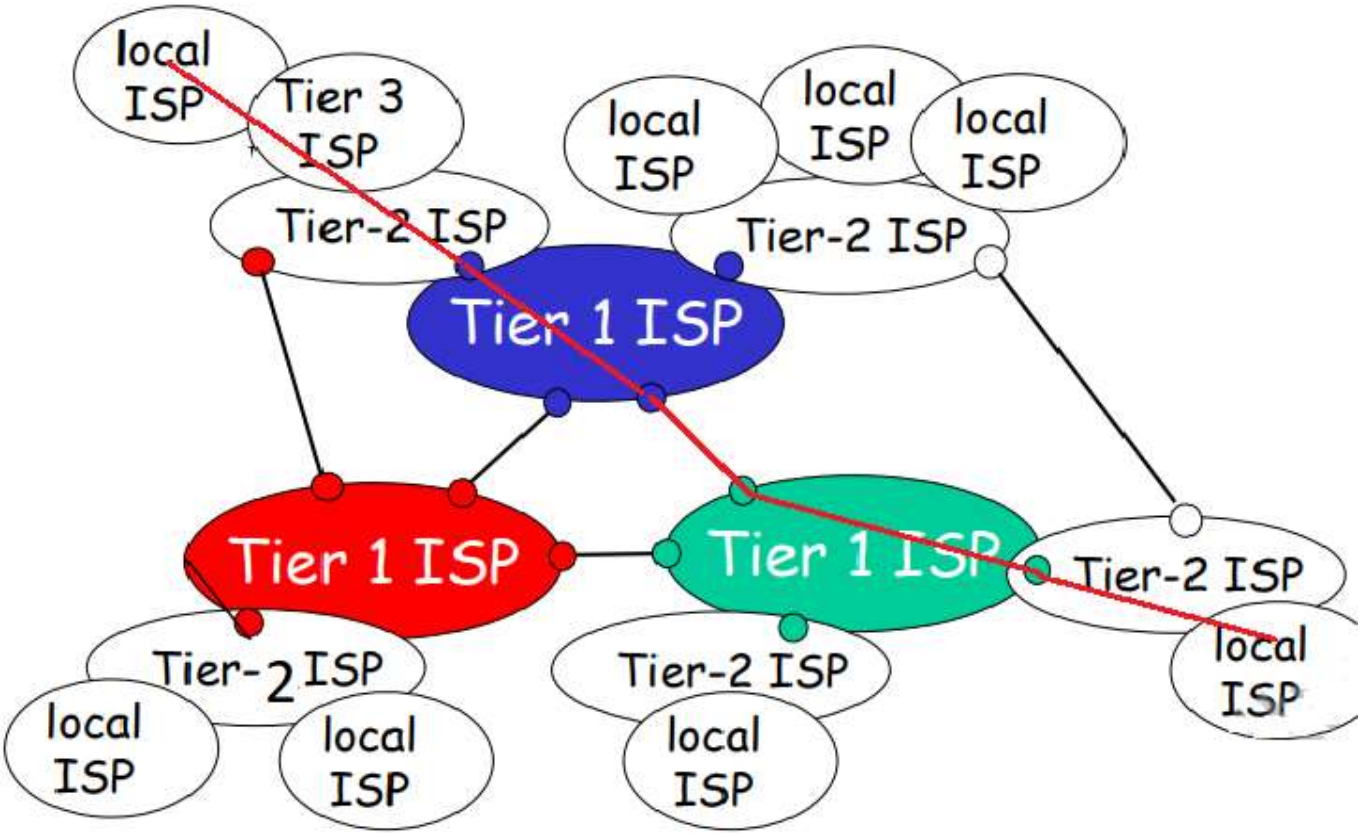
- **Dial-up** or analogue.
- **DSL** (digital subscriber line)

- **Cable broadband**.
- **Fibre** optic **broadband**.
- **Wireless** or Wi-Fi **broadband**.
- **Satellite** and **mobile broadband**.
- **Dedicated** leased line.

Tier 1 ISP
- Works as backbone of network
- Access to the entire Internet Region solely via its free and reciprocal peering agreements.
- Provides (usually sells) access to the global Internet. e.g., Vedaphone, Sprint, AT&T,
- National/ international coverage

"Tier-2" ISPs:
- smaller (often regional) ISPs
- Connect to one or more tier-1 ISPs, possibly other tier-2 ISPs

"Tier-3" ISPs
- local ISPs
- last hop ("access") network (closest to end systems)



Backbone

A **backbone** is a part of computer network that interconnects various pieces of network, providing a path for the exchange of information between different LANs or subnetworks. A backbone can tie together diverse networks in the same building, in different buildings in a campus environment, or over wide areas. Normally, the backbone's capacity is greater than the networks connected to it.

A large corporation that has many locations may have a backbone network that ties all of the locations together, for example, if a server cluster needs to be accessed by different departments of a company that are located at different geographical locations. The pieces of the network connections (for example: Ethernet, wireless) that bring these departments together is often mentioned as network backbone. Network congestion is often taken into consideration while designing backbones.

One example of a backbone network is the Internet backbone.

Backbone network uses optical fiber, satellite, teleport, marine cable etc

Types of backbone

1) **Distributed backbone**
   - a backbone network that consists of a number of connectivity devices connected to a series of central connectivity devices, such as hubs, switches, or routers, in a hierarchy.
2) **Collapsed backbone**
   - each hub provides a link back to a central location to be connected to a backbone-in-a-box. That box can be a switch or a router.
   - uses a central node (connection point)
   - ease of management since the backbone is in a single location and in a single box, and
   - since the backbone is essentially the back plane or internal switching matrix of the box, proprietary, high performance technology can be used.
3) **Parallel backbone**
   - very strong and trustworthy backbone
   - allows for duplicate connections when there is more than one router or switch.
   - more expensive than other backbone networks because they require more cabling
4) **Serial backbone**
   - simplest kind of backbone network.
   - consist of two or more internet working devices connected to each other by a single cable in a daisy-chain fashion