UNIT-1
Introduction: Network Types, LAN, MAN, WAN, Network Topologies Reference models- The OSI Reference Model- the TCP/IP Reference Model - A Comparison of the OSI and TCP/IP Reference Models, OSI Vs TCP/IP, Lack of OSI models success, Internet History. Physical Layer –Introduction to Guided Media- Twisted-pair cable, Coaxial cable and Fiber optic cable and unguided media: Wireless-Radio waves, microwaves, infrared.

Introduction to Computer Networks

COMPUTER NETWORK:

➢ A computer network is a system in which multiple computers are connected to each other to share information and resources.

➢ The physical connection between networked computing devices is established using either cable media or wireless media.

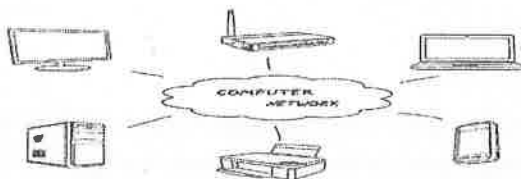➢ The best-known computer network is the Internet.

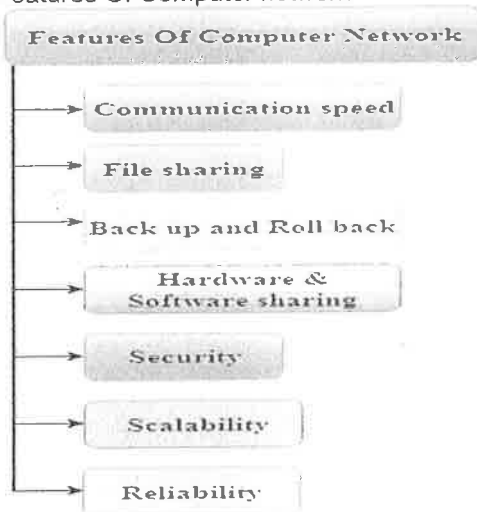**Fig:** Computer Network

Advantages of Computer Networks

1. **File sharing:** The major advantage of a computer network is that is allows file sharing and remote file access. **Resource sharing:** All computers in the network can share resources such as printers, fax machines, modems, and scanners.

2. **Better connectivity and communications:** It allows users to connect and communicate with each other easily.

3. **Internet access:** Computer networks provide internet service over the entire network. Every single computer attached to the network can experience the high speed internet.

4. **Entertainment:** Many games and other means of entertainment are easily available on the internet.

Disadvantages of Computer Networks

1. **Lack of data security and privacy:** Because there would be a huge number of people who would be using a computer network to get and share some of their files and resources, a certain user's security would be always at risk.

2. **Presence of computer viruses and malwares:** If even one computer on a network gets affected by a virus, there is a possible threat for the other systems getting affected too.

3. **Lack of Independence:** Since most networks have a centralized server and dependent clients, the client users lack any freedom whatsoever. Centralized decision making can sometimes hinder how a client user wants to use his own computer.

4. **Lack of Robustness:** As previously stated, if a computer network's main server breaks down, the entire system would become useless. Also, if it has a bridging device or a central linking server that fails, the entire network would also come to a standstill.

Features Of Computer network

Communication speed:Network provides us to communicate over the network in a fast and efficient manner. For example, we can do video conferencing, email messaging, etc. over the internet. Therefore, the computer network is a great way to share our knowledge and ideas.

File sharing:File sharing is one of the major advantage of the computer network. Computer network provides us to share the files with each other.

Back up and Roll back is easy:Since the files are stored in the main server which is centrally located. Therefore, it is easy to take the back up from the main server.

Software and Hardware sharing:We can install the applications on the main server, therefore, the user can access the applications centrally. So, we do not need to install the software on every machine. Similarly, hardware can also be shared.

Security:Network allows the security by ensuring that the user has the right to access the certain files and applications.

Scalability:Scalability means that we can add the new components on the network. Network must be scalable so that we can extend the network by adding new devices. But, it decreases the speed of the connection and data of the transmission speed also decreases, this increases the chances of error occurring. This problem can be overcome by using the routing or switching devices.

Reliability:Computer network can use the alternative source for the data communication in case of any hardware failure.

Network: A network consists of two or more computers that are linked in order to share resources (such as printers and CDs), exchange files, or allow electronic communications. The computers on a network may be linked through cables, telephone lines, radio waves, satellites, or infrared light beams

Local Area Network(L.A.N):-

- A LAN is system composed of computer hardware and transmission media and software.
- The standard of LAN is IEEE -802, which is popularly used shared media for peer-to-peer communications that broadcasts information for all stations to receive.
- The LAN enables stations to communicate directly using a common physical medium on a Point to point basis without any intermediate switching node.
- It generally use only one type of transmission media.
- LAN'S are privately owned networks within a single building (or) campus of upto kms in range.
- Depends on application and cost, various topology used in LAN(star,bus,ring).
- LAN transmits data amongst user stations.
- LAN transmission capacity is more than 1 mbps.
- LAN is limited to areas less than 5 sq.kms.

Fig.1 : Two broadcast networks . (a) Bus. (b) Ring.

LAN can provide users

- Flexibility and speed
- Adapatability and reliability
- Security and transparent interface
- Centralised mgt and private ownership

Advantages of LAN

There are various advantages of LAN, which are as follows –

- Inexpensive transmission media.
- It can simplify the physical association of a device to the media.
- It is used to high data transmission rates.
- A large rate of interconnection between devices.
- Each connected device has the potential to interact with another device on the network.
- It is flexible and growth-oriented.
- It allows file locking.

Disadvantages of LAN

There are various disadvantages to LAN, which are as follows –

- LAN software needed a memory area in each of the mainframe used on the network. This decreases the memory space available for the user's program.
- Some security system should be executed if it is essential to protect private data.
- Some control on the part of the customer is lost. We have to share a printer with different customers.
- Some current application programs will not run in a network environme

Metropolitan Area Network(M.A.N):-

- A MAN is larger than LAN which is limited to cities (or) group of nearby corporate offices.
- It uses similar technology as LAN.
- MAN standards are sponsored by IEEE. The Man standards is organized around a topology and technique called distributed queue dual bus (DQDB).
- MAN provides the transfer rates from 34 to150 mbps.
- MAN is designed with two unidirectional busses.
- Each bus is independent of the other in the transfer of traffic.
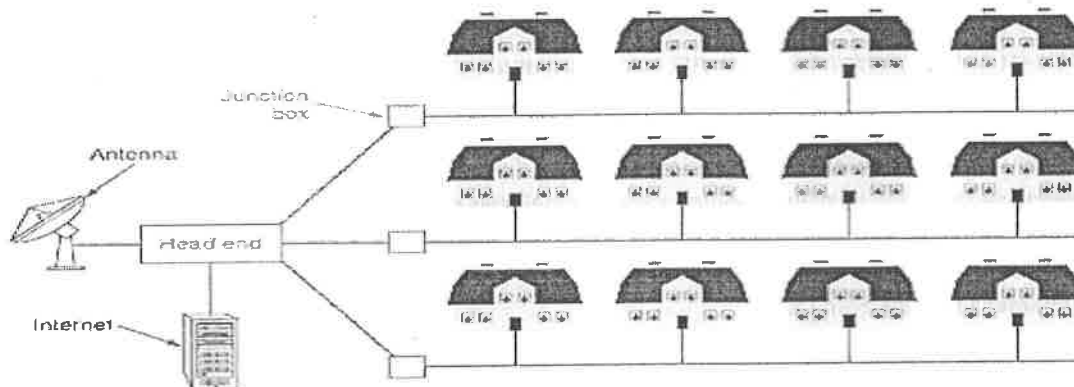- The topology can be designed as an open bus (or) a closed configuration.

Fig: A Metropolitan area networks based on cable TV.

- MAN are based on fiber optic transmission technology and provides high speed interconnections between sites. It supports both data and voice.
- MAN as a special category is that standard has been adopted for them and implemented which is called IEEE 802.6

Advantages of a metropolitan area network (MAN)

Below are some of the benefits of MAN:-

Less expensive: It is less expensive to attach MAN with WAN. MAN gives the good efficiency of data. In MAN data is easily managed in a centralized way.

Sending local emails: On MAN you can send local emails fast and free.

High speed than WAN:MAN uses fiber optics so the speed of data can easily reach upon 1000 Mbps. Files and databases can be transferred fast.

Sharing of the internet: In some installation of MANs, users can share their internet connection. So multiple users can get the same high-speed internet.

Conversion from LAN to MAN is easy:MAN is a faster way to connect two fast LANs together. This is due to the fast configuration of links.

High Security:MAN has a high-security level than WAN.

Disadvantages of metropolitan area network (MAN)

Difficult to manage: If MAN becomes bigger then it becomes difficult to manage it. This is due to a security problem and other extra configuration.

Internet speed difference:MAN cannot work on traditional phone copper wires. If MAN is installed on copper wires then there will be very low speed. So it required the high cost to set up fiber optics for the first time.

Hackers attack: In MAN there are high chances of attacking hackers on the network compared to LAN. So data may be leaked. Data can be secured but it needs high trained staff and security tools.

Technical people required to set up: To setup MAN it requires technical people that can correctly setup MAN. The technical people are network administrators and troubleshooters.

More wires required: In MAN additional cables are required to connect two LAN which is another problem.

Examples of metropolitan area network (MAN)

Some of the examples of MAN are:-

- Digital cable television
- Used in government agencies
- University campuses
- Cable broadband
- Used to connect several branches of the local school
- In hospital (for communication between doctors, research offices, labs)
- A network of fire stations
- In airports
- Networking between community colleges within the country

Wide Area Network(W.A.N):-

- A WAN is within the limit of country (or) continent.
- Machines are connected for running user applications (or) programs. These machines are called "hosts".
- All the hosts are connected by each other through communication subnet.
- Subnet carries messages from host to host.
- Subnet contains transmission lines and switching elements.
- Transmission line is used for data transfer between two machines.
- Switching elements are used for connecting two transmission lines.
- Switching elements are basically computers and they are called packets switching nodes,intetrmediate sustems and data switching exchanges.
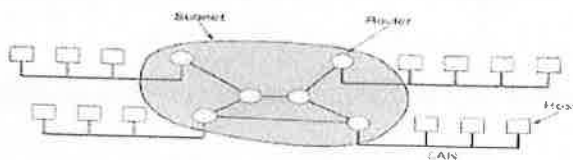

Relation between hosts on LANS and ther subnet.

- The above fig. shows the relation between hosts,subnet and routers in WAN. Each host is connected to a LAN on which a router is present.
- In the WAN a subnet is organized according to the principle,

Which a packet is sent from one router to another via one (or) more intermediate routers the packet is received to each intermediate router and stored until the required output line is free and then forwarded.

This is called "store and forward" (or) "packet switched subnet".

Wide Area Networks (2)
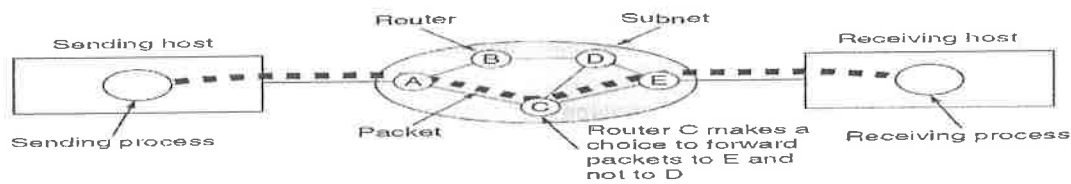
A stream of packets from sender to receiver.

Advantages of Wide Area Network

1. Area Coverage: WAN generally covers geographical areas of large proportions (1000kms or more than that).

2. Centralized Data: Using WAN means that you can share the data connected to all the devices in the respective network.

3. Updated Files: From WAN users can get updated files and data from the servers.

4. Message Exchange: With the advancement of Internet of Things (IoT) and LAN, a sudden growth of WAN based devices can be seen.

5. Increased Bandwidth: In order for forming a backbone of a respective network, corporate LAN often uses leased lines.

6. Assured Uptime: Another biggest plus of WAN is that they offer guaranteed uptime.

Disadvantages of Wide Area Network

1. Security Since WAN has more technologies combined to each other, it faces more security issues comparing to LAN and MAN.

2. Need of Security Solutions:As mentioned earlier WAN frequently faces security issues. Probably as a result of the data transfer that can be easily accessed by the hackers

3. Installation Costs:WANs are on default complicated and complex basically because of their geographical coverage.

4. Disconnection Problems:In some areas especially in remote locations, there is no proper electricity supply or line structure

5. Troubleshooting Issues Troubleshooting WAN issues is a difficult task and requires more time.

6. Maintenance Issues Maintaining WAN is a difficult task to carry out. Especially maintaining a data center that operates 24/7 is the biggest challenge out of all. It is full time job that needs assistance from network administrators and technicians.

Comparision between LAN,MAN,WAN:

BASIS OF COMPARISION	LAN	MAN	WAN
Expands to	Local Area Network	Metropolitan Area	Wide Area Network

		Network	
Meaning	A network that connects a group of computers in a small geographical area.	It covers relatively large region such as cities, towns.	It spans large locality and connects countries together. Example Internet.
Ownership of Network	Private	Private or Public.	Private or Public
Design and Maintenance	Easy	Difficult	Difficult
Propagation Delay	Short	Moderate	Long
Speed	High	Moderate	Low
Fault Tolerance	More Tolerant	Less Tolerant	Less Tolerant
Congestion	Less	More	More
Used for	College,School,Hospital.	Small towns,City.	Country/Continent.

NETWORK TOPOLOGIES

Topology is the arrangement of network by including nodes and connecting lines. (or) A physical or logical arrangement of nodes in a network is called network topology.

Different types of Network topologies are

- Bus topology
- Ring topology
- Star topology
- Mesh topology
- Tree topology

Bus Topology

In bus topology devices or nodes are connected to the same line or single cable and each computer system is connected to a single cable of bus

At any time, any computer can send the data over the bus. When more than one computer wants to send data at a same time a bus arbitration mechanism will decide which computer has to send.
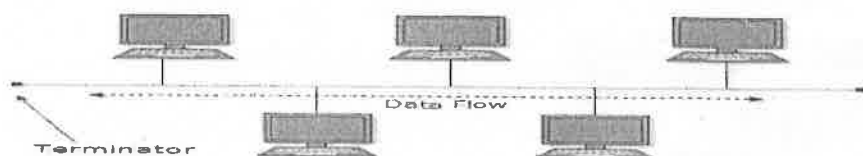
Advantages:

- Works well for small networks.
- Cost of network is low.

- Easy to add new nodes.
- Less cable is required because of backbone.

Disadvantages:

- Heavy n/w traffic can slow a bus.
- Management cost may be high.
- Failure of backbone affects failure of all devices on the n/w.

Ring Topology

In ring topology each device is connected by a dedicated point-to-point connection to its adjacent devices forms a ring structure and any node has exactly two branches connected to it.

Data is transmitted around the ring in a particular direction to reach its destination. In between the signal is regenerated by the repeater in the ring. So it is an active n/w and termination is not required.
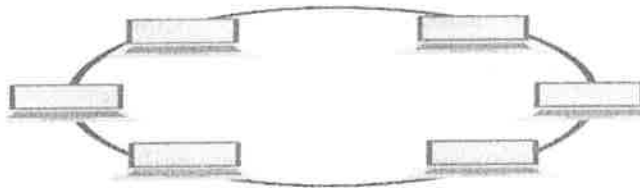
Advantages

- Easy to install
- Link failure can be easily found as each device is connected to its immediate neighbours only.
- Because every node is given equal chance to access the n/w by giving tokens to each node.

Disadvantages

- Maximum ring length and number of devices is limited.
- Failure of one node can affect the entire n/w.

Star Topology

In Star topology all the devices/nodes are connected to a central computer or server in a point-to-point connection stream. In star topology every node is connected to a central node, which is called Hub/Switch via cables. Hub connects different nodes which are present in the star network and it can manage or control whole network.

Advantages

- Less expensive than mesh since each device is connected only to the hub.
- Installation and configuration are easy.

- Less cable is need then mesh.
- Easy to fault identification and to remove parts.
- No disruptions to the network when connecting (or) removing devices.

Disadvantages

- If the central hub fails, the whole network fails to operate.

Mesh Topology

Each node is directly connected to all other nodes, which are present in the entire network. In this each node not only send its own data but also can broadcast the data from other nodes.

This topology is very expensive just because of there are many needless connections and is mainly used in wireless connections.

Mesh Topology

Advantages

- Dedicated link between nodes ensures optimum data rate and eliminate traffic problem.
- Better privacy and security.
- Failure of any link will not cause failure of entire network.

Disadvantages

- Large amount of cabling and i/o paths are required.
- Hardware required for each link and redundant link increases cost.
- It is Expensive.
- Difficulty in installation.
- Difficult to recognize.

Hybrid Topology: A network structure whose design contains more than one topology is said to be hybrid topology. 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).
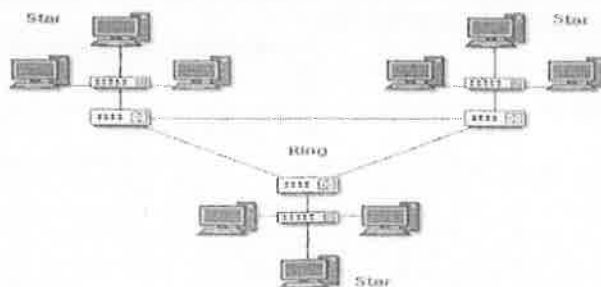
Advantages:

➤ Reliable as error detecting and trouble shooting is easy.

➤ Scalable as size can be increased easily.

➤ Flexible.

Disadvantages:

➤ Complex in design.

➤ Costly.

Comparison of the OSI and TCP/IP Reference Model

OSI(Open System Interconnection)	TCP/IP (Transmission Control Protocol/ Internet Protocol)
It has 7 layers	It has 4 layers
Model was first defined before implementation takes place	Model defined after protocol were implemented
OSI provides layer functioning and also defines functions of all the layers.	TCP/IP model is more based on protocols and protocols are not flexible with other layers.
In OSI model the transport layer guarantees the delivery of packets	In TCP/IP model the transport layer does not guarantees delivery of packets.
Follows horizontal approach	Follows vertical approach.
OSI model has a separate presentation layer	TCP/IP doesn't have a separate presentation layer
OSI is a general model.	TCP/IP model cannot be used in any other
Network layer of OSI model provide both connection oriented and connectionless service.	The Network layer in TCP/IP model provides Connectionless service.
OSI model has a problem of fitting the protocols in the model	TCP/IP model does not fit any protocol
Protocols are hidden in OSI model and are easily replaced as the technology changes.	In TCP/IP replacing protocol is not easy.
OSI model defines services, interfaces and protocols very clearly and makes clear distinction between them.	In TCP/IP it is not clearly separated its services, interfaces and protocols.
It has 7 layers	It has 4 layers

Similarities between OSI and TCP/IP reference model

These are similarities between TCP/IP and OSI models as follows.

S.NO.	Similarities	TCP/IP and OSI Model
1.	Model	Both TCP/IP are logical models.
2.	Structure	Both are arranged as layered wise which is also called an architectural model. These models have a stack of protocols it means the protocol is arranged in every layer. Both the models have some set of protocols.
3.	Networking	Both TCP/IP define standards for networking.
4.	Framework	Both TCP/IP provide a framework for creating and implementing networking standards and devices.
5.	Communication process	Both TCP/IP divide the network communication process into making their layers.
6.	Similar components	In Both TCP/IP models manufacturer allows making sets devices and network components that can co-exist and work with the devices and components that are made by the other manufacturers.
7.	functionality	In both TCP/IP models, a single layer defines a particular functionality and set standards for that functionality only.
8.	Troubleshooting	Both the TCP/IP models simplifying their troubleshooting process by dividing the layer's complex functions into simpler components of the layer.
9.	Ethernet standards	Instead of defining the already defined standards and protocols in both the TCP/IP models. For example, the Ethernet standards were already defined by IEEE before proceeding to create these models. So instead of defining them again in both the models of IEEE Ethernet standards.

Lack of OSI models success

- The OSI model appeared after the TCP/IP protocol suite. Most experts were at first excited and thought that the TCP/IP protocol would be fully replaced by the OSI model. This did not happen for several reasons, but we describe only three, which are agreed upon by all experts in the field.
  - Changing it cost a lot.
  - Some layers in the OSI model were never fully defined
  - OSI did not show a high enough level of performance

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1. OSI was completed when TCP/IP was

fully in place. changing it would cost a lot.

2. some layers in the OSI model were never fully defined. For example, although the services provided by the presentation and the session layers were listed in the document, actual protocols for these two layers were not fully defined, nor were they fully described, and the corresponding software was not fully developed.

3. when OSI was implemented by an organization in a different application, it did not show a high enough level of performance to entice the Internet authority to switch from the TCP/IP protocol suite to the OSI model.

Difference between connection oriented and connectionless services

Criteria	Connection-Oriented	Connection-Less
Connection	Prior connection needs to be established.	No prior connection is established.
Resource Allocation	Resources need to be allocated.	No prior allocation of resource is required.
Reliability	It ensures reliable transfer of data.	Reliability is not guaranteed as it is a best effort service.
Congestion	Congestion is not at all possible.	Congestion can occur likely.
Transfer mode	It can be implemented either using Circuit Switching or VCs.	It is implemented using Packet Switching.
Retransmission	It is possible to retransmit the lost data bits.	It is not possible.
Suitability	It is suitable for long and steady communication.	It is suitable for bursty transmissions.
Signaling	Connection is established through process of signaling.	There is no concept of signaling.
Packet travel	In this packets travel to their destination node in a sequential manner.	In this packets reach the destination in a random manner.
Delay	There is more delay in transfer of information, but once connection established faster delivery.	There is no delay due absence of connection establishment phase.

THE INTERNET

Internet is a global network that connects billions of computers across the world with each other and to the World Wide Web. It uses standard internet protocol suite (TCP/IP) to connect billions of computer users worldwide. It is set up by using cables such as optical fibers and other wireless and networking technologies. At present, internet is the fastest mean of sending or exchanging information and data between computers across the world.

POP

Client

Telephone System

Regional ISP

NAP →

Backbone

Server farm

Corporate LAN ←

Router
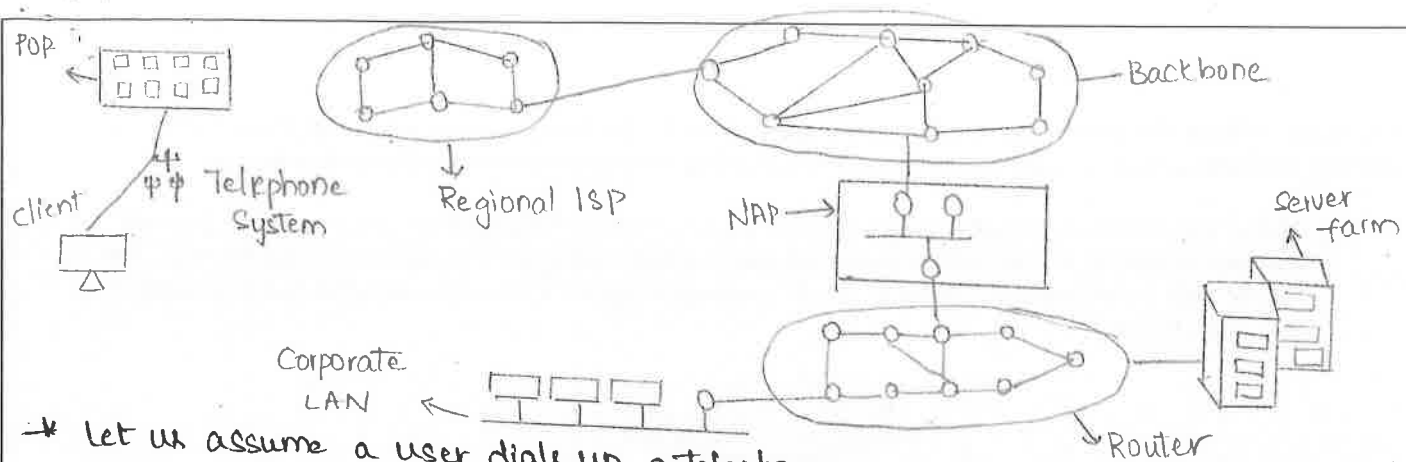
* Let us assume a user dials up a telephone line using electronic device called "modem". Modem converts the digital signals generated by PC's to analog signal & transfer these signals to the subscribe ISP's (Internet Service Providers) POP (Point Of presence)

* POP removes the telephone connection and gives connection to ISP's regional network and again converts signals back to digital form.

* The regional ISP, which consists of thousands of interconnected routers across no. of backbone networks, transfer the packet switched data to other backbones

* These routers are connected by high band with fibre optics.

* The server that provides services to the client's processes thousands of web pages per second are connected directly to the backbone networks. The backbone n/w are interconnected to each other through NAP (Network Access Points) which also contains many routers to forward the packet from one backbone to other.

* In addition to NAP's the layer backbones have numerous direct connections between these routers using technique called "Private Peering"

A Brief History

➤ Millions of people are users. Yet this extraordinary communication system only came into being in 1969

➤ In the mid-1960s, mainframe computers in research organizations were standalone devices.

➤ In 1967, at an Association for Computing Machinery (ACM) meeting, ARPA presented its ideas for ARPANET, a small network of connected computers.

➤ By 1969, ARPANET was a reality. Four nodes, at the University of California at Los Angeles (UCLA), the University of California at Santa Barbara (UCSB), Stanford Research Institute (SRI), and the University of Utah, were connected via the IMPs to form a network. Software called the Network Control Protocol (NCP) provided communication between the hosts.

➤ In 1972, Vint Cerf and Bob Kahn, both of whom were part of the core ARPANET group, collaborated on what they called the Interknitting Projec1. Cerf and Kahn's landmark 1973 paper outlined the protocols to achieve end-to-end delivery of packets. This paper on Transmission Control Protocol (TCP) included concepts such as encapsulation, the datagram, and the functions of a gateway.

The Internet Today : The Internet has come a long way since the 1960s. The Internet today is not a simple hierarchical structure. It is made up of many wide- and local-area networks joined by connecting devices and switching stations.

> Today most end users who want Internet connection use the services of Internet service providers (ISPs). There are international service providers, nation service providers, regional service providers, and local service providers. The Internet today is run by private companies, not the government. Figure 1.13 shows a conceptual (not geographic) view of the Internet
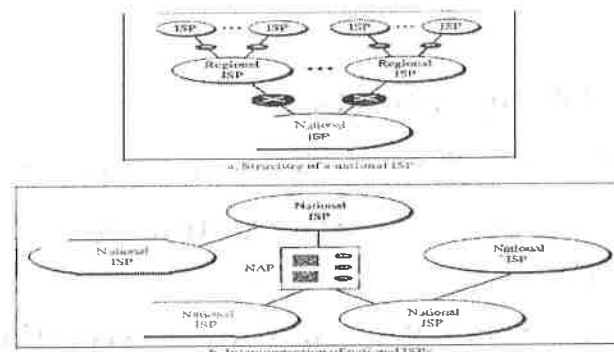
International Internet Service Providers: At the top of the hierarchy are the international service providers that connect nations together

National Internet Service Providers

To provide connectivity between the end users, these backbone networks are connected by complex switching stations (normally run by a third party) called network access points (NAPs). Some national ISP networks are also connected to one another by private switching stations called peering points. These normally operate at a high data rate (up to 600 Mbps).

Regional Internet Service Providers Regional internet service providers or regional ISPs are smaller ISPs that are connected to one or more national ISPs. They are at the third level of the hierarchy with a smaller data rate.

Local Internet Service Providers : Local Internet service providers provide direct service to the end users.

Advantages of the Internet:

o **Instant Messaging:** You can send messages or communicate to anyone using internet, such as email, voice chat, video conferencing, etc.

o **Get directions:** Using GPS technology, you can get directions to almost every place in a city, country, etc. You can find restaurants, malls, or any other service near your location.

o **Online Shopping:** It allows you to shop online such as you can be clothes, shoes, book movie tickets, railway tickets, flight tickets, and more.

o **Pay Bills:** You can pay your bills online, such as electricity bills, gas bills, college fees, etc.

o **Online Banking:** It allows you to use internet banking in which you can check your balance, receive or transfer money, get a statement, request cheque-book, etc.

o **Online Selling:** You can sell your products or services online. It helps you reach more customers and thus increases your sales and profit.

o **Work from Home:** In case you need to work from home, you can do it using a system with internet access. Today, many companies allow their employees to work from home.

o **Entertainment:** You can listen to online music, watch videos or movies, play online games.
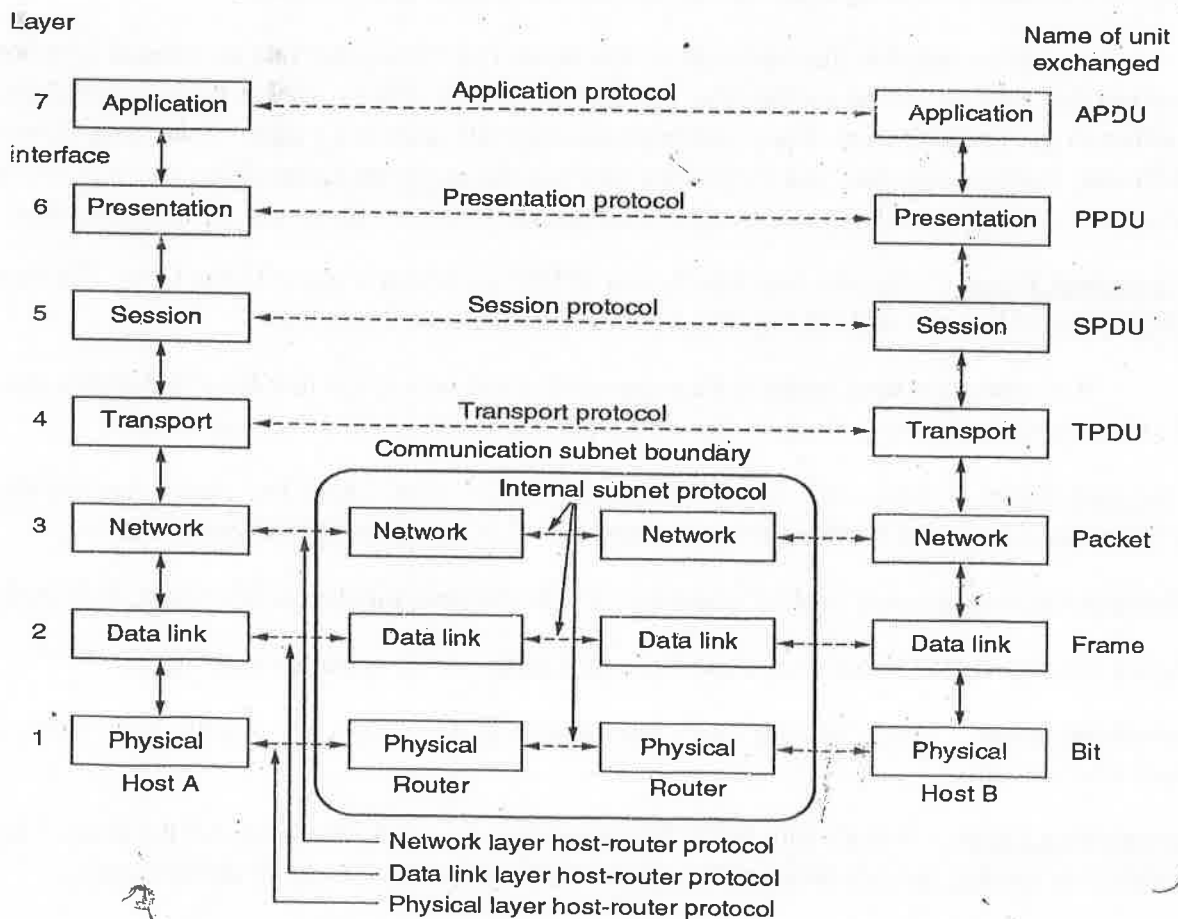
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Reference Models

There are mainly 2 types of reference models

- ❖ OSI reference model
- ❖ TCP/IP reference model

OSI Reference Model:
The international organisation for standardisation developed the OSI (open system Interconnection) reference model. OSI model is most widely used for networking. The OSI model has seven layers.

The principles of OSI model is as follows,

➢ Each layer should perform a well defined function.

➢ A layer should be created where a different abstraction is needed.

➢ The function of each layer should be chosen toward defining internationally standardized protocols.

➢ The layer boundaries should be chosen to minimize the information Flow across the interfaces.

➢ The no. of layers should be large enough that distinct functions need not be thrown together in the same layer out of necessity.

Layer						Name of unit exchanged
7	Application	Application protocol			Application	APDU
interface						
6	Presentation	Presentation protocol			Presentation	PPDU
5	Session	Session protocol			Session	SPDU
4	Transport	Transport protocol			Transport	TPDU
		Communication subnet boundary				
		Internal subnet protocol				
3	Network	Network	Network		Network	Packet
2	Data link	Data link	Data link		Data link	Frame
1	Physical	Physical	Physical		Physical	Bit
	Host A	Router	Router		Host B	

- Network layer host-router protocol
- Data link layer host-router protocol
- Physical layer host-router protocol

1

1) **Physical layer :** It is the lowest layer of the OSI model. This layer is responsible for raw transmission of a 0 bit and a 1 bit. The design issue of physical layer considers 4 attributes they are electrical mechanical procedural and functional attributes.

    a) Electrical attribute describes the voltage level -5v for 0 bit and +5v for a 1bit

    b) Mechanical attribute describes the connectors and wires of the interface

    c) The procedural attribute describe what connectors must do and the sequence of events required to effect actual data transfer across interface

    d) The functional attribute describes the function to be performed by the physical interface

2) **Data Link Layer:** Physical layer is dealing with the bits where as data link layer deals with frames. Frame is a collection of bits.

➤ DLL (Data Link Layer) break up the input data from sender into data frames (nearly 100 to 1000 bytes) and transmits the frames sequentially. An acknowledgement frame is sent after receiving.

➤ DLL detects and corrects the transmission errors using error correction methods.

➤ DLL also deals with fast transmission and data flow control to ensure that the DTE (Data Terminal Equipment) does not become overload.

3) **Network layer:** It deals how packets are routed from source to destination. Static tables are used for routing, with the help of routing table, the network layer selects an optimum path

    Congestion control is the main task of n/w layer. If too many packets are present in subnet at the same time, they will get in one another way forming bottleneck. When a packet has to travel from one n/w to another to get its destination, many problems can arise the addressing used by the second network may be different, from the first one. The second one may not accept the packet at all because it is too large. The protocols may be different. To overcome this problems the heterogeneous n/w to be interconnected.

4) **Transport Layer :** Transport Layer deals with TPDU's(Transport Protocol Data Unit) .This layer is responsible for assembling and dissembling the data that has been gone through it.

    It accepts data from router if necessary split it and pass to the n/w layer and ensure that the pieces all arrive correctly. It is also divides what type of service to provide to the session layer.

5) **Session layer:** It deals with SPDU's(Session Protocol Data Units).The major functionality is assigning particular time period for the users on the network. This layer provides various services.

❖ **Dialogue Control-** keeping track of whose turn it is to transmit(Simplex, Half-Duplex, Full-Duplex)

❖ **Token Management** – avoid two parties from attempting critical operation at same time

❖ **Synchronization** – check pointing long transmissions to allow them to continue from where they were after a crash.

6) **Presentation Layer :** It deals with PPDU'S(Presentation Protocol Data Unit).All the above 5 layers are just involved in sending the data only and they do not bother about the content of the message.

    The presentation layer is responsible for checking syntacs and semantics. It provides the data security by Encryption and Decryption

2

7) Application Layer : It contains various protocols like HTTP which is basis for WWW. When a browser wants a web page it sends the name of the page it wants to the server using HTTP. The server then sends the page back other protocols are used for file transfer, e-mail.

TCP/IP Reference model)

TCP/IP stands for Transmission Control Protocol/Internet Protocol. The TCP/IP reference model is a set of protocols that allow communication across multiple diverse networks. TCP/IP is considered to be a 4 Layer system.
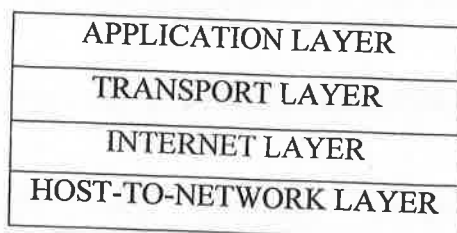
APPLICATION LAYER
TRANSPORT LAYER
INTERNET LAYER
HOST-TO-NETWORK LAYER

Fig: TCP/IP REFERENCE MODE

1) Host-to-Network layer :

This layer is also called as network interface layer. This layer is same as physical and datalink layer of OSI. This layer cannot define any protocol. It is responsible for accepting and transmitting datagram.

2) Internet layer:

- TCP/IP internet layer is similar to OSI network layer.

- The Internet Network level protocol handle machine to machine communications.

- These protocols provide for transmission and reception of transport requests and handle network level control.

- To avoid congestion packet routing is needed.

- The TCP/IP internet layer moves data from one host to another, even if the hosts are on different networks.

- The primary protocol used to move data is the Internet Protocol(IP), which provides the following services:
  - a) ADDRESSING: Determining the route to deliver data to the destination host.
  - b) FREAGMENTATION: Breaking the messages into pieces if the network cannot handle a large message.

It provides a connectionless method of delivering data from one host to another. It does not guarantee delivery and does not provide sequencing of datagram's. It attaches a header to datagram that includes source address and destination address, both of which are unique internet addresses.

3) Transport Layer .Application programs send data to the transport layer. There are 2 end-to-end transport protocols are defined.

1) TCP-Transmission Control Protocol

2) UDP-User Datagram Protocol

3

1) TCP : It is reliable connection oriented protocol that allows a byte stream originating on one machine to be delivered without error on any other machine i.e, lossless transmission. it also handles flow control to avoid fast send & slow receiving bottlenecks.

2) UDP : User datagram protocol is an un-reliable, connectionless protocol for applications. It is also useful for client-server type request-reply queries and applications in which prompt delivery important than accurate delivery.

4) Application Layer : Application layer includes all process and services that use the transport layer to deliver data.

The most widely known application protocols are: TELNET,FTP(File Transfer Protocol),SMTP,SNMP(Simple network Management Protocol).TELNET is the Network terminal protocol, which provides remote login over the network.
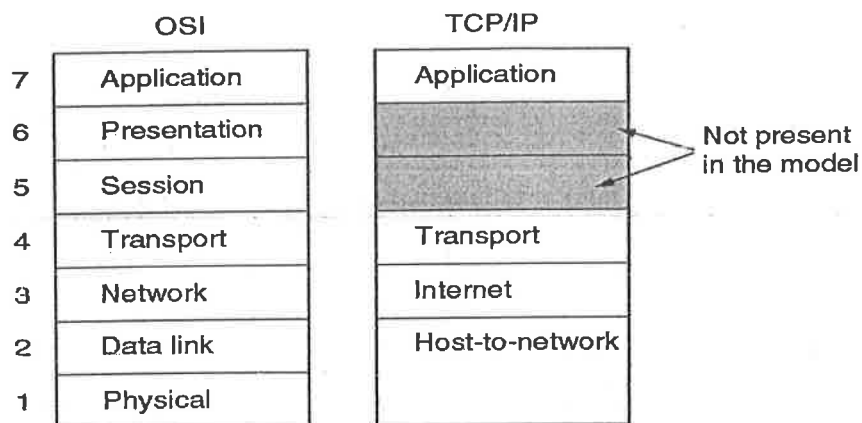
1. The TCP/IP reference model
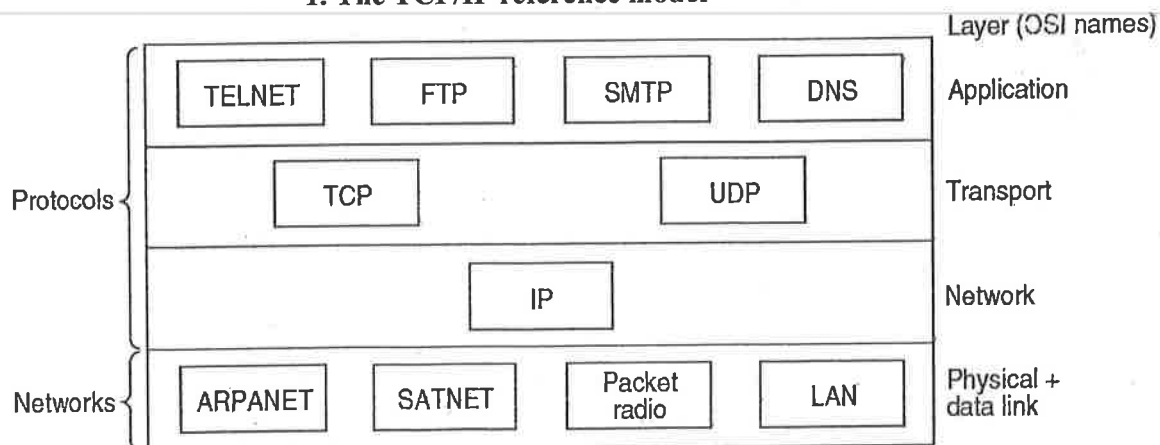
II)Protocols and networks in the TCP/IP model initially

PHYSICAL LAYER

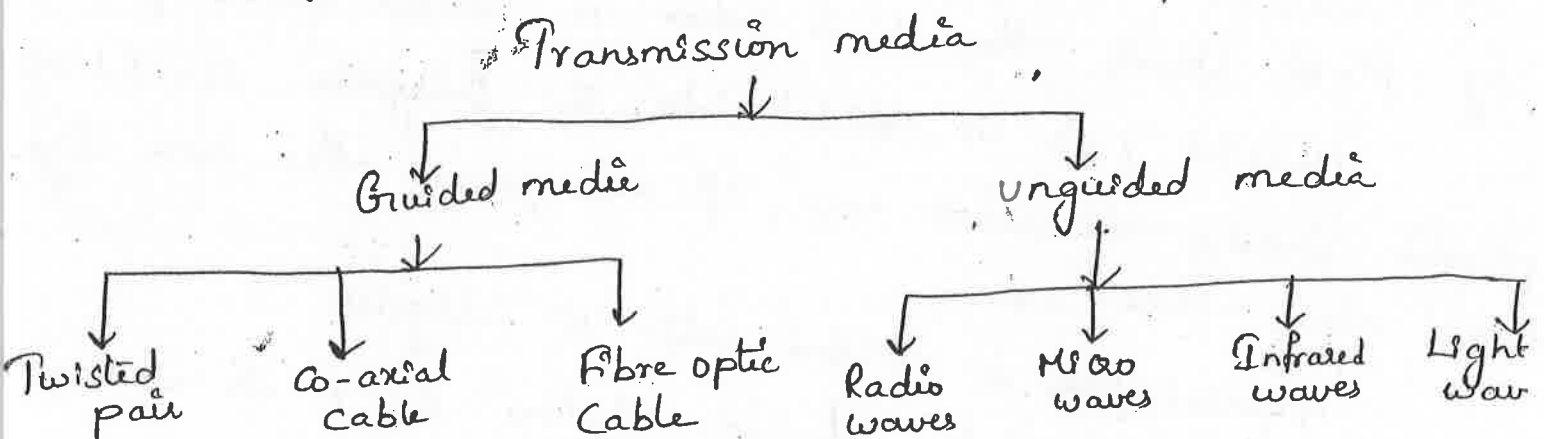**Introduction :-** The main function of physical player is to transmit late in the form of bits over the transmission media.

Transmission media :- "Media" is a term used to describe the path that forms the physical channel between Sender and receiver. The transmission media is the physical path between transmitter and receiver in the data transmission System.

Classifications of Transmission media

The transmission media can be classified into 2 types

① Guided media (or) Bounded media (or) Wired media
② unguided media (or) unbounded media (or) wireless media

```
                    Transmission media
                           │
          ┌────────────────┴────────────────┐
          ↓                                  ↓
     Guided media                      unguided media
          │                                  │
   ┌──────┼──────┐              ┌──────┬──────┼──────┐
   ↓      ↓      ↓              ↓      ↓      ↓      ↓
Twisted  Co-axial  Fibre optic  Radio  Micro  Infrared  Light
 pair    cable     Cable        waves  waves  waves     wave
```

Guided media :- In this type, a physical path is established between Source and destination. It is a wired communication med

→ **Twisted pair Cable :-** Twisted pair Cable Consists of two Copper wires which are twisted together and they form a helical Structure and this structure is used for Strengthning the cable
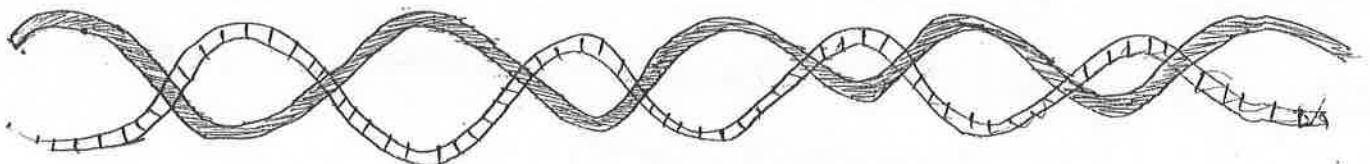

Fig. Twisted pair cable

It may be used for both analog and digital signal transmission. It is most commonly used in telephone neti transmitting analog signals, amplifiers are needed at every .6 to strengthen the signal. For digital signals repeaters are needed at every 2 or 3 km intervals.

Types of Twisted pair cables

There are 2 types of twisted pair cable — they are

1. Unshielded Twisted pair (UTP) cable
2. Shielded Twisted pair (STP) cable

Unshielded Twisted pair (UTP) cable :- If the cable is not covered by any plastic sheath, then it is called as unshielded Twisted pair (UTP) cable.

Shielded Twisted pair (STP) cable :- If the cable is covered by plastic sheath, then it is called as Shielded Twisted pair cat plastic inorder to reduce noise, if not present then noise Sign travel along those wires.

Twisted pair is divided into 5 categories shielded wi Twisted pair is divided into 5 categories

Category 1 :- Mostly used in telephone systems. Cat 1 is suitable for voice low speed data communication.

Category 2 :- It support transmission speed upto 4 Mbps & suitab for voice data transmission.

Category 3 :- It supports transmission speed upto 10 mbps, atleast 3 twist, and used in telephone system.

Category 4 :- It support transmission speed of 16 Mbps & 3 twist unit

Category 5 :- Used in LAN (Local Area network) . It support upto 100 Mbps data transmission speed

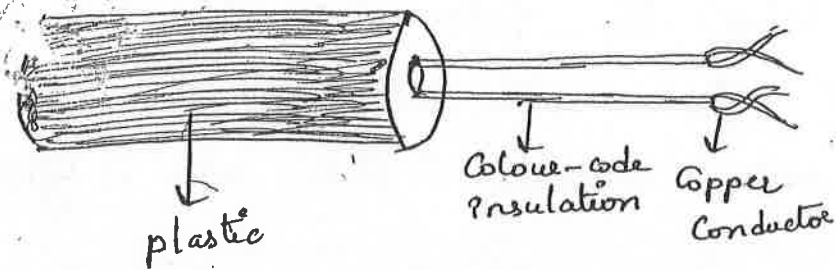Category 5 has more twist then category... categorys... are used for netw. computer.

plastic   Colour-code Copper   plastic
                 Insulation   Conductor

Fig: Unshielded Twisted pair cable
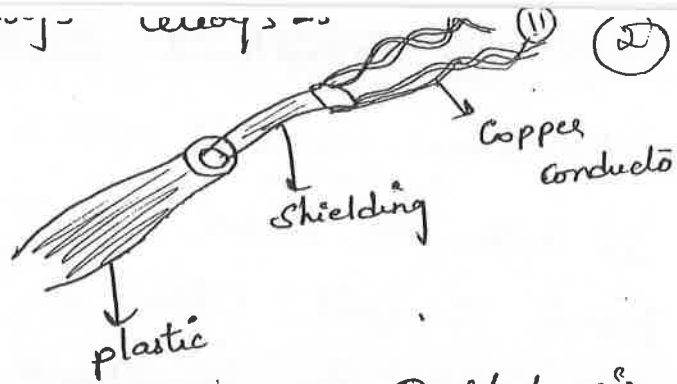
Fig: Shielded Twisted pair Cable

Comparision of UTP & STP

parameter	UTP	STP
① Date rate	10 – 100 Mbps	150 Mbps
② Cable length	100 m (max)	500 m (max)
③ Installation	Easy	Very easy
④ Electrical Interference	most Susceptible to Cross talk	Less Susceptible
⑤ Cost	Low cost	Little Costly

Co-axial Cable :- Coaxial Cable is also made up of Copper wires and there are used for longer distances because this cable is having more Signal to Noise ratio (SNR). The Construction of Coaxial Cable is different from that of twisted pair Cek. The Coaxial Cable Contains Copper wire which are Covered by an insulat material and it is again Covered by a mesh. Finally plastic Sheath used to Cover the entire cable.


protective plastic   wire mesh   Insulating   Copper wire
Covering   material
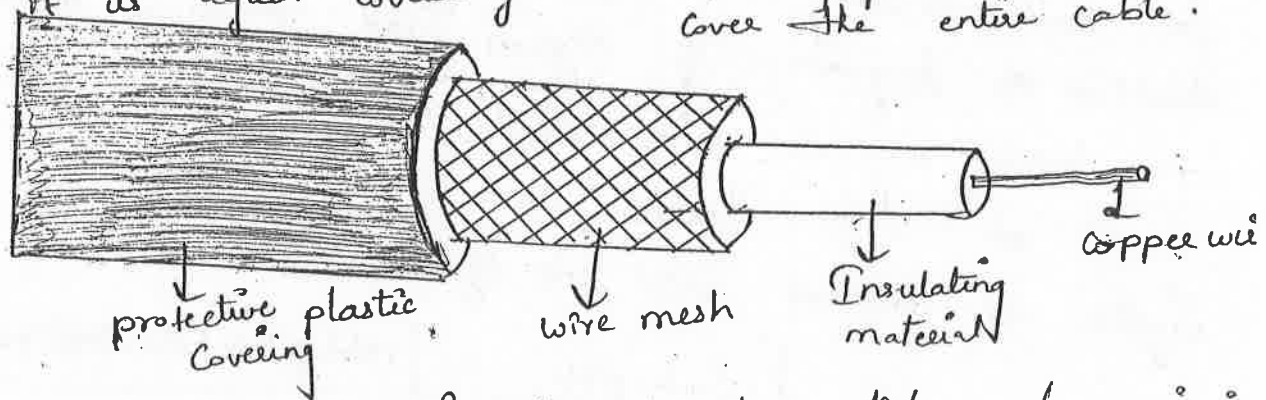
Coaxial Cables are used both for long & Short distance transmission. There are two Variaties under Coaxial Cable. They are
① Bare Band Coaxial Sig. Cable :- for digital Communication

(2) Broadband Coaxial Cable - For analog Communication

Broadband Co-axial cable :- When the distance is very for it is better to prefer analog transmission and for this broad band Co-axial Cable, is more Suitable. There are 2 types of Cables in broadband.

(i) Dual Cable System :- In this System two Cables exists. is for Sending and another one is for receiving. Both cable are connected to all the Computers in the network through an amplifier Called as, Head-End. By cable1 a Computer ca Send data to the head-end on Cable2, the other Compu receives the data from head-end.
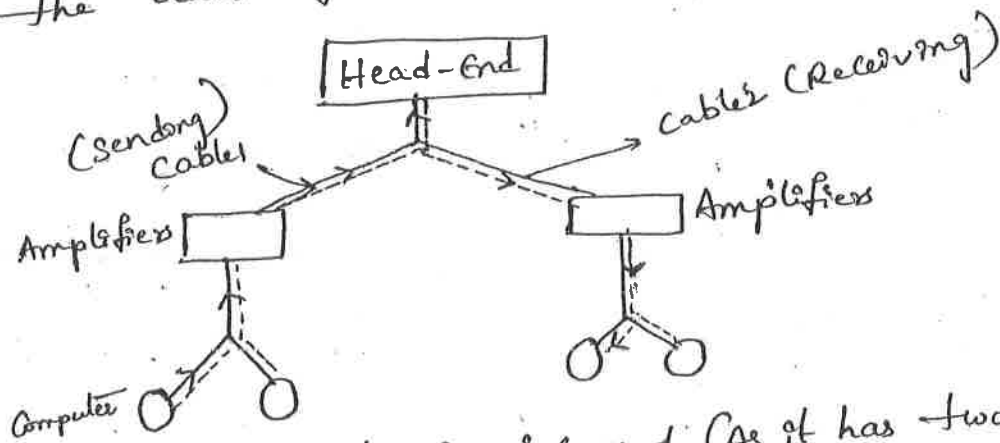
The disadvantage is cost is increased (As it has two wires)

& (ii) Single cable System :- This System is Containing only Single cable for both Sending and receiving, this is possible by making a division on frequency of Signals. The frequency is divided into two bands : one is for Sending and another one is for receive Based on these bands and their ranges the Single Cable System is divided into 2 types -

	Subsplit	Midsplit (or) Multisplit
Sending	5 - 30 MHz	5 - 116 MHz
Receiving	40 - 300 MHz	168 - 300 MHz

Here Cost is reduced but traffic is increased.

Fiber optics :-

① A fibre optic cable is a light pipe which is used to carry a light beam from one place to another.

② Light is an electromagnetic signal and can be modulated by information, since the frequency of light is extremely high. So, it can accomodate wide bandwidth of information, also higher date rate can be achieved with excellent reliability.

③ The modulated light travel along the fibre at the farend are converted to an electrical signal by means of a photo electric cell, thus the original input signal is recovered at the farend.

④ Fiber optic cable transmits light signals rather than electrical signals. Each fiber has a inner core of glass (or) plastic that conducts light. The inner core is surrounded by cladding a layer of glass that reflects the light back into core.

⑤ A cable may contain a single fiber, but often fibres are bundled together in the center of the cable.

⑥ Fibre optic cable (Foc) may be single mode (or) multimode fiber uses multiple light paths and are typically used with laser signal. It has greater bandwidth.

Types of Fibre :- There are 3 varieties of fiber optics. All 3 varieties are constructed of either glass, plastic (or) combination of glass & plastic.

   ⓘ plastic core and cladding

② Glass core with plastic cladding (called pcs fiber, silica-clad-silica)

③ Glass core and glass cladding (called scs, silica-c silica)

① plastic core and cladding :- plastic fibers have more advantages over glass fibers. First plastic fibers are more flexible and more strong than glass. They are less expensive, and weight is 60% less than glass. The disadvantage is they do not propagate light as efficiently as glass. They are limited to short runs, within a single building.

② Glass core with plastic cladding :- Fibers with glass cores exhibit low attenuation. pcs fibers are better than scs fibers. pcs fibers are less affected by radiation and are therefore more attractive to military applications.

③ Glass core & glass cladding :- scs fibers have the best propagation characteristic and scs cables are less storage and more susceptible to increase in attenuation when exposed to radiation.

characteristics :- ① Transmission rate is 100 mhps

② For (fibre optic cable) support cable length of 2 km (or) more.

③ It supports voice, data and video

④ It is a secured media.

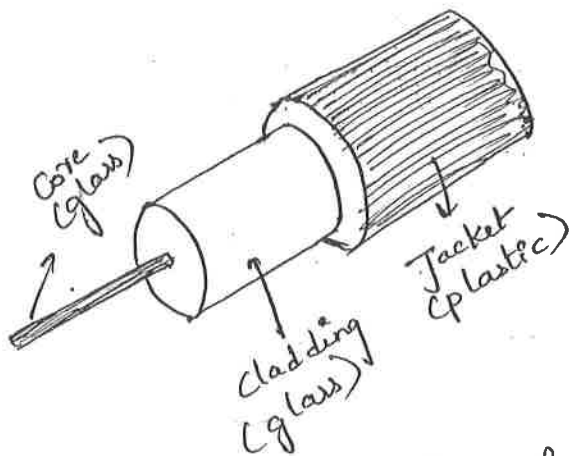⑤ Not affected by electrical interference.
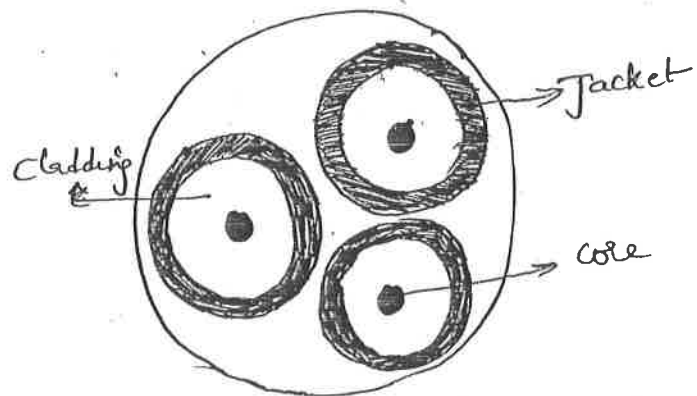

Fig (a) Side view of a single fiber   Fig (b) End view of a sheath with 3 fibers

Advantages and disadvantages of Fiber Optic Cable (FOC)

Advantages

1. **Bandwidth :-** Due to high frequency range the information Carrying Capability is much higher.

2. **Low Losses:** Fibre optics offers less Signal attenuation (reduct in strength of Signals) over long distance

3. **Light weight:** Fibre optics are made of Silica glass or plastic which is lighter than copper (or) aluminium Cable

4. **Small Size :** The diameter of fiber much Smaller Compared to other Cables, other cables requires less Storage Sp.

5. **Security** ~~Note Strength~~: Fibre optics are difficult to tap. As they dor radiate electromagnetic energy

6. **Long distance transmission:** Because of less attenuation transmiss at a longer distance is possible.

7. **Flexibility :** Optical fibre has greater tensile strength than Copper. It is flexible bends easily.

8. **Cost :** The Cost of glass is cheap than Copper as glass are plentiful.

Advantages

1. **protection:** Optical fibres require more protection around the Cable when Compared to Copper.

2. **Cost :** Cables are expensive to install

Comparision of Guided media

Twisted-pair cable	Co-axial cable	fibre optic cable.
) uses ectrical Signal for transmission	① uses electrical Signal for transmission	① uses optical for of Signals over a gl fibre.
2) Cheapest	② moderately costly	② Costly

Twisted pair cable	Co-axial cable	Fiber Optic Cable
③ Bandwidth is low (3 MHz)	③ Bandwidth is moderately high (350MHz)	③ Bandwidth is very high (2 GHz) ✓
④ Support low data rates (4Mbps)	④ Support moderately high data rates (500 Mbps)	④ Data rate is very high (2 Gbps) ✓
⑤ Supports all radio frequencies	⑤ Supports all radio frequencies	⑤ Frequency range is 902 — 928 MHz
⑥ High attenuation	⑥ Low attenuation	⑥ Very low attenuation

Wireless Transmission (unguided transmission media)

people who need on-line all the time, they are using Laptops, notebook, wrist watch Computers, means they are user wireless transmission (without using any physical path). Guided media is made by Copper wires, but unguided media is made by electromagnetic waves. There are 4 types of media used under this category.

① Radio transmission
② Microwave transmission
③ Infrared transmission
④ Lightwave transmission

②
| 10^0 | 10^2 | 10^4 | 10^6 | 10^8 | | 10^{10} | 10^{12} | 10^{14} | | 10^{16} | 10^{18} | 10^{20} | 10^{22} | | 10^{24} |

| | Radio waves | microwave | Infrared | | UV rays | X-rays | Gamma rays |

↓ visible light

(Hz) 10^4 10^5 10^6 10^7 10^8 10^9 10^{10} 10^{11} 10^{12} 10^{13} 10^{14} 10^{15} 10^1

Twisted pair
coaxial
Satellite
microwave
Maritime AM radio
FM radio
TV
fibre optics
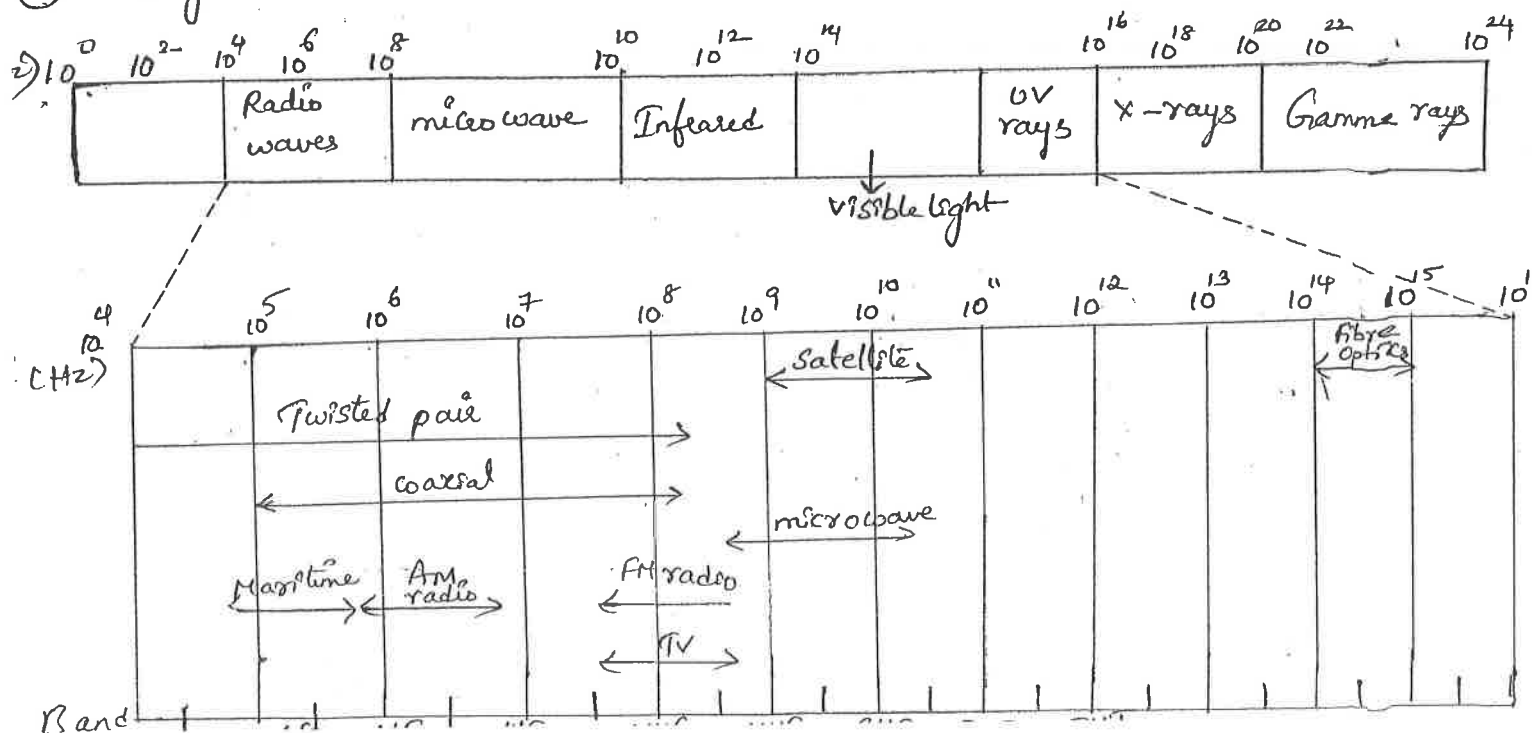
Band

Most transmissions use narrow frequency band to get the best reception. In some cases wideband is used with two (14) variations.

I) Frequency hopping Speed Spectrum, the transmitter hops from frequency to frequency hundreds of time per second. It is popular for military Communication because it makes transmission hard to detect and to jam.

II) Direct Sequence Spread Spectrum Spreads the Signal over a wide frequency band getting popularity in the Commercial world

LF, MF, HF (low, Medium, high frequencies),
VHF, UHF, SHF, EHF, THF (very, ultra, Super, Extremely, and tremendously High frequency bands).

Radio waves :- The electromagnetic waves with a frequency of 3 KHz to 1 GHz are Called Radio waves.

Radio waves are used for longer distance transmission and these waves will propagate easily in the air and at lower frequencies they will easily propagate through obstacles also. But at higher frequencies they can't propagate through obstacles.

Another advantage of radio waves is they are omni directional i.e the way can propagate all directions irrespective of the placement of Sender and receiver.

Application :- Radio waves are used in multicasting with one Sender and more receivers due to omni directional, Such as AM, FM radio, TV etc.

Microwaves :- A wave is called a microwave which has frequency above 100 mHz. The Sending and receiving antennas

must be aligned. Since the microwaves travel in a straight line, if the towers are too far apart, then repeater are needed. The distance between repeaters goes up very roughly with the Square root of the tower height. For 100 m high towers, repeaters can be Spaced 80 km apart.

Radio waves are able to pass through obstacles do also, but microwaves Cannot. Even though it is possible the middle of transmission the wave is diverted in multiple paths. This effect is called "multipath fading".

Infrared waves :- The waves with frequency ranging from 300GHz to 400 THz are called infrared waves. unguided infrared light wave are widely used for Short range Communication. The remote Control used in TV, VCR and Stereos all use infrared Communication. They are relatively directional, cheap and easy to build. The drawback is they do not pass through Solid objects. The infrared System in one room of a building will not interf with a Similar System in adjacent rooms.

Lightwave transmission :- In this media light is used as a interface for data transfer. These waves are called as optical Signals. Inorder to use this media the total System has to maintain two devices.
① Laser ② photodetector.
Laser emits a light Signal which is going to the other Side and this one is received by photodetector or the otherSide

The drawback of this media, it is expensive and they will work properly only under Sunny days and not in rainy days.

UnGuided Transmission

- An unguided transmission transmits the electromagnetic waves without using any physical medium. Therefore it is also known as **wireless transmission**.
- In unguided media, air is the media through which the electromagnetic energy can flow easily.

Unguided transmission is broadly classified into three categories:

Radio waves

- Radio waves are the electromagnetic waves that are transmitted in all the directions of free space.
- Radio waves are omnidirectional, i.e., the signals are propagated in all the directions.
- The range in frequencies of radio waves is from 3Khz to 1 khz.
- In the case of radio waves, the sending and receiving antenna are not aligned, i.e., the wave sent by the sending antenna can be received by any receiving antenna.
- An example of the radio wave is **FM radio**.

Applications Of Radio waves:

- A Radio wave is useful for multicasting when there is one sender and many receivers.
- An FM radio, television, cordless phones are examples of a radio wave.

Advantages Of Radio transmission:

- Radio transmission is mainly used for wide area networks and mobile cellular phones.
- Radio waves cover a large area, and they can penetrate the walls.
- Radio transmission provides a higher transmission rate.

Microwaves
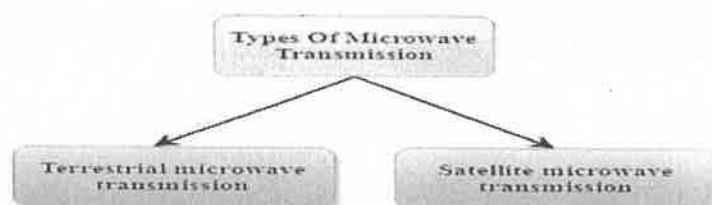
Microwaves are of two types:

- Terrestrial microwave
- Satellite microwave communication.

Terrestrial Microwave Transmission

- Terrestrial Microwave transmission is a technology that transmits the focused beam of a radio signal from one ground-based microwave transmission antenna to another.
- Microwaves are the electromagnetic waves having the frequency in the range from 1GHz to 1000 GHz.

- Microwaves are unidirectional as the sending and receiving antenna is to be aligned, i.e., the waves sent by the sending antenna are narrowly focussed.
- In this case, antennas are mounted on the towers to send a beam to another antenna which is km away.
- It works on the line of sight transmission, i.e., the antennas mounted on the towers are the direct sight of each other.

Characteristics of Microwave:

- **Frequency range:** The frequency range of terrestrial microwave is from 4-6 GHz to 21-23 GHz.
- **Bandwidth:** It supports the bandwidth from 1 to 10 Mbps.
- **Short distance:** It is inexpensive for short distance.
- **Long distance:** It is expensive as it requires a higher tower for a longer distance.
- **Attenuation:** Attenuation means loss of signal. It is affected by environmental conditions and antenna size.

Advantages Of Microwave:

- Microwave transmission is cheaper than using cables.
- It is free from land acquisition as it does not require any land for the installation of cables.
- Microwave transmission provides an easy communication in terrains as the installation of cable in terrain is quite a difficult task.
- Communication over oceans can be achieved by using microwave transmission.

Disadvantages of Microwave transmission:

- **Eavesdropping:** An eavesdropping creates insecure communication. Any malicious user can catch the signal in the air by using its own antenna.
- **Out of phase signal:** A signal can be moved out of phase by using microwave transmission.
- **Susceptible to weather condition:** A microwave transmission is susceptible to weather condition. This means that any environmental change such as rain, wind can distort the signal.
- **Bandwidth limited:** Allocation of bandwidth is limited in the case of microwave transmission.

Infrared

- An infrared transmission is a wireless technology used for communication over short ranges.
- The frequency of the infrared in the range from 300 GHz to 400 THz.
- It is used for short-range communication such as data transfer between two cell phones, TV remote operation, data transfer between a computer and cell phone resides in the same closed area.

Characteristics Of Infrared:

- It supports high bandwidth, and hence the data rate will be very high.
- Infrared waves cannot penetrate the walls. Therefore, the infrared communication in one room cannot be interrupted by the nearby rooms.
- An infrared communication provides better security with minimum interference.
- Infrared communication is unreliable outside the building because the sun rays will interfere with the infrared waves.