

# COMMUNICATION AND NETWORKING CONCEPTS

**A computer network is any collection of interconnected autonomous computing devices that communicate with one another over a shared network medium so as to exchange information or share resources.**

# Need for networking

- Resource sharing - files and peripherals
- Improving communication
- Access to remote database
- Cost reduction

# Components of a Computer Network

## Major components :

- a) Hosts/Nodes (PCs, Laptops, Smartphones..)
- b) Servers
- c) Clients
- d) Network Hardware(NIC, router, switch, hub ...)
- e) Communication channel (cables, radio-links...)
- f) Software (Protocol, Network OS...)
- g) Network services (File-Sharing, BNS...)

# Requirements of a Network

Every network includes:

- At least two computers - Server or Client workstation.
- Network Interface Cards (NIC)
- A connection medium, usually a wire or cable, although wireless communication between networked computers and peripherals is also possible.
- Network Operating system software, such as Microsoft Windows NT or 2000, Novell NetWare, Unix and Linux....

# Network Terminologies

## i) Nodes (Workstations)

- A computer becomes a node (also called a workstation) as soon as it is attached to a network.
- Each user on a network works on a workstation. If there are no nodes there would be no network

## ii) Server

A computer that facilitates sharing of data, software and hardware resources on the network is known as the server.

Each server has a unique name on the network and all users of network identify the server by its unique work.

# Servers can be of two types:

- a) Dedicated and
- b) Non dedicated servers

*Dedicated Servers:* *These are generally used on big network installations where one computer is reserved for server's job. It helps all nodes access data, software and hardware resources. Since it does not double up as a workstation but only manages the network, so it is known as a dedicated server and such type of networks are called master- slave networks.*

*Non dedicated servers:* *In small networks, a workstation can double up as a server. These servers are known as non dedicated servers. The small networks using such a server are known as Peer to Peer networks.*

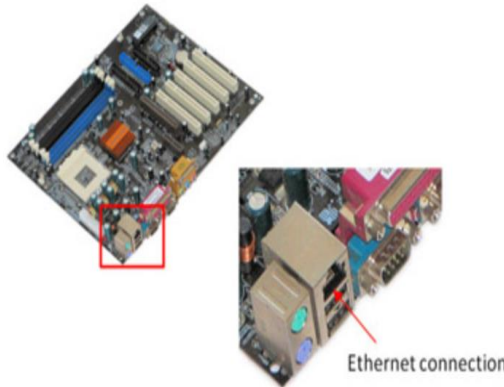
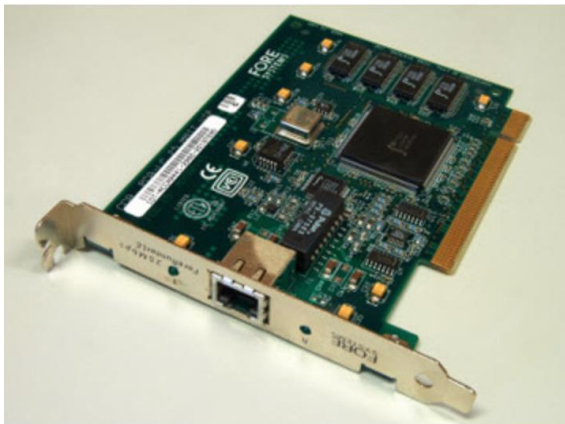


### iii) Network Interface Unit(NIU)

A network interface unit is a device that is attached to each of the workstations and the server which helps to establish communication between the server and workstations.

NIC is also called Network Interface Unit or Terminal Access Point(TAP).

Hub, switch, router are other connectivity devices.



# Communication channel

- Hosts in a network interact with other hosts and server(s) through communication channel or communication medium.

## Communication Channel

### Wired Communication

- Twisted-pair
- Coaxial Cable
- Fibre-optic

### Wireless Communication

- Microwaves
- Radio waves
- Satellites
- Infrared waves
- Laser

# Software

- The software layers of a network make networking possible.
- The software includes Protocols, Network OS.
- A NOS is a specialized OS that can handle networking tasks.
  - Types of NOS
    - Peer-to-Peer NOS
    - Client-server NOS

# Network Services

- They provide different functionalities over a network –
- DNS – Domain Name System
- File Sharing
- VoIP (Voice over IP).

# Types of Networks:

Networks vary in terms of their size and complexity.

## PAN (Personal Area Network)

- A Personal Area Network is a computer network organized around an individual person.
- Personal area networks typically involve a mobile computer, a cell phone and/or a handheld computing device such as a PDA.

## LAN (Local Area Network)

- In a LAN, network devices are connected over a relatively short distance.
- They are generally privately owned networks within a single building or campus, of up to a few kilometers in size.
- Nowadays we also have WLAN (Wireless LAN) which is based on wireless network
- Traditionally, LANs are said to have geographical spread of upto 1 Km.

# MAN (Metropolitan Area Network)

- This is basically a bigger version of LAN and normally uses similar technology.
- It might cover few buildings in a city and might either be private or public.
- This is a network which spans a physical area (in the range of 5 and 50 km diameter) that is larger than a LAN but smaller than a WAN.
- MANs are usually characterized by very high-speed connections using optical fibres or other digital media and provides uplink services to wide area networks (WANs) and the Internet.
- For example in a city, a MAN, which can support both data and voice might even be related to local cable television network.

# **WAN (Wide Area Network)**

WAN spans a large geographical area, often a country or a continent and uses various commercial and private communication lines to connect computers.

The internet is the largest WAN , spanning the entire earth.



# LAN Vs WAN

LAN	WAN
It is spread over a small area.	It is spread over a very large area.
It usually costs less to set it up.	It costs higher to set it up.
It is usually a single network	It is usually a network of many networks.

# Types of Networks by Component Roles

- Peer-to-Peer Networks

- P2P networks are popular as home networks and for use in small companies as they are inexpensive and easy to install, but they are limited in scope and are difficult to secure.
- P2P are often termed as non-dedicated servers
- Typically a P2P network has up to ten computers

- Client/Server Networks

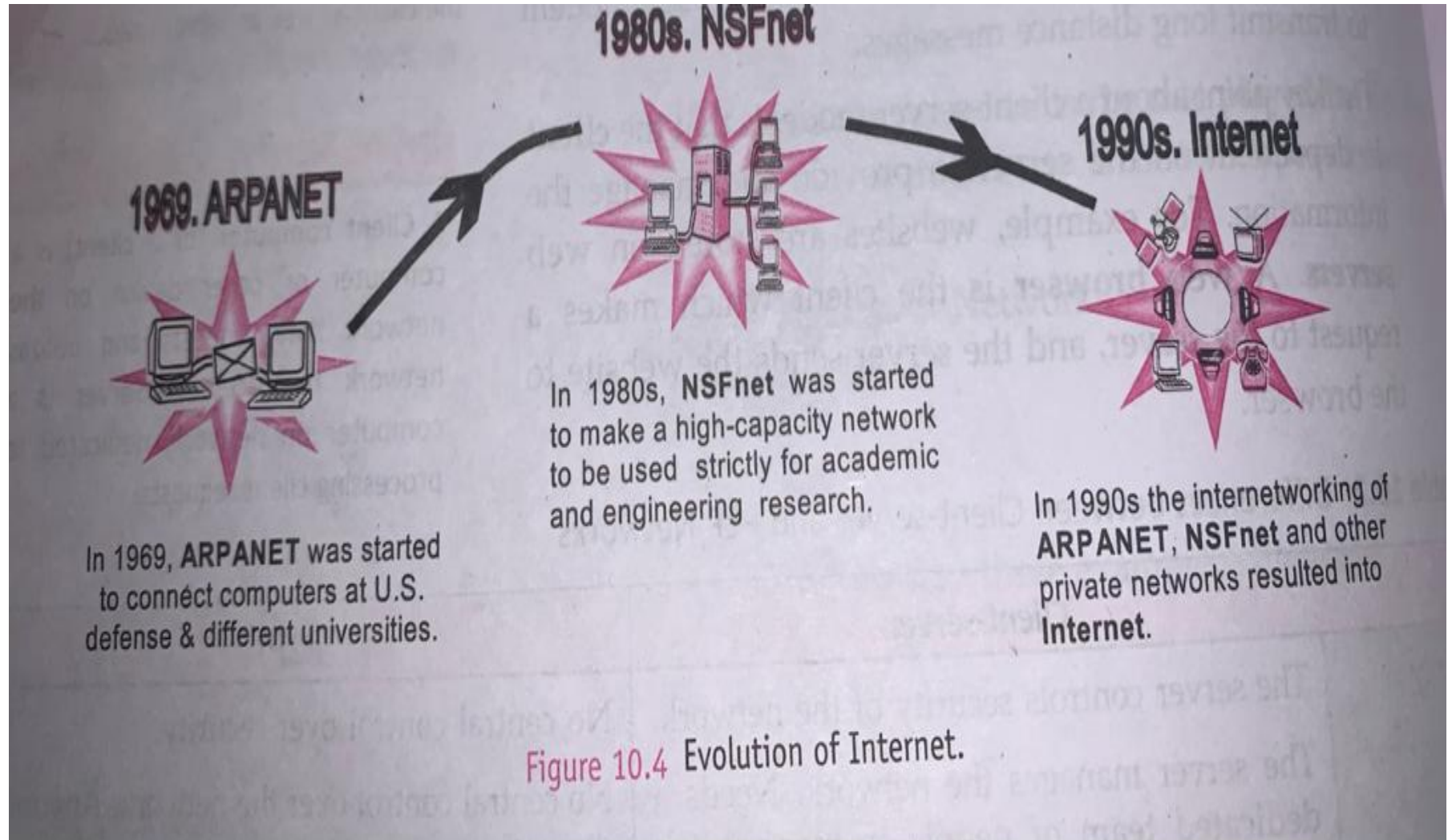
- To have centralized control client-server networks or Master-Slave networks.
- A client computer is a computer or other device on the network that requests and utilizes network resources.
- A server is a computer on network, dedicated to processing client requests.
- A web browser is a client which makes a request to the server, the server then sends the request to website to the browser.

# Client-server and P2P networks

	Client-Server	P2P
Security	The server controls security of the network.	No central control over security.
Management	The server manages the network. Needs a dedicated team of people to manage the server.	No central control over the network. Anyone can set up.
Dependency	Clients are dependent on the server.	Clients are not dependent on a central server.
Performance	The server can be upgraded to be made more powerful to cope with high demand.	If machines on the network are slow they will slow down other machines
Backups	Data is all backed up on the main server.	Each computer has to be backed up. Data can easily be deleted by users.

# Evolution of Networking

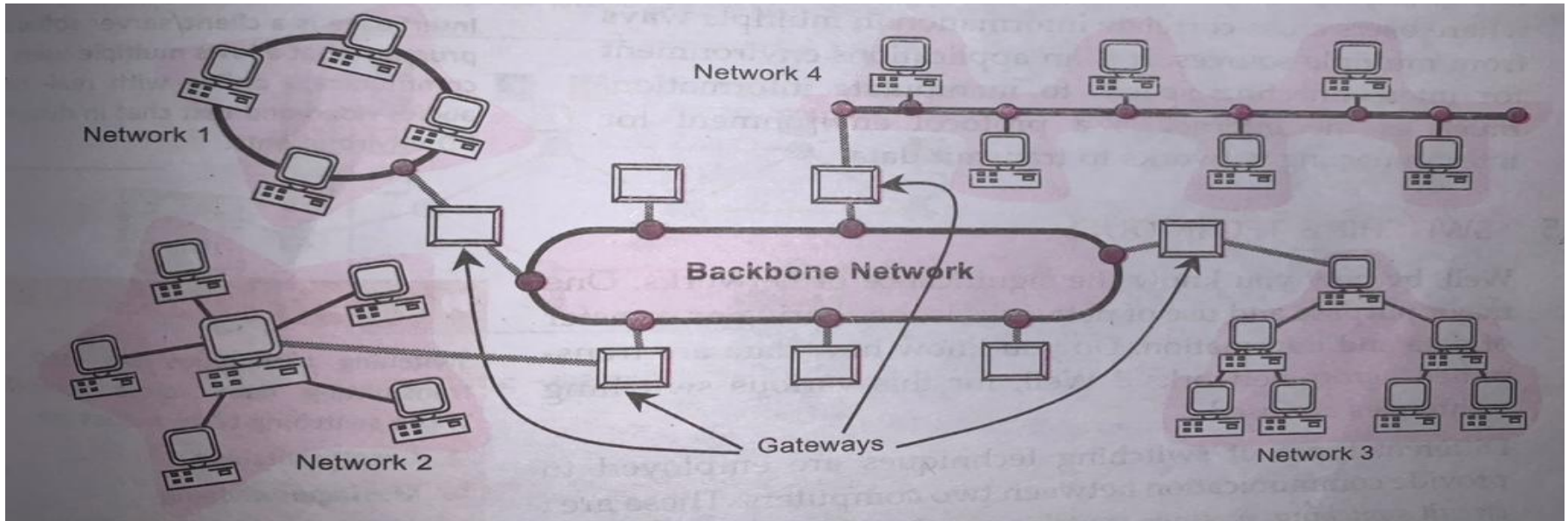
- ARPANET – Advanced Research Projects Agency Network
- NSF – National Science Foundation



# Internet

- The Internet is a world-wide network of computer networks.
- The Internet is a system of linked networks that are worldwide in scope and facilitate data communication services such as remote login, file transfer, electronic mail, the World Wide Web and newsgroups.
- The Internet is made up of many networks each run by a different companies and are interconnected at peering points.
- It is really a network of networks spread across the globe, Internet is a super-network.

# How does Internet work?



- Gateway – A Gateway is a device that connects dissimilar networks.

Internet Function:

Source Computer – message or file/document □ divided into very small parts called Packets. ( A packet generally contains some information)

Packets – numbered serialwise.

Packets □ address of destination computer.

Destination □ receives data packets in random manner

Packets are reassembled at destination computer.

# Internet functioning

- Protocol helps to make Internet work without any trouble.
- Protocol – is set of rules that governs the communication.
- TCP/IP – communication protocol

TCP – Transmission Control Protocol – this is the protocol which is responsible for dividing file/message into packets on the source computer. TCP is also responsible for reassembling the received packets at the destination computer.

IP - Internet Protocol – is responsible for handling the address of destination computer so that each packet is routed(sent) to its proper destination.

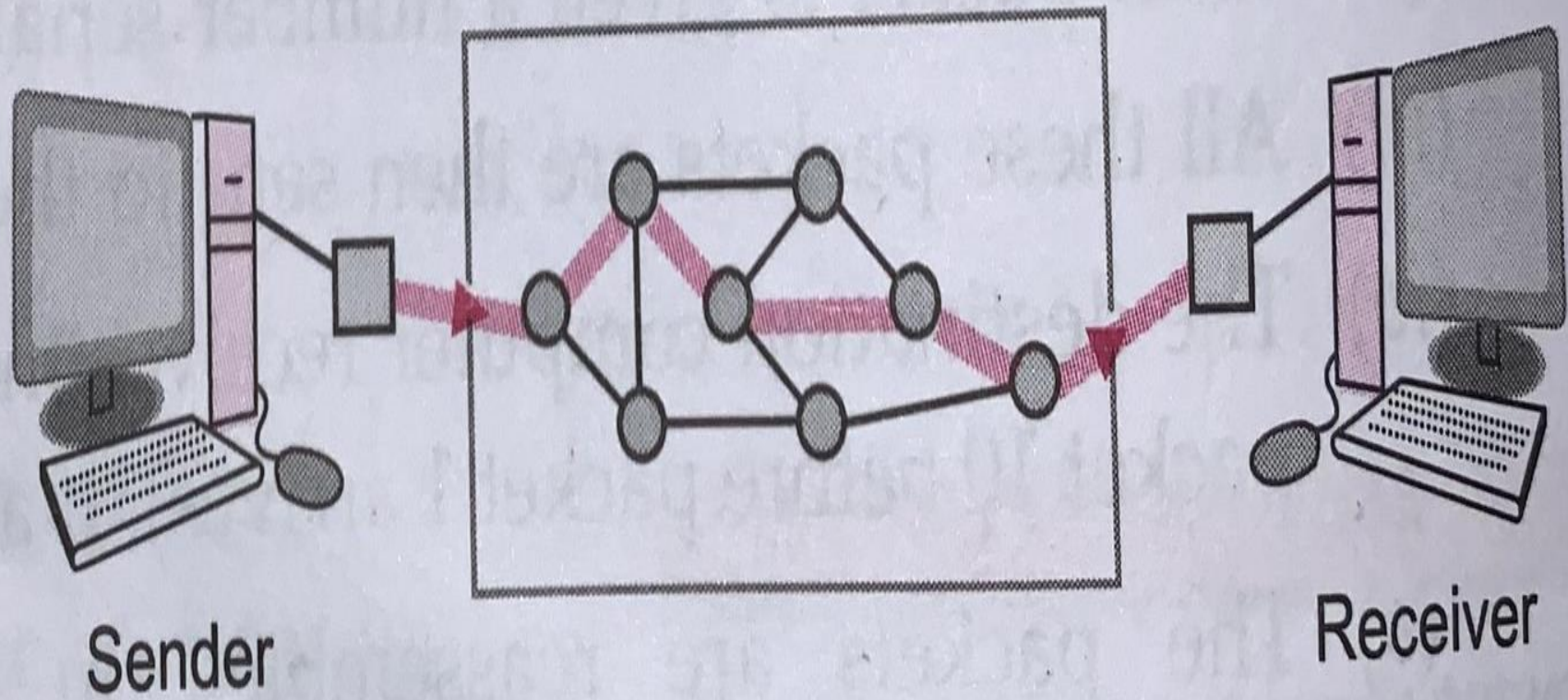
# **Interspace**

It is a client/server software program that allows multiple users to communicate online with real time audio, video and text chat in dynamic 3D environments.



# Switching Techniques

- Switching techniques are used to efficiently transmit data across the network.
- The types of switching techniques are employed nowadays to provide communication between two computers on a network are:
- Circuit Switching, Message Switching and Packet Switching



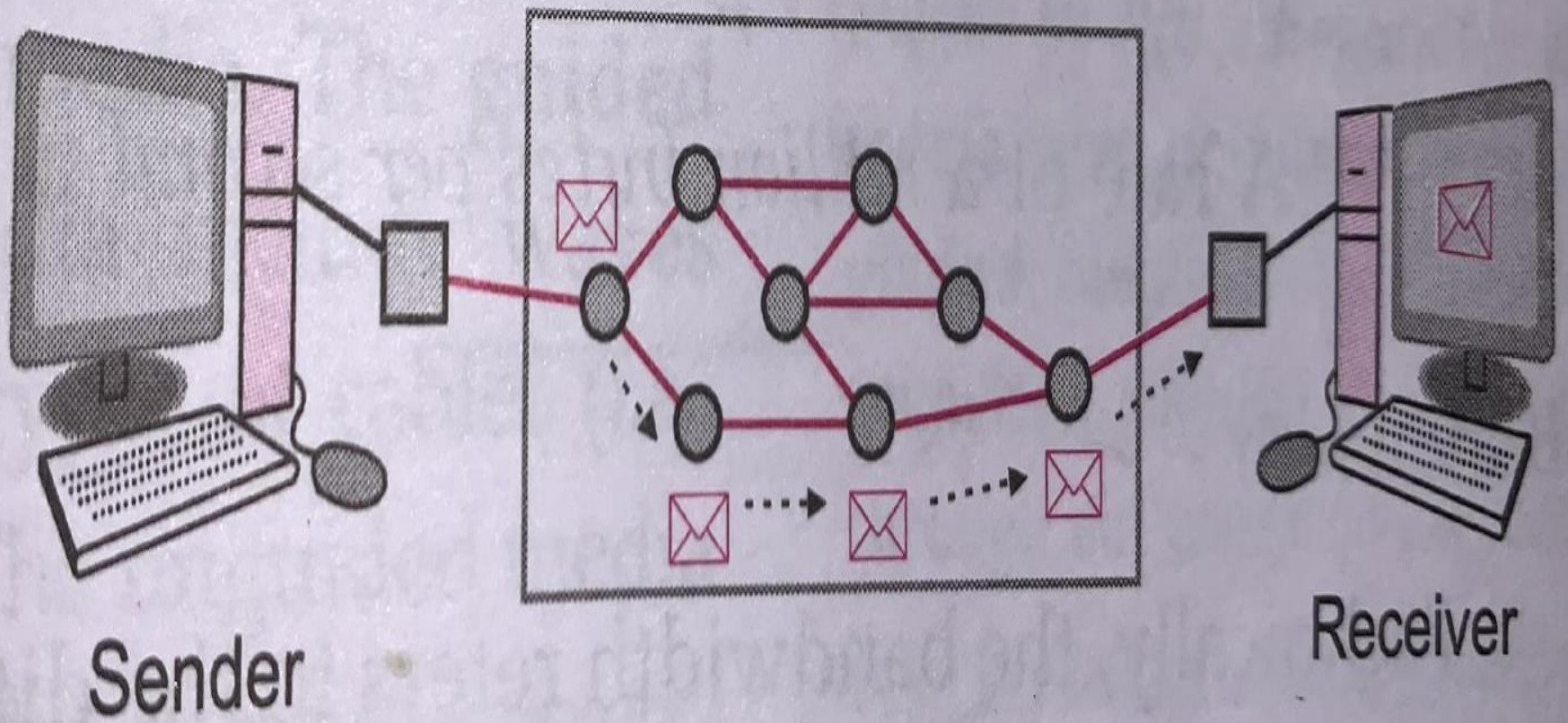
(a) **Circuit switching** – a complete physical connection is established between the sender and the receiver

# Circuit Switching

Circuit switching is a technique in which a dedicated and complete physical connection is established between two nodes and through this dedicated communication channel, the nodes may communicate.

- The defining example of a circuit-switched network is the early analogue telephone network.
- When a call is made from one telephone to another, switches within the telephone exchange create a continuous wire circuit between the two telephones, for as long as the call lasts.

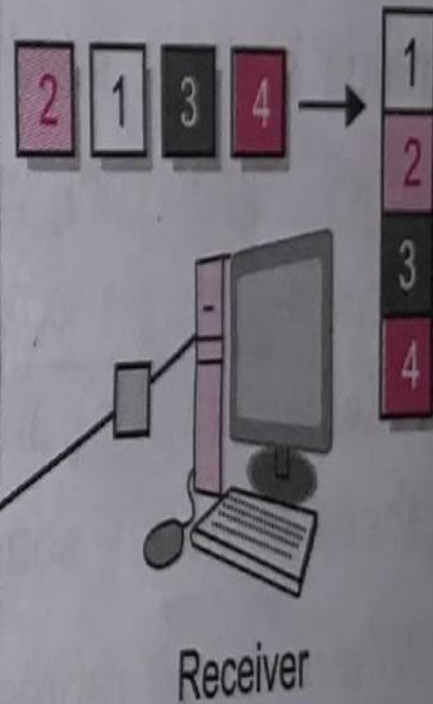
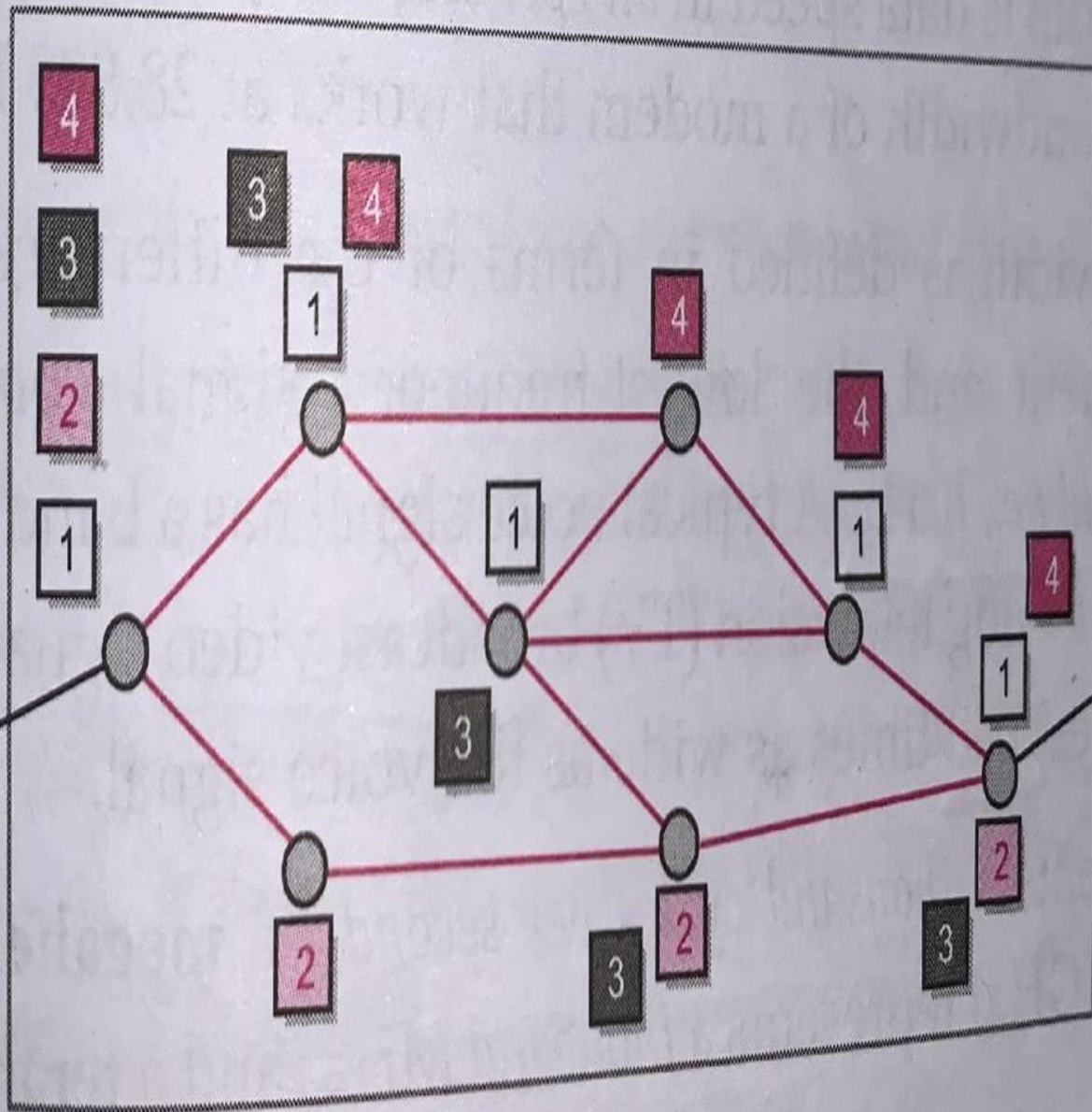
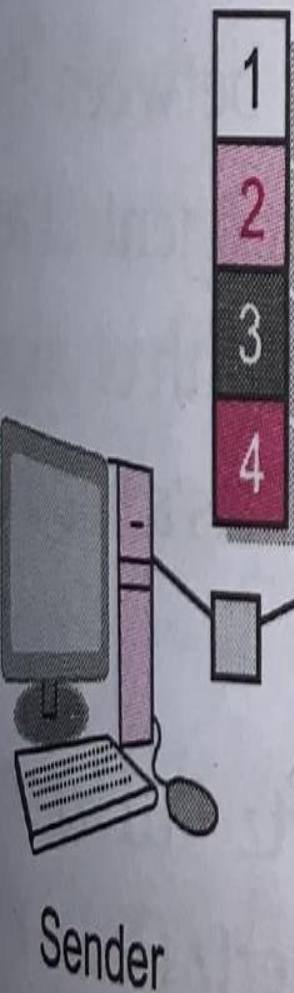




(b) **Message switching** – full message travel across different intermediate hops or switching offices.

# Message switching

- The source computer sends data or message to the switching office first, which stores the data in its buffer.
- It then looks for a free link to another switching office and then sends the data to this office.
- The process is continued till the data are delivered to the destination computers.
- This principle is called store and forward.



(c) **Packet switching** – message is divided into packets and packets travel across hops.

# Packet Switching

- Packet switching is a switching technique in which packets (discrete blocks of data of fixed size and of any content, type or structure) are routed between nodes over data links shared with other traffic.
- The term "packets" refers to the fact that the data stream from your computer is broken up into packets of about 200 bytes (on average), which are then sent out onto the network.



- The main advantage of packet-switching is that the packets from many different sources can share a line, allowing for very efficient use of the communication medium.
- With current technology, packets are generally accepted onto the network on a first-come, first-served basis.
- If the network becomes overloaded, packets are delayed or discarded ("dropped").
- This method of data transmission became the fundamental networking technology behind the internet and most Local Area Networks.

## Circuit Switching

1. Reserves the required bandwidth in advance.
2. Fast technology as compared to packet switching
3. Requires a dedicated path. Once the connection is established the communication path is entirely dedicated to it until the data is completely transferred from sender to receiver.
4. If the path is overloaded the call is blocked and communication is delayed.
5. Circuit switching is used for phone calls.
6. Efficiency is less compared to packet switching.

## Packet Switching

1. Uses bandwidth as and when required by the packets to be transmitted.
2. Slow mechanism of transferring packets from sender to receiver.
3. Packets can use dynamic path.
4. If the path is overloaded, packets are allocated to different paths.
5. Packet switching networks are used to handle data.
6. More efficient because the cost of the link is shared by many users.

# Data Communication Terminologies

## Channel

- A communication channel is a medium that is used in the transmission of a message from one point to another.
- In simple terms we can say that it is a pathway over which data is transferred between remote devices. It may refer to the entire physical medium, such as a telephone line, optical fibre, coaxial cable or twisted pair wire, or, it may refer to one of the several carrier frequencies transmitted simultaneously within the line.

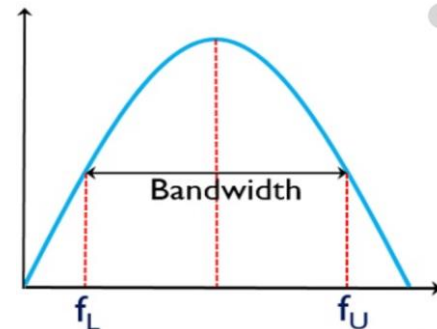
# Data Communication Terminologies

Depending on their speed, we have three broad categories of communication channels

- narrow band - which is slow and used for telegraph lines and low speed terminals;
- voice band - used for ordinary telephone communication and
- broad band - which is fastest and is used for transmitting large volumes of data at high speeds.

# Bandwidth

- In electronic communication , bandwidth refers to the range of frequencies available for transmission of data.
- It is expressed as the difference in Hertz(Hz) between the highest frequency and the Lowest frequency.
- In computer networking, bandwidth is often used as a synonym for data transfer rate.



# Data transfer rate (DTR)

- The data transfer rate (DTR) is the amount of data in digital form that is moved from one place to another in a given time on a network.
- This can also be referred to as throughput, although data transfer rate applies specifically to digital data streams.
- Data transfer rate is often measured in bits per second (bps), although the unit baud , which is one bit per second is also used. It is commonly used to measure how fast data is transferred from one location to another.

# Transmission Medium

- A transmission medium (plural media) is one which carries a signal from one computer to another. It is also known as communication channel.
- Transmission medium can be wired or wireless. We also name them as Guided and Unguided Media respectively.
- Wired transmission media includes twisted pair cable, Ethernet cable, coaxial cable and optical fibre whereas wireless transmission media includes microwave, radio wave, satellite, infrared, Bluetooth, WiFi etc

# **Wired Transmission Media**

The wired or guided transmission media physically connects the two computers. The data signal physically gets transferred from the transmitting computer to the receiving computer through the wired transmission medium.



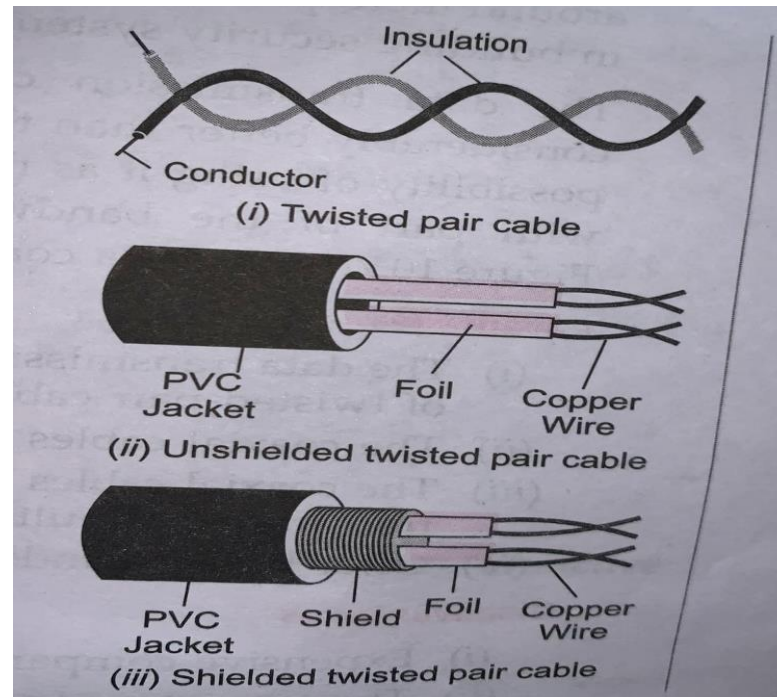
# Twisted Pair Cables

Most common form of wiring in networks

VGM - Voice Grade Medium - used for telephonic communication, consists of two wires wrapped together in a double helix.

Electrical characteristics - length, resistance, capacitance - can cause differences in the wires and hence can lead to poor communication using VGM so LAN applications use DGM (Data Grade medium)

The bleeding of a signal from one wire to another and which can corrupt signal and cause network errors. This form of signal interference is called **crosstalk**

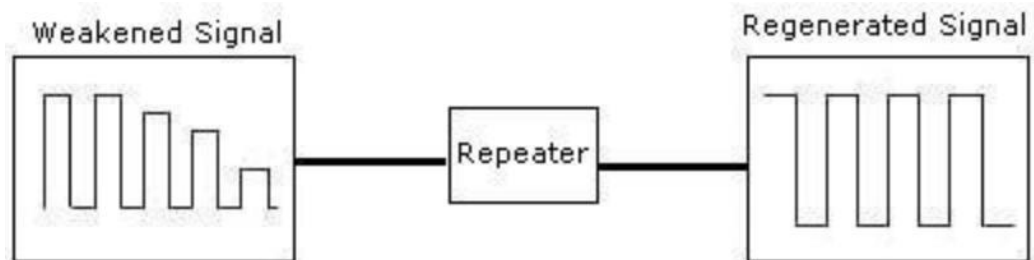


## Advantages:

- It is easy to install and maintain
- It is physically flexible
- It has a low weight
- It can be easily connected
- It is very inexpensive

## Disadvantages:

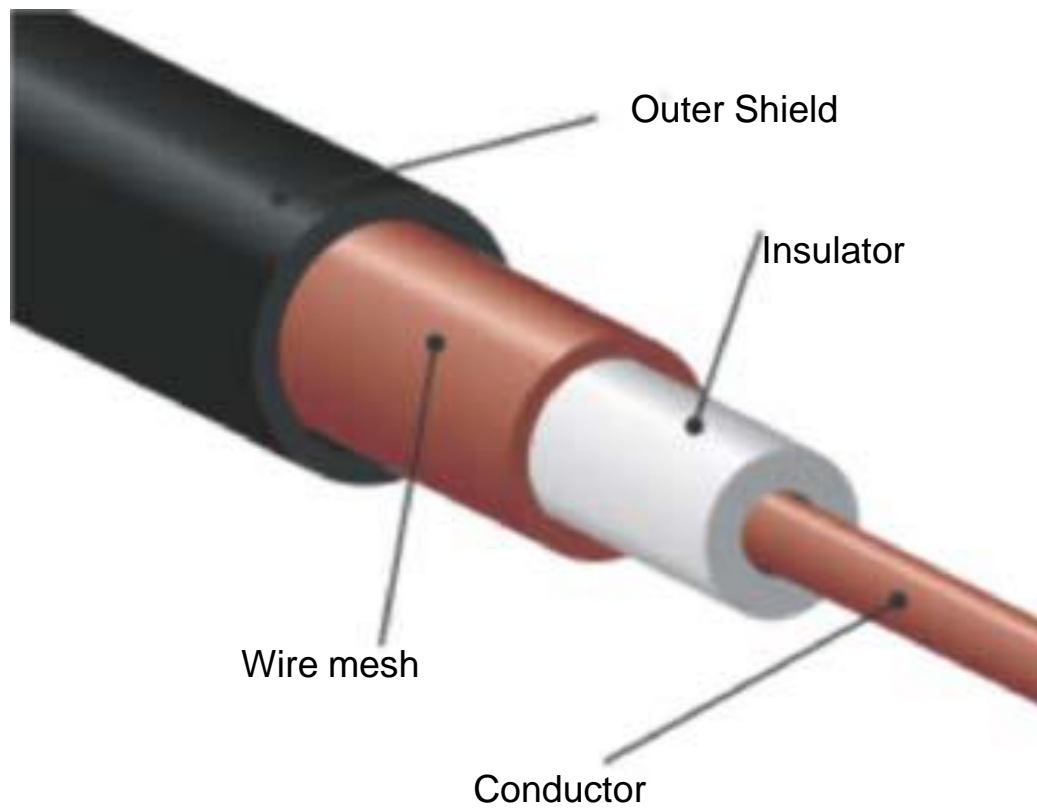
- Because of high attenuation, it is incapable carrying a signal over long distances without use of repeaters.
- Its low bandwidth capabilities make it unsuitable for broadband applications.
- It supports maximum data rates 1 Mbps, without conditioning and 10 Mbps with conditioning.



# Coaxial Cables

- It is the most commonly used transmission media for LANs.
- It consists of solid wire cores surrounded by one or more foil or wire shields, each separated by some kind of plastic insulator.
- The inner core carries the signal and the shield provides the ground.
- It has high electrical properties and is suitable for high speed communication.
- It is widely used for television signals and also by large corporations in building security systems.
- Multi channel television signals can be transmitted around metropolitan areas at considerably less cost.

# ***A coaxial cable***



## Advantages

- Data transmission characteristics are better than that of twisted pair.
- It can be used for broadband communication i.e. several channels can be transmitted simultaneously.
- It offers high bandwidth (up to 400 mbps)
- It can be used as the basis for shared cable network.

## Disadvantages

- It is expensive as compared to twisted pair cables
- They are not compatible with twisted pair cables

## Types of coaxial cables:

The two most common types of cables are Thicknet and Thinnet. Whereas thicknet is thicker and its cable segments can be up to 500 metres long.

The thinnet on the other hand is thinner and it can have a maximum segment length of 185 metres.

### ThickNet vs. ThinNet Core



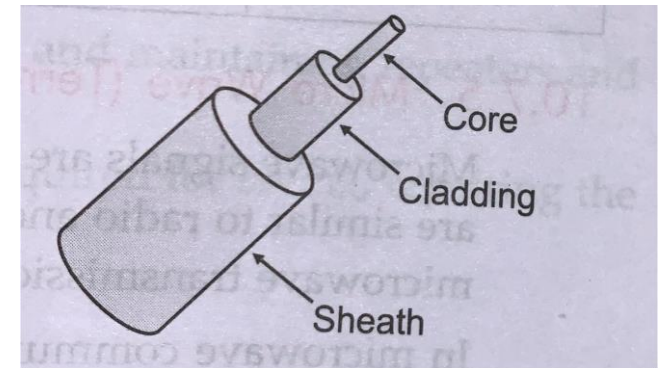
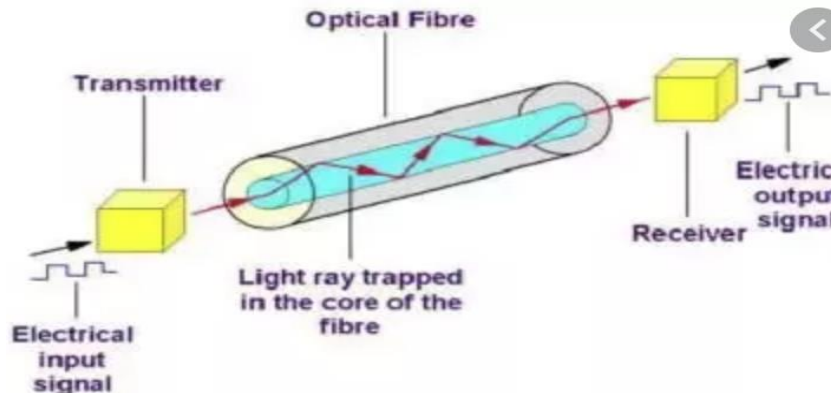
ThickNet core



ThinNet core

# Optical Fibres

- These consists of thin strands of glass or glass like material which are so constructed that they carry light from a source at one end of the fibre to a detector at the other end.
  - The light sources used are either light emitting diodes (LEDs) or laser diodes (LDs).
  - The data to be transmitted is modulated onto a light beam using frequency modulation techniques.
  - At the receiver's end, the signals are demodulated.
  - Optical fibres offer a very high bandwidth and this makes it capable of multichannel communication.



- **The Optical fibre consists of three layers:**
- Core - glass or plastic through which the light travels
- Cladding - covering of the core that reflects the light back to the core
- Protective (Buffer) coating-protects the fibre cable from hostile environments

<https://youtu.be/jZOg39v73c4>



## *Layers of an Optical Fiber*

Coating



Core

Cladding



## Advantages

- It is immune to electrical and magnetic interference.
- It is highly suitable for harsh industrial environments.
- It guarantees secure transmission and has a very high transmission capacity.
- It can be used for broadband transmission where several channels can be handled in parallel.

## Disadvantages

- It is difficult to install and maintain since they are quite fragile.
- It is most expensive of all cables.
- Connecting two fibres together or even connecting the light source with the cable is a difficult process. Hence connection loss is a common problem
- Light can reach the receiver out of phase.

Fibre Optic cable can be of two types:

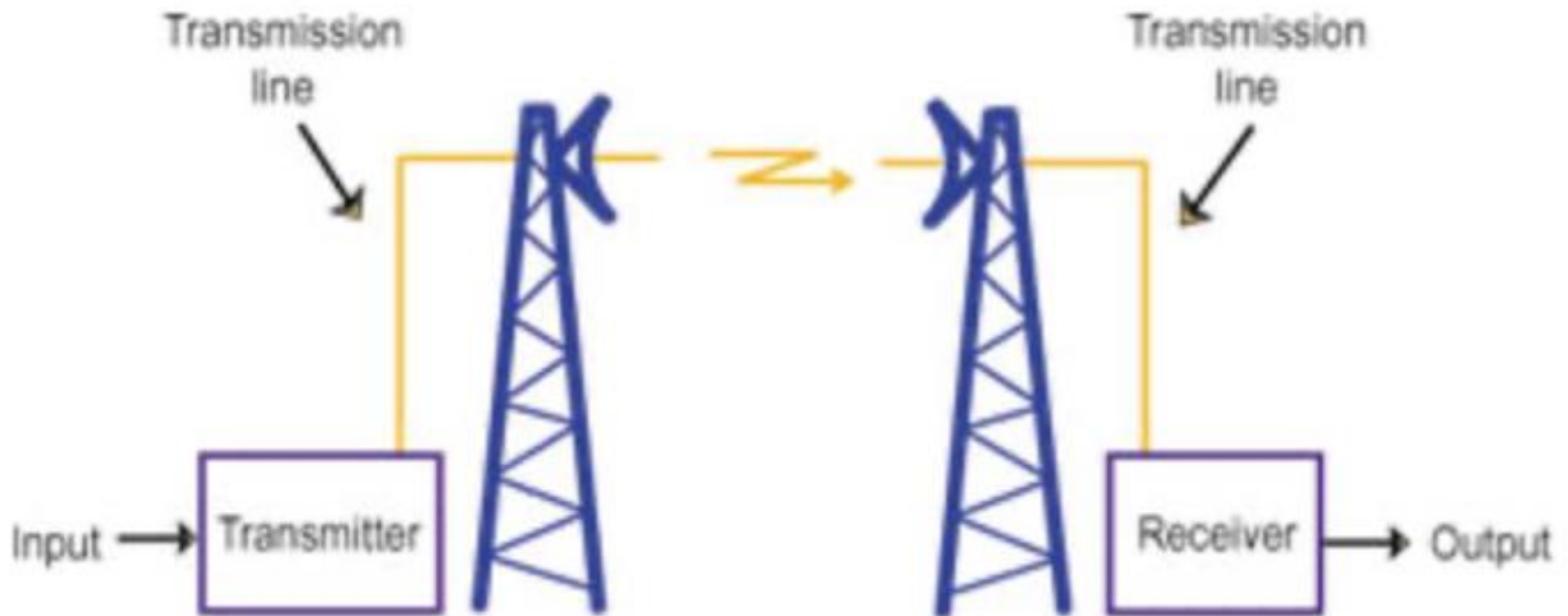
- i. Single node fibre optic cable: It supports a segment length of up to 2kms and bandwidth of up to 100 Mbps
- ii. Multinode fibre optic cable: It has a segment length of 100kms and bandwidth of 2Gbps

## **Wireless Transmission Media**

Wireless or unbounded or unguided media transport electromagnetic waves without using a physical conductor. The signals are broadcasted through air or water and thus are available to anyone that has a device capable of receiving them. Some of the wireless media are:

# Microwaves

- Microwave signals - transmit data without cables.
- Similar to radio and TV signals - long distance communications.
- Transmitter, receiver and the atmosphere.
- The microwave transmission is line-of-sight transmission.



# Advantages

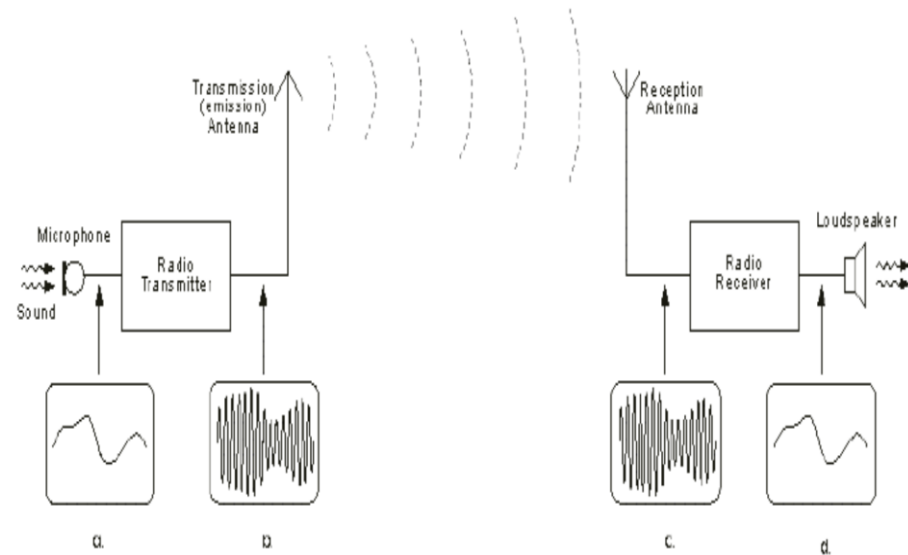
- It proves cheaper than digging trenches for laying cables and maintaining repeaters and cables if cables are broken by a variety of causes.
- It offers ease of communication over difficult terrain.
- Microwaves have the ability to communicate over oceans.
- It offers freedom from land acquisition rights.

# Disadvantages

- Microwave communication is an insecure communication.
- Microwave communication is susceptible to weather effects like rains, thunder storms etc.

# Radio waves

- The transmission making use of radio frequencies is termed as radio-wave transmission.
- All radios waves use continuous sine waves to transmit information.
- Each different radio signal uses a different sine wave frequency.
- Any radio setup has 2 parts:
  - transmitter
  - receiver
- Both transmitter & receiver use antennas to radiate and capture the radio signal.





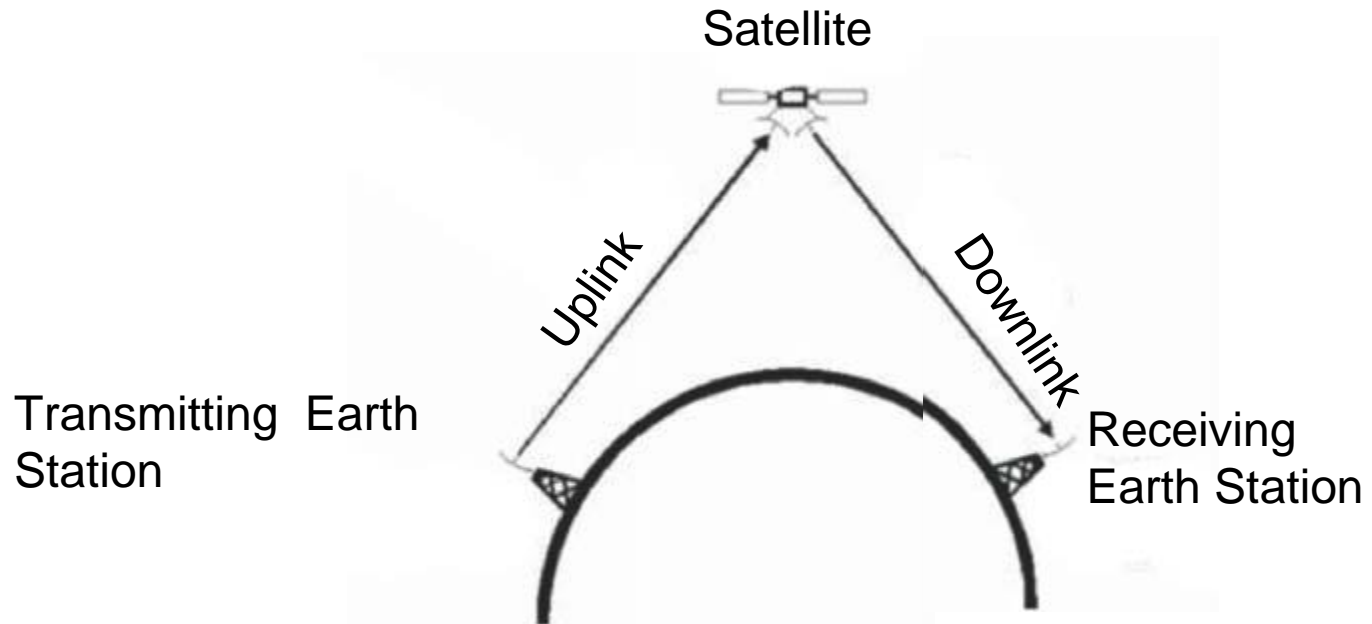
## **Advantages**

- It is easy to communicate through radio waves in difficult terrains since there is no need of digging and laying cables.
- Radio waves can travel through long distances in all directions. Also they can easily pass through obstacles like a building so they can be used for both indoor and outdoor communication.

## **Disadvantages**

- It is susceptible to weather effects like rain, thunderstorm etc.
- Data transmitted through radio waves is not secure

# Satellite Communication



# Satellites

- Satellites are an essential part of telecommunications systems worldwide today. They can carry a large amount of data in addition to TV signals.
- Satellite communication is a special use of microwave transmission system.
- A satellite is placed precisely at 36000 km above the equator where its orbit speed exactly matches the earth's rotation speed.

- This allows the ground station to aim its antenna at a fixed point in the sky. The ground station consists of a satellite dish that functions as an antenna and communication equipment to transmit (called Uplink) and receive (called Downlink) data from satellites passing overhead.
- Capacity or number of channels used in satellite communications depends on the frequency used.
- Typical data transfer rates are 1 to 10 Mbps.

## Advantages

- The area coverage through satellite transmission is quite large.
- The heavy usage of intercontinental traffic makes the satellite commercial attractive.

## Disadvantages

- Placing the satellite into its orbit involves very high cost.
- Since signals sent to a satellite are broadcasted to all receivers, so necessary security measures have to be taken to prevent unauthorized tampering of data.

## **Infrared**

- TV remotes, wireless speakers use this type of transmission.
- Infrared light transmits data through the air and can propagate throughout the room, but cannot penetrate walls.
- Infrared is widely used in digital camers, PDAs, Pager etc. and is considered as a secured one.

## **Advantages**

- Since it is having short range of communication hence it is considered to be a secure mode of transmission.
- It is quite inexpensive transmission medium.

## **Disadvantages**

- It can only be used for short range communication
- Infrared wave transmission cannot pass through obstructions like walls, buildings etc.