Transmission Media and Switching

Unit 2

A transmission medium can be defined as, "anything that can carry information from a source to a destination.

Need of Transmission/Communication Media:

1. Transmission media are needed for interacting with the devices.
2. Without transmission media communication cannot take place.
3. Communication media is the middle part of sender and receiver.
4. Transmission media is needed for faster communication.
5. It is needed for reliable delivery of data with efficient methods.
6. Transmission media is needed for secure transmission of data.

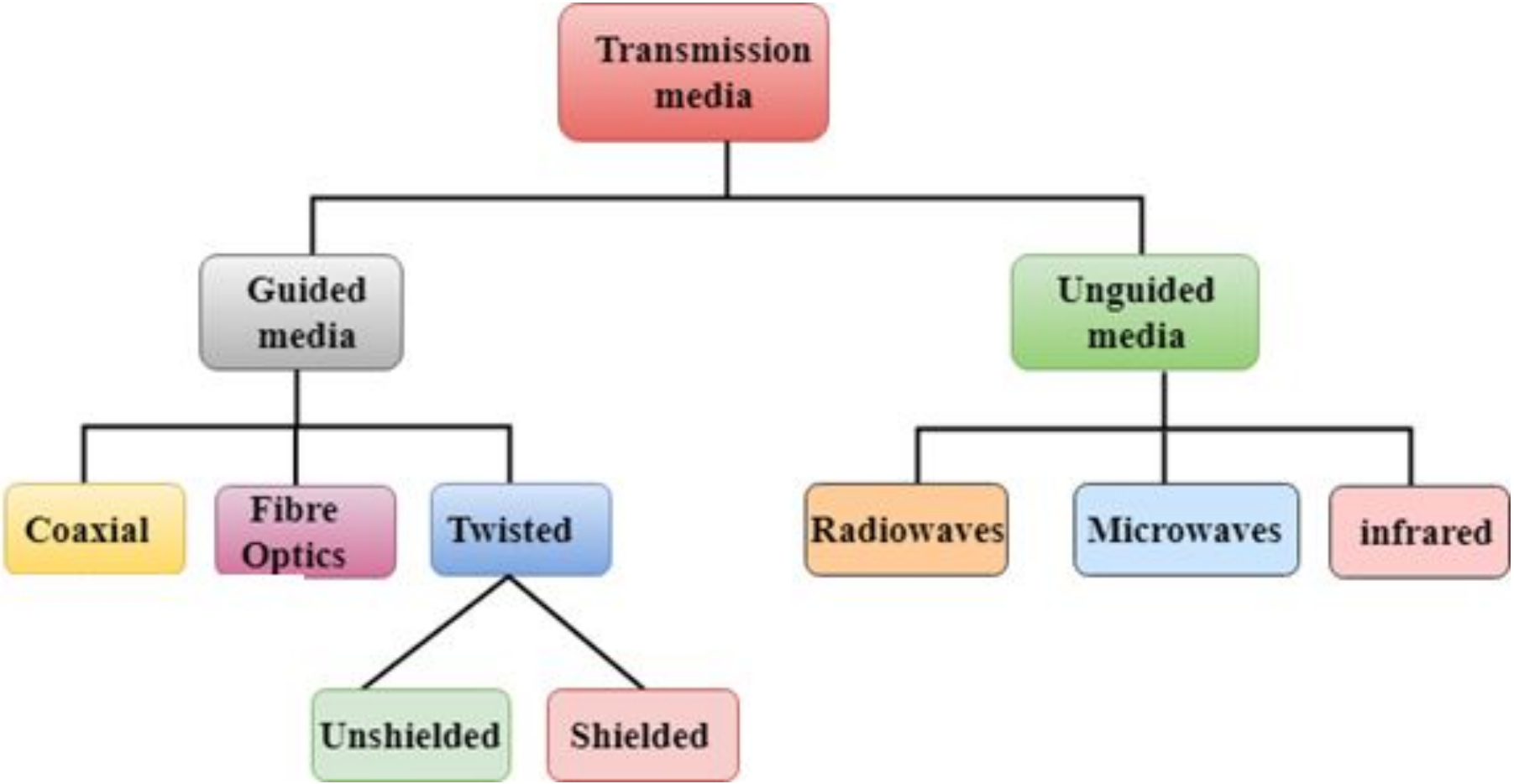
Criteria to Selection of Transmission Media:

1. **Transmission Rate** refers to the speed or data transmission rate.
2. **Bandwidth** is the measure of the capacity of the transmission medium to transmit data.
3. **Attenuation** is a measure of how much a signal weakens as it travels through a medium

    Attenuation refers to loss of energy as signal propagates outwards.

4. **No. of Users (Density)** is the concurrent number of users supported/connected by communication media.
5. The **cost** of the transmission media.
6. The **data security** capabilities provided by the transmission media.
7. The communication medium should be **flexible** in order to expand network, the need for extra equipment or devices.

Classification Of Transmission Media:

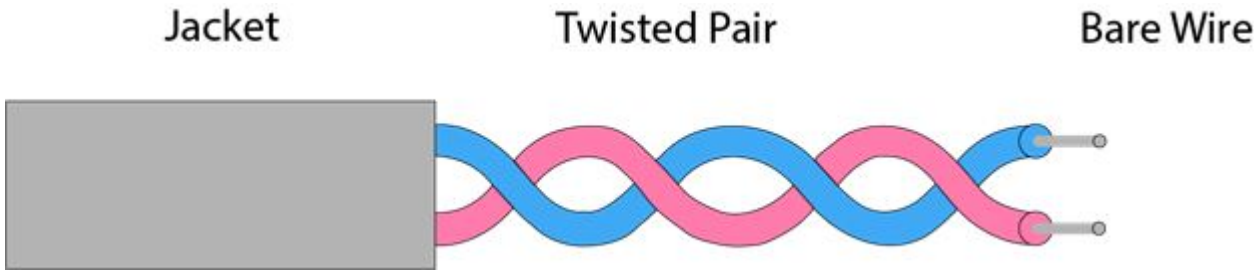


Guided Transmission Media

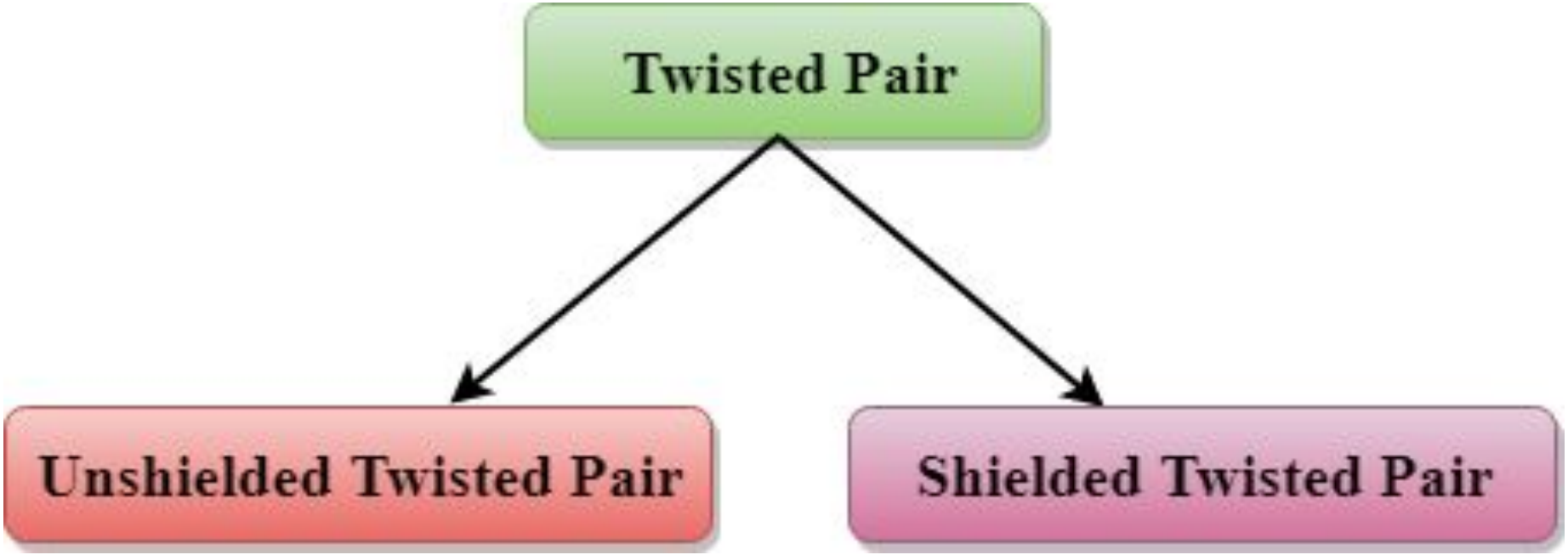
- It is defined as the physical medium through which the signals are transmitted. It is also known as Bounded media which, include twisted-pair cable, coaxial cable, and fiber-optic cable.
- Twisted-pair and coaxial cable use metallic (copper) conductors that accept and transport signals in the form of electric current. Optical fiber is a cable that accepts and transports signals in the form of light.

Twisted Pair (TP) Cable

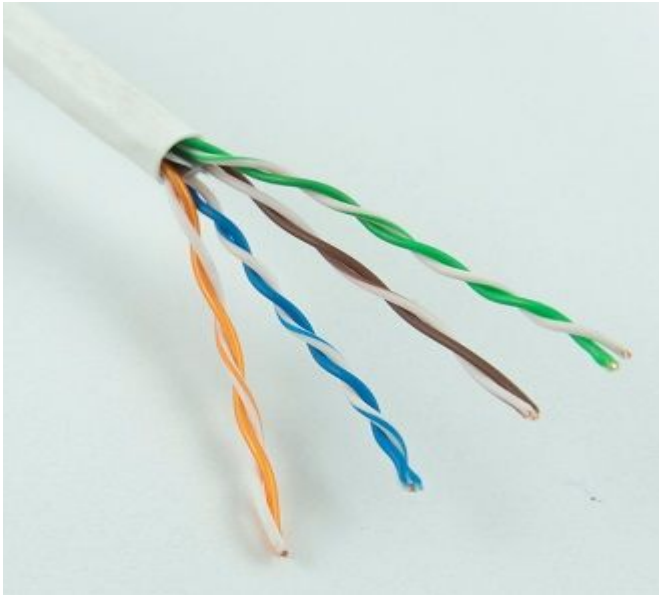
- Twisted pair cable is the most common type of cable used in data communication. It is reliable, flexible and cost effective.
- The least-expensive and most widely-used guided transmission medium is twisted pairs. A twister pair consists of two conductors (normally copper).
- The frequency range for twisted pair cable is from 0 to 3.5KHz. A twisted pair consists of two insulated copper wires arranged in a regular spiral pattern.
- The degree of reduction in noise interference is determined by the number of turns per foot. Increasing the number of turns per foot decreases noise interference.



Types of Twisted pair:



1. **Unshielded Twisted Pair (TP) Cable**



- ❏ UTP is a set of twisted pairs of cable within a plastic sheet. Cables without a shield are called as Unshielded twisted pairs Cable.
- ❏ UTP is least expensive of all the transmission media commonly used for lan, and is easy to work with and Simple to install.

Advantages of UTP

1) Easy to installation and setup
2) Capable of high speed for LAN
3) It is cheap in cost.

Disadvantages :-

This cable can only be used for shorter distance because of attenuation.

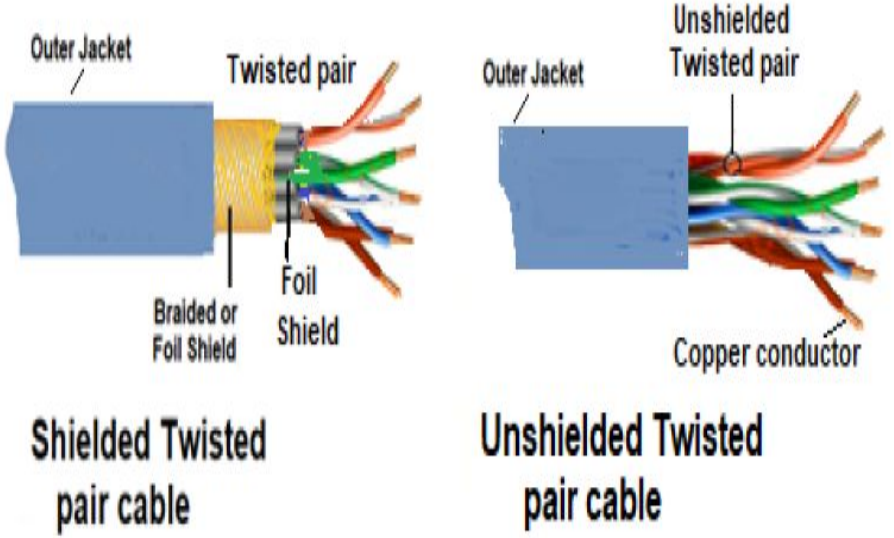
2. Shielded Twisted Pair (TP) Cable

A shielded twisted pair is a cable that contains the mesh surrounding the wire that allows the higher transmission rate.

The shielding absorbs radiation and reduce the EMI. As a result, STP can handle higher data speeds than UTP.

Advantages of UTP

1) STP reduces interference.
2) Faster than UTP and coaxial cable.
3) Better performance at higher data rates.



Disadvantages :-

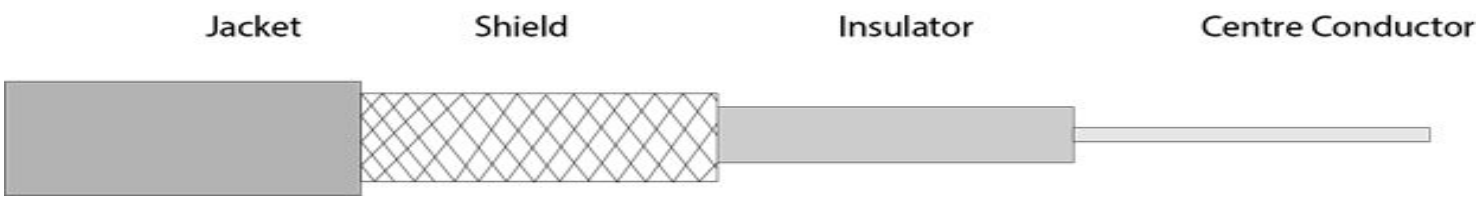
1)High Cost 2) High Attenuation rate.

3)More difficult installation and setup.

4)It is more expensive as compared to UTP and coaxial cable.

3. Coaxial Cable

- Coaxial cable is very commonly used transmission media, for example, TV wire is usually a coaxial cable.
- The name of the cable is coaxial as it contains two conductors parallel to each other.
- It has a higher frequency as compared to Twisted pair cable.
- The inner conductor of the coaxial cable is made up of copper, and the outer conductor is made up of copper mesh. The middle core is made up of non-conductive cover that separates the inner conductor from the outer conductor.
- The middle core is responsible for the data transferring whereas the copper mesh prevents from the **EMI**(Electromagnetic interference).



3. Coaxial Cable

Advantages of UTP

1. The data can be transmitted at high speed.
2. It has better shielding as compared to twisted pair cable.
3. It provides higher bandwidth.
4. Can be used for both analog and digital signals

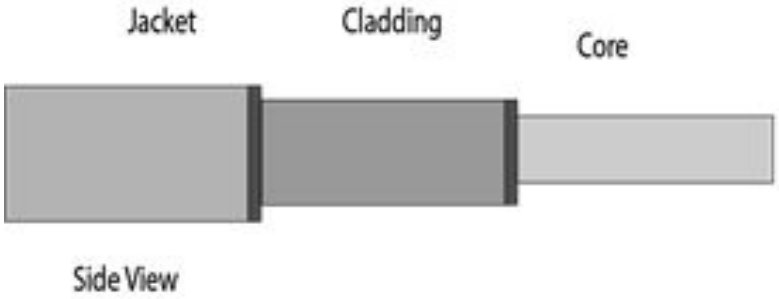
Disadvantages :-

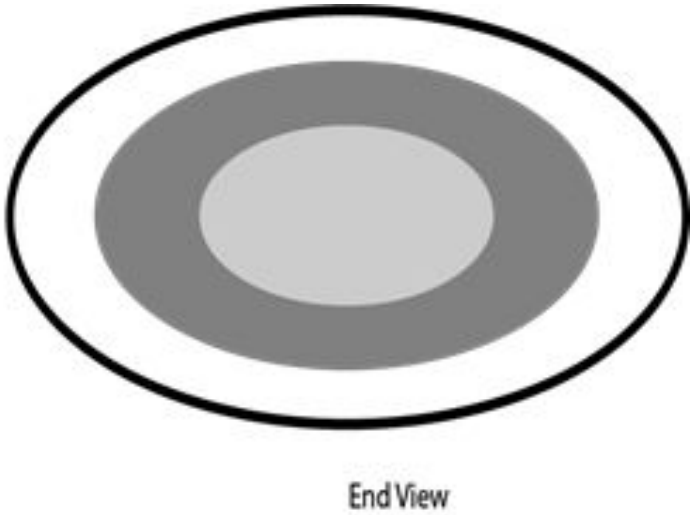
1) It is more expensive as compared to twisted pair cable.

2.) If any fault occurs in the cable causes the failure in the entire network.

Fibre-optic Cable

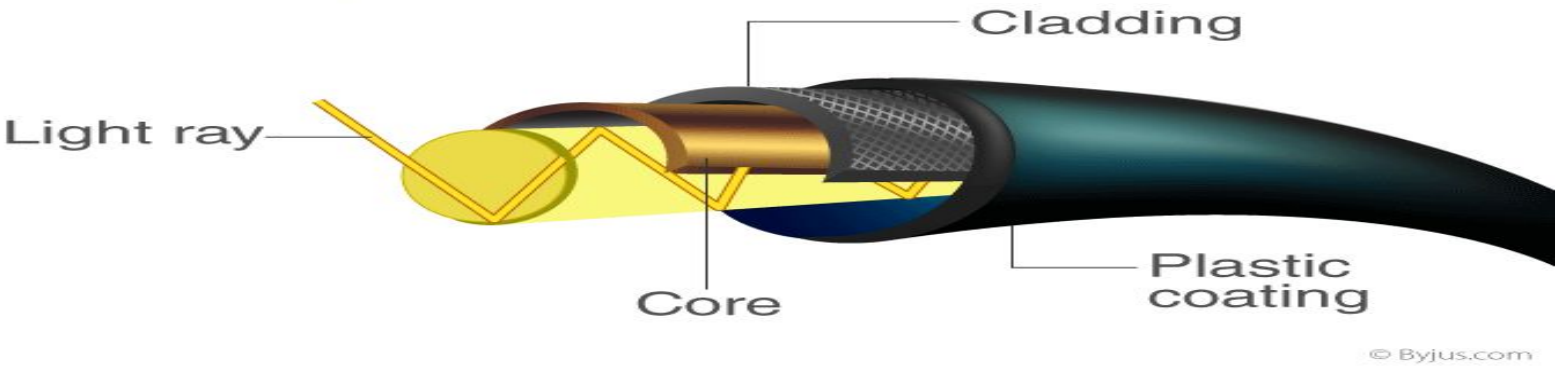
- Fibre optic cable is a cable that uses electrical signals for communication.
- Fibre optic is a cable that holds the optical fibres coated in plastic that are used to send the data by pulses of light.
- The plastic coating protects the optical fibres from heat, cold, electromagnetic interference from other types of wiring.
- Fibre optics provide faster data transmission than copper wires.





Fibre-optic Cable

- **Core:** The optical fibre consists of a narrow strand of glass or plastic known as a core. A core is a light transmission area of the fibre. The more the area of the core, the more light will be transmitted into the fibre.
- **Cladding:** The concentric layer of glass is known as cladding. The main functionality of the cladding is to provide the lower refractive index at the core interface as to cause the reflection within the core so that the light waves are transmitted through the fibre.
- **Jacket:** The protective coating consisting of plastic is known as a jacket. The main purpose of a jacket is to preserve the fibre strength, absorb shock and extra fibre protection.



Fibre-optic Cable

Advantages of fibre optic cable

1) Higher data rate than twisted pair and coaxial cable
2) Less signal Attenuation
3) Noise resistance
4) More Reliability
5) Long Distance

Disadvantages of fibre optic cable

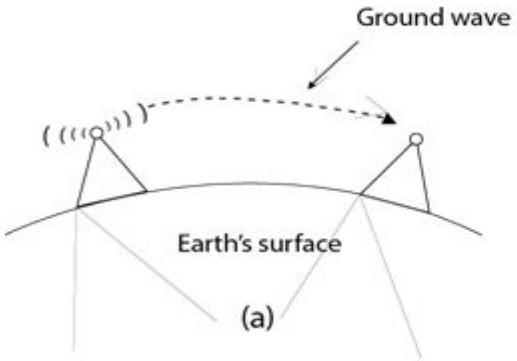
1. Installation and maintenance need expertise that is not yet available everywhere
2. Fibre optic cable is more expensive
3. Propagation of light is unidirectional

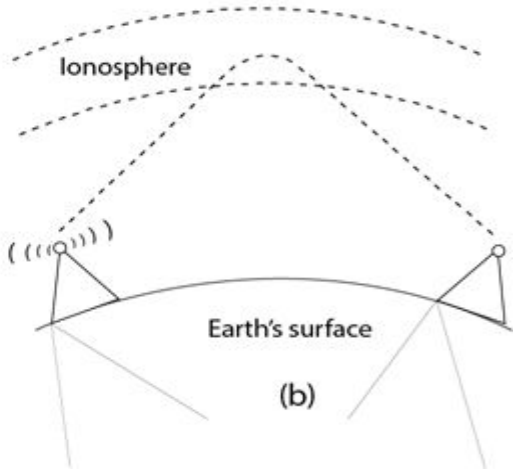
Unguided Transmission Method

- 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.

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.

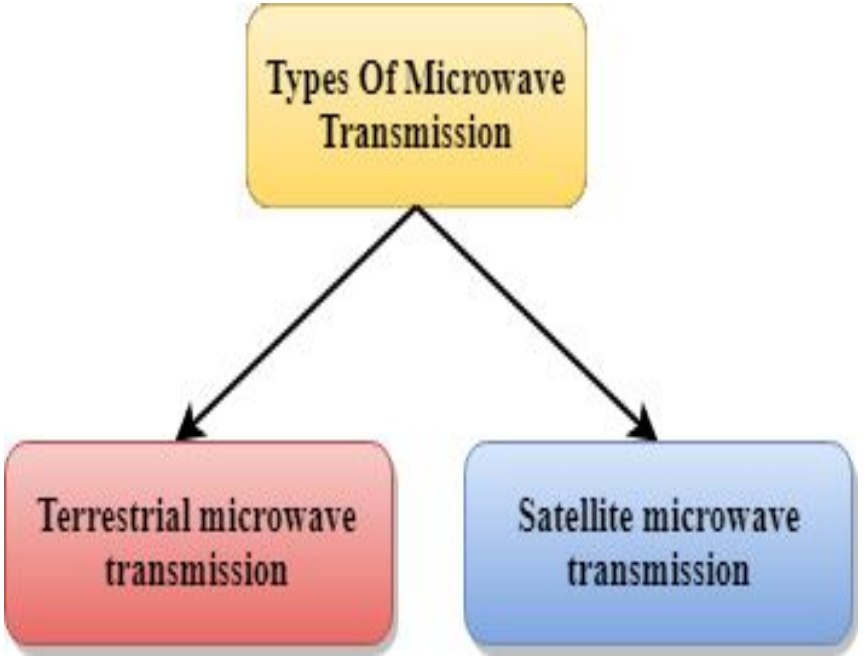
Advantages Of Radio transmission:

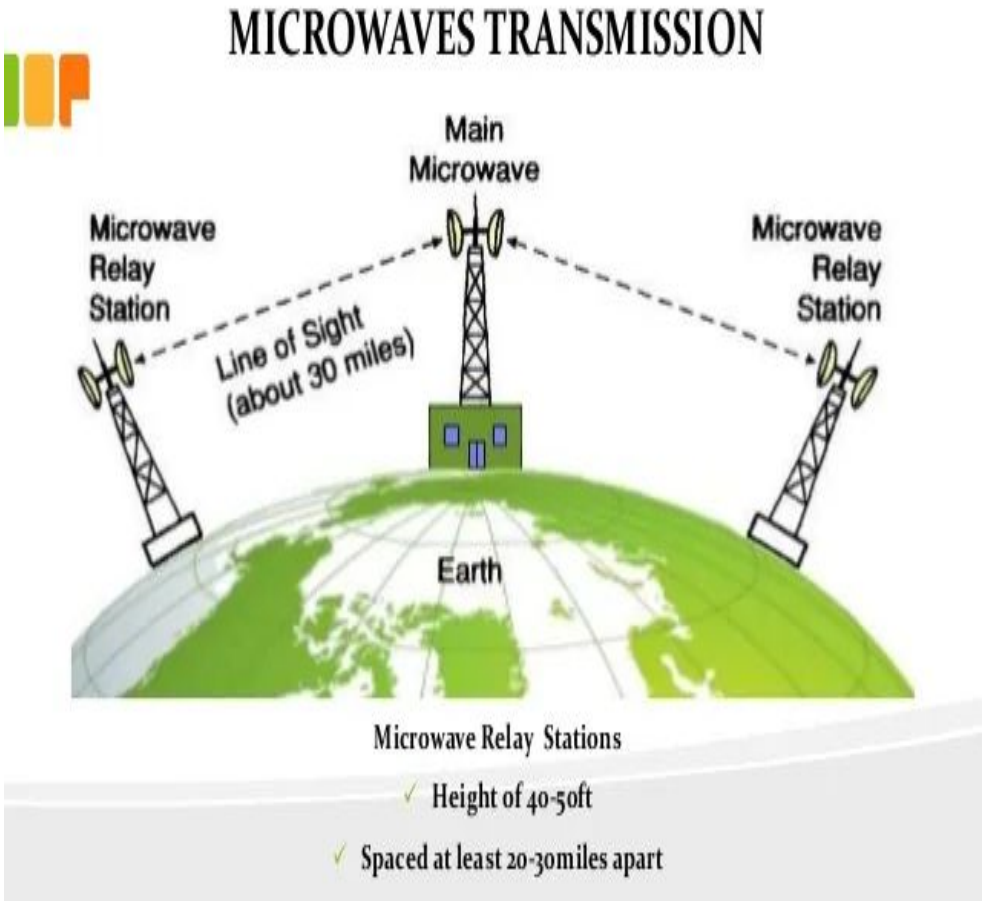
- Radio transmission is mainly used for wide area networks and mobile cellular phones.
- Radio waves cover a large area, and they can penetrate the walls.
- Radio transmission provides a higher transmission rate.

Disadvantages Of Radio transmission:

- Greater power consumption.
- Limited spectrum of Frequency
- Travel in the Straight line,So repeater stations may be needed.

Microwaves


Types Of Microwave Transmission
Terrestrial microwave transmission
Satellite microwave transmission


MICROWAVES TRANSMISSION
Main Microwave
Microwave Relay Station
Microwave Relay Station
Line of Sight (about 30 miles)
Earth
Microwave Relay Stations
✓ Height of 40-50ft
✓ Spaced at least 20-30miles apart

Frequency Band	Wavelength	Application
30Hz-300 Hz(Extremely low Frequencies(ELF)	10^4 km to 10^3 km	Used in power transmission
300Hz-3khz(voice freq)	10^3 km to 100km	Used in audio application
3khz-30khz(Very Low Freq)	100km to 10 km	Used in submarine ,navy,military communication.
20khz-300khz Low frequencies	10km to 1km (long waves)	Used in aeronautical and marine navigation
300khz-30Mhz Medium frequencies	1km to 100m Medium waves	Used in AM radio broadcast,Marine commnun.
30Mhz-300Mhz Very high frequencies	10m to 1m	Used in Tv broadcasting and FM Broadcasting
300Mhz-3Ghz Ultra high Freq.	1m to 10cm Microwaves	Used in Tv channels, Cellular Phone.
3Ghz- 30 GHz super High Frq	10^-1 to 10^-2	Used in satellite communication and radar.

Microwaves

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.

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.
- **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.

Satellite Transmission

- A satellite is a physical object that revolves around the earth at a known height.
- Satellite communication is more reliable nowadays as it offers more flexibility than cable and fibre optic systems.
- We can communicate with any point on the globe by using satellite communication.

Advantages Of Satellite Transmission:

- The coverage area of a satellite microwave is more than the terrestrial microwave.
- The transmission cost of the satellite is independent of the distance from the centre of the coverage area.
- Satellite communication is used in mobile and wireless communication applications.
- It is easy to install.
- It is used in a wide variety of applications such as weather forecasting, radio/TV signal broadcasting, mobile communication, etc.

Disadvantages Of Satellite Transmission:

- Satellite designing and development requires more time and higher cost.
- The Satellite needs to be monitored and controlled on regular periods so that it remains in orbit.
- The life of the satellite is about 12-15 years. Due to this reason, another launch of the satellite has to be planned before it becomes non-functional.

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:

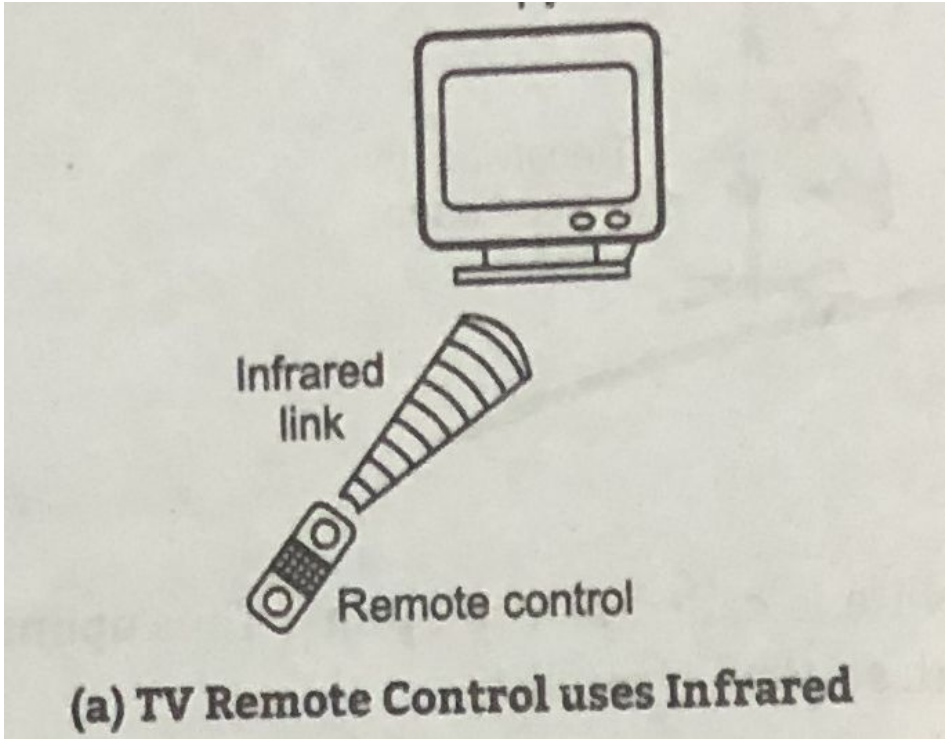
- It supports high bandwidth, and hence the data rate will be very high.
- Infrared waves cannot penetrate the walls. Therefore, the infrared communication in one room cannot be interrupted by the nearby rooms.
- An infrared communication provides better security with minimum interference.
- Infrared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

Advantage of Infrared

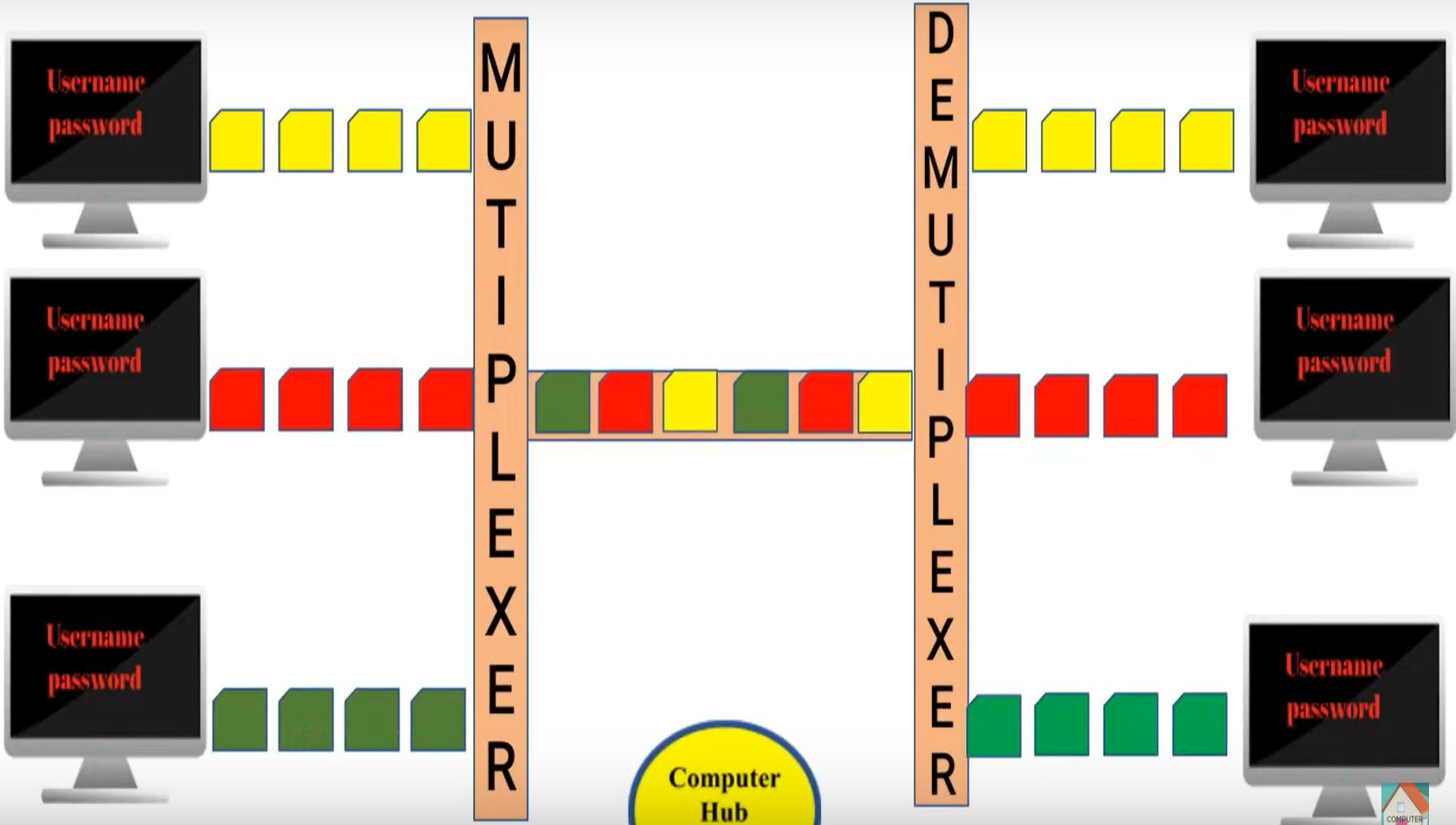
- Simple circuit and cheap in cost
- Low power consumption
- Portable
- No license needed
- High Security and simple Shielding

Disadvantage Of Infrared:

- Works only on Line of Sight mode
- Short range.
- Low bandwidth.
- Speed is comparatively low.

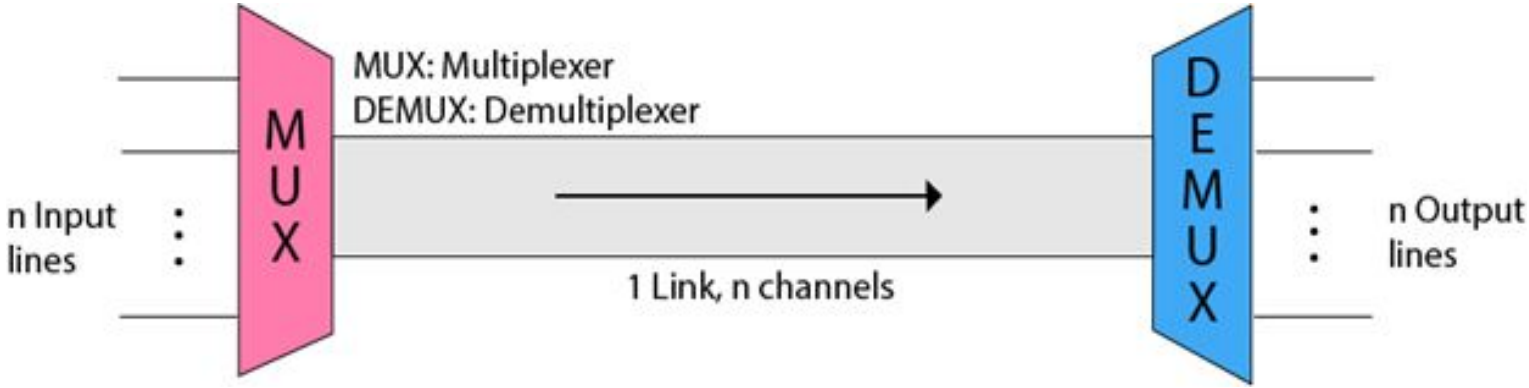


(a) TV Remote Control uses Infrared


Username
password
Username
password
Username
password
MUTIPLEXER
DEMUTIPLEXER
Username
password
Username
password
Username
password
Computer
Hub

- Multiplexing is a technique used to combine and send the multiple data streams over a single medium. The process of combining the data streams is known as multiplexing and hardware used for multiplexing is known as a multiplexer.
- Multiplexing is achieved by using a device called Multiplexer (**MUX**) that combines n input lines to generate a single output line. Multiplexing follows many-to-one, i.e., n input lines and one output line.
- Demultiplexing is achieved by using a device called Demultiplexer (**DEMUX**) available at the receiving end. DEMUX separates a signal into its component signals (one input and n outputs). Therefore, we can say that demultiplexing follows the one-to-many approach.

- The transmission medium is used to send the signal from sender to receiver. The medium can only have one signal at a time.
- If there are multiple signals to share one medium, then the medium must be divided in such a way that each signal is given some portion of the available bandwidth. For example: If there are 10 signals and bandwidth of medium is100 units, then the 10 unit is shared by each signal.
- When multiple signals share the common medium, there is a possibility of collision. Multiplexing concept is used to avoid such collision.
- Transmission services are very expensive.
- Multiplexing technique is widely used in telecommunications in which several telephone calls are carried through a single wire.
- Multiplexing originated in telegraphy in the early 1870s and is now widely used in communication.
- George Owen Squier developed the **telephone carrier multiplexing** in 1910.

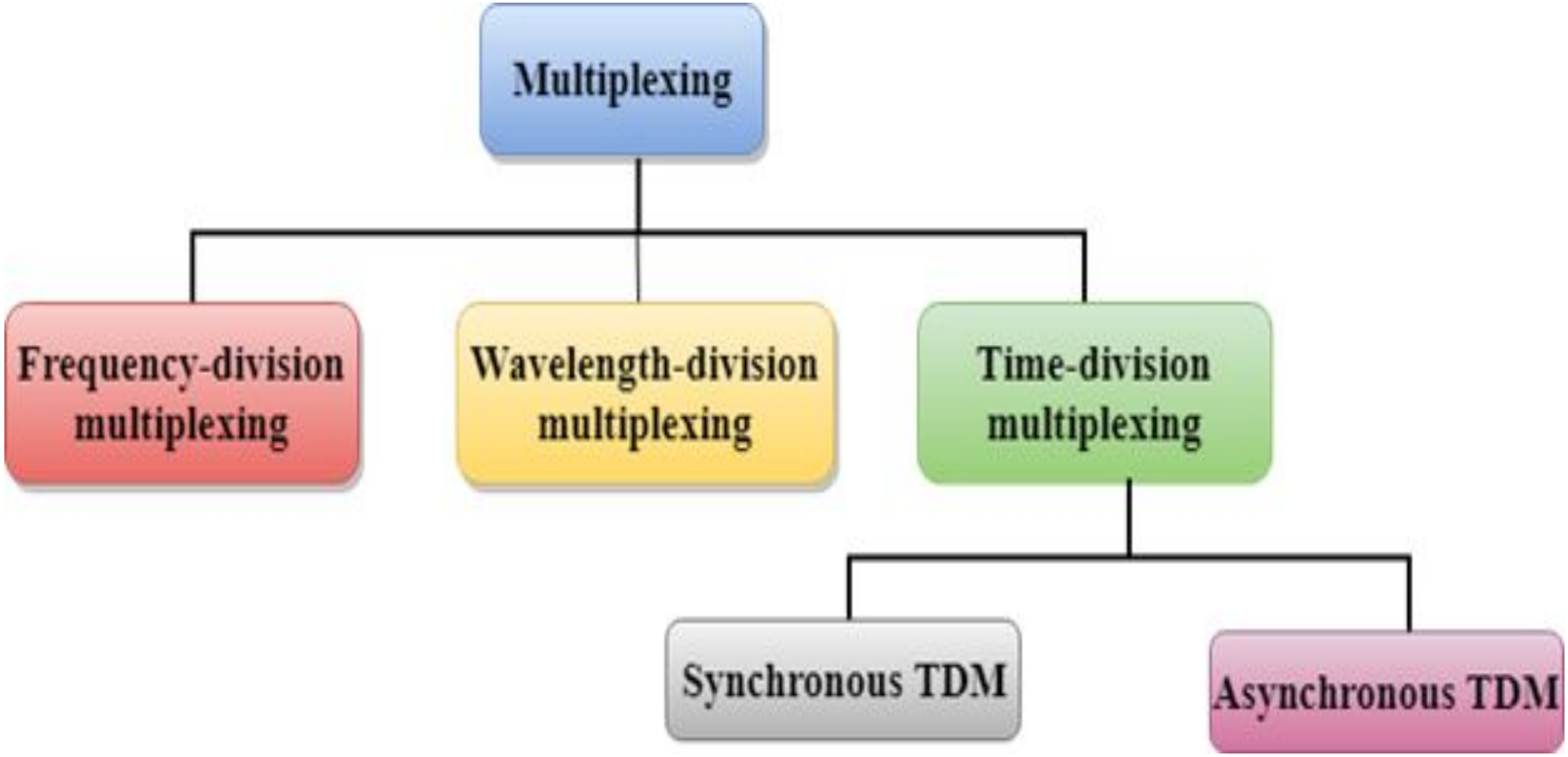


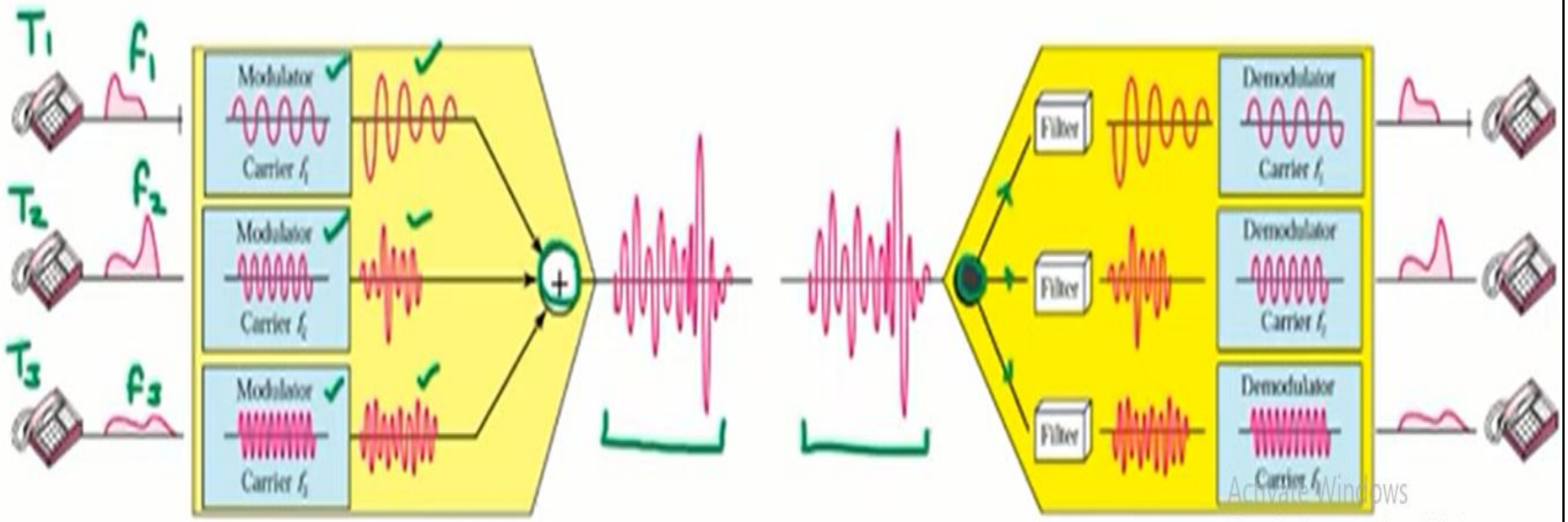
Advantages of multiplexing

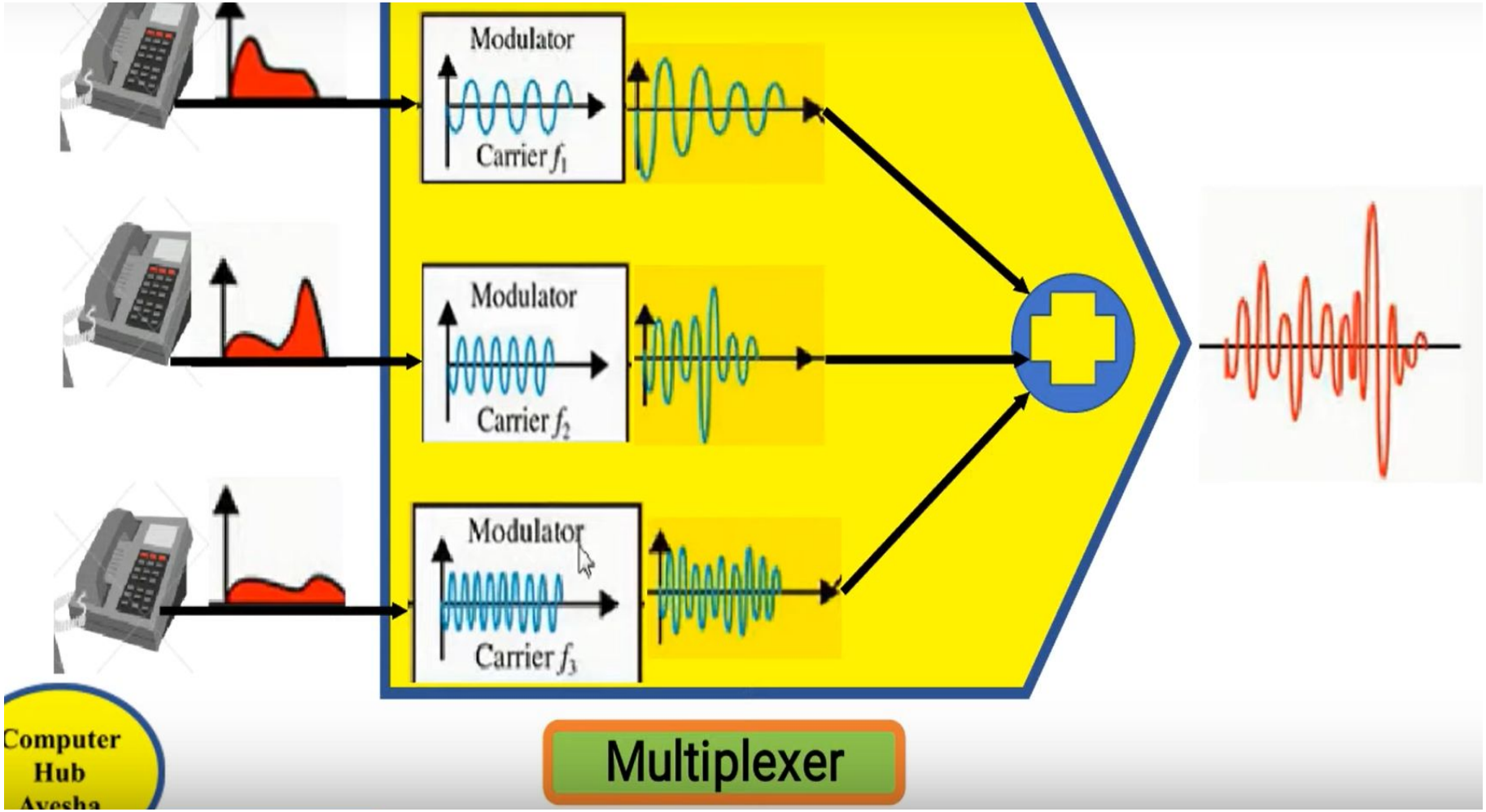
1) Simple and Easy
2) It reduces number of wires
3) Inexpensive and signals may have varying speed
4) It reduces circuit complexity and cost

Disadvantages of Multiplexing

1) Complexity
2) Extra I/O ports required to control the multiplexer.


Multiplexing
Frequency-division multiplexing
Wavelength-division multiplexing
Time-division multiplexing
Synchronous TDM
Asynchronous TDM




Modulator
Carrier f_1
Modulator
Carrier f_2
Modulator
Carrier f_3
Computer Hub Ayesha
Multiplexer

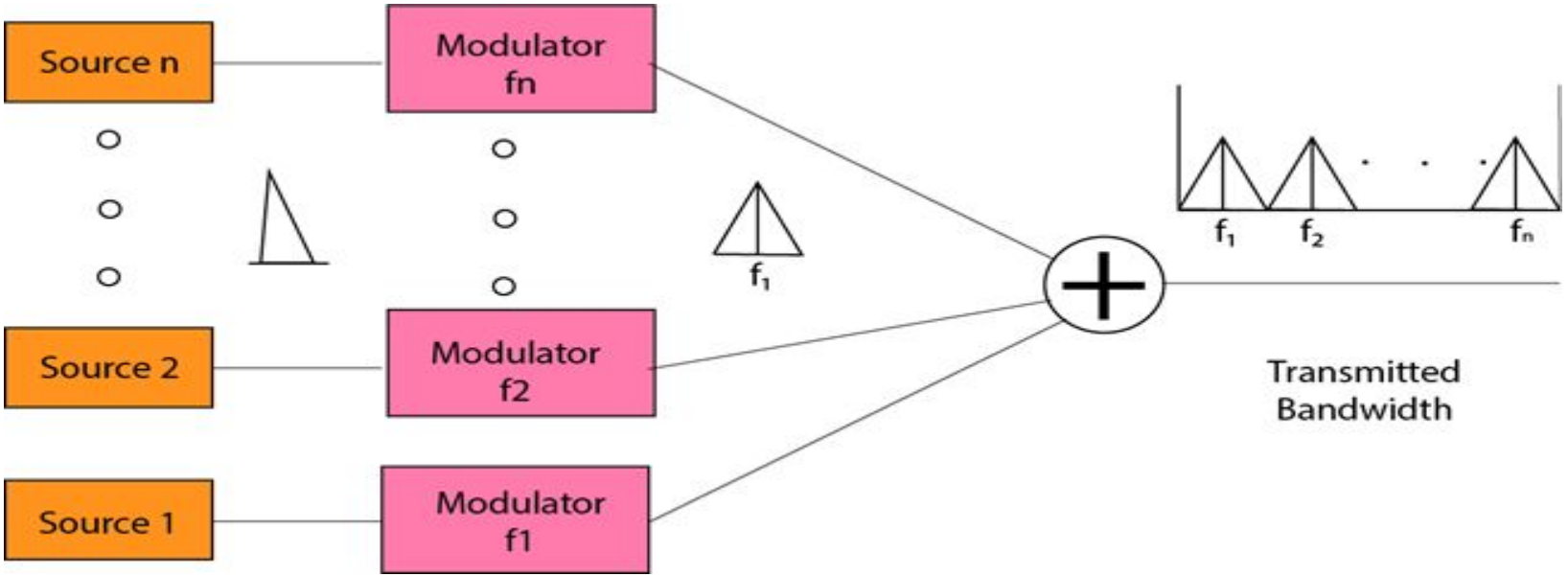
Frequency-division Multiplexing (FDM)

- It is an analog technique.
- **Frequency Division Multiplexing** is a technique in which the available bandwidth of a single transmission medium is subdivided into several channels.

- In the above diagram, a single transmission medium is subdivided into several frequency channels, and each frequency channel is given to different devices. Device 1 has a frequency channel of range from 1 to 5.
- The input signals are translated into frequency bands by using modulation techniques, and they are combined by a multiplexer to form a composite signal.
- The main aim of the FDM is to subdivide the available bandwidth into different frequency channels and allocate them to different devices.

Frequency-division Multiplexing (FDM)

- Using the modulation technique, the input signals are transmitted into frequency bands and then combined to form a composite signal.
- The carriers which are used for modulating the signals are known as **sub-carriers**. They are represented as f1,f2..fn.
- **FDM** is mainly used in radio broadcasts and TV networks.



Advantages Of FDM:

- FDM is used for analog signals.
- FDM process is very simple and easy modulation.
- A Large number of signals can be sent through an FDM simultaneously.
- It does not require any synchronization between sender and receiver.

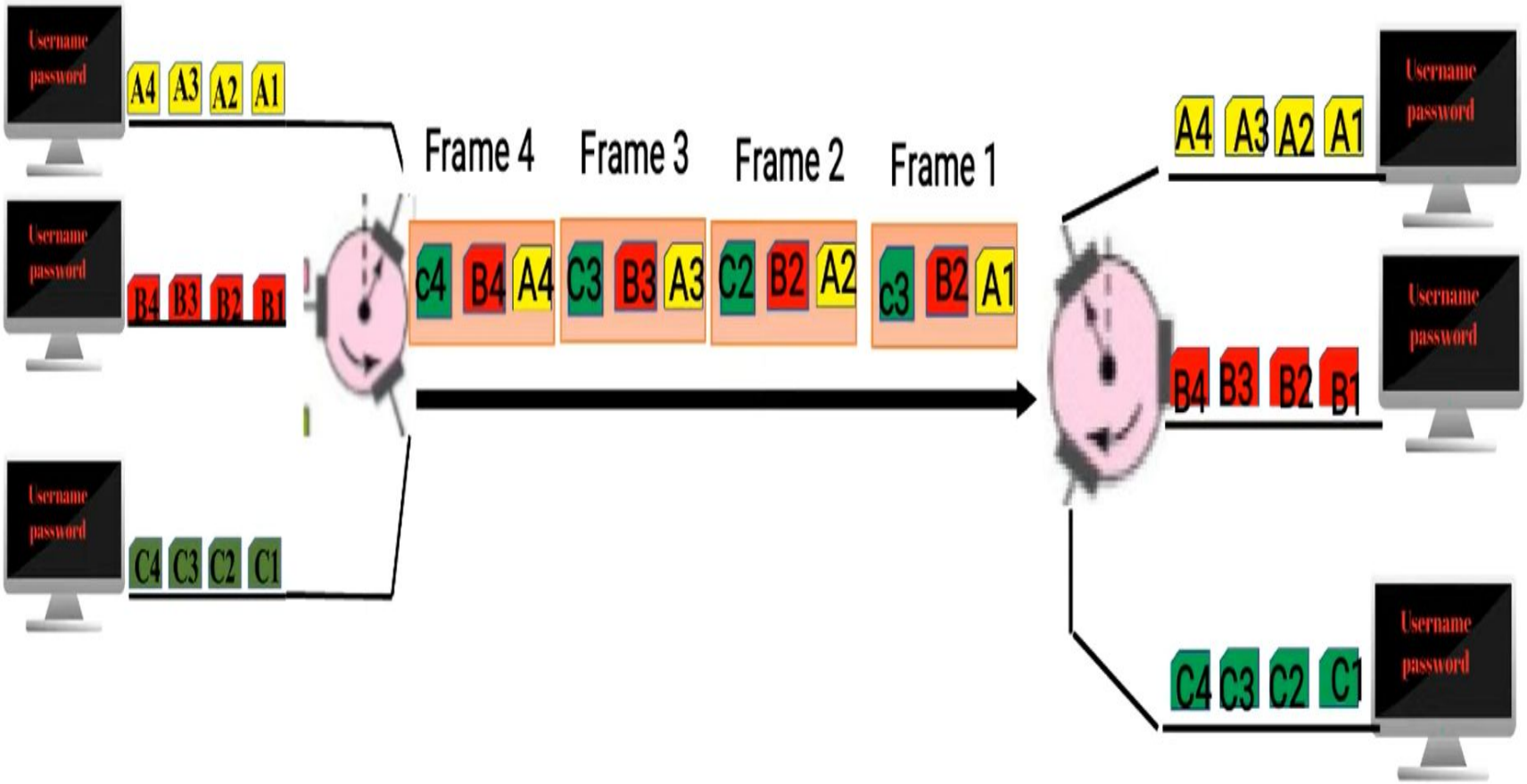
Disadvantages Of FDM:

- FDM technique is used only when low-speed channels are required.
- It suffers the problem of crosstalk.
- A Large number of modulators are required.
- It requires a high bandwidth channel.

Applications Of FDM:

- FDM is commonly used in TV networks.
- It is used in FM and AM broadcasting. Each FM radio station has different frequencies, and they are multiplexed to form a composite signal. The multiplexed signal is transmitted in the air.

Time Division Multiplexing

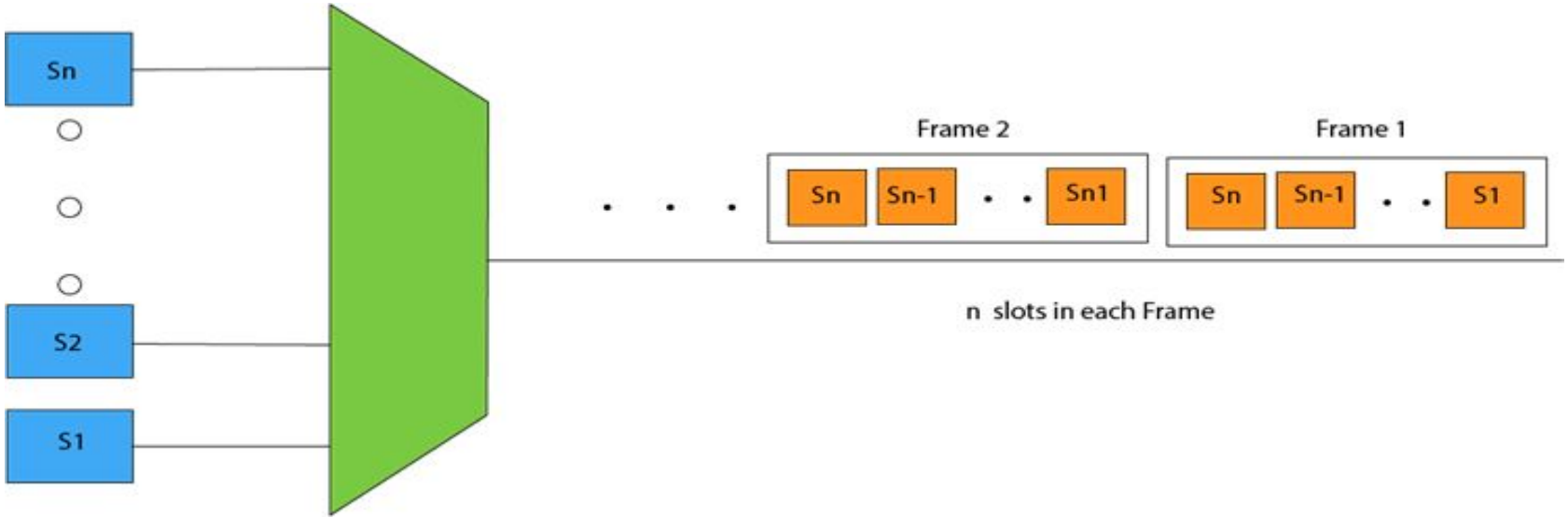


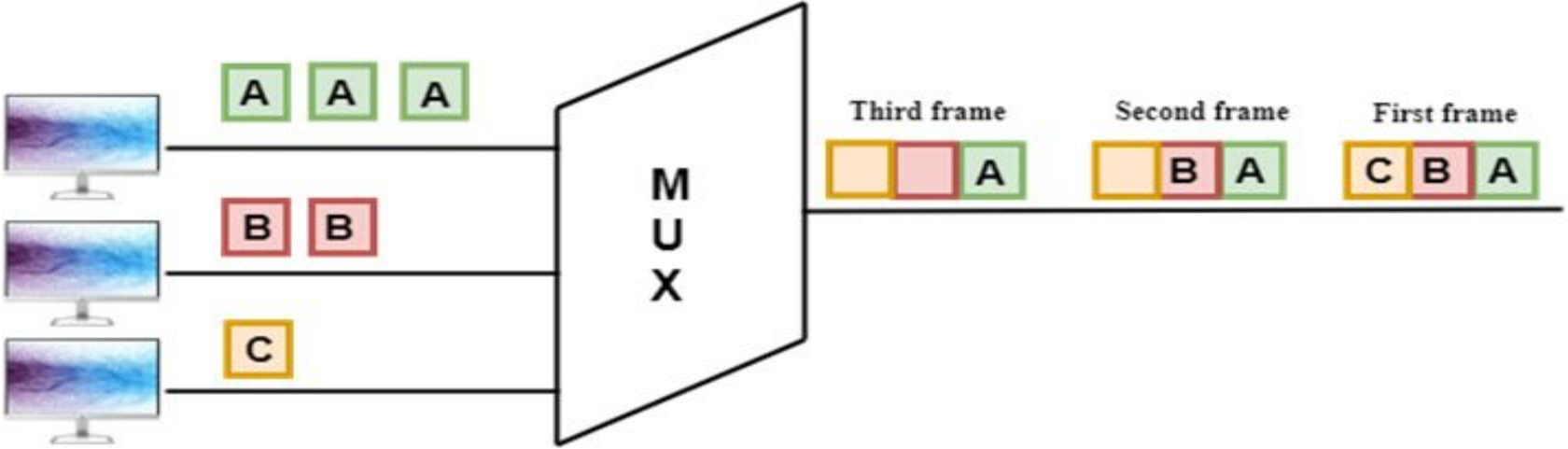
Time Division Multiplexing

- It is a digital technique.
- In Frequency Division Multiplexing Technique, all signals operate at the same time with different frequency, but in case of Time Division Multiplexing technique, all signals operate at the same frequency with different time.
- In **Time Division Multiplexing technique**, the total time available in the channel is distributed among different users. Therefore, each user is allocated with different time interval known as a Time slot at which data is to be transmitted by the sender.
- A user takes control of the channel for a fixed amount of time.
- In Time Division Multiplexing technique, data is not transmitted simultaneously rather the data is transmitted one-by-one.
- In TDM, the signal is transmitted in the form of frames. Frames contain a cycle of time slots in which each frame contains one or more slots dedicated to each user.
- It can be used to multiplex both digital and analog signals but mainly used to multiplex digital signals.

There are two types of TDM:

- Synchronous TDM
- Asynchronous TDM or statistical TDM





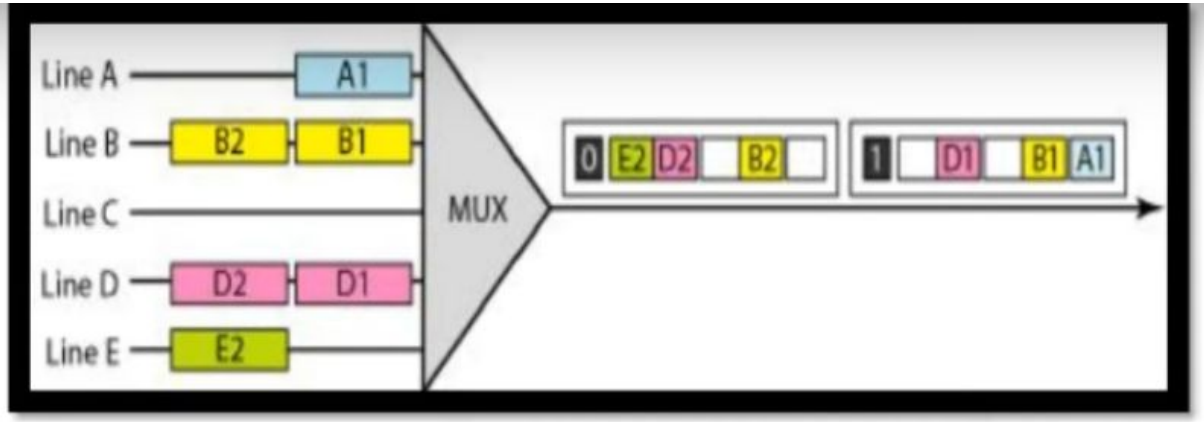
Synchronous TDM

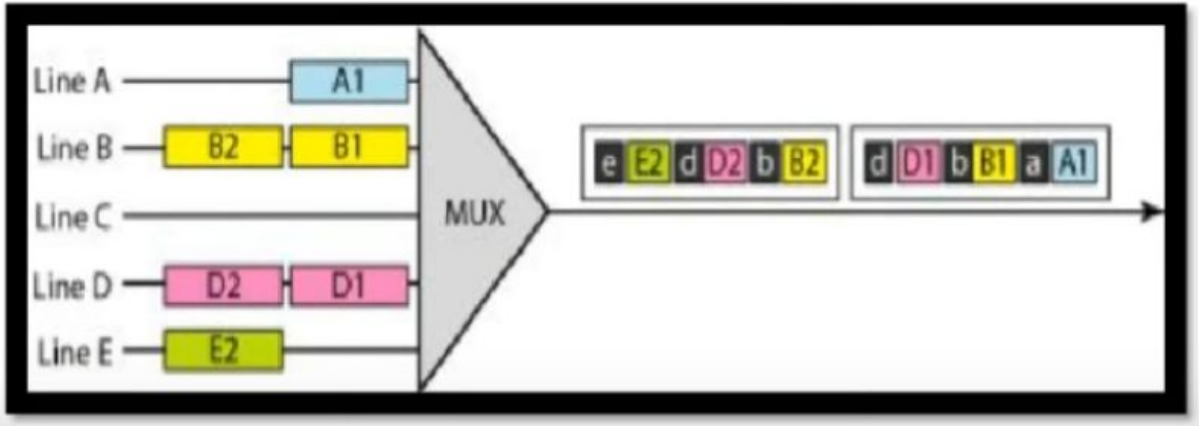
- A Synchronous TDM is a technique in which time slot is preassigned to every device.
- In Synchronous TDM, each device is given some time slot irrespective of the fact that the device contains the data or not.
- If the device does not have any data, then the slot will remain empty.
- In Synchronous TDM, signals are sent in the form of frames. Time slots are organized in the form of frames. If a device does not have data for a particular time slot, then the empty slot will be transmitted.
- In the above figure, the Synchronous TDM technique is implemented. Each device is allocated with some time slot. The time slots are transmitted irrespective of whether the sender has data to send or not.

Disadvantages Of Synchronous TDM:

- The capacity of the channel is not fully utilized as the empty slots are also transmitted which is having no data. In the above figure, the first frame is completely filled, but in the last two frames, some slots are empty. Therefore, we can say that the capacity of the channel is not utilized efficiently.
- The speed of the transmission medium should be greater than the total speed of the input lines. An alternative approach to the Synchronous TDM is Asynchronous Time Division Multiplexing.

Synchronous TDM





Statistical TDM

Asynchronous TDM

- An asynchronous TDM is also known as Statistical TDM..
- An asynchronous TDM technique dynamically allocates the time slots to the devices.
- Asynchronous Time Division multiplexor accepts the incoming data streams and creates a frame that contains only data with no empty slots.
- In Asynchronous TDM, each slot contains an address part that identifies the source of the data.
-