

# Computer Networks

Unit - 7

## Computer Network :-

A computer network is set of device connected through links. A node can be computer, printer, or any other device capable of sending or receiving the data. The links connecting the nodes are known as communications channels.

## Data communication components :-

Data communication is process in which more than one computer transfers information, instructions to each other and for sharing resources. Or in other words communication is a process or act in which we can send or receive data.

## Components of Data communication :-



(1) Message :- A message is a piece of information that is to be transmitted from one person to another. It could be a text, file, an audio file, video file etc.

2. Sender : It is simply a device that sends data message. It can be a computer, mobile, telephone, laptop, ①

Video camera or workstation.

(3) Receiver: It is a device that receives messages. It can be computer, telephone, mobile etc.

(4) Transmission medium/ Communication channels: Communication channels are the medium that connect two or more workstations. Workstations can be connected by either wired media or wireless media.

(5) Set of rules (Protocol):— When someone sends the data it should be understandable to the receiver also otherwise it is meaningless. For eg Sonali sends a message to Chetan. If Sonali writes in Hindi & Chetan cannot understand Hindi it is a meaningless conversation. Therefore there are some set of rules protocols that is followed by every computer connected to the Internet & they are:

- TCP (Transmission Control Protocol): It is responsible for dividing message into packets on the source computer and reassembling the received packet at the destination or recipient computer. It also makes sure that the packets have the information about the source of the message data, the destination of the message data should be de-assembled and checks if the message has been sent correctly to the specific destination.

## P Protocol :- (internet protocol)

Do you ever wonder how does computer determine which packet belongs to which device what happens if the ~~sent~~ message sent by you to your friend is received by your father? scary right. well IP is responsible for handling the address of the destination computer so that each packet is sent to its proper destination.

## Type of data communication

- 1. Simplex communication
- 2. Half duplex communication
- 3. Full - duplex communication

### Simplex communication:-

It is one-way communication or we can say that unidirectional communication in which one device only receives from another device only sends data and devices uses their entire capacity in transmission. eg entering data using a keyboard, listening music using a speaker etc.

### 2. Half Duplex communication:-

It is a two way communication or we can say that it is bidirectional communication in which both the device can send and receive data but not at the same time. when one device is sending data another device is only receiving & vice-versa. for eg walkie-talkie.

### (3) Full duplex communication:-

It is two-way communication or we can say that it is a

bidirectional devices can send & receive data at the same time for example mobile phones, landlines etc.

## Communication channels

Communication channels are the medium that connect two or more workstations.

Workstations can be connected by either wired media or wireless media. It is also known as transmission medium.

There are two categories of communication media

- Guided media transmission
- Unguided media transmission

## Data representation

A network is a collection of different devices connected and capable of communicating.

Different Data types in a computer network

- (1) Texts
- (2) Numbers
- (3) Images
- (4) Videos
- (5) Audios.

## Textual data :-

Data in text format is represented using bit patterns. Textual data is nothing but a string, a string is collection of characters.

## (2) Numerical data :

Number are directly converted into binary patterns by dividing by 2 without any encoding.

Number formats:

- Integers
- Date
- Boolean
- Decimal
- fixed point
- floating point

Eg. 78°

Binary representation: 1100 001100

Image :- Image data is also transferred

as a stream of bits like textual data.

An image also called a pixels. A

single pixel is the smallest addressable element of a picture & it is like a dot

#### 4. Audios :

Transferring an audio signal is different from other format. Audio is broadcasting recorded sound or music. An audio signal is generated as an analog wave converted into digital format to be stored in a computer by representing the wave amplitude at moments in bits.

file extensions:-

.mp3, .m4a, .wav, .AAC etc.

#### 5. Videos:

A video is a collection of frames each frame is a picture with the same all different dimensions. These frames/images are represented as matrices.

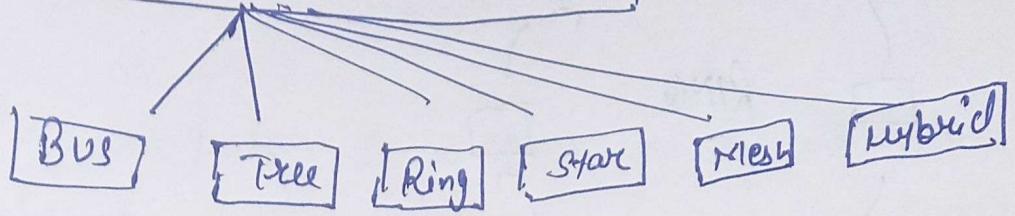
## Topology :

Topology defines the structure of the network of how all the components are interconnected to each other.

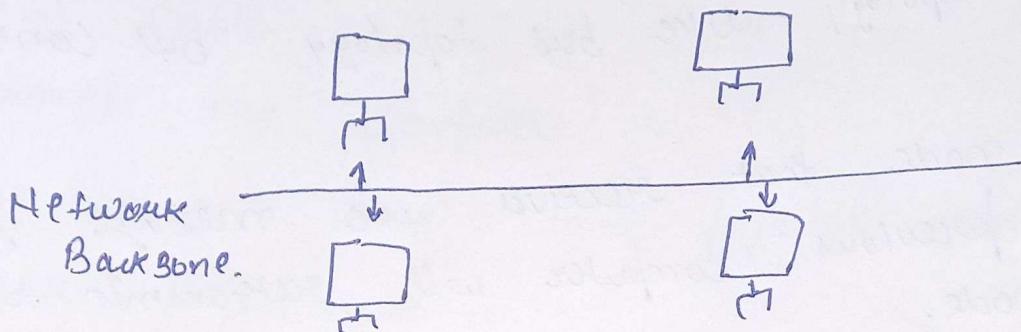
There are six type of Topology.

Ring Topology, Tree, Star, Mesh, Hybrid Topology.

## Types of Topologies In Network

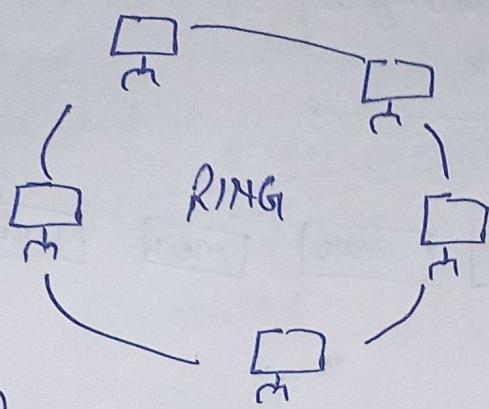


### (1) Bus Topology :-



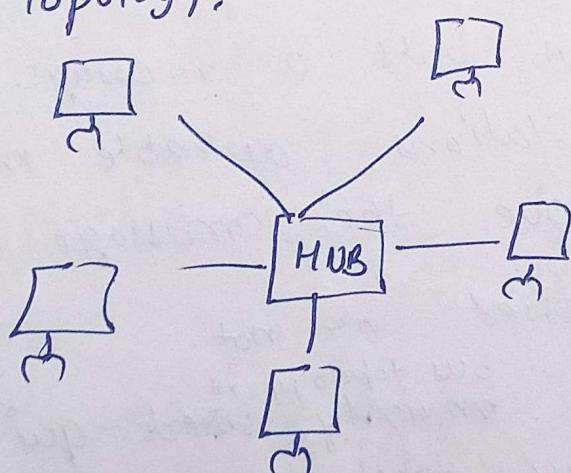
- The bus topology is designed in such a way that all stations are connected through a single cable known as a backbone cable.
- Each node is either connected to a backbone cable by drop cable or directly connected to the backbone cable.
- > When a node wants to send a message over the network it puts a message over the network. All stations available in the network will receive the message whether it has been addressed or not.
- The configuration is <sup>bus topology is</sup> ~~analogous to~~ quite simpler as compared to other topologies.
- The backbone cable is considered as a single line through which the message is broadcast to all stations.

## (2) Ring Topology:-



- RING Topology like bus topology but connected ends.
- The node that receives the message from the previous computer will retransmit to the next node.
- The data flows is one direction it is Unidirectional.
- It has no terminated ends. Each node is connected to other node & having no termination point.
- The data in ring topology flow in a clockwise direction.

## 3) STAR Topology:-

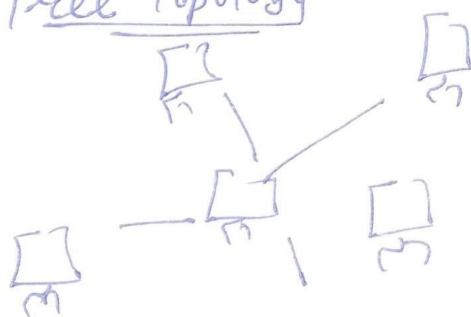


- Star Topology is an arrangement of the

Network in which every node is connected to central hub, switch or a central computer.

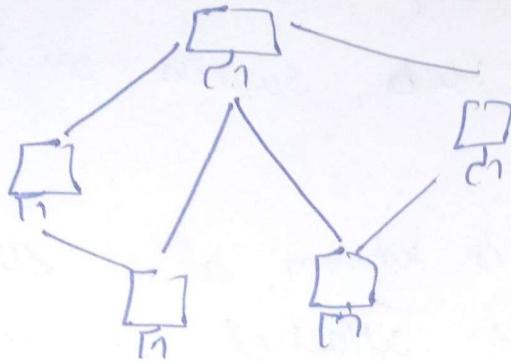
- The central computer is known as a server & the peripheral devices attached to the server are known as client.
- Coaxial cable or RJ-45 cables are used to connect the computers.
- Star topology is the most popular topology in network implementation.

#### 4) Tree Topology



- Tree topology combines the characteristics of bus topology & star topology.
- A Tree topology is a type of structure in which all the computers are connected with each other in hierarchical fashion.
- The top-most node in tree topology is known as a root node and all other nodes are the descendants of the root node.

### (5) Mesh :



- Mesh technology is an arrangement of the network in which computers are interconnected with each other through various redundant connections.
- There are multiple paths from one computer to another computer.
- It does not contain the switch, hub or any central computer.
- Mesh topology is mainly used for wireless networks.

### Hybrid Topology

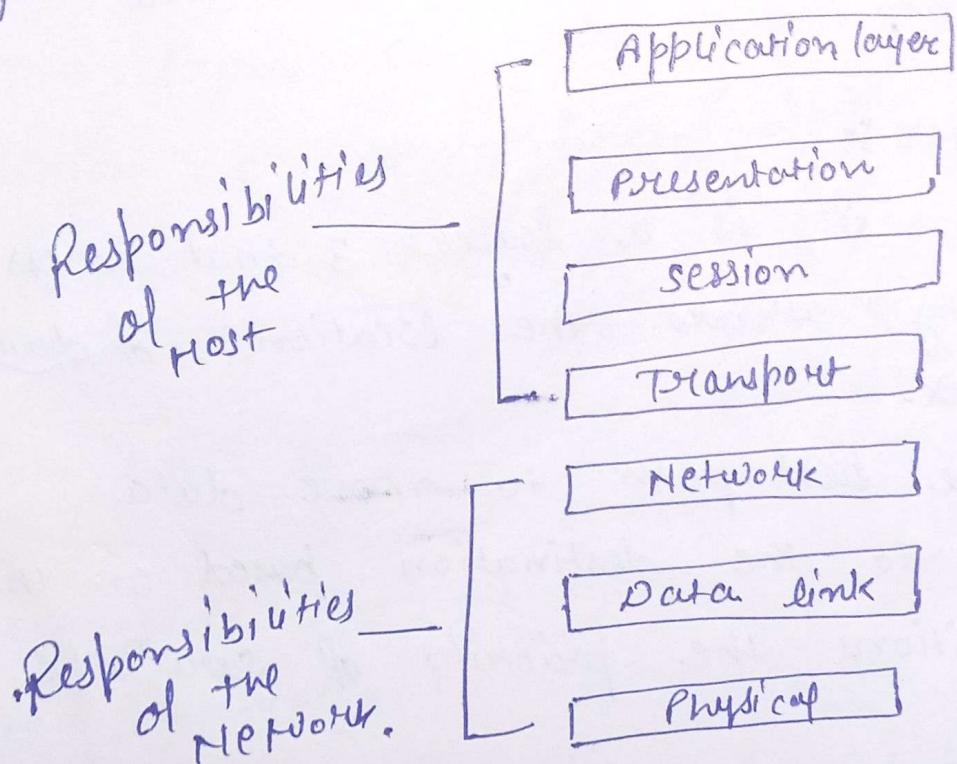
The combination of various different topologies is known as hybrid topology.

- A hybrid topology is a connection b/w different links & nodes to transfer the data.

# OSI model

OSI stands for open system interconnection  
is a reference model that describe how  
information from a software application in one  
computer moves through a physical medium to  
the software application in another computer.

- OSI consist of seven layer & each layers  
performs a particular network functions.
- OSI model divides the whole task  
into seven smaller & manageable tasks. Each  
layer is assigned a particular task.



## 1) Physical Layer :-

The main functionality of the physical layer is to transmit the individual bits from one node to another node. It is responsible for the actual physical connection b/w the devices.

## 2) Data link layer :-

The Data link layer is responsible for the node to node delivery of the message. The main function of this layer is to make sure data transfer is error-free from one <sup>node</sup> to another over the Physical layer.

## 3) Network layer :-

It is a layer 3 that message device addressing, tracks the location of device on the network. It determines the best path to move data from source to the destination based on the network conditions like priority of service & other factors.

## 4) Transport layer:

Transport layer 4 ensures that message are transmitted in the order in which they are sent & there is no duplication.

of data.

- The main responsibility of the transport layer is to transfer the data completely.
- It receives the data from the upper layer and converts them into smaller units known as segments.
- This layer can be termed as an end to end layer as it provides point to point connection b/w source and destination to deliver the data reliably.

5). session layer :- (main aim establish, manage, & terminate the connection b/w application).

The connection b/w the computers connected in a network is managed at this layer.

- This layer can also terminate or end any session or transmission which is complete.

6). Presentation layer :-

The Presentation layer is the sixth layer of the OSI model which mainly concentrates on the syntax and semantics of the information exchanged b/w the system. The main aim of the presentation layer is to convert the data from one presentation format to the other format as different application may use different application.

## 7) Application layer

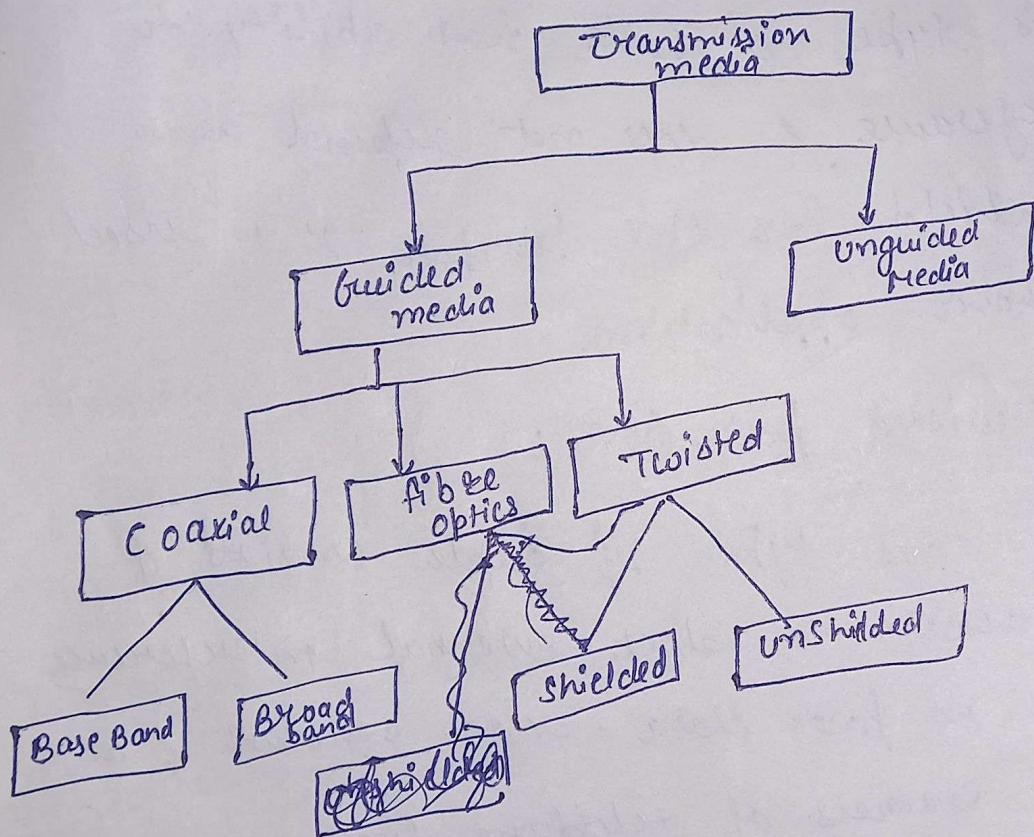
The Application layer is the seventh & the last layer of the OSI model which mainly concentrates/關注 providing services to the users.

Application layers allow users to access and share files, access and send emails access webpages etc.

## Transmission media :-

Transmission media is a communication channel that carries information from the Sender to the Receiver. Data is transmitted through the electromagnetic signals.

It is Physical path b/w transmitter & receiver in data communication.



### 1) Guided media :-

It is also referred to as wired or bounded transmission media. There are 3 major type of guided media

### 1) Twisted pair cable:

It consists of 2 separately

Insulated conductor wires ~~wire~~ about each other. Other generally several such pairs are bundled together in a protective sheath. They are most widely used transmission media.

Twisted Pair is of two types:-

### (1) Unshielded Twisted Pair (UTP)

UTP consists of two insulated copper wires twisted around one another. This type of cable has ability to block interference & does not depend on a physical shield for this purpose. It is used for telephone applications.

### - Shielded Twisted pair (STP):-

This type of cable consists of a special jacket to block external interference. It is used in fast data-rate Ethernet & voice & data channels of telephone lines.

### 2) C coaxial cable:

It has an outer plastic covering containing an insulation layer made of PVC or Teflon & 2 parallel conductors each having a separate insulated protection cover. The coaxial cable transmits information

two modes,

Baseband mode & Broadband mode.

Cables TVs and analog television network widely use coaxial cables.

### 3) Optical fiber cable:-

It uses the concept of refraction of light through a core made up of glass or plastic.

It is used for transmission of large volumes of data.

The cable can be unidirectional or bidirectional.

Advantage

- Increased capacity & bandwidth.
- Light weight.
- less signal attenuation.

Disadvantage.

- High cost
- Difficult to install & maintain.

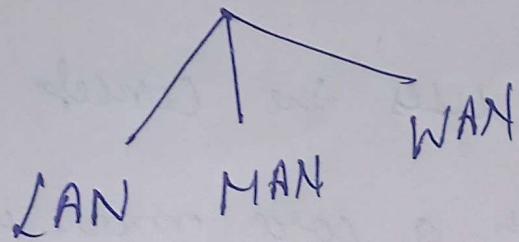
### Unguided media:-

It is also referred to as wireless or unbounded transmission media. No physical medium is required for transmission.

of electromagnetic signals.

Example are Radio waves, micro waves etc.

## Types of Network



LAN (Local area network) is defined as a computer network that is responsible for connecting local areas like schools, residents Universities etc. The main function of the local area network is to link the computers thereby providing access to the printers, photo copies & other services.

MAN :  $\rightarrow$  A MAN also called the metropolitan area network is defined as the computer networks that joins the metropolitan areas. MAN works either through wires / cables or modem.

Telephone company network is a common example of MAN is that it is the interconnection b/w several link networks

in metropolitan  
km).

Area: MAN range from 5-50

## WAN

: WAN is also called wide Area Network is defined as a telecommunication Network that extends over a large area. The primary purpose of WAN is computer Networking. The networks are linked to communicate with one other.

- The largest area like a country is covered by WAN.

# TECHNIQUES for Bandwidth Utilization

Bandwidth is basically a measure of the amount of data that can be sent and received at any instance of time.

That simply means that higher is the bandwidth of a network. Larger is the amount of data a network can be sending to and from across its path.

Bandwidth is something that deals with the measurement of capacity and not the speed of data transfer.

Unit of measurement-

Bandwidth is usually measured in bits transferred per second through a path or link (BPS, Mbps, Gbps)

(Bits per second, Megabits per second, Gigabits per second)

Bandwidth utilization is the wise use of available bandwidth to achieve specific goals. Efficiency can be achieved by multiplexing; privacy and antijamming can be using spreading.

## MULTIPLEXING :-

Multiplexing is the set of techniques that allows

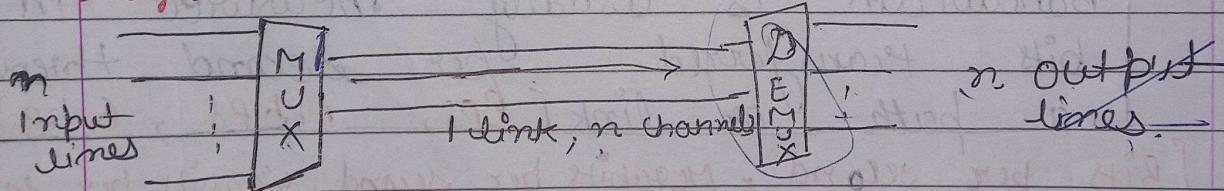
the simultaneous transmission of multiple signals across a single data link.

In a multiplexed system,  $n$  lines share the bandwidth of one link. The process of combining the data streams is known as multiplexing and hardware used for multiplexing is known as 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 input lines & one output line.

Diagram:-



- The  $n$  input lines are transmitted through a multiplexer and multiplexer combines the signals to form a composite signal.

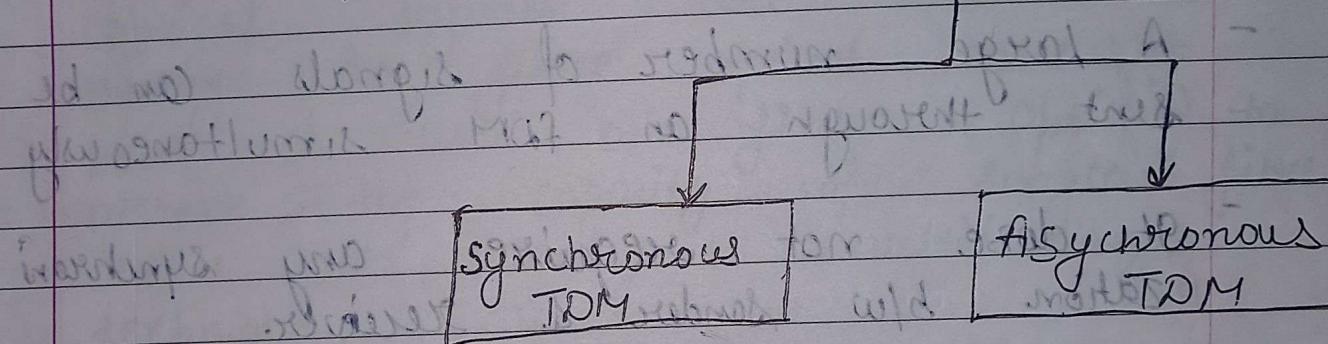
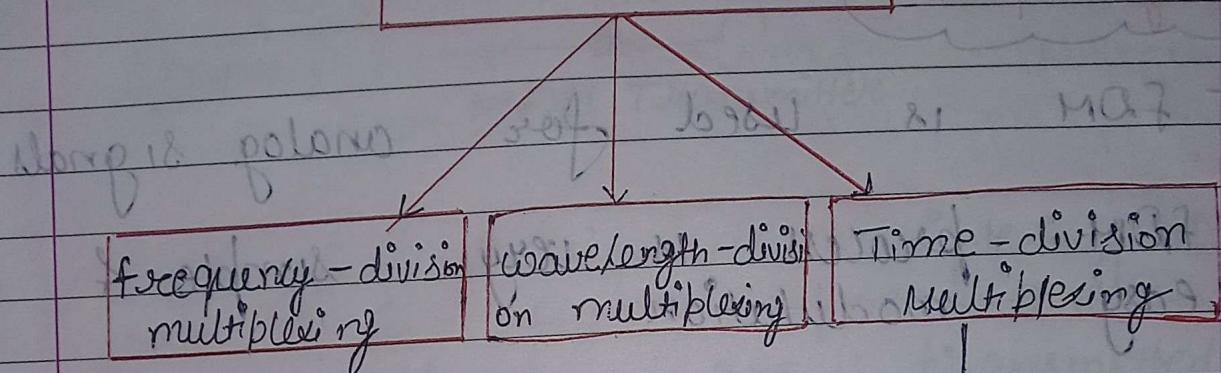
- The composite signal is passed through a Demultiplexer & demultiplexer separates the signal to component signals and transfers them.

to their respective destinations.

## Multiplexing Types

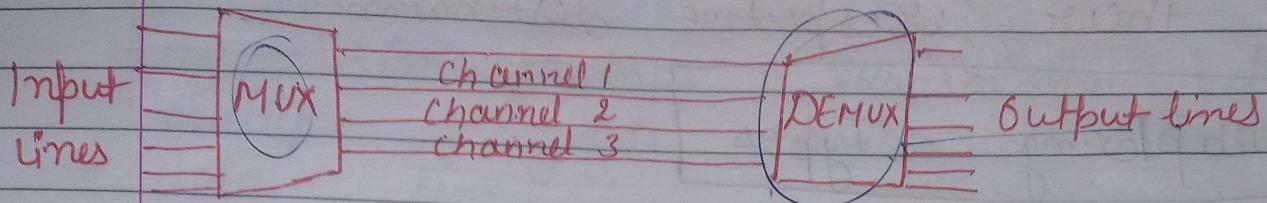
There are Three types of Multiplexing

### Multiplexing



### 1. Frequency Division Multiplexing (FDM)

frequency division multiplexing is defined as a type of multiplexing where the bandwidth of single physical medium is divided into a number of smaller independent frequency channels. Frequency Division multiplexing is used in radio and television transmission.



[diagram of FDM]

### Advantage of FDM

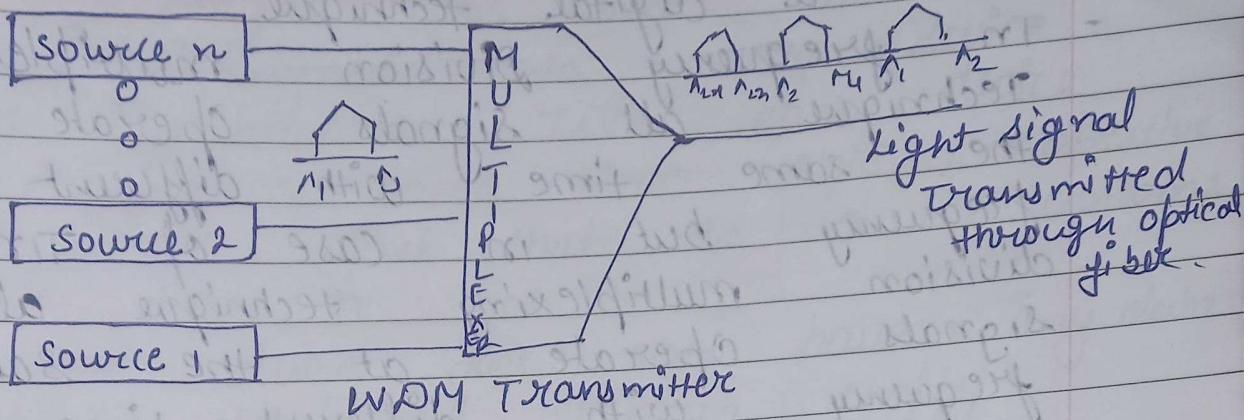
- FDM is used for analog signals
- FDM process is very simple & easy
- A large number of signals can be sent through an FDM simultaneously
- It does not require any synchronization b/w sender & receiver.

### Disadvantage of FDM

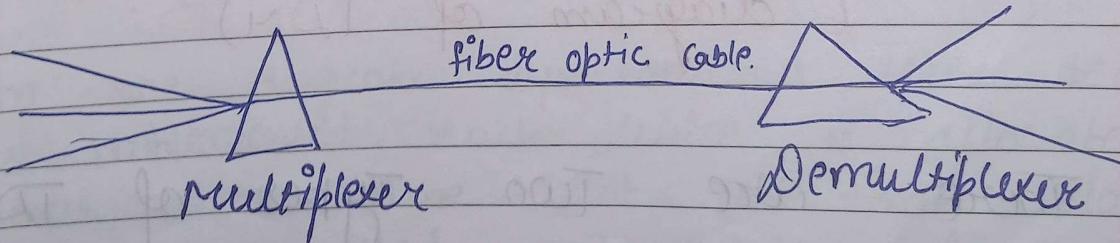
FDM technique is used only when low speed channels are required.

- It suffers the problem of crosstalk
- A large number of modulators are required.
- It requires a high bandwidth channel.

# WaveLength <sup>Division</sup> Multiplexing



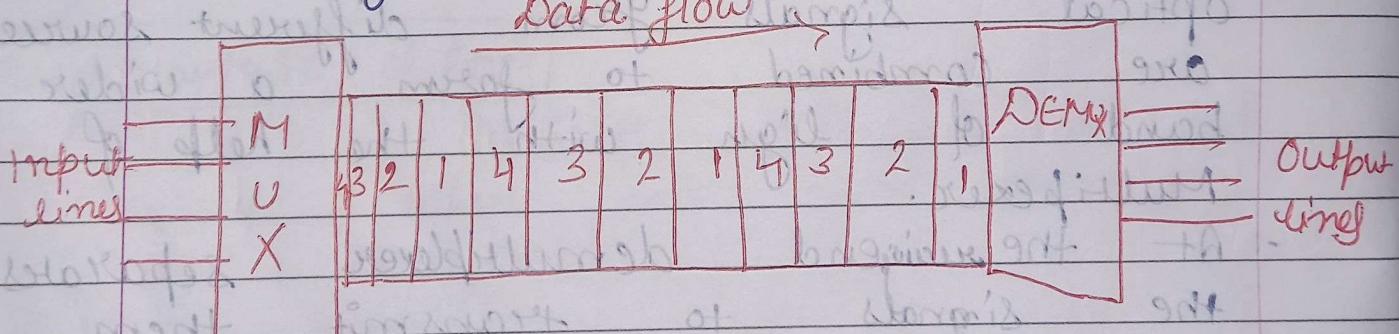
- wavelength division multiplexing is same as FDM expect that the optical signals are transmitted through the fibre optical cable.
- WDM is used on fibre optics to increase the capacity of single fibre.
- It is an analog multiplexing technique.
- Optical signals from different source are combined to form a wider band of light with the help of multiplexer.
- At the recipient demultiplexer separates the signals to transmit them to their respective destinations.



## 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.



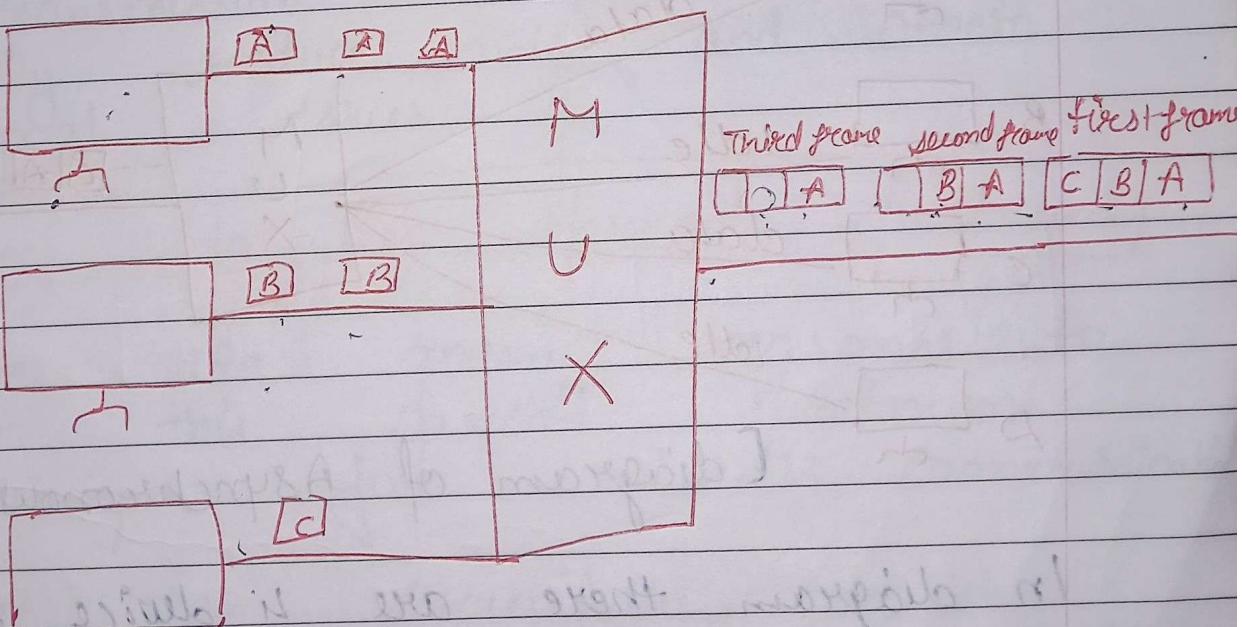
(diagram of TDM)

There are Two Types of TDM

1. Synchronous Time division multiplexing
2. Asynchronous Time division multiplexing

## \* 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 slot will remain empty.
  - In synchronous TDM signals are sent in the form of frames. If a device does not have data for a particular time slot then the empty slot will be transmitted.



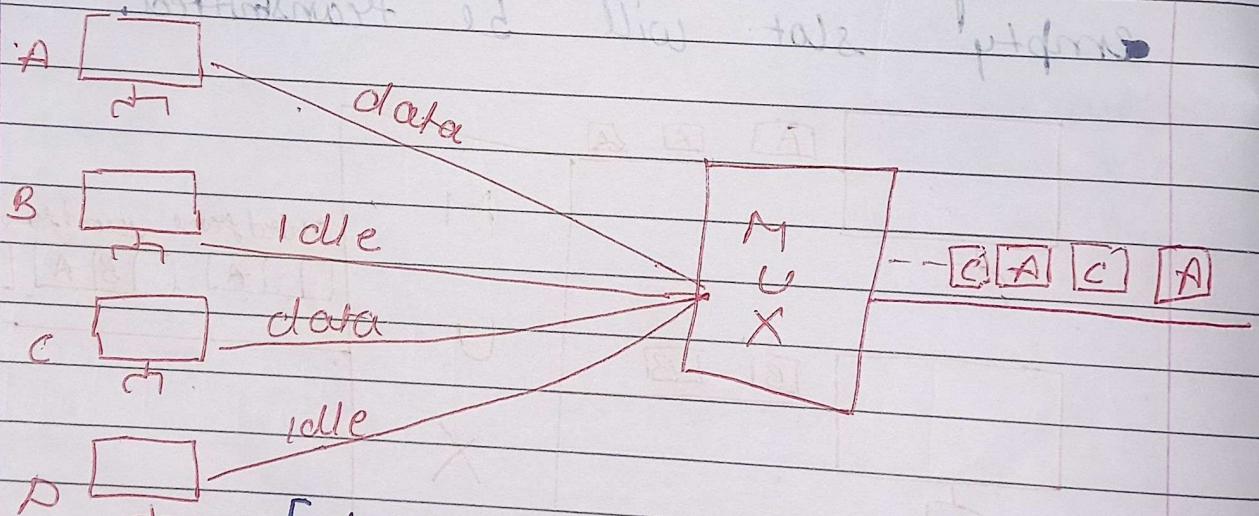
In the diagram synchronous TDM technique is implemented. Each device is allocated with some time slot. The time slots are transmitted irrespective of whether the sender has data to send or not.

## Asynchronous TDM | 8-

is also known as statistical TDM.

Asynchronous TDM  
as statistical

An asynchronous TDM is a technique in which time slot are not fixed as the case of synchronous TDM. Time slots are allocated to only those devices which have the data to send. Therefore we can say that Aynchronous TDM only the data from active workstations.



[Diagram of Asynchronous TDM]

In diagram there are 4 device but only two device are sending the data A & C therefore the data of A & C are only transmitted through the transmission line.

## \* Concepts on spread spectrum

Spread spectrum is a technique used for wireless communications in telecommunication and radio communication.

In this technique the frequency of transmitted signal of specific frequencies are varied slightly to obtain greater bandwidth as compared to initial bandwidth.

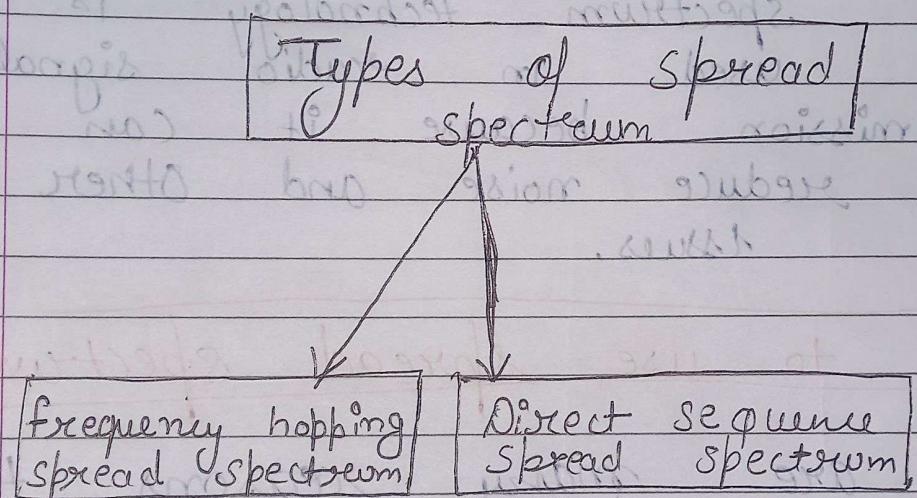
spread spectrum technology is widely used in radio signals transmission because it can easily reduce noise and other signal issues.

### Reasons to use spread spectrum

There are many reasons to use this spread spectrum for wireless communication.

- It can successfully establish a secure medium of communication.
- Initially the spread spectrum was adopted in military applications because of its resistance to jamming difficulty intercepting.

- This is also used in commercial wireless communication.
- It is most preferred because of its useful bandwidth utilization ability.
- It can limit the power flux density. (e.g. satellite down links)
- It can enable multiple access communications.



\* Frequency hopping spread spectrum :-

FHSS allows us to utilize bandwidth properly and maximum. In this technique the whole available bandwidth is divided

channels & spread between channels  
arranged continuously.

FHSS (frequency hopping spectrum) classified into two types.

frequency hopping  
spread spectrum

slow hopping      fast hopping

\* slow hopping :- In slow hopping multiple bits are transmitted on a specific frequency or same frequency.

\* fast hopping :- In fast hopping individual bits are split and then transmitted on different frequencies.

\* Direct sequence spread spectrum:-

The Direct sequence spread spectrum is a spread modulation technique primarily used to reduce overall signal interference in telecommunication.

## Application of Direct sequence Spread Spectrum :-

- Direct sequence spread spectrum used in LAN technology.
- DSSS is also used in satellite communication application.
- DSSS is used in the military & many other commercial application.
- It is used in the low probability of the intercept signal.
- It supports code division multiple access.