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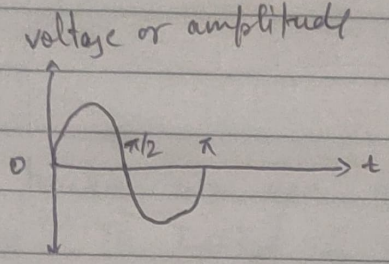
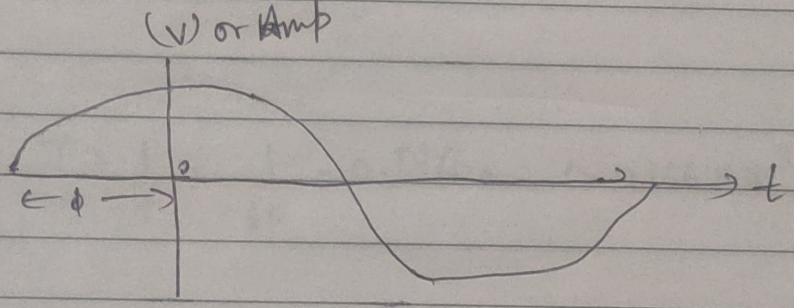
frequency is the rate of change with respect to time

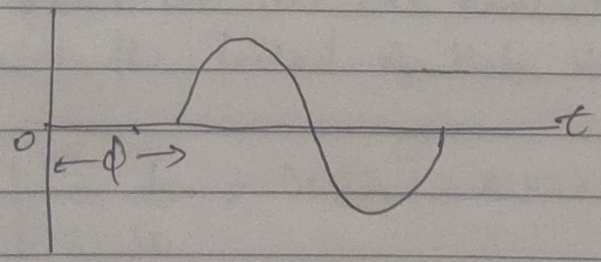
If a signal does not change at all, its frequency is zero.

If a signal changes instantaneously, its frequency is infinite.

Phase describes the position of the waveform relative to time 0.







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Units of period & frequency

(Unit)	(Equivalent)	(Unit)	(Equivalent)
Seconds (s)	1s	Hertz (Hz)	1 Hz
Millisecond (ms)	10^{-3} s	Kilohertz (KHz)	10^3 Hz
Microsecond (μs)	10^{-6} s	MegaHertz (MHz)	10^6 Hz
Nanosecond (ns)	10^{-9} s	Giga Hertz (GHz)	10^9 Hz
Picosecond (ps)	10^{-12} s	Tera Hertz (THz)	10^{12} Hz

Q The power we use at home has a frequency of 60 Hz. The period of this sine wave can be determined as follows.

Sol $T = \frac{1}{f} = \frac{1}{60} = 0.0166\,s = 0.0166 \times 10^3\,ms = 16.6\,ms$

Q The power we use at home has a frequency of 50Hz. Calculate the period of this sine wave.

$T = \frac{1}{f} = \frac{1}{50} = 0.02\,s = 0.02 \times 10^3\,ms = 20\,ms$

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Q The period of a signal is 100 ms. Calculate its frequency in kilohertz?

$T = 100\ ms$

$f = \frac{1}{T} = \frac{1}{100} = 10^{-2}\ kHz$

B

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Band Width :- The difference between maximum frequency and minimum frequency of the signal.

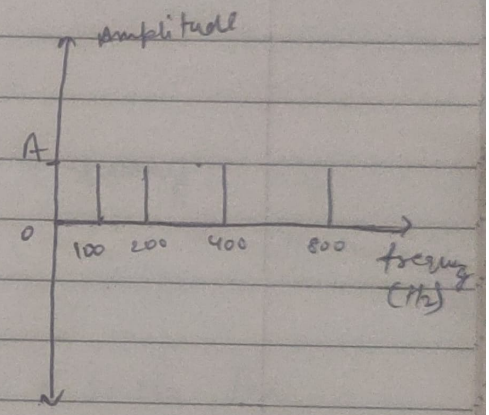
$$B.W. = (f_{max} - f_{min})$$

Ques A signal (composite signal) having different frequencies are 100 Hz, 200 Hz, 400 Hz and 800 Hz. Calculate the bandwidth of this composite signal.

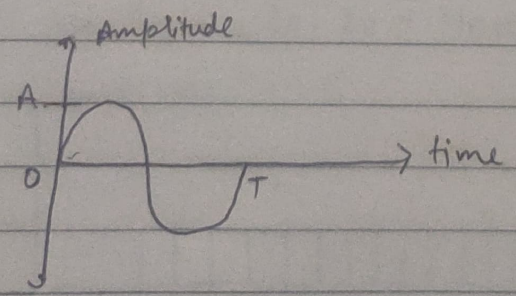
$$B.W. = (f_{max} - f_{min})$$

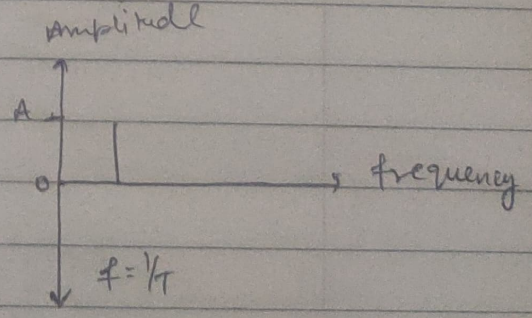
$$= 800 - 100$$

$$= 700$$



A complete sine wave in the time domain can be represented by one single spike in the frequency domain.





time Domain ⟷ frequency domain

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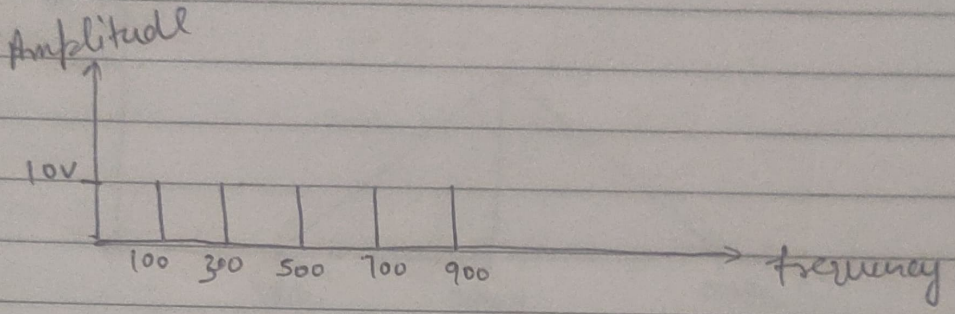
Ques If a periodic signal is decomposed into five sine waves with frequencies of 100, 300, 500, 700 and 900 Hz. What is its bandwidth? Draw the spectrum, assuming all components have a maximum amplitude of 10 V.

Sol

$$B.W. = (f_{max} - f_{min})$$

$$= 900 - 100$$

$$= 800 \text{ Hz}$$

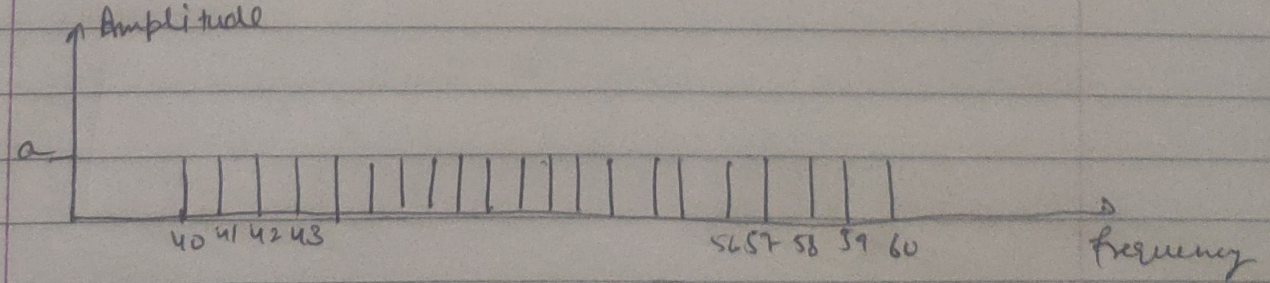


Ques A periodic signal has a bandwidth of 20 Hz. The highest frequency is 60Hz. What is the lowest frequency? Draw the spectrum if the signal contain all frequencies of the same amplitude.

Sol

$$B.W. = f_{max} - f_{min}$$

$$\Rightarrow f_{min} = 60 - 20 = 40 \text{ Hz}$$



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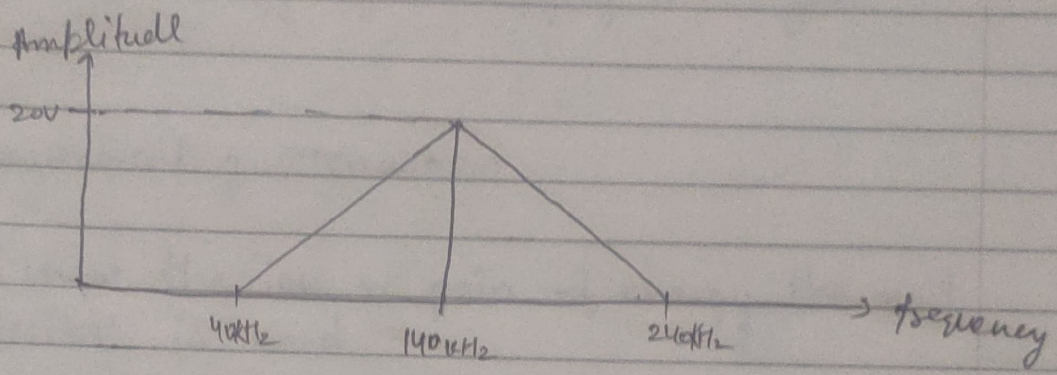
Ques A nonperiodic composite signal has a bandwidth of 200 KHz, with a middle frequency of 140 KHz and peak amplitude of 20 V. The two extreme frequencies have an amplitude of 0. Draw the frequency domain of the signal

Sol B.W. = 200 KHz

middle frequency = 140 KHz Amplitude = 20V



Ques What are Transmission Impairment? Discuss and explain various causes of impairments.

Ques Draw neat & clean diagram for each cause of impairment.

Attenuation

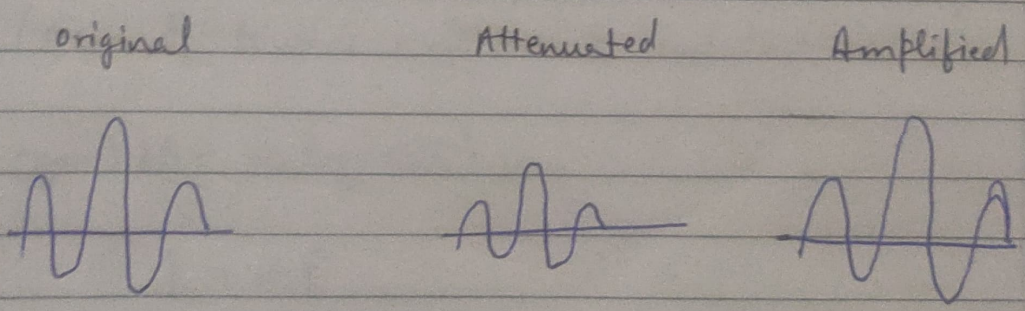
- It means loss of energy → weaker signal
- When a signal travels through a medium it loses energy overcoming the resistance of the medium.
- Amplifiers are used to compensate for this loss of energy by amplifying the signal.

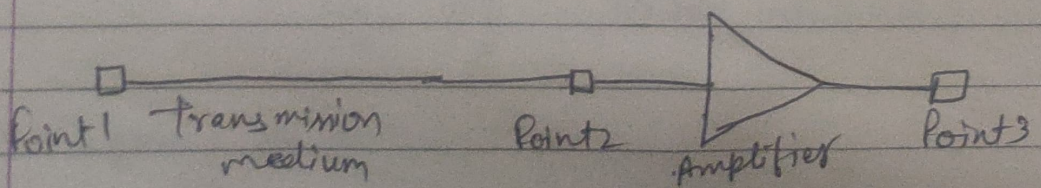
Measurment of Attenuation

To show the loss or gain of energy the unit "decibel" is used.

$$dB = 10 \log_{10}(P_2/P_1)$$

P_1 = Power of input signal
P_2 = Power of output signal





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Ques Suppose a signal travels through a transmission medium & its power is reduced to one-half. This means that P_2 is $(1/2)P_1$. In this case, the attenuation (loss of power) can be calculated as:

$$dB = 10 \log_{10} (P_2/P_1)$$

$$P_2 = (1/2)P_1$$

$$dB = 10 \log_{10} \frac{1 P_1}{2 P_1} = 10 \log_{10} 0.5$$

$$dB = 10(-0.3) = -3$$

Ques A signal travels through an amplifier, and its power is increased 10 times. This means that $P_2 = 10P_1$. In this case, the amplification (gain of power) can be calculated as:

$$(gain)\ dB = 10 \log_{10} (P_2/P_1)$$

$$P_2 = 10 P_1$$

$$= 10 \log_{10} \frac{10 P_1}{P_1} = 10 \log_{10} 10 = 10$$

$$gain = 10\ dB$$

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Sometimes the decibel is used to measure signal power in milliwatts. In this case, it is refered to as dB_m and is calculated as $dB_m = 10 \log_{10} P_m$, where P_m is the power in milliwatts. Calculate the

Distortion

- It means that the signal changes it's form or shape
- It occurs in composite signal.
- Each frequency component has it's own propagation speed travelling through a medium.
- The different components therefore arrive with different delays

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Noise

There are different types of noise

{ Anything that is not valuable / informative to us is noise }

Thermal Noise

random noise of electrons in the wire creates an extra signal.

Induced Noise

from motors & appliances, devices act are transmitter antenna and medium as receiving antenna.

Crosstalk

same as above but between two wires.

Impulse

spikes that result from power lines, lightning, etc.

Signal to Noise Ratio (SNR)

- To measure the quality of a system the SNR is often used. It indicates the strength of the signal wrt the noise power in the system.

- It is the ratio between two powers.

- It is usually given in dB and referred to as SNR_{dB}

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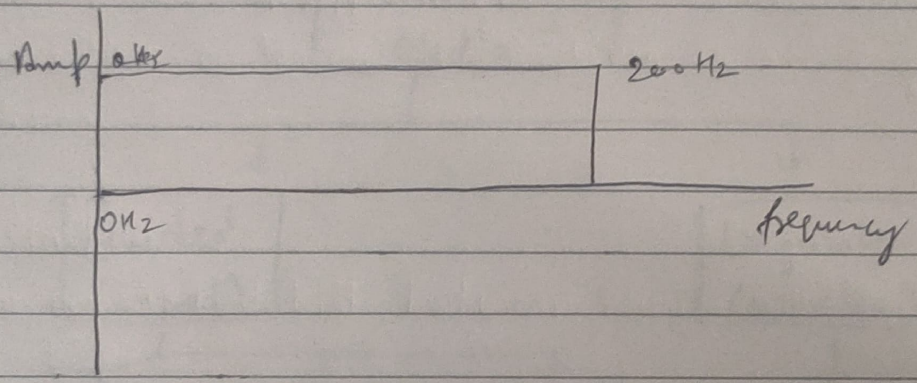
$$\text{Band width} = |f_{max} - f_{min}|$$

Ques What is the bandwidth of a signal that can be decomposed into five sine waves with frequencies at 0, 20, 50, 100 and 200 Hz? All the peak amplitudes are same. Draw the bandwidth.

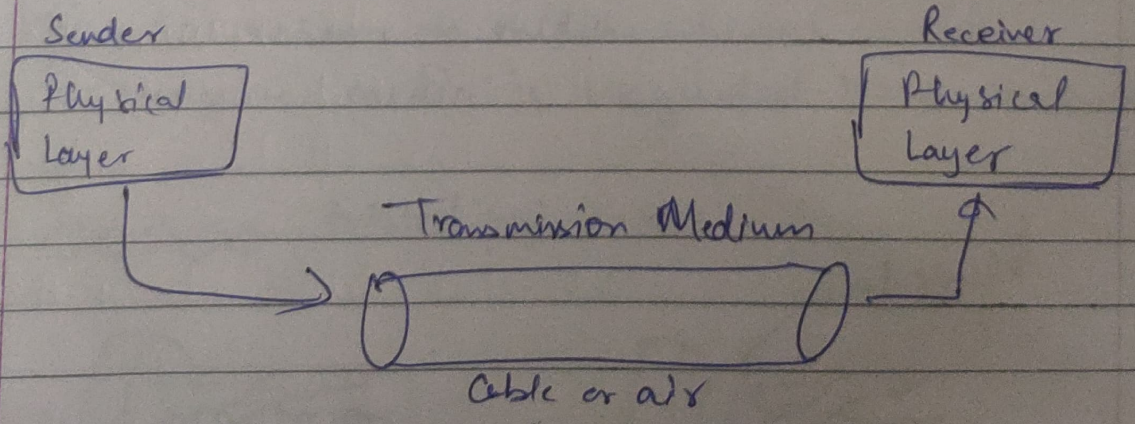
$$\text{Band width} = |200 - 0|$$

$$= 200 \text{ Hz}$$



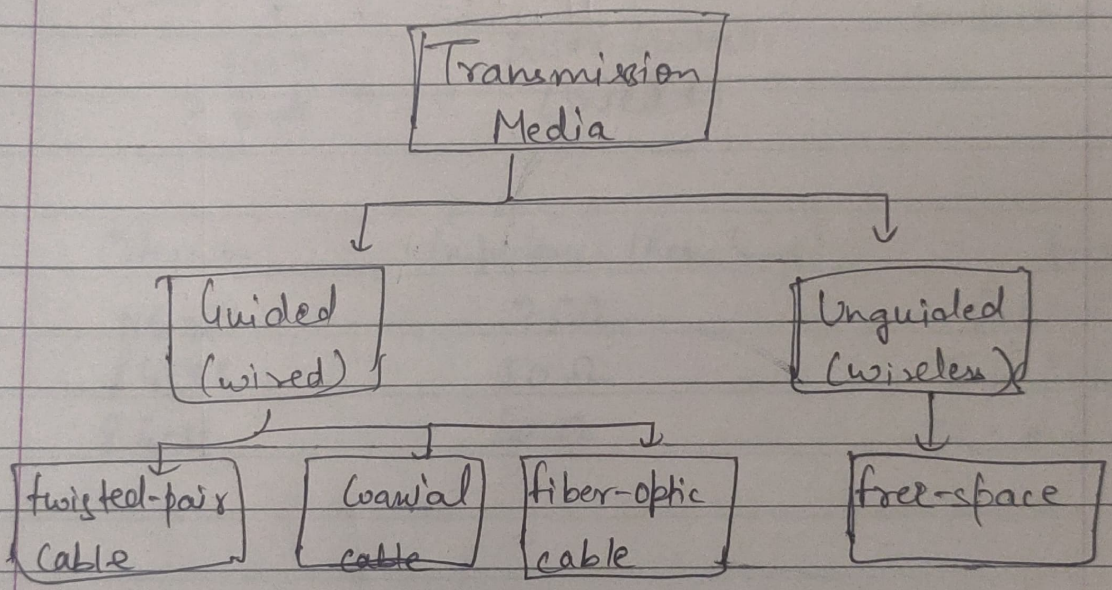
Chapter-7

Transmission media



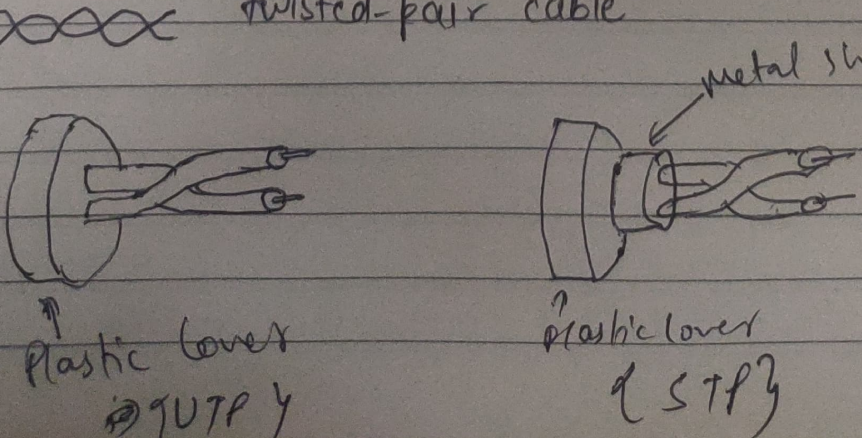
A sender transmits a signal from it's physical layer with the help of transmission medium to the physical layer of reciver.

The transmission medium b/w sender & reciever can be categorised into two categories i.e.
i) wired
ii) wireless



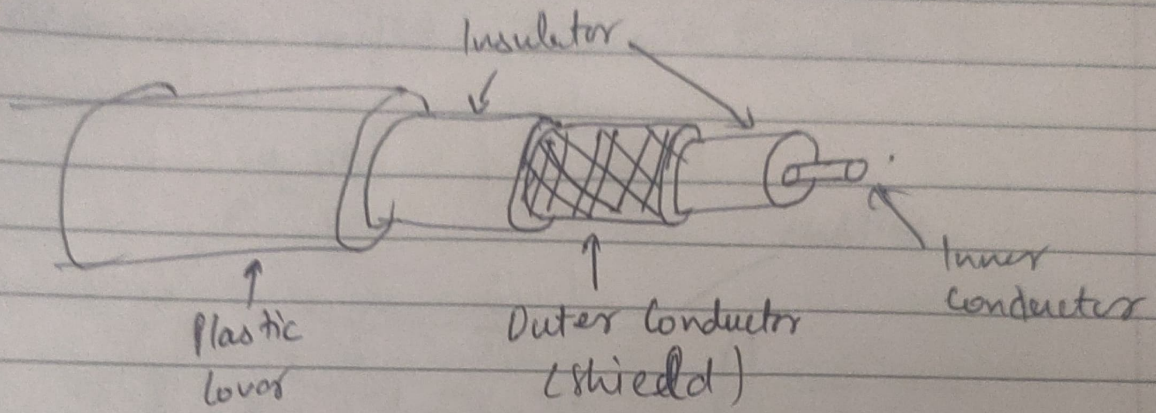
wired transmission media is also known as guided-transmission media whereas wireless transmission media is unguided-transmission media.

twisted-pair cable



UTP => unshielded twisted pair
STP => shielded twisted pair

Coaxial Cable



Category	Impedance (Resistance)	Use
RG-59	75Ω	Cable TV
RG-58	50Ω	Thin Ethernet
RG-11	50Ω	Thick Ethernet

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BNC Connectors

It is a miniature used to connect & disconnect radio frequency connector for the co-axial cables.

Fiber Optics

Fiber allows light to transmit through it.

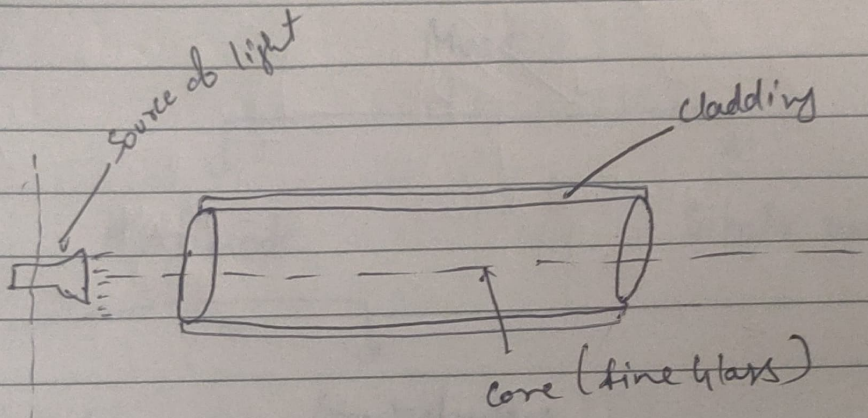
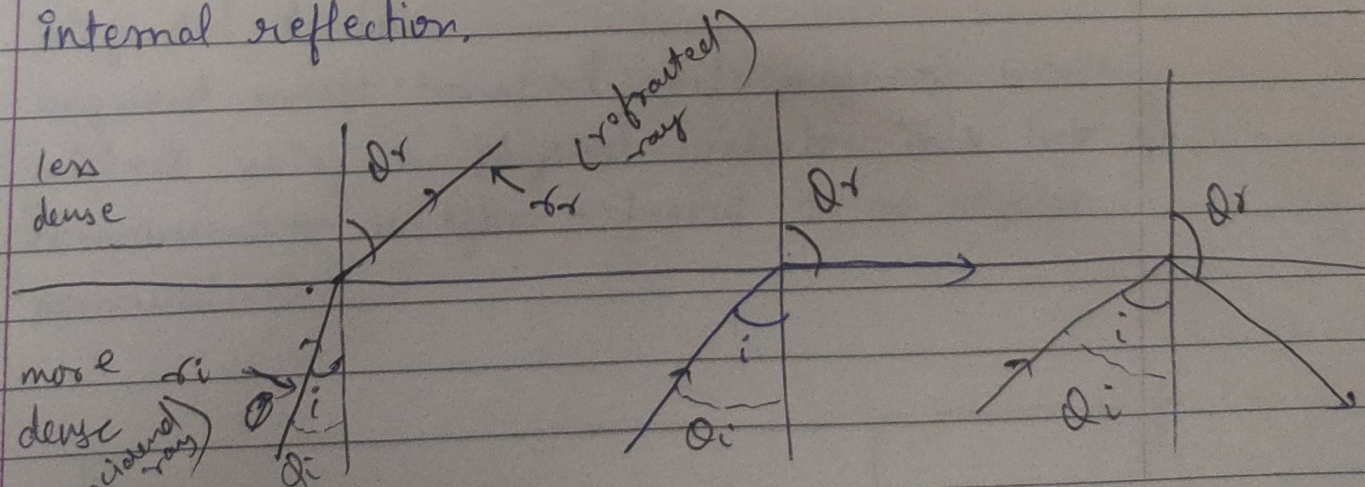
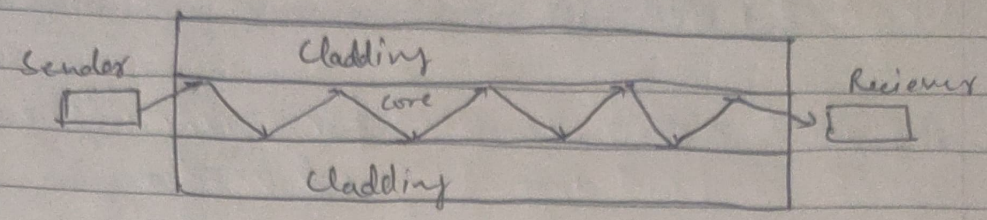


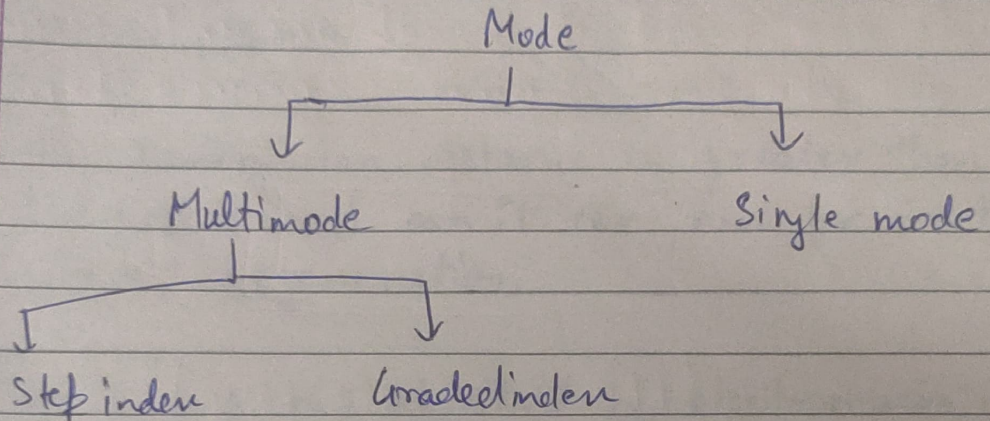
fig. fiber

Optical fiber allows light to transmit through it on the basis of phenomena known as total internal reflection.





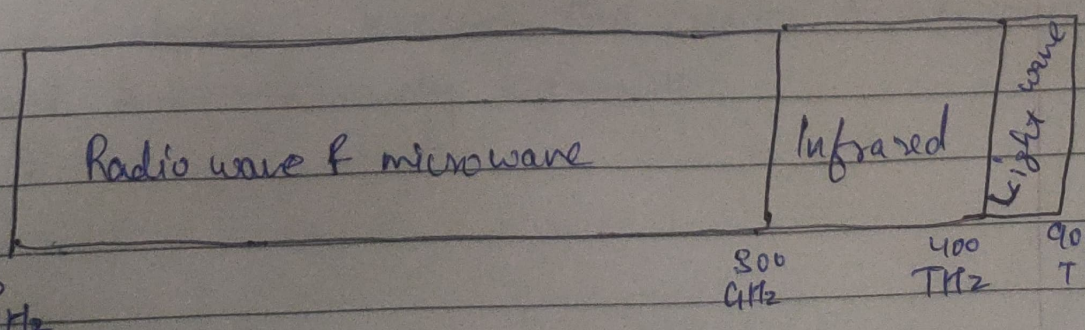
Propagation modes



mode: how many no. of rays transmitted

Unguided Media

unguided media transport electromagnetic waves without using a physical conductor. This type of communication is often referred to as wireless communication.



Electromagnetic spectrum for wireless communication

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Advantages of ~~Guided Media~~ Optical fiber

- Provides high quality transmission of signals at very high speed.

Used for both analog & digital signals.

These cables are much lighter than the copper cables.

Its transmission distance is greater than the twisted pair & ~~can~~ it can run for 50 kms without regeneration.

These are not affected by electromagnetic interface to noise & distortion is very less.

Disadvantages of optical fiber.

It needs expertise which is not available everywhere. So it is difficult to install.

Propagation of light is unidirectional & we need two fibers for bidirectional communication.

It is expensive because the cables & interfaces used are relatively expensive.

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Unguided media

Unguided media is used for transmitting the signal without any physical media.

It transports electromagnetic waves and is often called wireless communication.

Signals are broadcast through air and recieved by all who have devices to reciene them.

Radio waves

Radio frequency (RF) waves are easy to generate, can travel long distances, and can penetrate buildings easily, so they are widely used for communication, both indoors & outdoors.

Radio waves also are omnidirectional, meaning

If the communication is b/w single source & destination then it is called unicast.

If one source is transmitting signal and any destination that is in the range may be able to reach it then it is called broadcast.

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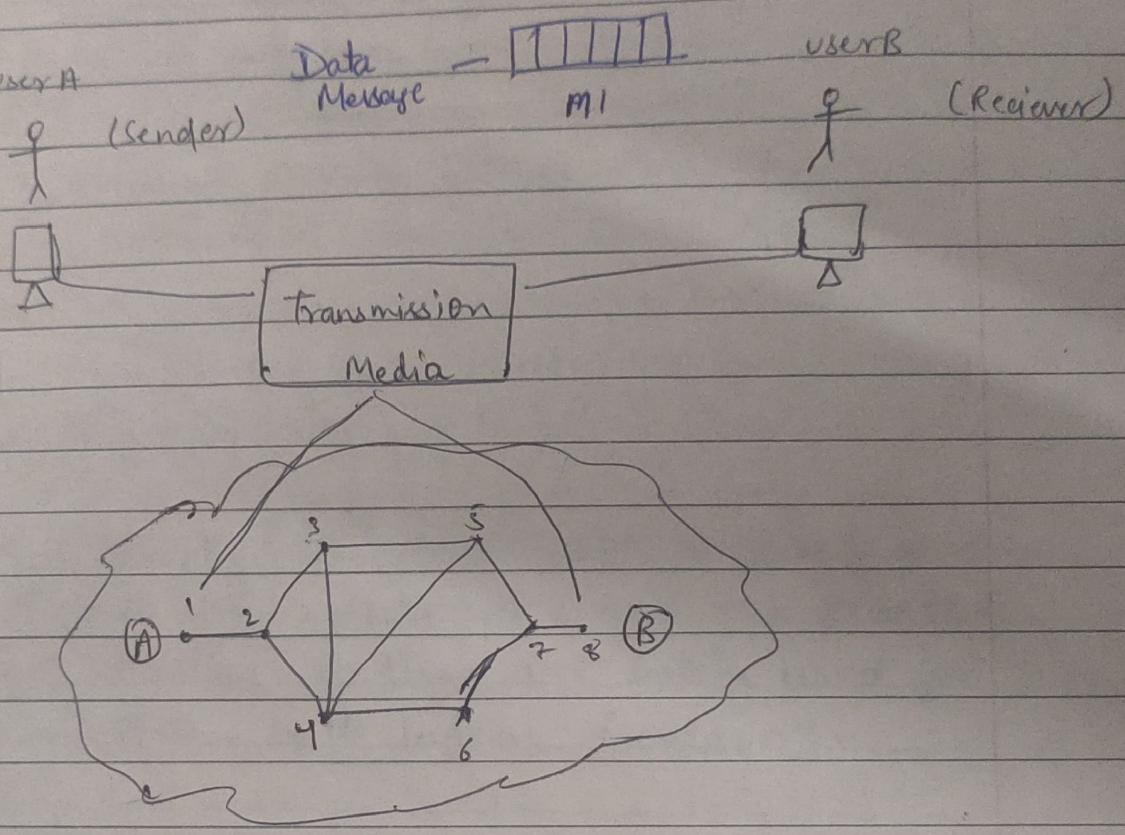
Switching Techniques

- Circuit Switching
- Message Switching
- Packet Switching



Communication Network

Switching Techniques

In large networks their can be multiple path from sender to receiver. from this figure we can have path;

P_1 :- 1 → 2 → 3 → 5 → 7 → 8

P_2 :- 1 → 2 → 4 → 6 → 7 → 8

P_3 :- 1 → 2 → 3 → 4 → 5 → 7 → 8

P_4 :- 1 → 2 → 3 → 5 → 4 → 6 → 7 → 8

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The switching technique will decide the best route for data transmission.

Switching technique is used to connect the system for making one to one communication

Switching technique is divided into three different categories.
i) Circuit Switching
ii) Message Switching
iii) Packet Switching

Circuit Switching is a switching technique that establishes a dedicated path between sender & reciever.

Once the connection is established, then the dedicated path will remain active until the connection is terminated.

This technique operates in a similar way as a telephone works.

A complete end-to-end path must exist before the communication takes place.

When any user want to transmit data (voice, vedio, photo) is sent to reciever, then reciever sends back the acknowledgement to ensure the availability of dedicated path. After recieving acknowledgement, dedicated path transfers the data.

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Fixed data can be transferred at a time in circuit switching.

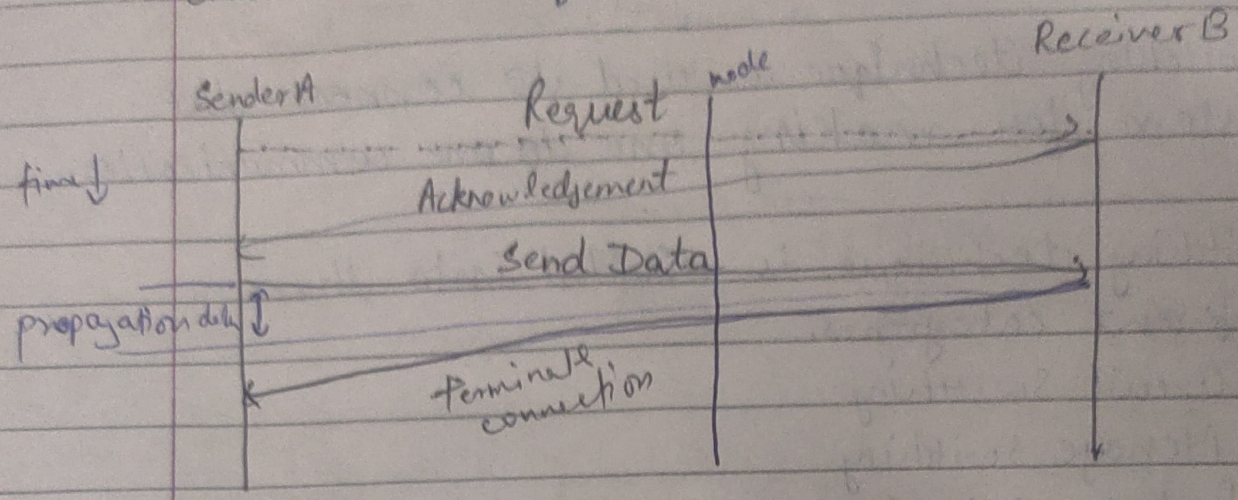

fig. timing diagram (Circuit switching)

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Advantages of Circuit switching

In the case of circuit switching techniques the communication channel is dedicated.

It has fixed bandwidth.

Disadvantages of circuit switching

Once the dedicated path is established, the only delay occurs in the speed of data transmission

It takes a long time to establish a connection.

It is more expensive than other switching techniques because a dedicated path is required for each connection.

It is inefficient to use because once path is established and no data is transferred then the capacity of that path is wasted.

In this case the connection is dedicated therefore no other data can be transferred even if the channel is free.

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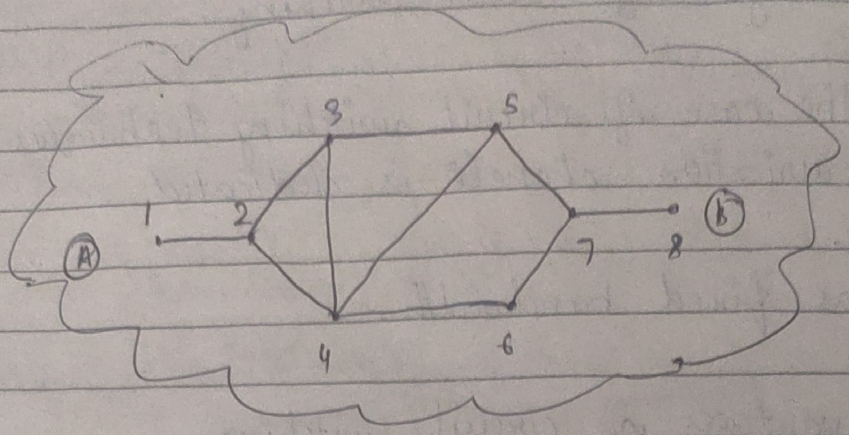

Message Switching

In this technique message is transferred as complete unit and routed through immediate nodes at which it is stored and forwarded.

In this technique there is no establishment of a dedicated path between sender & reciever.

The destination address is appendid to the message.

Message switching provides the dynamic routing as the message is forwarded through the intermediate nodes based on the information available in the message.

Message switches are programmed in such a way so that they can provide the most efficient routes.

Each & every node stores the entire message & then forward it to the next nodes. This type of network is known as store & forward network.

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Message switching treats each ~~meth~~ message as an independent entity/identity.

Advantages of Message Switching

Data channels are shared among the communicating devices that improves the efficiency of using available bandwidth.

Traffic conjestion can be reduced because the message is stored temporarily in the nodes.

Message priority can be used to manage the network.

The size of message which is sent over network can be varied. Therefore it supports the data of unlimited size.

Disadvantages of Message switching.

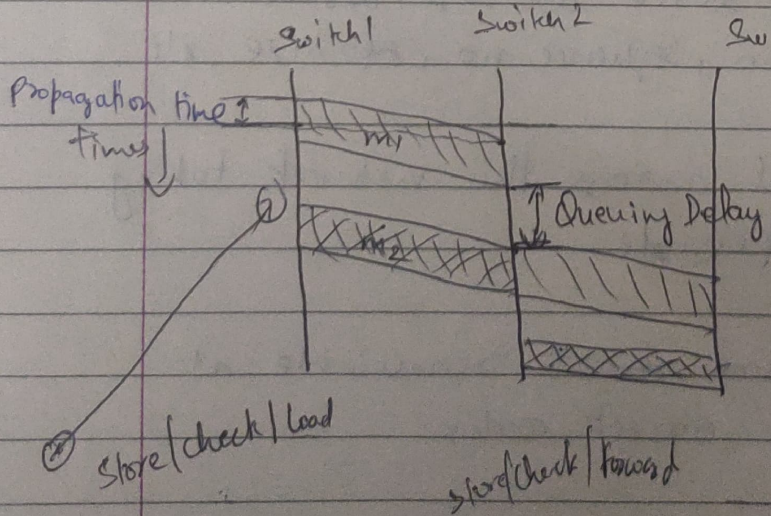

fig. timing diagram (message switching)

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In a network there are different kinds of delay propagation delay, queue delay (queuing delay)

Q Explain the switching techniques with help of timing diagrams.

Packet Switching

In this switching technique message is sent in one go but it is divided into pieces & they are sent individually.

The message splits into smaller pieces known as packets & given a unique no. to identify their order at the recieving side.

Every packet contains some information in it's header such as source address, destination address, identity no., sequence no., size, etc.

Packet will travel across the network taking shortest path possible.

All the packets are reassemble at recieving end in correct order.

If any packet is missing or corrupted then message will be sent to resend the message &

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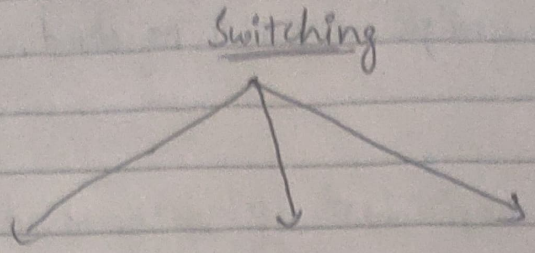
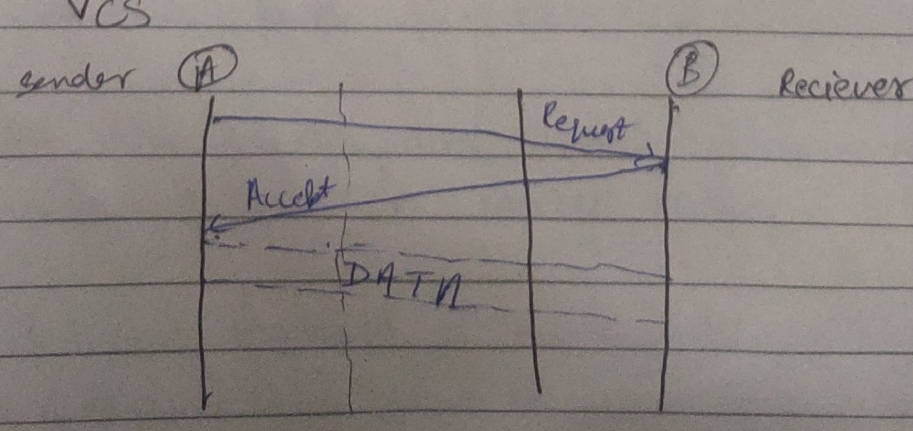


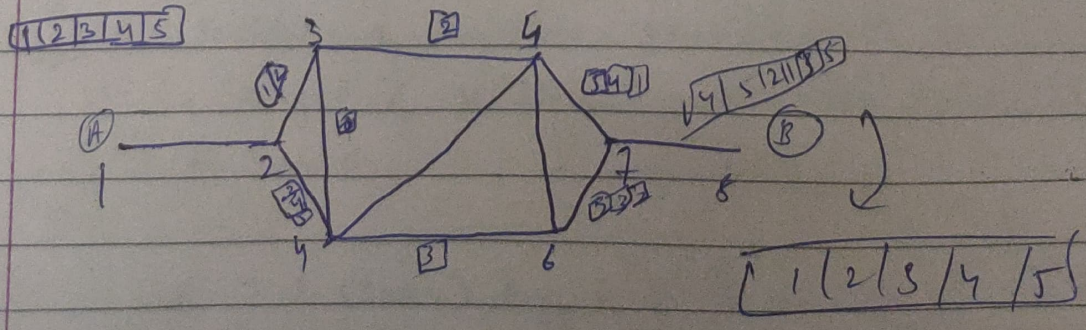
In packet switching there are two different approaches.
first approach is datagram packet switching
& second is virtual circuit switching

Virtual circuit switching is also known as connection oriented switching.
In case of virtual circuit switching, a preplanned route is established before the message are sent.
Call request & call accept packets are used to establish the connection b/w sender and reciever.
In this case the path is fixed for the duration of a logical connection



from this diagram A & B are sender & reciever respectively. In the figure call request & call accept packets are transmitted blw sender & recievers to establish a dedicated channel.
After transmission of data an acknowledgement signal is sent by the reciever that the message has been recieved.
If user want to terminate the connection than he can send the end/close signal to reciever.

Datagram Packet Switching is a packet switching technology in which packet is known as datagram.
Datagram is considered as an independent entity. Each packet contains the information about destination. Switches use this information to forward the packet to correct destination.
The packets are reassembled at destination in correct order
In Datagram packet switching the path is not fixed.
Intermediate nodes take the routing decision to forward the packets.
Datagram packet switching is also know as connection less switching.



Channel Capacity

Capacity of a System

The bit rate of a system increases with an increase in the no. of signal levels we use to denote a symbol.

A symbol can consist of a single bit or "n" bits.

The number of signal levels = 2^n.

As the no. of levels goes up, the spacing between level decreases → increasing the probability

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Nyquist Theorem

Nyquist gives the upper bound for the bit rate of a transmission system by calculating the bit rate directly from the no. of bits in a symbol or signal level and the bandwidth of system (assuming two signals per second).

Nyquist Theorm states that for a noiseless channel capacity can be written as

$$C = 2B \log_2 2^n$$

where C = capacity in bit per second
B = Bandwidth in hertz
2^n = no. of levels

Ques Consider a noiseless channel width a bandwidth of 3000 Hz transmitting a signal with two signal levels. The maximum bit rate calculated with the help of Nyquist Theorm as:

$$C = 2 (3000) \log_2 2 \qquad \{\log_2 2 = 1\}$$
$$= 6000 \text{ bits per second}$$

Ques Consider a noiseless channel with a a singal of 4 signal levels. bandwidth of 3000 Hz.

$$C = 2 (3000) \log_2 2^2 = 12000 \log_2 2 = 12000$$

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ATM three tier architecture & discuss ISTN fast ethernet, gigabyte ethernet, FDDI

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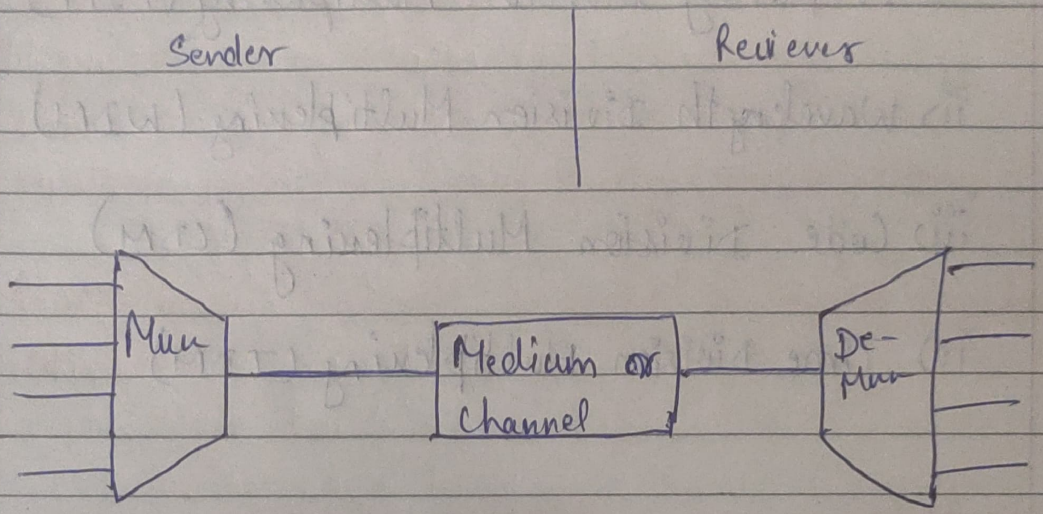
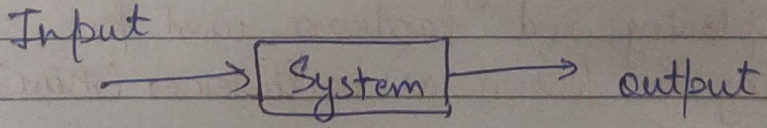
Multiplexing

Bandwidth Utilization:
Multiplexing and spreading

Multiplexing



Block-diagram of Mux and De-Mux in communication system.



Response = $\frac{\text{output}}{\text{input}}$

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Bandwidth utilization is the wise use of available bandwidth to achieve the specific goals.
Efficiency can be achieve by multiplexing; i.e., sharing of the bandwidth between multiple users.

Multiplexing is divided into different categories:-

i) frequency Division Multiplexing (FDM)

ii) Wavelength Division Multiplexing (WDM)

iii) Code Division Multiplexing (CDM)

iv) Time Division Multiplexing (TDM)

Multiplexing is a technique used to combine and send the multiple data streams over a single medium.

The process of combining data streams is known as multiplexing and hardware used for multiplexing is known as multiplexer (mux).

Why are we using Multiplexing?

The transmission medium is used to send the signal from sender to reciever. The medium can only have one signal at a time.

If there are multiple signals at a same time to share one medium, then medium must be divided in such a way that each signal is given some portion available bandwidth.
for example,
If there are three signals and bandwidth of medium is three units & then one unit is shared by each signal.

When multiple signals share the common medium, there is a possiblity of collision,

Multiplexing concept is used to avoid such collisions.

Frequency-Division Multiplexing

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ISDN (integrated services Digital Network)

ISDN is a circuit switch telephone network system but it also provides access to packet switch networks that allows digital transmission of voice and data.
This results in potentially better voice & data quality.
ISDN interfaces are divided into three different categories :-

i) Basic Rate Interface (BRI)
ii) Primary Rate Interface (PRI)
iii) Broadband ISDN (B-ISDN)

i) BRI

There two data bearing channels (B-channel) and one signalling channel (D-channel)

(2B + 1D) channels = 3 channels

The 2B-channels operates at max 64 Kbps speed
The D-channel operates at 16 Kbps speed

ii) PRI

PRI consist of D-channel & either 23 or 30 B-channels depending on the country you are in.
A digital pipe with 23 B-channel and one 64 Kbps D-channel is usually present in PRI.
23 B-channels are having capacity of 64 Kbps
1 D-channel have capacity of 64 Kbps.
Total capacity of PRI = 1536 Kbps

The PRI uses 8 Kbps overhead also.
then total capacity 1544 Kbps
is complete PRI capacity.

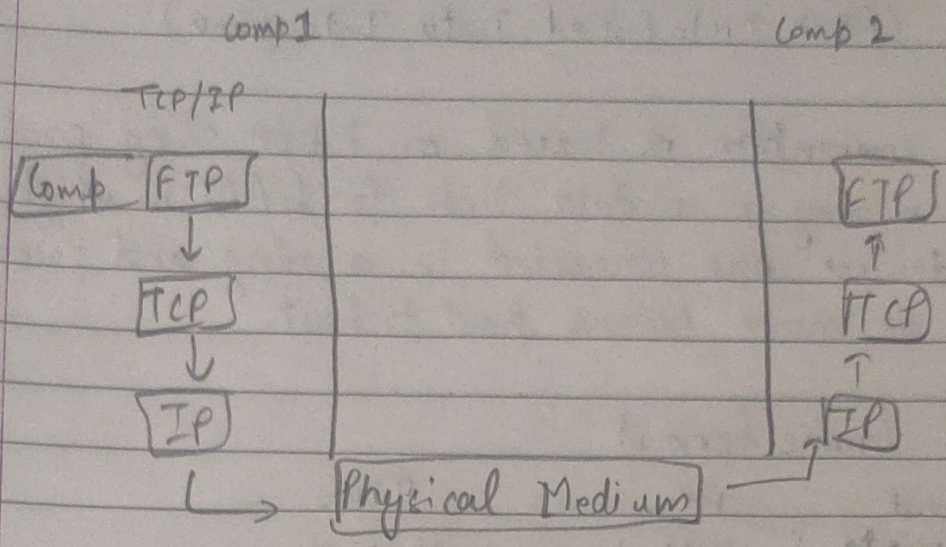
iii) B-ISDN

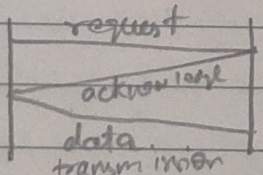
B-ISDN rellies mainly on the evolution of fibre optics. B-ISDN is best described as a service requiring transmission channel capable of supporting rates greater than PRI.

TCP/IP Model

OSI Model we disscused constitutes 7-layers whereas when we discuss TCP/IP model is was developed by DOD (Department of Defence)

TCP/IP Model is made of 5 layers
i) Physical } Physical & Data link layer
ii) Data Link
iii) Network
iv) Transport
v) Application

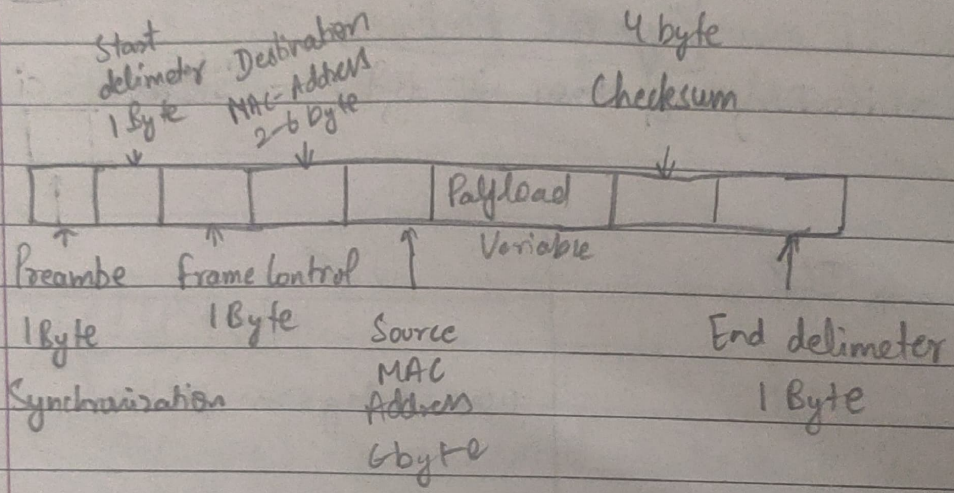


TCP	UDP
T.C.P.	user datagram protocal
connection oriented	connection less
3 way handshaking 	No such mechanism
data loss probability is less	data loss probability is more

FDDI (Fiber Distributed Data Interface)

FDDI convention is based on token ring protocol. A token ring is a data link for LAN in which all the devices are connected in a ring and passes one or more tokens host to host.

FDDI frame format



Hamming
CRC
Data Rate
SNR
Bandwidth
Timing Diagram of Switching
OSI Model / TCP
fast Ethernet / Gigabite Ethernet

Go back to n

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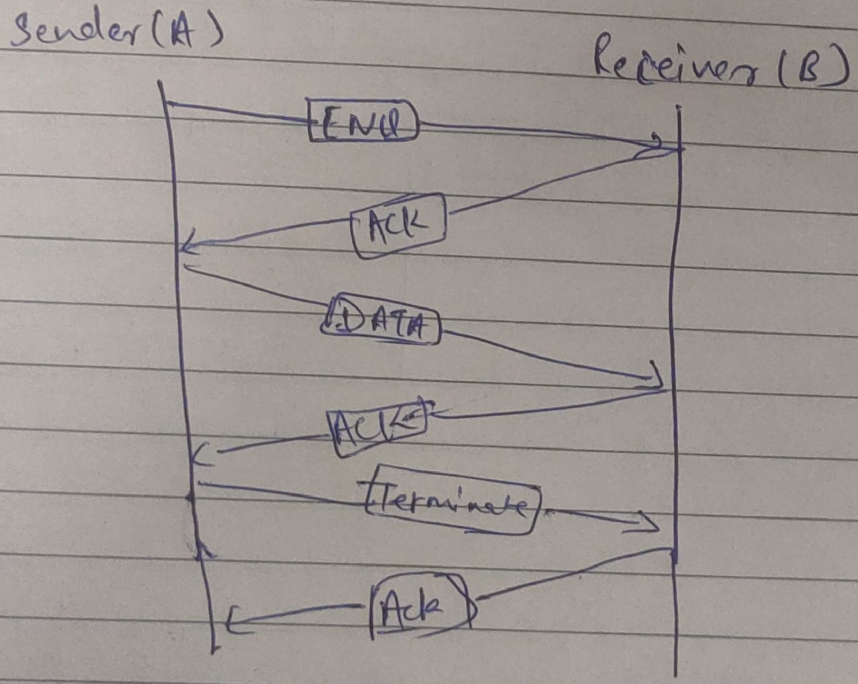
Data Link Layer

- Line discipline
- flow control
- Error control

Line discipline control is ~~controlled by~~ performed either by ~~control~~ poll or select mechanism

- Line discipline
  - Poll
  - Select



Line discipline is a functionality of the data link layer that provide the coordinations among the linked system.

Ack => Acknowledgement
ENQ => Enquiry

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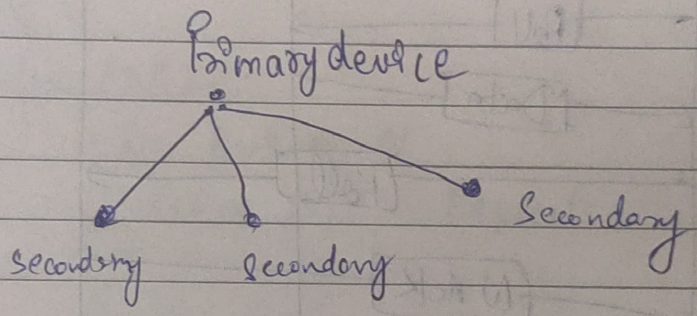
It determines which device can send & when it can send the data.

1) Line Discipline

- ENQ / Ack
- Poll / Select



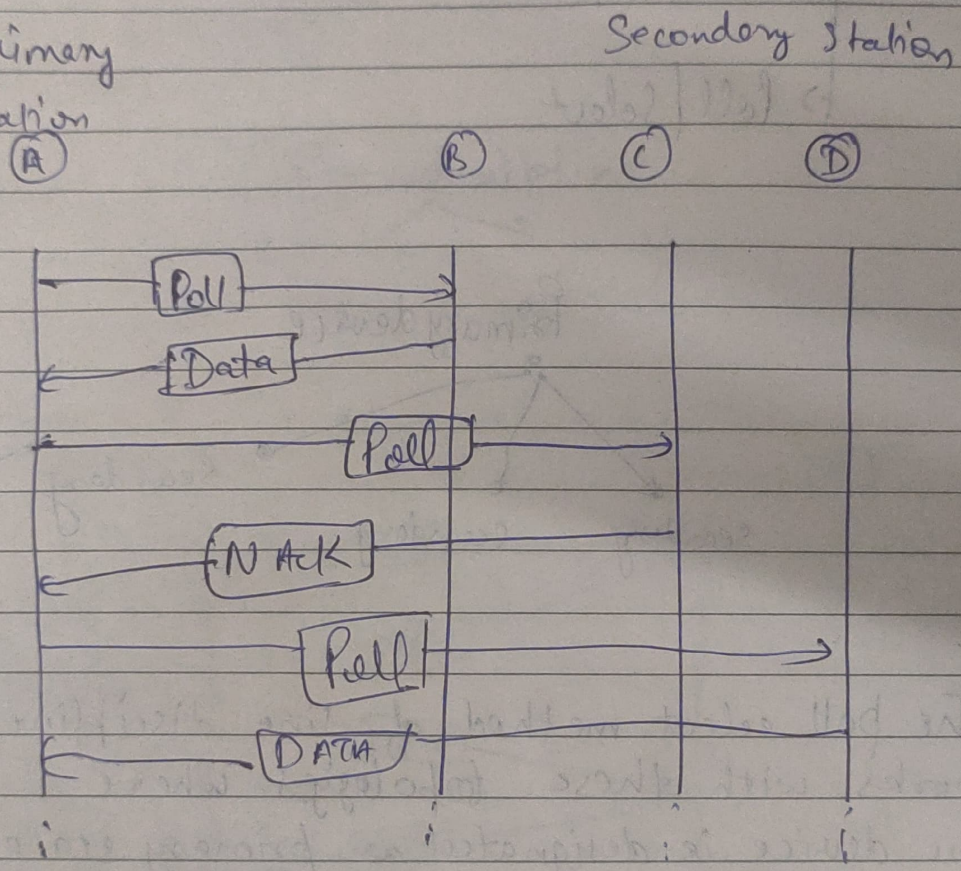
The poll select method of line discipline works with those topologies where one device is designated as primary stationed & other devices are secondary stationed.

All the communication / data transmission are controlled by primary station.

Secondary device follows the instructions from the primary device. We can also say primary device is a initiator of a session.

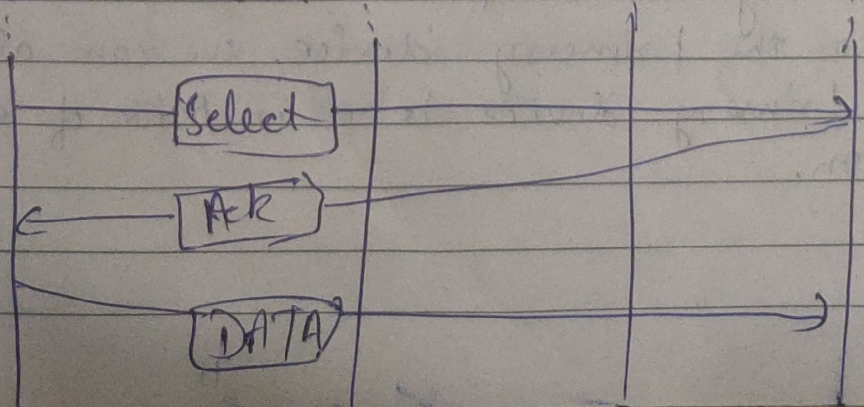
NAck ⇒ Not Acknowledged.

If primary device wants to recieve data from secondary device it asks secondary devices that they can send anything & ~~this~~ this process is called polling.



Select

When primary station want to transmit data to secondary station, then select mode is used.



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Flow Control

It is the set of procedures that tells the sender how much data it can transmit before the data is lost in between.

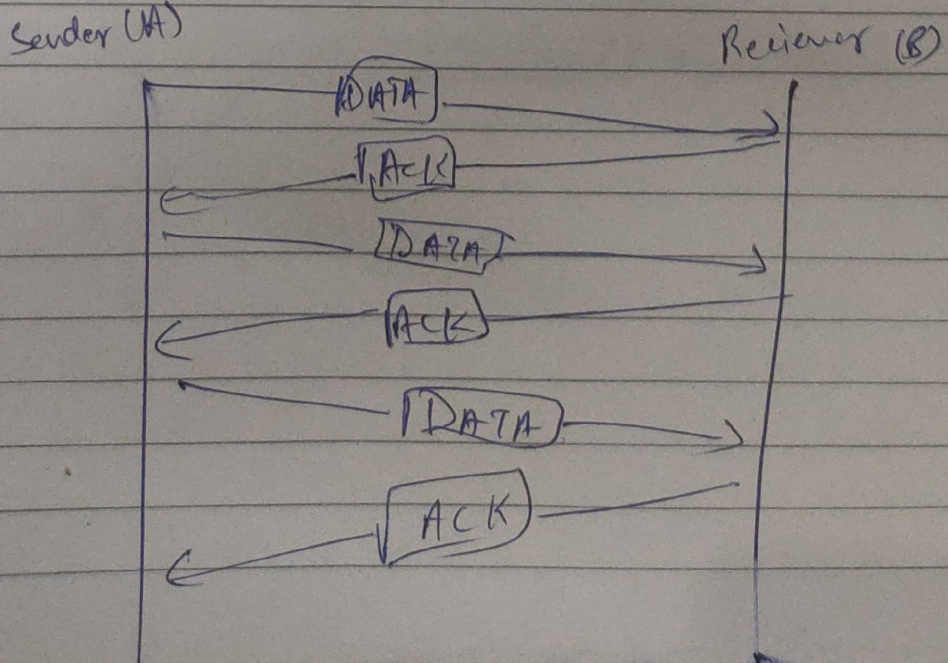
Stop & wait

- Frame/Data Loss
- Ack Loss

Sliding Window Method

- Go Back to N
- Selective Repeat Request

In the stop & wait method the sender waits for an acknowledgement after every frame it sends. When acknowledgement is recieved then only next frame is sent.



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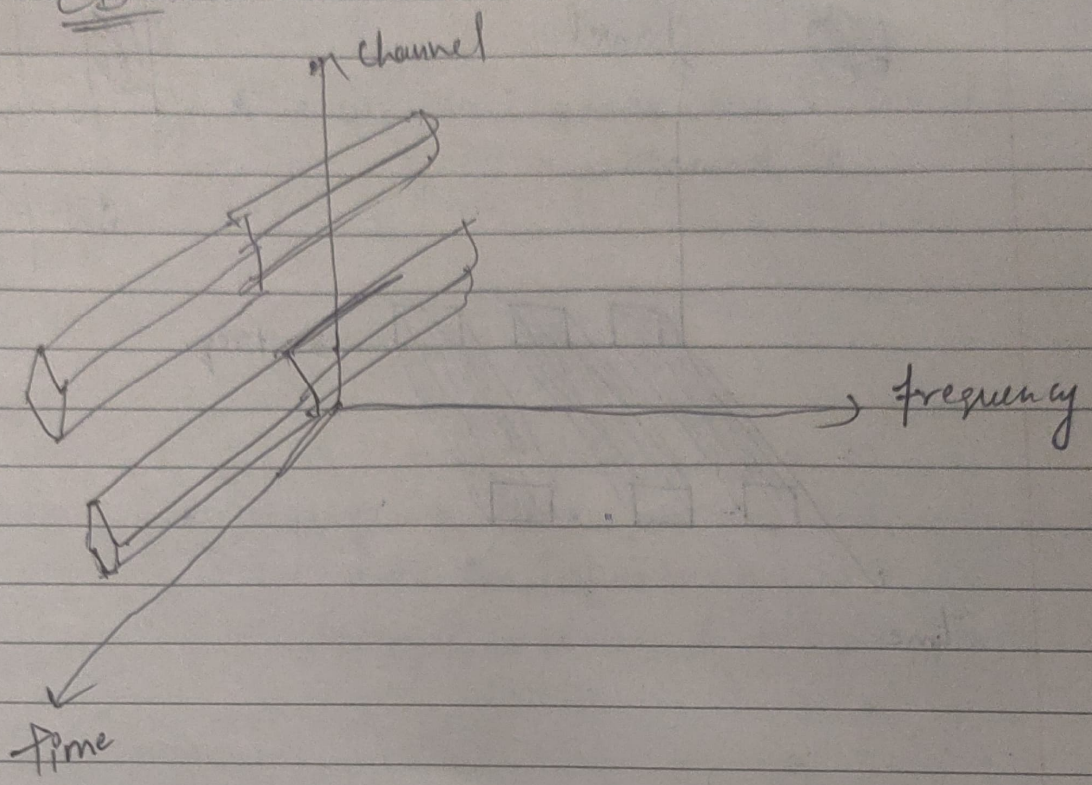
Advantages of stop & wait

All the data recieved in sequence wise,
synronisation of data is maintained.
no data is lost

Disadvantages of stop & wait

Problem occurs due to lost data
User(A) wait for infinite time for an acknowlegedment
reciever waits for data for infinite time.
problem due to delayed acknow. & delayed data.

CDM



FDM is inherently analog technology. As the name specifies, the frequency dimension spectrum is split b/w smaller frequencies.

Applications

traditional radio, cable wires.

Advantages

FDM applies to both analog signal & digital signal. It facilitates you to send multiple signals simultaneously within a single connection.

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Disadvantage

It is less flexible & the bandwidth wastage may be high.

TDM

Time Division Multiplexing is a digital technology that uses time instead of frequency. It is used for a specific time in which whole spectrum is used.

Advantages

It facilitates single user at a time.
It is less complicated & has a more flexible architecture.

Disadv.

It is not easy to implement.

Application

used in telephonic services.

CDM

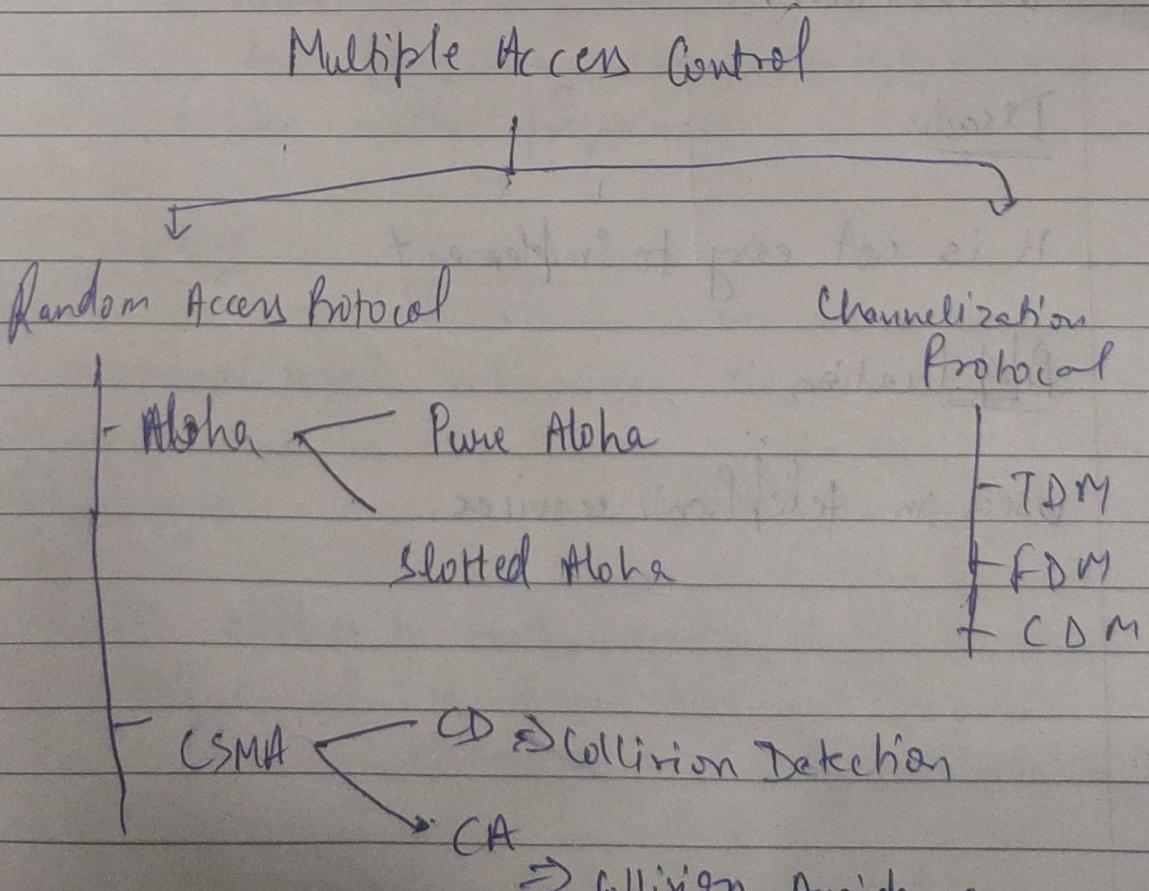
Code Division Multiplexing allots a unique code to every ~~each~~ channel so that each of these channels can use the same frequency spectrum simultaneously at the same time.

Adv.

It is highly efficient & less interference.

Disadv.

Data transmission rate is slow & it is complex



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Random Access Protocol

In this all the stations have equal priorities to send data over a channel.
In Random Access Protocol one or more station can not depend on another station.
Depending on the channel state any station can send data. However, if more than one station send the data over the channel, there may be a collision b/w data, due to the collision data packets may be lost or changed and hence data does not recieved at recievers, following are the different methods of random access protocol for broadcasting dataframes over a channel.

Aloha

It is designed for wireless lan but can also be used in shared medium to transmit data.

Any station can transmit data to channel anytime.
It does not require any carrier sensing.
Collisions & dataframes may be lost during the transmission of data. ~~frames collision detection~~
Acknowledgement of the ~~frames~~ exist in aloha
Hence there is no collision detection
It requires retransmission of data after some random amount of time.

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Types of Aloha

1) Pure Aloha

Whenever data is available for sending over a channel for stations we use aloha. In pure aloha when each station transmits data to a channel without checking whether channel is idle or not the chances of collision may occur and data frame can be lost.

When any station transmits the data to a channel the pure aloha waits for reciever's acknowledgement. If it does not acknowledge the reciever end within specified time the station waits for random time called as back of time. The station may assume the frame has been lost or destroyed, therefore it retransmits the frame until all the data are succesfully transmitted to the reciever.

2.) Slotted Aloha

Slotted Aloha is ~~designed~~ similar to pure aloha It is designed to overcome the efficiency of pure aloha because pure aloha have a very high possibility of frame hitting or data collision. In slotted aloha the shared channel is divided into fixed time interval called as slots so that if a station wants to transmitt data to a shared channel the data can only be sent at the begning of the slot & only one frame is allowed to be sent to each slot. However, the possibility of the collision remains when trying to send a frame at the begning of two or more station

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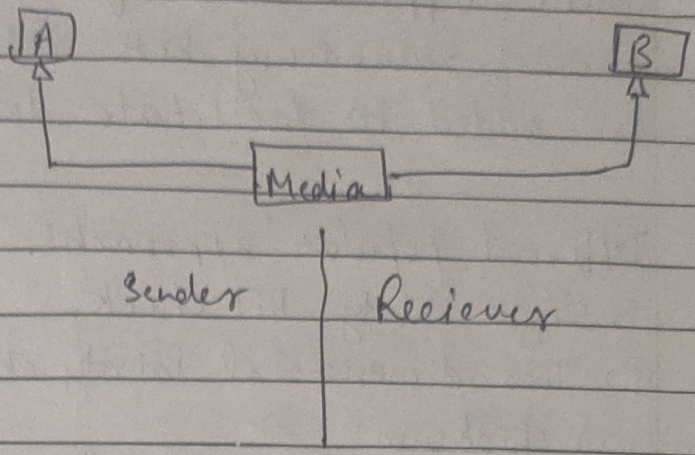

Error

When bits are transmitted over computer network they are subject to get corrupted due to transmission medium.
The corrupted bit leads to error in the bits.
A condition when recievers information does not match with senders information.
During transmission digital signals suffer from noise that can introduce errors in the binary bits travelling from sender to reciever.
That means 0 bit may change to 1 or vice versa.
Error detecting codes (implemented either at data link layer or transport layer of OSI model).

Whenever a message is transmitted, it may get scrambled by noise or data may get corrupted.
To avoid this we use error detecting codes which are additional data added to given digital message.

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Basic approch used for error detection is the use of redundency bits where additional bits are added to facilitate detection of error.

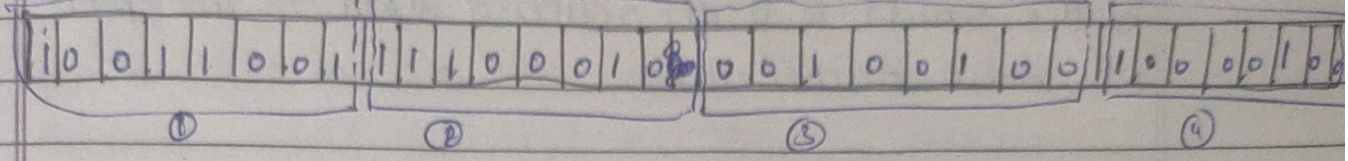
Different popular approaches:
i) Single Pairty Bit check
ii) Two dimensional Pairity check
iii) Checksum
iv) CRC (cyclic Redundancy checksum)

Single Pairty Bit check
Blocks of data from source are subjected to a check bit or pairty bit generator form where a pairty of:
1 is added to the block if it contains odd no. of 1's
0 is added to the block if it contains even no. of 1's

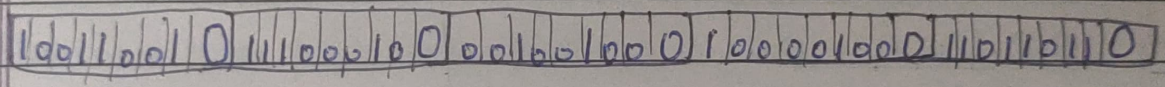
This scheme makes the total no. of 1's even that's why it is called as even pairty checking

Two dimensional pairty check.
Pairty check bits are calculated for each row which is equivilent to a simple pairty check bit.
Pairty check bits are also calculated for all columns then both are sent along with data.
At the recieving end these are compared with the pairty bits calculated on the recieving data.

Original message



① 10011001
② 11100010
③ 00100100
④ 10000100
11011011



Checksum

in checksum error detection scheme the data is divided into 'k' segements where each segment contains 'm' bits.

in The sender's end the segments are added using 1's complement airthemetic to get the sum. The sum is complemented to get the checksum.

10011001 11100010 00100100 10000100

K=4 m=8

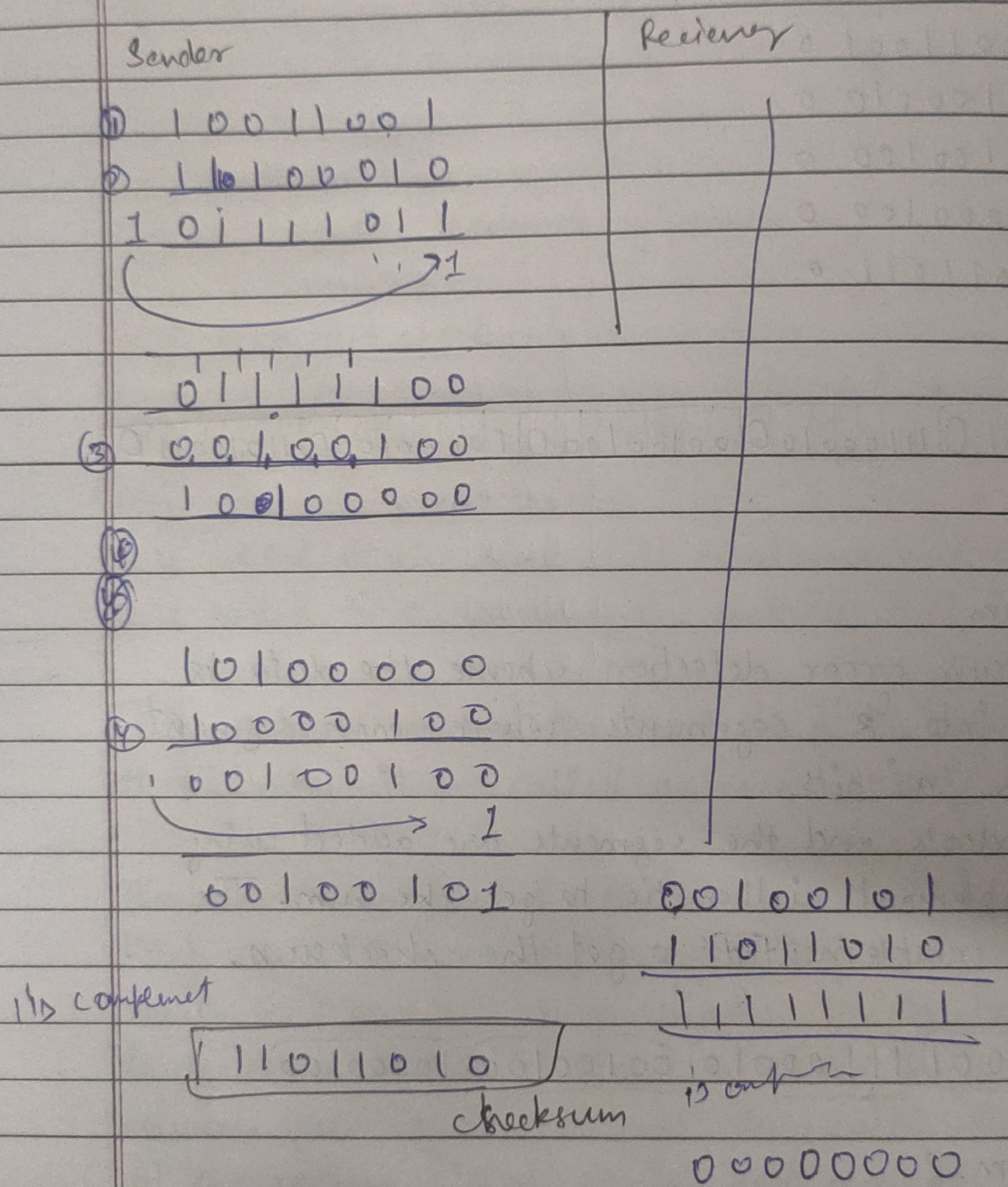
~~sender~~

The checksum segment is sent along with the data segment.

~~Reciever~~

At the reciever's side, all recieved segments are added using 1's complement to get the sum.

The sum is complemented.
If the result is 0 the recieved data is accepted otherwise discarded.



CRC (Cyclic Redundancy Checksum)

Unlike checksum scheme which is based on addition, CRC is based on binary division. In CRC a sequence of redundant bits called cyclic redundancy check bits are appended to the end of data unit so that resulting data unit becomes exactly divisible by a second predetermined binary number.
At the reciever's side the incoming data unit is divided by same number, if at this step there is no remainder then data unit assume to be correct & therefore accepted. A remainder indicates that the data unit has been damaged in transmit & therefore it must be rejected.

Original Message

1010000 | Divisor → generated with the help of polynomial generator

$x^3 + 1$

$\ldots + x^4 + x^3 + x^2 + x + 1$

1001

```
      111
1001)1010000
     1001↓↓
     -----
      0011 00
       1001↓
       ----
       0101 0
        1001
        ----
        0011
```

If CRC generator is of 'n' bits then it is appended 'n-1' 0s in the end of original message

Final message = 10100000011

```
          11111
      ┌──────────
1001 ) 10100000011
       1001↓↓
       00110 0
         1001
         ----
         0101 0
          1001
          ----
          0011 01
            1001
            ----
            01 001
             1001
             ----
             0000
```

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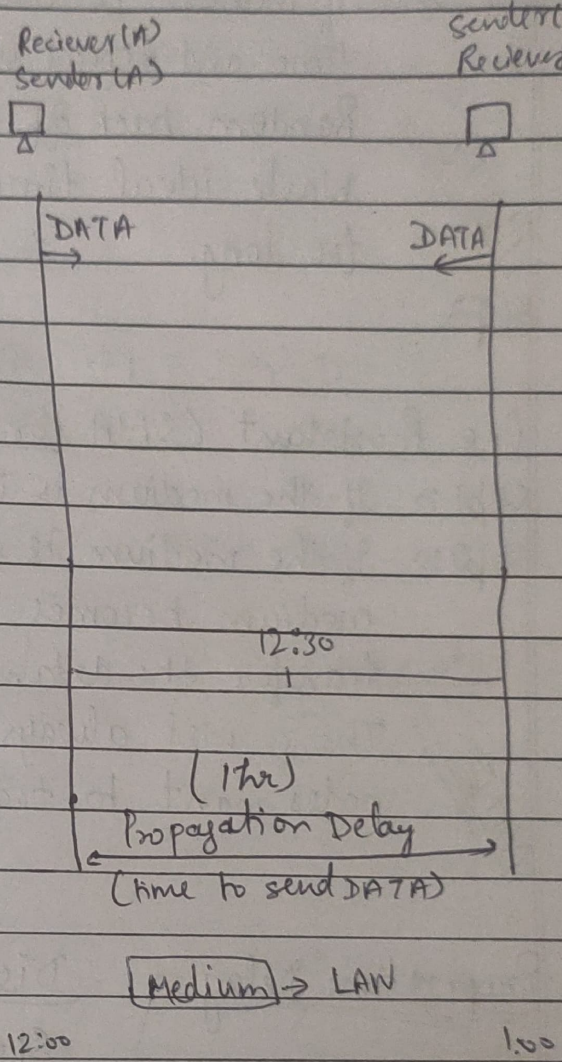
CSMA/CD

Carrer Sense Multiple Access / Collision Detection



Transmission time > Propagation Delay of A

CSMA is divided in two types is non-persistant CSMA & ii) Persistant CSMA

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Non-Persistant CSMA

Step 1:⇒ If the medium is ideal transmit immediately

Step 2:⇒ If medium is busy wait a random amount of time and repeat step 1.

Random back off reduces probability of collisions.

Waste ideal time if the back off time is too long.

One Persistant CSMA Protocol

Step 1:⇒ If the medium is ideal transmit immediately

Step 2:⇒ If the medium is busy continue to listen until medium becomes ideal and then immediately transfer the data.

There will always be a collision if two nodes want to transmit

$$\text{Propagation Delay} = \frac{\text{Distance}}{\text{Speed}} \text{ (seconds)}$$

$$\text{Transmission Time} = \frac{\text{Data or Frame or L}}{\text{Bandwidth}}$$

Worst Case $TT \geq 2PD$

$$\text{efficiency} = \eta = \frac{1}{1+a}$$

$$a = \frac{PD \text{ or } TP}{TT}$$

$1\ Gbps = 10^9\ b$

$1\ Mbps = 10^6\ b$

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Ques Consider a CSMA/CD network that transmit a data at the rate of 100 Mbps over 1 km cable with no repeaters. If the minimum frame size required for this network is 1250 byte, what is the signal speed (km/s) in the cable?

Sol

$TT \geq 2PD$

$PD \neq \frac{1\,km}{speed} \quad \frac{L}{BW} = \frac{2 \times D}{speed}$

$TT = 12500$ $\quad speed = \frac{2 \times D \times BW}{L}$

rate = BW

$= \frac{2 \times 1\,km \times 100 \times 10^6\,bit/sec}{1250 \times 8\,bit}$

$= \frac{10^7}{500} = \frac{10^5}{5}\,km/s$

$= 2 \times 10^4\,km/s$

Ques In CSMA/CD network running at 1 Gbps over a 1 km cable with no repeaters, the signal speed in the cable is 2,00,000 km/s. What is the minimum frame size?

Sol $TT = \frac{L}{BW} = \frac{2 \times D}{speed}$

$L = \frac{2 \times D \times BW}{speed} = \frac{2 \times 1\,km \times 1\,Gb/s}{200000\,km/s}$

$L = \frac{1}{100000} = 10^{-5}\,Gb = 10^{-5} \times 10^9 = 10^4\,bits$

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Ques A 2 Km long broadcast LAN has 10^7 bit/sec BW and uses CSMA/CD, the signal travels along the wire at 2×10^8 m/sec. What is the minimum packet size that can be used on this network.

Sol

$$\frac{L}{BW} = \frac{2 \times D}{speed}$$

$$L = \frac{2 \times D \times BW}{speed} = \frac{2 \times 2\ km \times 10^7\ bit/sec}{2 \times 10^8\ m/sec}$$

$$= \frac{2 \times 10^7\ km\ bit}{10^8 \times 10^{-3}\ km}$$

$$= 2 \times 10^2\ bit$$

$$= 200\ bit$$

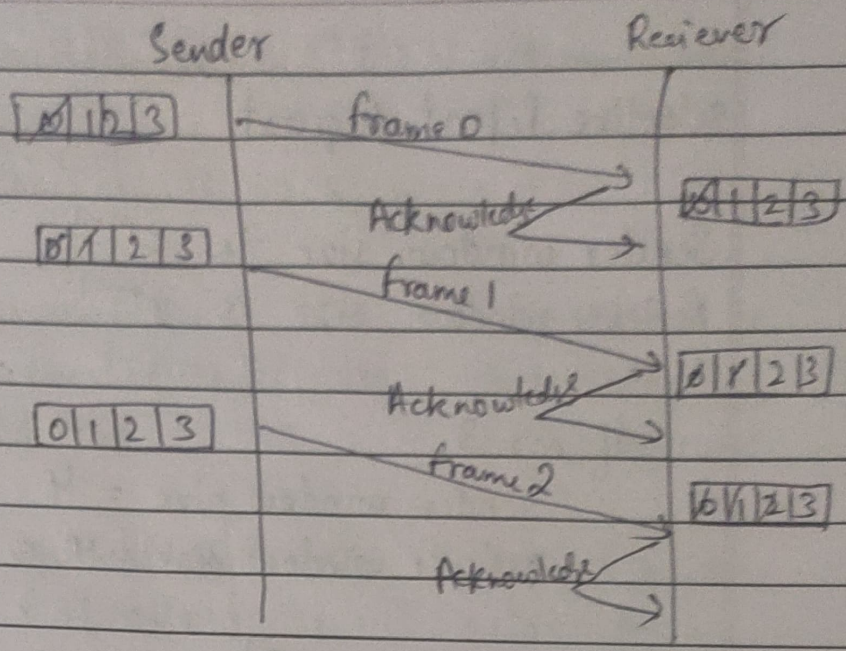
Go Back to -N (it is a sliding window method)

The sequence no. are $|2^m|$ where m is the size of sequence no. filled in bits.
The send window is having size $2^m - 1$
Reciever window size is always size of 1.
Let's assume data :=>

$$m = 2$$

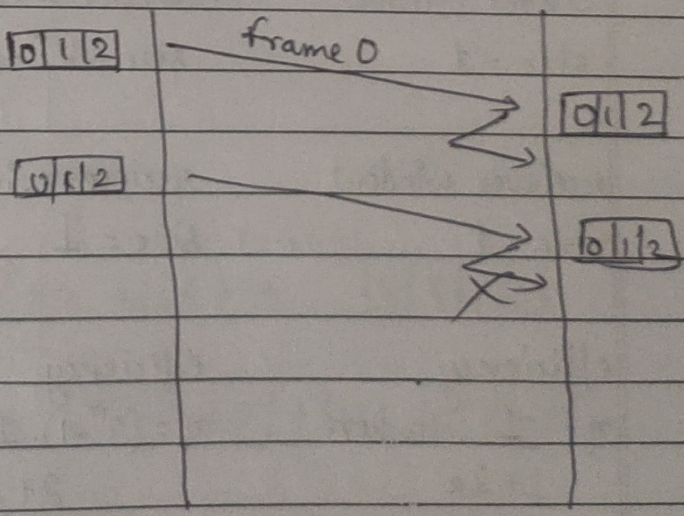
$$|2^m| = 4$$

$$2^m - 1 = 3$$ (window size at sender side)



if frame 1 is lost
it will resetnd
all the frames
from frame 1 to the end
it will discard the
previously sent data

Selective Repeat Request



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selective Repeat Request

Sender window size is 2^{m-1}
Reciever window size is 2^{m-1}

if $m = 3$
sender window size = 4
reciever window size = 4

Sequence no is $|2^m|$

Stop and Wait	Go back to-N	Selective Repeat Request
only 1 frame transmitted at a time	multiple frames transmitted	multiple frames transmitted
sender window size = 1	sender window size = $2^m - 1$	sender window size = 2^{m-1}
reciever window size = 1	reciever window size = 1	reciever window size = 2^{m-1}
efficiency $\eta = \frac{1}{1+2a}$ where $a = \frac{PD}{TT}$ or TP	efficiency $\eta = (2^m - 1) \cdot \frac{1}{2+2a}$	efficiency $\eta = 2^{m-1} \cdot \frac{1}{1+2a}$ where $a = \frac{PD}{TT}$

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retransmission is after 1 frame or retransmission = 1

retransmission = $2^m - 1$

retransmission = 1

individual acknowledgement

commulative acknowledgement will be sent

commulative or independent acknowledgemet

available sequence number = sender window size(w) + receiver window size (w) = 2w

optimal window size = 1+2a

optimal window size = 1+2a

Ques In SR protocol suppose frames ~~through~~ through 0 to 4 have been transmitted. Now imagin 0 times out, 5 (a new frame) has been transmitted, 1 time out, 2 time out, 6 (another new frame) transmitted at this time what will be the outstanding packets in sender's window

Sol

4 3 2 1 0

Step 1 ⇒ | 4 | 3 | 2 | 1 | 0 | → (0 is sent) → | 4 | 3 | 2 | 1 |

Step 2 ⇒ 0 times out → | 0 | 4 | 3 | 2 | 1 | → | 0 | 4 | 3 | 2 |

Step 3 → 5 (a new frame) → | 5 | 0 | 4 | 3 | 2 |

Step 4 → 1 times out → | 1 | 5 | 0 | 4 | 3 | 2 | → | 1 | 5 | 0 | 4 | 3 |

Step 5 2 times out → | 2 | 1 | 5 | 0 | 4 | 3 | → | 2 | 0 | 4 |

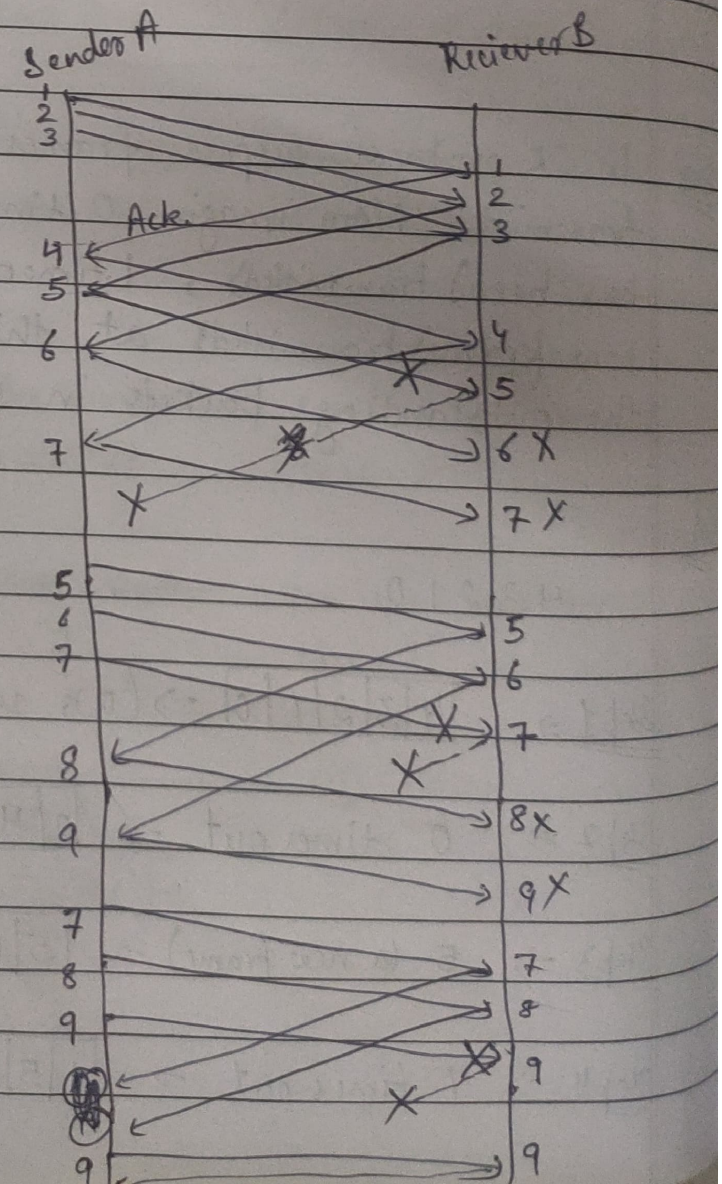
Step 6 6 a new frame → | 6 | 2 | 1 | 5 | 0 | 4 | 3 |

Ques A send continuosly 9 packets to B using sliding window, size is 3 and (Go back to N) all packets are ready & immediately available for transmission. If every fifth packet is lost or corrupted then what is the number of packet that A will transmit for sending the message to B.

Sol

| 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |

every fifth packet at sender side is lost or corrupted



Total no. of frames required to transmit complete message is 16