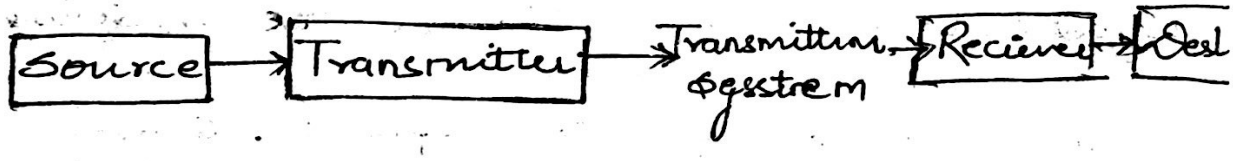
Unit-I

Computer Network :- A Computer Network is a set of devices often refers to as nodes Connecting by the media links like wired or wireless. A node can be a printer, Computer or any other device capable of sending or recieving data generated by other nodes on the n/w. The links connecting the devices are called communication channel.

Computer Network is nothing, more than two Computers Connecting togethers by media links, so that they can exchange the Information.

Data Communication Model :-

I



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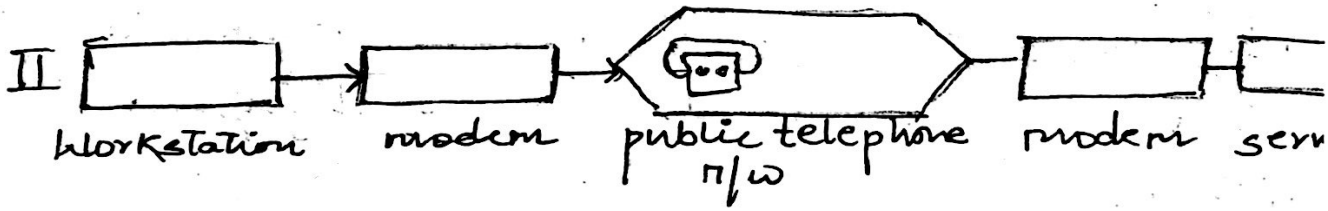

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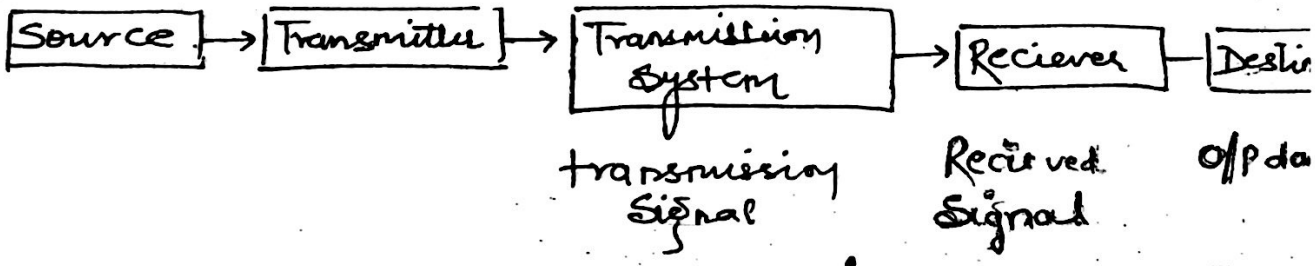


6. O/p Information

Key elements of CN:-

Source:- Links device generated the data to be transmitted. Eg. telephone, PC etc

Transmitter:-

It transports and encode the important produce electromagnetic signal. These electromagnetic signals can be transmitted system. Ex. a modem takes a digital bit stream from an attachment device (PC, telephone) and transform that bit into an analog signal which can be handled by telephone N/w.

Transmission System:- Can be a single transmission system can be a single transmission line or a complex n/w which is used to connect the source or destn.

Reciever :- The reciever accepts an analog signal coming from a n/w or transmission line and converts it into a digit bit stream.

Destination :- A destination takes the incoming data from the reciever.

Goals and Application of Computer Network :- (2)

Basically there are 4 goals of Computer Network They are as follows :-

1. Security goal :-
   - (a) Virus
   - (b) Unauthorized access
     - At lowest level - username password.
     - At higher level - encryption technique.
   - (c) Substituting technique: Each element are mapped into another element. Ex. A → D.
     Transpositing technique: Each element are these are rearranged. Ex. A → B → C

2. Reliability Cost :-
   - failure frequency.
   - Average down time → must be less.
   - Catastrophic effect → Back up is maintained.

3. Performance Goal :-
   - (a) Transit time - must be in min.
   - (b) Response time - Enquiry response time must be min.
   - (c) N/w transmission medium → fi propolic microwave.
   - (d) H/W - Storage Capacity Speed.
   - (e) S/W - High performance speed.
   - (f) Traffic Loader:

4. Network Cost :-
   - (a) fixed Cost : Hub, Switch, Router etc.
   - (b) Runtime Cost :- Maintanence Cost.

App^{n} of Computer Network :-

(i) Exchange file between systems.

(ii) Exchange emails with used an other Computer.

(iii) Execute program on another Computer

(iv) Remote login.

(v) Share peripheral devices.

(vi) Teleconferencing.

(vii) N/w for companies :-

a. to keep track of inventories.

b. monitor productivity.

c. to extract and co-relate information about company.

d. Resource sharing.

e. Saving money.

f. High Reliability

g. Powerfull communication medium.

h. Local payroll.

(viii) N/w for peoples :-

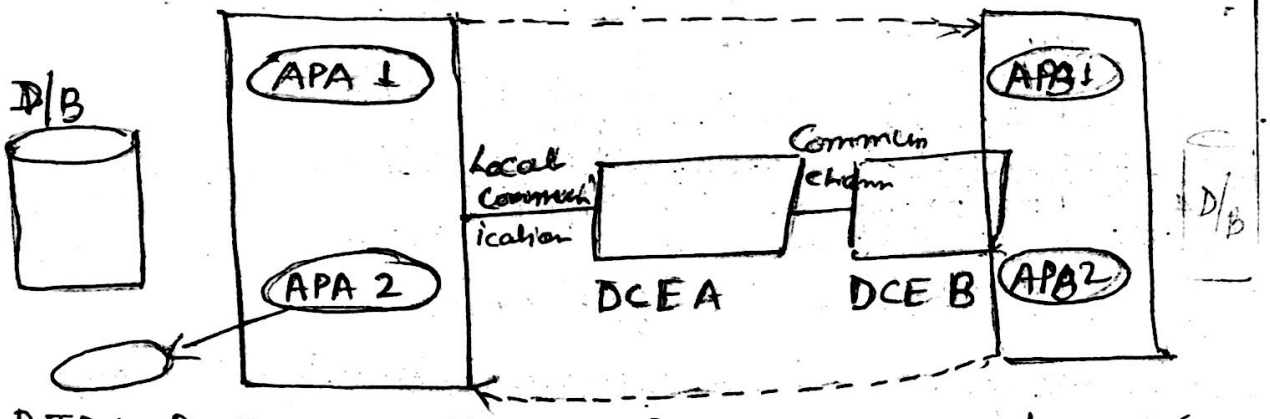
a. Access to remote information.

b. Home Shopping.

c. Person to person communicating.

d. Interactive entertainment.

e. from www we can fetch information about arts, business, health, Science, Sports, travels, etc.



DTE :- Data terminal equipment on end user device.

DCE :- Data connection Equipment. Eg. (modem)

AP :- Appⁿ process

The fig shows a base Communication System. DTE is a general term used to define the end user machine which may be a computer terminal, mobile phone, p.c., a workstation for the railway, reservation counter.

The function of a communication n/w (DCE) is used to connect DTE so, that they can share resource and provide backups to each other.

From the fig site A called execute an applic's process (APA1) is the form of a s/w program to access an appⁿ process at site B (APB_1)

The best example DCE is modem.

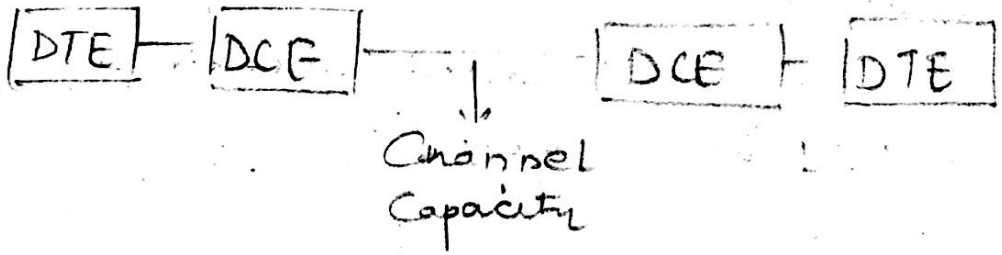
Some general Concept provide the provide to bases code understand the n/w structure and architecture :-

1. channel/ networking Configuration
2. Transmission mode.
3. N/w Topology design.
4. Categories of the N/w.
5. Channel characteristics

1 **Channel Configuration** :- Also referred to as channel configuration. In this two possible Concepts are there.

(a) Point to point Configuration
It provides a dedicated link b/w two Communication devices.

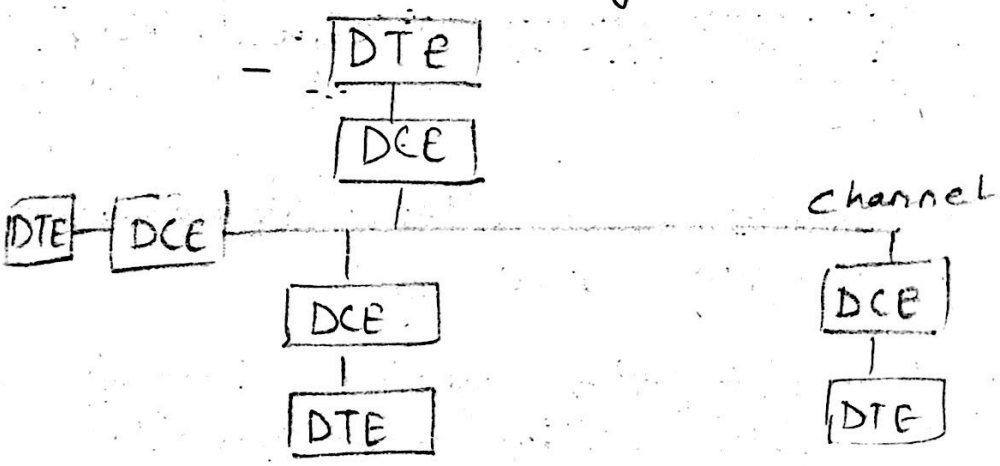
→ The entire channel capacity is for transmission b/w only those two Communication devices.
Eg. Our television set and its infrared remote Control have point to point Channel Configuration.



(b) Point to multiple point Configuration :-
This Configuration, more than two Configuration devices are connected to the same channel.
It is also known as point to multi drop Channel Configuration.
Time division :- If several devices are sharing the

channel one by one.

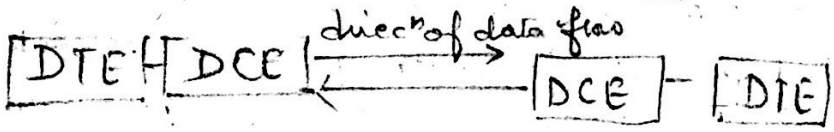
Spatial division:- If several devices are sharing channel simultaneously.



2. Transmission mode:- It defines the direction of data flow b/w 2 communicating devices.

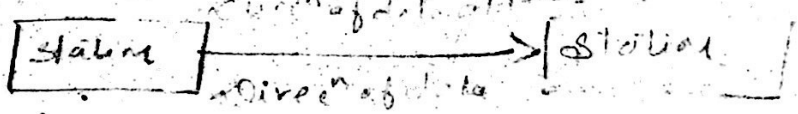
Simplex:- Transmission in one direction only, one end will always transmit other end will always recieve.

Ex. Keyboards and printers.



Half Duplex:- It permits transmission in both dirc^n but at a time in only one direction. It is also known as 2-way alternate. (TWA)

Eg. enquiry and response apps and walky talkie Comm^n are Eg. of half duplex.



Full duplex :- It permits transmission simultaneously in both direction, it is also known as two-way simultaneously (TWS). In full-duplex mode the channel capacity may be shared in 2-ways.

- Capacity of channel is divided into signals travelling in opposite direction.
- 2 channel must contain 2 physically separate transmission path one for recieving & other for sending. Eg:- telephone n/w.

3. N/w Topology design :- Station — Station — direction of data all the time

Topology :- It means form of something. A n/w topology is the shape or physical and logical connectivity of network.

The network design has 4 measures :-

(a) Throughput :- Ratio of succesfully recieved packets and total no. of transmitted packets in percentage. $\frac{\text{Successfully}}{\text{Transmitting}}$

(b) N/w reliability :- It refers to the availability to deliever the user data without any error from source to destination.

(c) Least Cost path :- Rout the traffic across the least cost path b/w the sending and recieving devices

- providing min. expensive channel for an applications.

• for transmission of a low priority data over a less expensive dial-up low speed telephone line instead of transmitting it over expensive least line. (5)

d) minimising response time: it includes minimising delay b/w the transmission and the reciept of the data b/w source to destination. (5)

Types of N/w topology :-

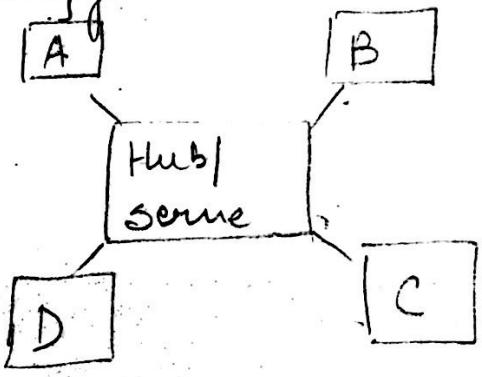
- Star
- Ring
- Mesh
- Bus
- Tree
- Hybrid

Two types of relationships are possible when we select a topology :-

a. Peer to peer :- where the devices share the links with equal status.
Eg. ring, mesh, bus.

b. Primary Secondary :- where one devices controls the flow of traffic and other must transmit through it. Eg :- star, tree.

(1) Star Topology :-



In the star topology, devices are not

directly linked to each other, each of devices has a dedicated point to point link only to a central hub.

Advantages:-

(i) Addition of new device is easy.

(ii) Any link failure doesn't effect other layers.

(iii) fault diagonsis removal is easy.

(iv) Better control and security over data flow as entire data passes from central side.

Disadrahtages:-

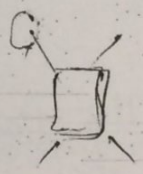
(i) Single site is responsible for routing of all the traffic.

(ii) Bottle neck problem does arise for central side.

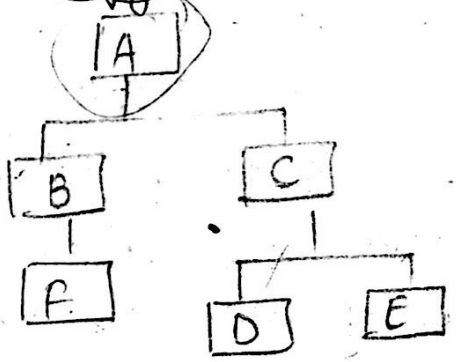
(iii) Cost is high.

(iv) If one link phase fails, n/w fails and no alternate to connect with rest of the n/w's.

Note:- STAR topology is usefull for centralized area.



2. TREE Topology :- Hierarchical topology



Advantages :-

(i) Addition of new DTE is very easy.

(ii) Failure of any DTE will impact on that branch only.

(iii) More layers of control and security of data flow is possible as traffic as control at every branch node.

(iv) more layers of control and security of data flow is possible as traffic as control to every branch node.

Disadvantages :-

(i) Cost is high.

(ii) If root node fails then entire n/w will not function properly.

(iii) If this node is not fully back up by another Computer

(iv) As b/w any two nodes in the tree n/w, there exist a single path if any link failure occurs there is no alternate path available.

Bus Topology :- Popular

- Also called horizontal topology.
- It is a point to multipoint".
- One long cable acts as a back bone to link all the devices in a n/w.
- Nodes are connected to tap and drop line.

Dropline :- It is the connection b/w the devices and the main bus cable.

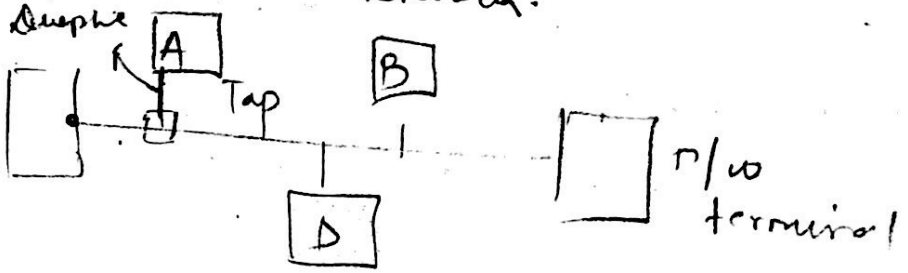
TAP :- It is a connector used to connect to the cable of main bus.

Advantages :-

(i) Cost is very low as single bus is required to connect to all devices.

(ii) addn of new devices is easy.

(iii) It is successfull when broadcasting is required on a network.



Disadvantages :- Very difficult to isolate and resolve problem with a partial DTE on the bus.

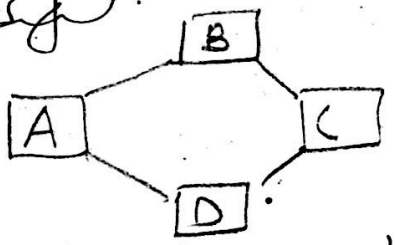
- There is no security control on the flow of data as information transmitted is

available to each DTE.

- If main bus fails, it results in network failure.

(7)

Ring Topology :-



- The ring topology is named today because of the circular aspect of data flow.
- Data flow is unidirectional always.
- Each device in the ring contains a repeator.
- When a device receives a signal then repeator regenerates or amplifies the signal of other devices.

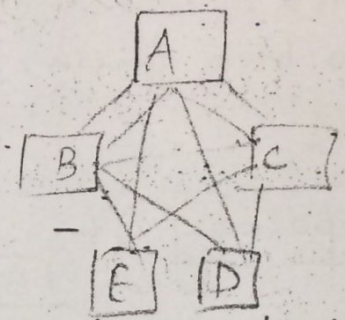
Advantages :-

- Consecutive systems are connected hence making a loop.
- No bottle neck problem arises.
- Low cost need for cabling.
- Unidirectional so, no conjection and suitable for using optical fibre as a medium of transmission.

Disadvantages :-

- Failure of any node causes n/w failure.
- Difficult to diagnose fault

Mesh Topology



Advantages:-

No traffic problem.

Better Security.

Fault identification once fault isolation

This topology is robust to link failure.

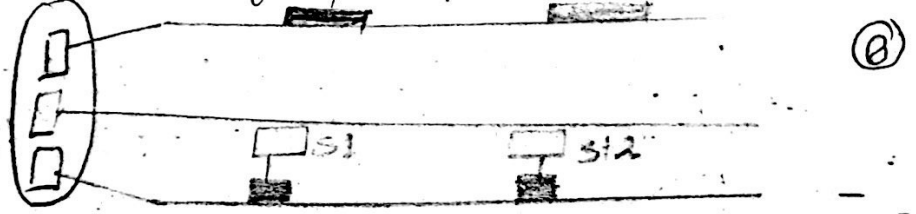
Disadvantages:-

- Cost of n/w is very high because every device is to be connected to every other device, amount of cabeling and no. of I/p, o/p ports required is very high which in turn leads to high cost.
- Bulk of wires required large space and leads to complexity in fault diagnosis.

Note If there are n nodes in a fully mesh connected topology then no. of cables required equals to

$$\frac{n(n-1)}{2}$$

No. of ports Equal to $(n-1)$.



4 hybrid Topology :- Star backbone with 3 bus topology

Category of Network :-

1. LAN (Local Area Network)
2. MAN (Metropolitan ")
3. WAN (Wide Area Network)

LAN (Local Area Network) :- Computer network that are confined to a localized area, for eg. a building, a factory ar an office.

Lans operate on a very high speed lines from (1 Mbps) to 400 Mbps.

∴ 1 Mbps = 10^6 bits.

Bus, Ring and Star Topology are basically used for the L.A.N.

IEEE (Institute of electrical and electronic Engineers) IEEE-802.5 is a popular ring raised Lan operating at 4-16 Mbps.

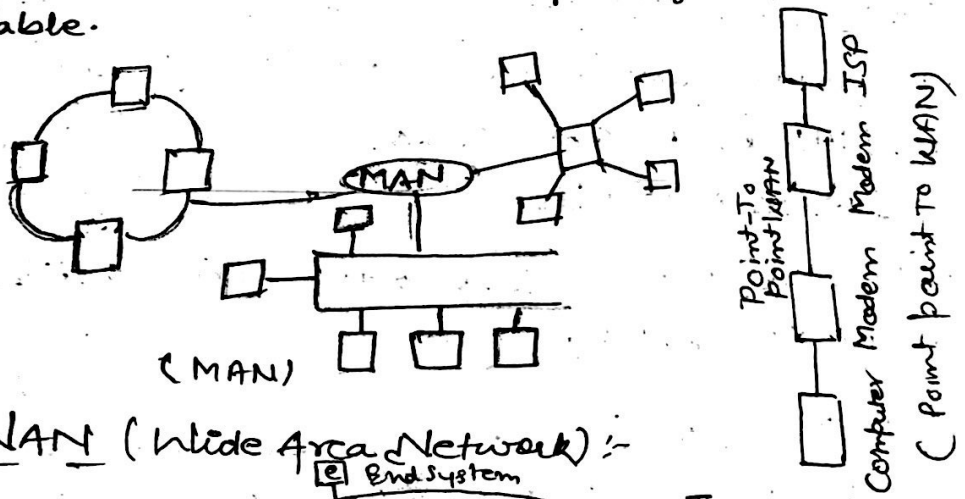
Single building LAN with Ring Topology

Single building LAN with Bus "

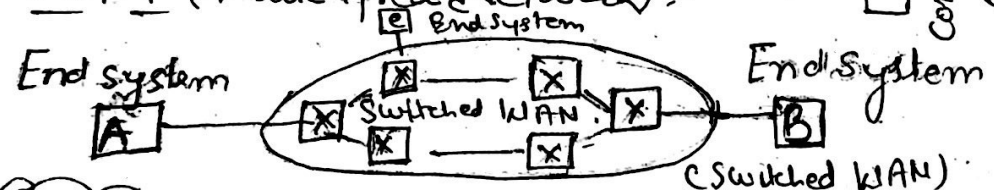
" " " " Star "

MAN (Metropolitian Area Network)

- It is designed to extend over an entire city. MAN operates at a high speed from 35-Mbps to 150 Mbps.
- It helps in connecting LAN's with WAN's.
- MAN is a network with a size b/w LAN and WAN.
- It is design for customers who need a high speed connectivity normaly to the internets.
- A good example of a MAN is the part of telephone network company, that can provide a high speed DSL to the customer, another example of MAN is t.v. cable.



WAN (Wide Area Network):-



Point to Point WAN:- A WAN provides long distance transmission of data, images, audio and video info. over large geographic area that may compress a country.

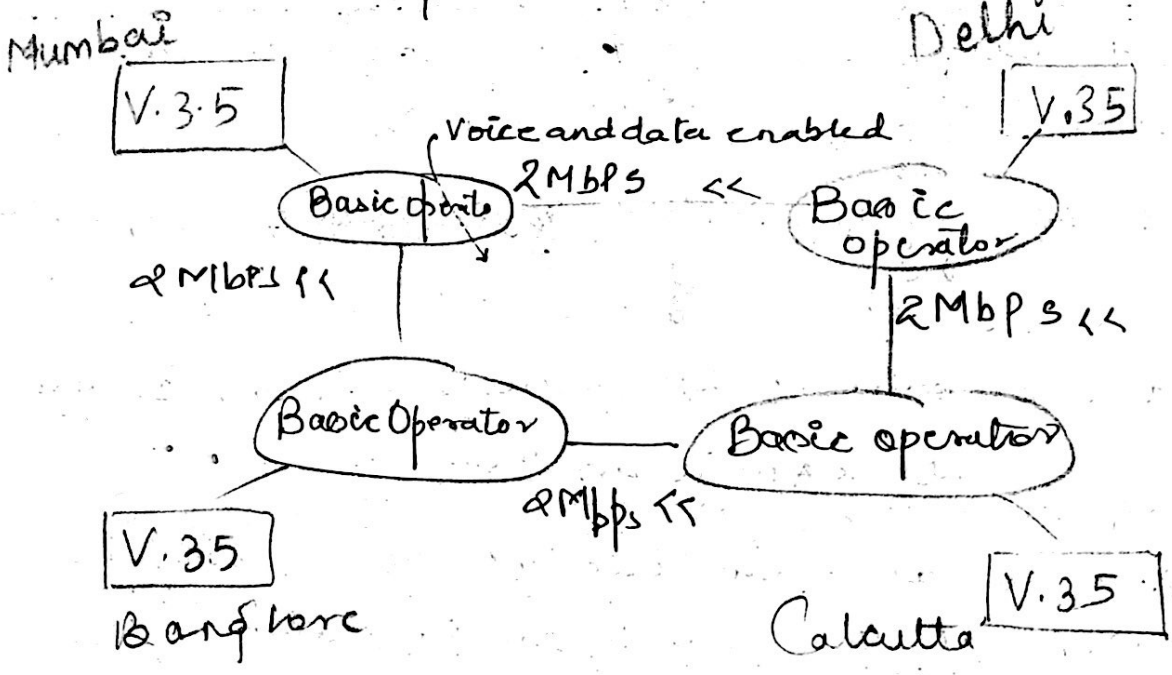
from the fixed fig, the switched WAN connects end systems which usually (9)
comprise a router (internet working connecting device) that connects to another local area or wide area N/w.

from the fig 2 point to point WAN is normally a lease line from a telephone or TV cable provider that connects a home computer or a small LAN to an ISP.

X.25 is an early example of a switched WAN that is used to provide connectivity b/w end users. X.25 now is replaced by high speed and more efficient network called frame Relay.

X.25	Frame Relay
1. X-25 N/w's work at speed upto 64 Kbps.	It operates at high sped of 1.5 Mbps
2. More reliable.	unreliable.
3. frames are delivered in order.	frames are not delevied in order.
4. Provides flow control.	Does not provide flow Control.
5. Provides acknowledgment signal.	Does not provide acknowledgment signal.
6. Connection oriented Services.	Connectionless Services.

A good Eg^n of Switched WAN is Asynchronous transfer mode, which is a n/w with fixed size data units packets called cells.

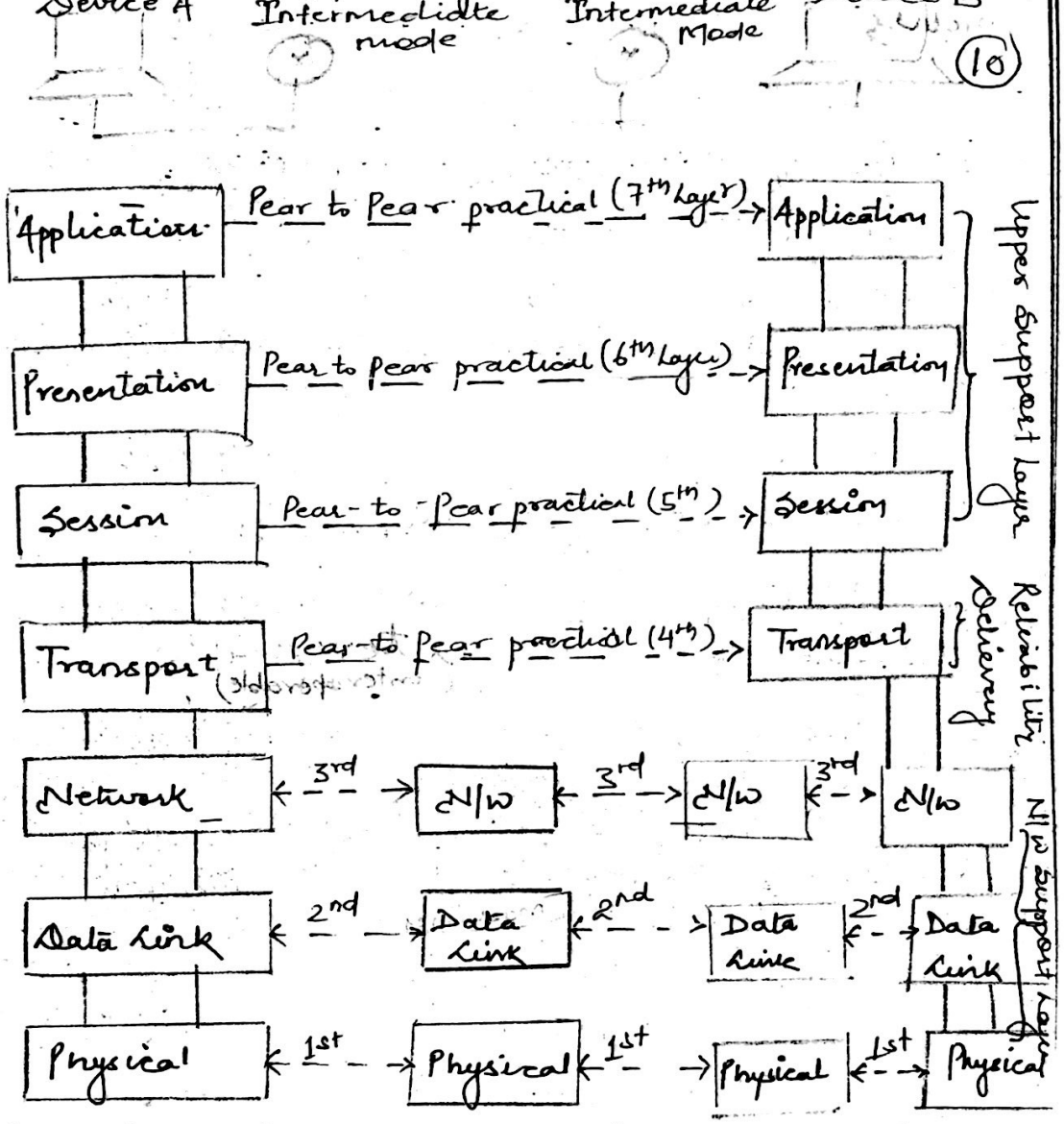


V.35 interface is used to connect high speed routers to channel service unit / data service unit, for communication over leased line. It is one of the popular DTE/DCE interface is used today for LAN/WAN connectivity.

V.35 uses block shaped 34 pins for DTE to DCE connection.

(V.35 connector)

OSI Model (Open System interconnection model)



OSI model was established in 1947 by the International Standard Organisation.
It is a multinational body dedicated to world wide agreement on International Standards.

- An ISO standards that Covers all aspects of n/w Communication is the 'Open System interconnection module'.

- An open System is a set of protocols that allows any two different Systems to Communicate to each other.

- The purpose of OSI model is to show how to facilitate Communication b/w different System without requiring changes to the logic of the underlying H/W & S/W.

- The O.S.I. model is not a protocol it is a model of understanding & designing a n/w architecture is flexible robust and interoperable. (interoperable)

Note :- ISO is a organisation while OSI is a model.

Peer :- The entities Comprises the Corresponding Layer as different m/c's are called peer. (Machines)

Entity :- The active element in each Layer are often called entities. An entity Can be a S/W entity such as a process or H/W entity such as intelligent i/p o/p chip.

Header :- • Instructions have been placed in the header to invoke functions in the peer entities to the another node in the n/w.

- Header includes Control information such as sequence number.
- The header added to the peer (Same Configuration) Layer at the transmitting site are used to inform Symmetrical & Complimentary func^n at the receiving side.

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Interface between Layers:- Passing of data and network information down through the Layers of the sending device and back up through the Layers of the recieving device is made possible by an Interface between each pair of adjacent Layers. (11)

Note:- It consists of 7 separate but related Layers each of which defines a part of the process of moving information across a network.

Responsibilities of Layers :-

a. Physical :- • first Layer of O.S.I. model.
- Concerned with transmitting raw bits
- Deals with electrical and mechanical specification of interfaces of transmitting media.
- Data rate is the responsibility.
  Ex. No. of bits / second.
- Physical topology : Ex. Bus, Star.
- Represen^n of bits (data unit)
- Line Configuration

b. Data link :- • Node to Node delivery of data.
- Second Layer of OSI model.
- Data unit :- frame.
- Error Correction and detection
  (Parity, checksum, Hamming code)
- Physical addressing. (MAC Address)
  ↳ Medium Access Control
  NIC
  ↳ Network Interface Card
  to define the Sender and Reciever of the frame

. Trailor is used for error control.

- Retransmittion of the damaged frame.
- Flow Control :- Data rate must be controlled according to the reciever.
- If two systems are connected to same link then there is no need for a network layer.

3. (Network) :- It is responsible for source to destination delivery of data.
- Third layer of O.S.I.
- It provides the service for transport layer.
- Logical address / I.P. address
  It adds a header to make unique logical network address of source and destination station.
- Routers :- finding the best path by using routing algorithm -
  Ex. Dijkstra's, Bellman.
- Responsible for how packets are routed from source to destination.
- Control of conjection also belongs to this layer.

4. (Transport) :- • 4th layer of OSI model.
- Process to process delivery of data (entire message).
- provide the services to the session layer.
- It provides two types :-
  - Connection oriented
  - Connectionless

However if two systems are attached to different network with connecting devices (routers) between the networks then there is a need for the network layer to accomplish source to destination delievery of the data.

Connection oriented
→ Reliable.
→ Ex. T.C.P.

A connection oriented transport layer delivers error free mesg in the correct order.

Connect :- Set up a connection blw ports.

Data :- Delievers a sequence of mesg in correct order and without error.

Delevers an urgent mesg by making them jump ahead of non-urgent mesg.

Disconnect :- Release the connection

- It provides the guarantee ato delievery of data from source to destination
* ALL packets follow the same Route

Connectionless
→ Non-Reliable
→ Ex. ~~IN~~, U.D.P., IP

- It doesn't provide guarantee to delievery of mesg from source to destination.
- Speed or data rate is fast in comparision to the connection oriented.
- No acknowledgment from Reciever.
* Unreliable.
* Packets are not joined in sequence
* All the packets follow the different route

- Segmentation and reassembly of the mesg.
- Flow control.
- Connection Control.
- Port address. (Transport layer works with the port address to differentiate blw.

different process).

Session • provides service for presentation layer.

- It is the 5th layer of O.S.I. model
- Session layer allows users on different machine to establish session between them.
- Basic feature of session layer:-
  (1) Synchronization
  (2) Dialog control

Synchronization:- Session layer allows check points or synchronization pt. to a stream of data

Ex. If a system is sending a file of 2000 pages then it is advisable to insert checkpoints after every 100 pages to ensure that each 100 page unit is recieved and acknowledged independently. If the crash happens during the transmission of P. 523, the only pages that need to be resend after system recovery.

Dialog Control:- Session layer allows two systems to enter into a dialog. It allows the communication b/w two processes to take place in either half duplex or full duplex.

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Presentation Layer:- • 6th Layer of O.S.I. model.
• provides Services for App^n.
• Basic features are:-
→ Encryption
→ Compression
→ Translating

Encryption:- To Carry Sensitive information a System must be able to ensure privacy

Encryption means the Sender transforms the original information to another form. and Sends the Resulting msg over the network.

Decryption technique is used at the Recieving side to decrypt the msg

Compression:- Data Compression reduce the bits Contained in the information.

Data Compression becomes particularly important in the transmission of multimedia: text, audio and video.

Translation:- The process (running program) in two System are usually exchanging inform^n in the form of character string, numbers

The information must be changed to bit stream before being transmitted.

Application Layer provides service
→ User Support Layer.
→ 7th Layer of Application Layer.

Applic^n Layer is responsible for providing Services to the user.

This Layer enables the user, human or software to access the network.

It provides the user interfaces and support for services such as e-mail, remote file access and transfer, shared database management.

Basic services are :-

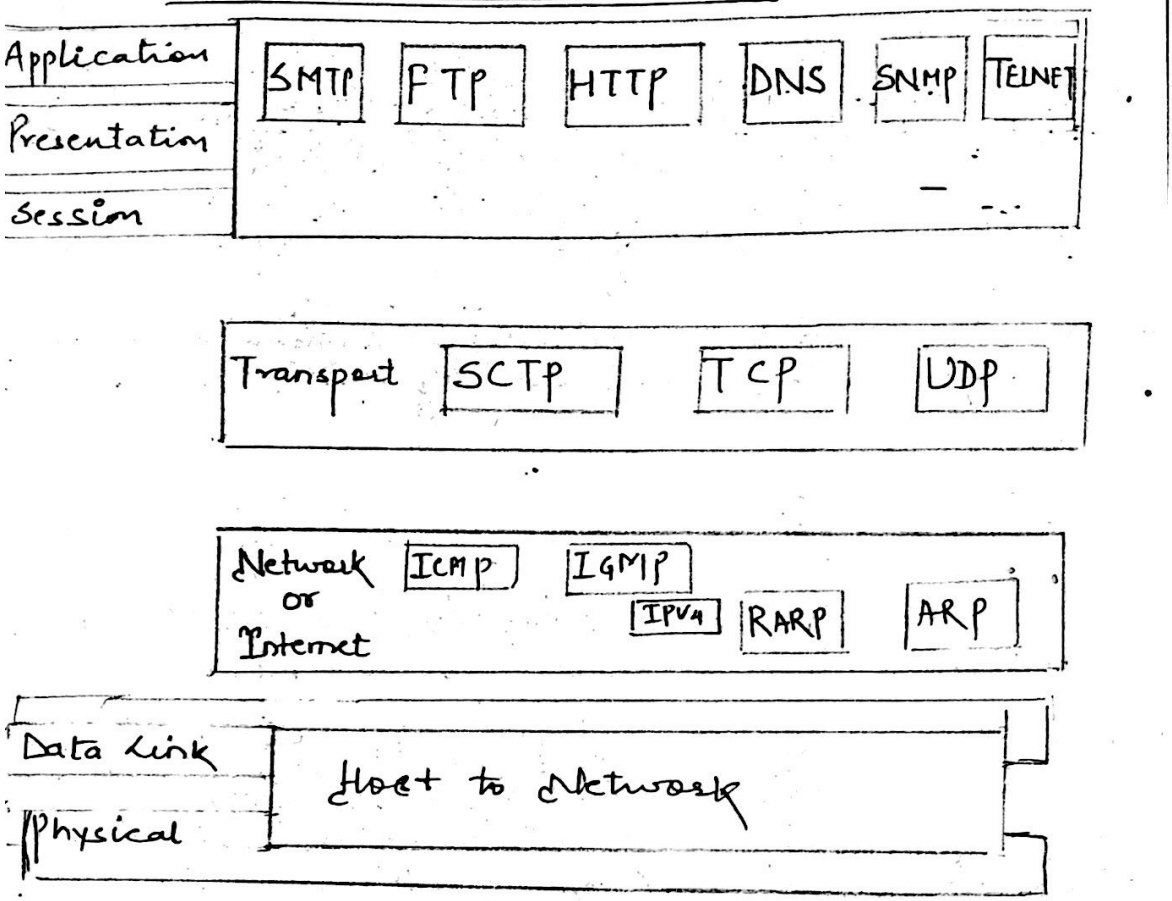
a. Network virtual terminal :- is a s/w version of a physical terminal and it allows a user to log on to a remote host

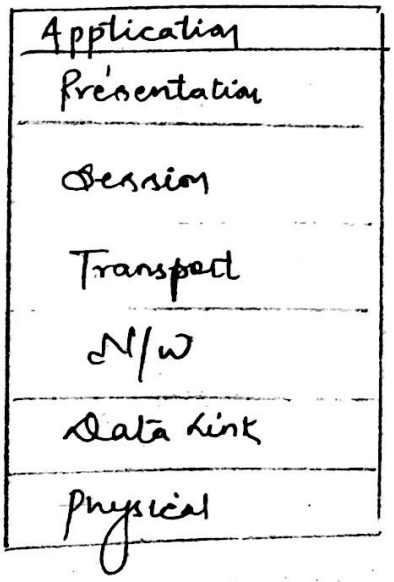
b. file access, transfer & mgmt
This appn allows a user to access files in a remote host, to retrieve files from a remote computer

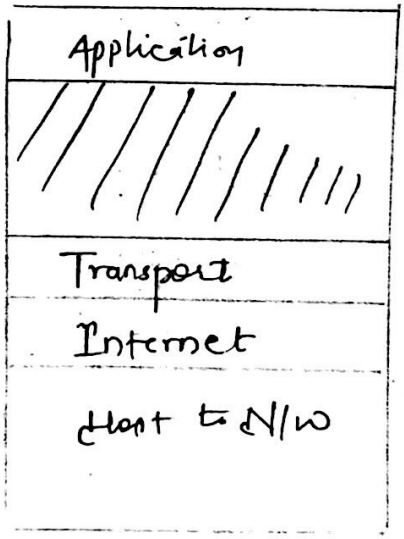
c. Mail Services :- This appn provides the basis for e-mail forwarding and storage.

d. Directory Services :- This appn provides distributed databases, sources and access for global information about various objects and services.

TCP/IP Refrence Model :-







- The OSI model used in the grandparent of all computer networks.
- The 'Arpanet' (Advanced Research project Agency network) was a Research DOD (Department of Defence). It eventually connected 100's of university and government installatin using Least Line.

When Satellite and radio network were added later then the existing protocoals in the O.S.I. model had trouble interworking with them so a new refence architechure was needed and this architecture later became known as TCP/IP reference model.

It was first defined in 1974.

A Latter perspective is given in 1985.

The original TCP/IP protocoal suite as having 4 Layers.

1. Host to N/W
2. Internet
3. Transport
4. Application

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Network

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a. IP: V
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b. ICMP
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ICMP.
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At the physical and data link layer, TCP/IP doesn't define any specific protocol.

It supports all the standard protocols.

A network in the T.C.P. Internetwork can be LAN or WAN.

Network Layer or Internet:-

At the network layer following protocols play very imp. role:

a. IP: Non-reliable.
- doesn't provide guarntee to delivery of data
- no acknowledgment from Reciever.
- fast service.
- All the packets of the data follows diff. path. (Each packets move independently).
- Lack of Error Control
- No error reporting
- No error correcting.

b. ICMP:- (Internet Control Message protocol)
- Companion of I.P.
- ICMP sends Query reporting mesg and error reporting mesg to the Sender.
- ICMP does not Correct error.
- It simply reports them.

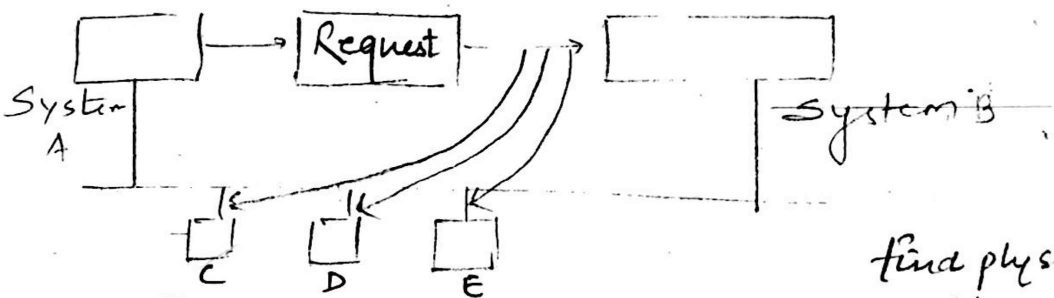
For Ex. Destination Unreachable
Time Exceeded.
Redirection, Parameter problems.

c. IGMP :- Internet Group Msg Protocol

- Used to facilitate the Simontaneous transmission of a message to a group of Reciepients.
- Three types of Casting :-
  1. One to one - Unicasting
  2. One to many - Multicasting
  3. One to all - Broadcasting.

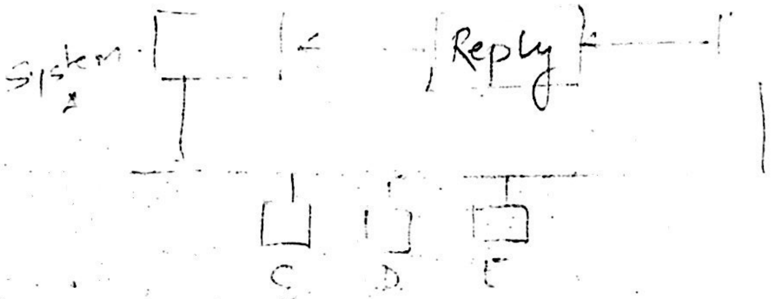
IGMP is a group mgmt protocoal that helps a multicast router to create and update a list of loyal members, related to each router interfaces.

d. ARP (Address Resolution protocoal)
It is used to find the physical address of the node whenever its internet address, logical address of IP is known.



[Broadcasting ARP Request]

find physical address if logical is given



[ARP Reply is Unicasted]

e. ...
It ...
address of ...
its physi...

Transport ...
and ...

a. T.C.P :-
- ...
- ...
- ...
da...
- Lea...
- Erro...

b. U.D.P.
- Process... port ...
- Conne...
- Perfor...
- U.D. ... a fix...
- Sendin... much ... Reciever...

e. RARP (Reverse Address Resolution protocol)
It allows a host to discover its internet address or I.P. address when it knows only its physical address.

(16)

Transport Layer :- In this layer, T.C.P., U.D.P. and ~~S.C.T.P~~ protocol plays very imp. role.

a. T.C.P :-
- Reliable
- Connection oriented
- All packets follows same path.
- Provides acknowledgment
- Provides guarantee to delievery of data from source to destination.
- Less speed than I.P.
- Error Reporting.

b. U.D.P. :- (User Datagram protocol)
- Process to process protocol that adds only port address.
- Connectionless and non-Reliable protocol.
- Performs limited error checking.
- U.D.P. packets called Datagram have a fixed size header of 8 byte.
- Sending a small mesg by U.D.P. takes much less interaction b/w Sender and Reciever than using T.C.P. / S.C.T.P
  └ (Stream Control Transmission protocol)

c. ~~Http~~

c. S.C.T.P :- (Stream Control Transfer protocol)

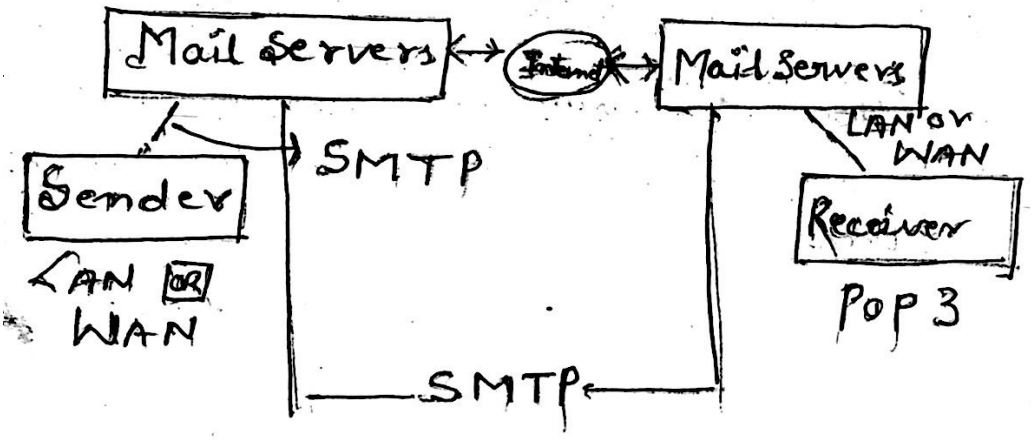
- Supports for newer appⁿ suppose voice over the Internet

Application Layer :-

(a.) SMTP (Simple Mail Transfer protocol).

- It is an internet standard for E-mail transmission across internet protocol (I.P.) networks.

- SMTP is used two times b/w sender and sender's mail servers and b/w two mail servers.



- ASMTP is a delivery protocol only while Pop and IMAP
  └ (Internet Message Access Protocol) for retrieving message.

b. FTP (File Transfer Protocol)

- Provides a way to move data efficiently from machine to another.

For Ex. E-mail for file transfer.

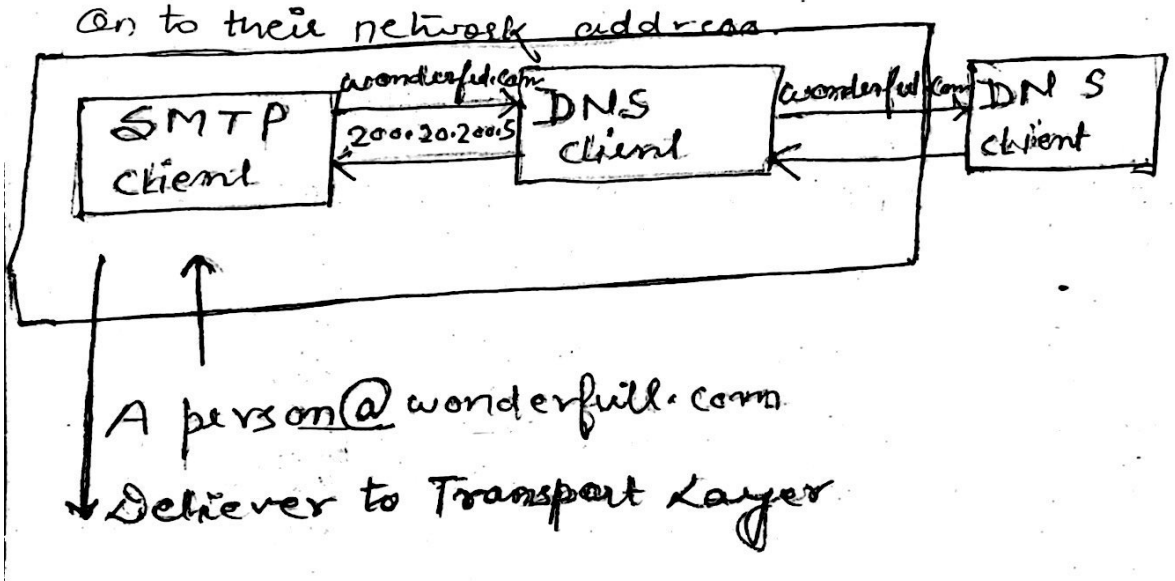
- It is reliable and secure because use the service of T.C.P.

c. Http :- (Hyper text transfer protocaal)

- It is used for fetching the web pages from www.

d. DNS :- (Domain Name Services)

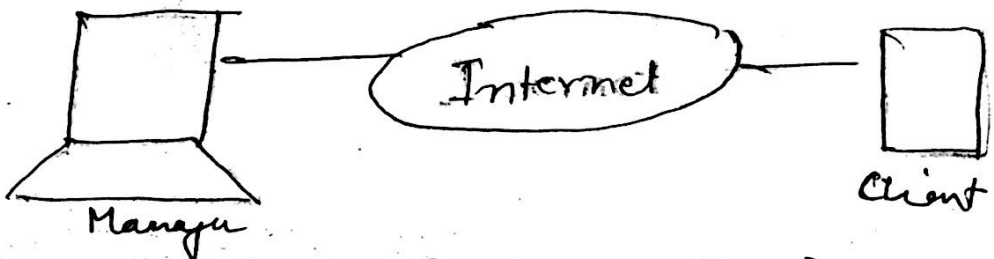
- It is used for mapping host name (rediffmal.com) on to their network address.



SNMP: (Simple Network Management protocaal)

It provides a Systematic Way for monitoring and manging Computer n/w.

* SNMP uses the Concept of manager and agent.



* Mangmt Section is Called Manager.
* It is a host that runs SNMP client.
* A managmnt Section is Called Agent, is a router that runs SNMP server program.

* Management is achieved through a manger and agent interaction.

TELNET

- It is an application used on the Internet to Connect to a Remote Computer, Enabling access to the Computer and its Resources.
- It allows the user one one machine to log on to a distant machine and work there.

~~Delay Analysis~~ :-

OSI model	TCP/IP Model
1. It has 7 Layers.	1. It contains 4 Layers.
2. Horizontal Approach	2. Vertical Approach
3. Transport Layer takes the guarentees to delevig of packets	3. Transport Layer doesn't guarentee to delevery of packets.
4. Separate Session Layer	4. No Session Layer.
5. Separate presen" "	5. No presentation Layer.
6. Network Layer provides both Connectionless and Connection Oriented Service. For. Ex. T.C.P. - Con. Orient I.P./UDP - Connectionless	6. Network Layer provid only Connectionless Servi For Ex. I.P.
7. It defines Services, Interfaces and protocols very clearly.	7. It doesn't clearly distinguish Services,

a di

O.S.I. model

9. It has a protocol in a r

"O

Ser

H6

H5 D

H4 D4

H3 D3

D2

010 0101

and makes a clear distinction b/w them.

8. O.S.I. is truly a general model.

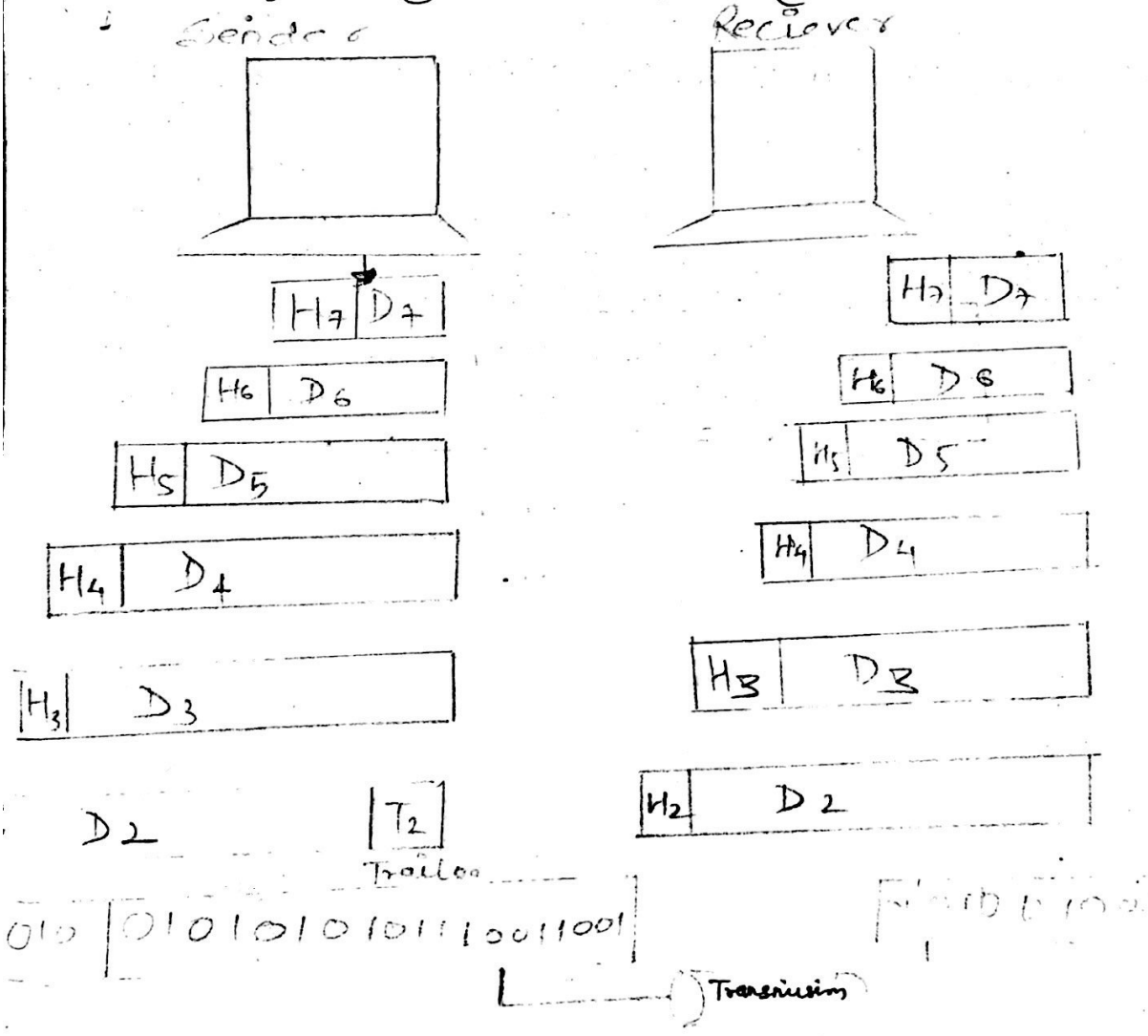
9. It has a problem of protocols fitting into a model.

interfaces and protocol

8. T.C.P./I.P. Can't be used for any other app^n.

The model doesn't fit for any other protocol stack.

"Organization of Layers"



Delay Analysis:- (Latency) Performance

In this we will discuss about performance parameter of a n/w which are mainly used:-

1. Bandwidth.
2. Throughput.
3. Media/Communica? Channel.
4. Latency / Delay

1. (Bandwidth):- It is a potential measurment of link / max. capacity of the communication channel.

2. (Throughput):- is the successfully Recieved packets out of total no. of sending packet in % age.

$$\% = \frac{\text{Recived packets}}{\text{Sending packets}} \times 100$$

OR

It is an actual measurment that "how fast we can send data"

Ex.
A network with bandwidth of 10 Mbps can pass only an average of 12000 frames per minute. With each frame carrying an average of 10,000 bits. What is the throughput of network.

10×10^6 = bits per second

1 frame = $10{,}000 \times 12000$

$= 120000000$

60

$\times 10^6$ = 2000000

$\frac{2\times10^6}{10\times10^6} = \frac{1}{5} = 0.2$

3. **Media/Communication Band**

If we use fibre (optical) instead of coaxial then

4. **Latency** :-

Latency = Propogation + Transmission + Queing

Delay defines how long it takes for an entire msg to completely arrive at the destination from the time, the first bit is sent out from the source and last bit received from the ~~see~~ destination.

1. Propogation time :- It measures the time required for a bit to travel from source to destination.

$$\text{Propogation time} = \frac{\text{Distance}}{\text{Propogation Speed}}$$

Example :- The propogation speed of the electromagnetic signal depends on the medium and on the frequency of signals.

In a vacuum, light is propogated with the speed 3×10^8 m/s.

It is slower in air.

& much slower in cable.

Q. What is the propogation distance is 12000 km and assume speed is 2.4×10^8 m/s in Cable

$$\text{Propog} = \frac{\text{Propo}}{\text{Speed}} = \frac{12000 \times 10^3}{2.4 \times 10^8 \times 10^9} = \frac{12 \times 10^6}{24 \times 10^9}$$

= .50 ms

Transmission Time :- $\frac{\text{Message Size}}{\text{Bandwidth}}$.

There is a time b/w the first bit leaving the sender and last bit arriving at the reciever.

Q. What the propogation time and transmission time for a 2.5 KB mesg (e-mail) if Bandwidth of n/w is 1 Gbps? Assume that the distance b/w the sender and Reciever is 12000 km and the light travels at 2.4×10^8 m/s.

✓ Propogation = 0.5 ms

transmission = ~~2.5 × 10³ Byte~~ / ~~1 ×~~ =

1 kg = 1000

1 KB = 1000 Byte

$$\Rightarrow \frac{2.5 \times 10^3 \times 8}{1 \times 10^9}$$

$$\Rightarrow \frac{25 \times 10^4 \times 8}{10^9}$$

$\Rightarrow$ 20

Queuing time :- The time needed for each intermediate and devices to hold the mesg it can proceeded. It is not a fixed factor. (28)
It can be changed with the load imposed on N/w.

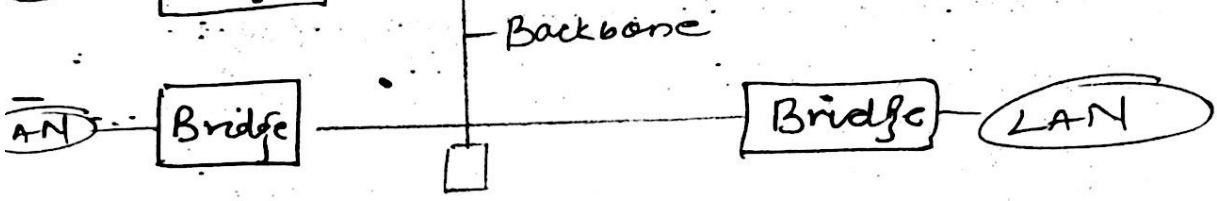
BACKBONE DESIGN :- Connecting diff LAN

- Back Bone is a part of our network that ties different department into a single whole.
- It is basically used as medium to large size network.
- A backbone network allows several lines to be connected for connecting different L.A.N.
- We require same high speed network and with high reliability so that the bulk of the data b/w different LANs can be transferred.
- For the design of the backbone the main consideration is for delay and bandwidth and other consideration for the backbone design are :-

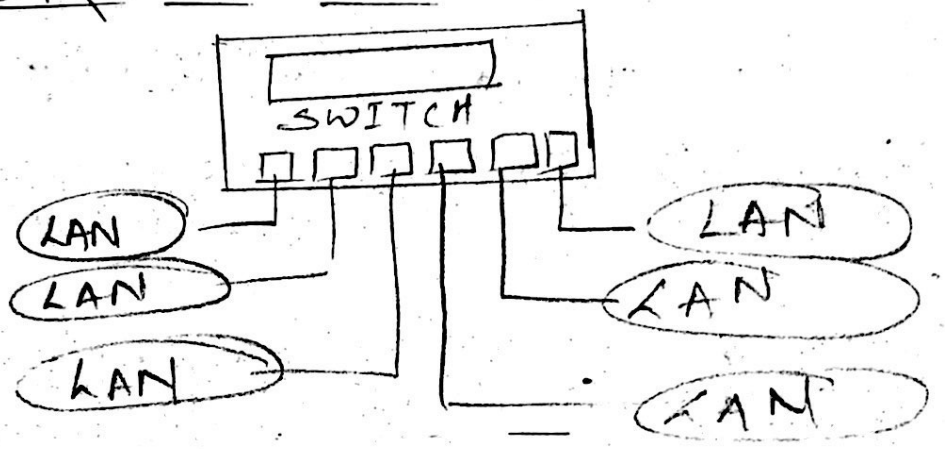
(1) Reliability :- no network failure

(2) Capacity of channel :- Same data rate

(3) Distributed backbone :-
It refers to the using Cables to join different departmental network topology, mesh topology or star topology.
This cabling refers to as backbone cabling and it connects HUB, switch, router of each network into a single whole.



(2) STAR BACKBONE:-



Module 3:

What is Switching?

Switching methods:-

- A series of interlinked nodes are called Switches.
- Switches are devices capable of creating temp Connections.

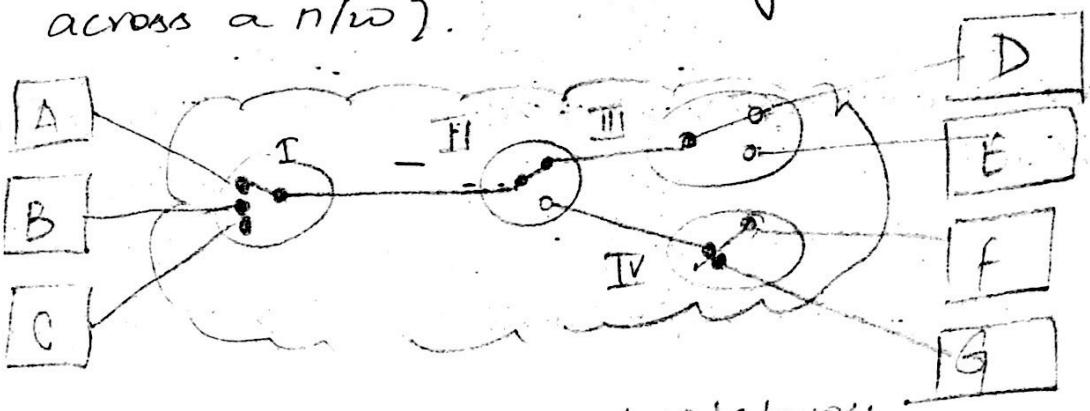
1. How the connections are made?
2. How the data handled in W.A.N.

a. Circuit Switching:- In telephonic System, " " is used.

- In ckt " , path is established b/w sender and reciever which is maintained during the entire duration of Conversation.
- The telephone n/w are Connection oriented because they require the setting up of a Connection befor the actual transfer of

information can take place.

- Real time transmissing (2 way of voice signals across a n/w).



Circuit switched network

- From the figure I, II, III and IV are the ckt nodes for ckt switches.
- Node I, III, IV are connected to the communicating devices.
- → Node II is only routing node.
- → The end to end connection is maintained duration of a call.

Advantages:-
- The major advantages of ckt switching is that the dedicated transmission channel.
- Computers establish a link with the receiving links.

2. After the link is established, data is transmitted from sender to reciever.

3. After the dataflow stops, the link is released.

Disadvantages:-
- The connections are dedicated, then it cannot be used to transmit any other data even if the channel is free.
- Dedicated channels more bandwidth.
- It takes long time to establish the connection.

Packets Switching:- • Connectionless Services.

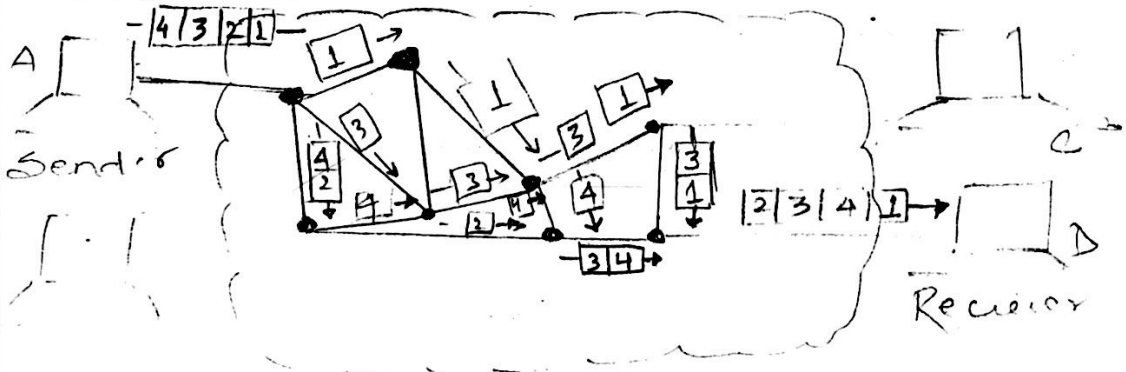
- Messages are broken into packets each of which includes a header with source and destination and intermediate node address information.
- Individual packets takes different routes to reach the destination.

Advantages:- • Bandwidth is Reduced by splitting data on to different routes in a busy ckt.

- If a certain links in the network goes down during the transmission then the remaining packets can be sent through another ~~Route~~ route.

Types
- Datagram
- Virtual ckt.

Datagram:-



Datagram packet Switching.

In this method, msg is divided into a stream of packets. Each packet is separately addressed and treat it as an independent unit. with its control instructions.

and

- In virt packets b/w Send
- Once the two ends Conversa

Messa

In tele transmit office to

- At the tel takes the the ~~decis~~ informati
- The opera a Comm or Store Like Beca
- Message path blu
- In mes an Inde destinat Each i and st

Virtual ckt packet Switching:- It establishes logical address connection b/w the sending and recieving device called virtual ckt.

- In virtual ckt packet switching, all the packets travel through the logical connection b/w sending device and recieving device.
- Once the virtual ckt is established, then two devices uses it for the rest of the conversation.

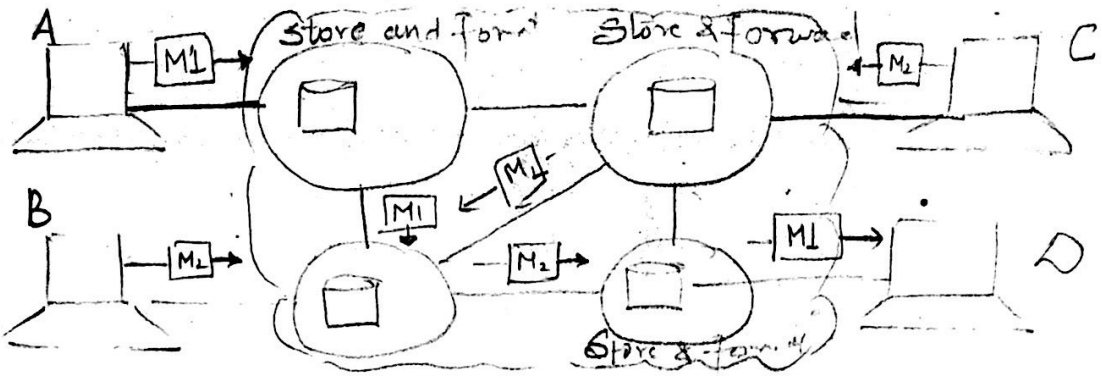
Message Switching:

In telegraph networks, the text msgs are transmitted from the source telegraph office to the telegraph switching station.

- At the telegraph switching station, an operator takes the decision of routing the msg based on the ~~decision of routing~~ destination address information.
- The operator will either forward the msg if a communication channel to destination is free. or store the msg till the communication line become free.
- Message switching doesn't establish a dedicated path b/w two communicating devices.
- In message switching each msg is treated as an Independent unit and Includes its own destination and source address.

Each intermediate device recieves the message and store it untill the next devices are

ready to recieve it and then forwards it to the next device. So mesg switching networks is called as a Store and forward networks.



[Message switching]

Advantages:- • Congestion reduced because it is able to store mesg until a Communic channel becomes available.

• It provides efficient traffic mgmt by assigning priority to the messages to be switched.

Disadvantages:- • Storing and forwarding delay, hence can't be used for Real time appln like voice and video.

Intermediate device require a large storing capacity since it has to store the message unless a free path is available.

Scanned by CamScanner

ISDN :- (Integrated

- ISDN provides many services text, videos, audios, fax (multiple services to multiple user)
- It is a W.A.N. becoming available widely.
- ISDN supports a variety of app^n that include both switched and non switched connection.

Types of ISDN

- NISDN — Narrow Band
- Broad Band ISDN

NISDN :- first generation of ISDN.

- It have smaller bandwidth and can support data rate 64KBps.
- due to low bit rate the quality of service provided by an ISDN is poor.
- Quality of video signal in NISDN is also poor.
- It is a circuit switching orientation.

Example :- Frame Relay :- provides the service to determine the start and end of each frame.

- It also detects the transmission errors.
- It provides higher throughput and lower latency.
- It can be used at excess upto 2Mbps.

Broad Band ISDN :- It supports higher data rates due to the use of optical fibre Cable.

- Quality of service is improved by using the broadband ISDN.
- The bandwidth of an optical fibre Cable is very high, so the broadband can allow transmission, images, video.

Ex. ATM (Asynchronous Transfer Mode) Connections are called virtual ckts.

- They are similar to leased telephone line
- Atm uses fixed ~~AAL~~ length packets called cells.
- A.t.m. works in range of 10 to 100 Mbps.

Services provided by ISDN :-

a. fax
b. video text services.
c. telly text services.
d. data applications.
e. voice applications.

ISDN address Structure :-

provides services to the multiple users simultaneously so it is essential to identify the specific user to which the service is to be provided.

For this purpose, we need to use ISDN address.

Types of

1. B cha
2. D cha
3. H cha

a. Basic

It is

= 2B+1D
= 2*64+1

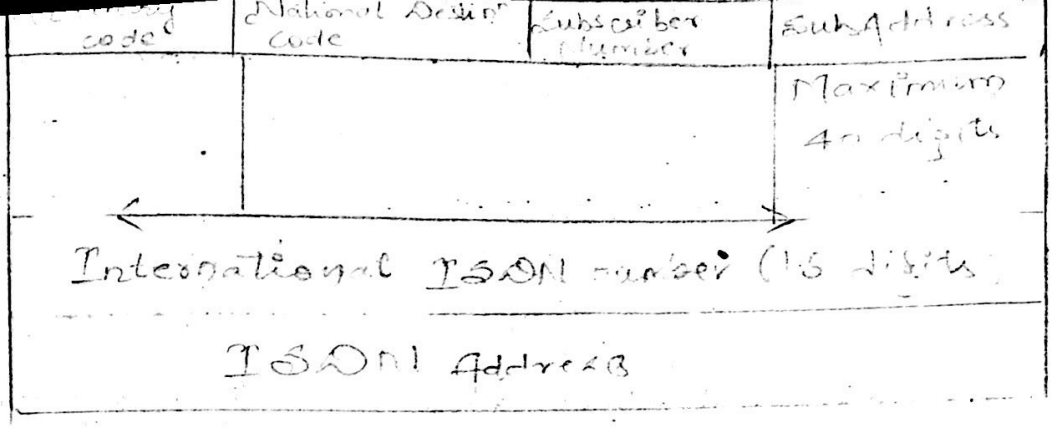
b. Primary

for

=

=

=



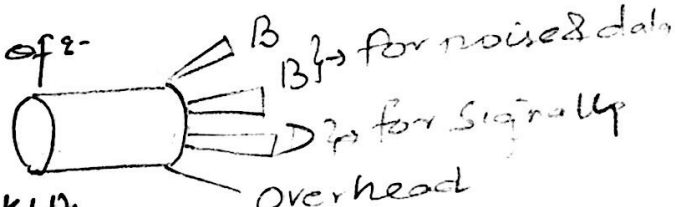
ISDN Address Structure (24)

Types of ISDN channels

1. B channel (Bearer channel) → 64Kbps
2. D channel (Delta and Demand channel) → 16 to 64Kbps
3. H channel (High Capacity channel)
   : 384 (H0), 1536 (H11) & 1920 (H12) Kbps.

a. Basic Access : (Basic Rate Interface) BRI

It is Composed of :-



= 2B + 1D + overhead

= 2 * 64 + 16 + 48 = 192 Kbps

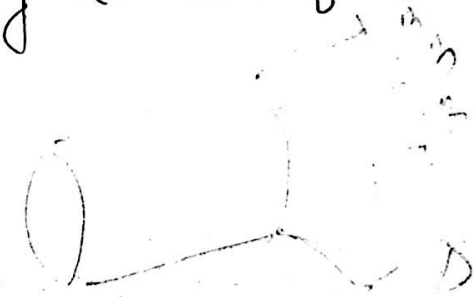
b. Primary Access (Primary Rate Interface) PRI

for 1.544 Mbps

= 23 B + 1 D

= 23 * 64 + 1 * 64

= 1.544 Mbps

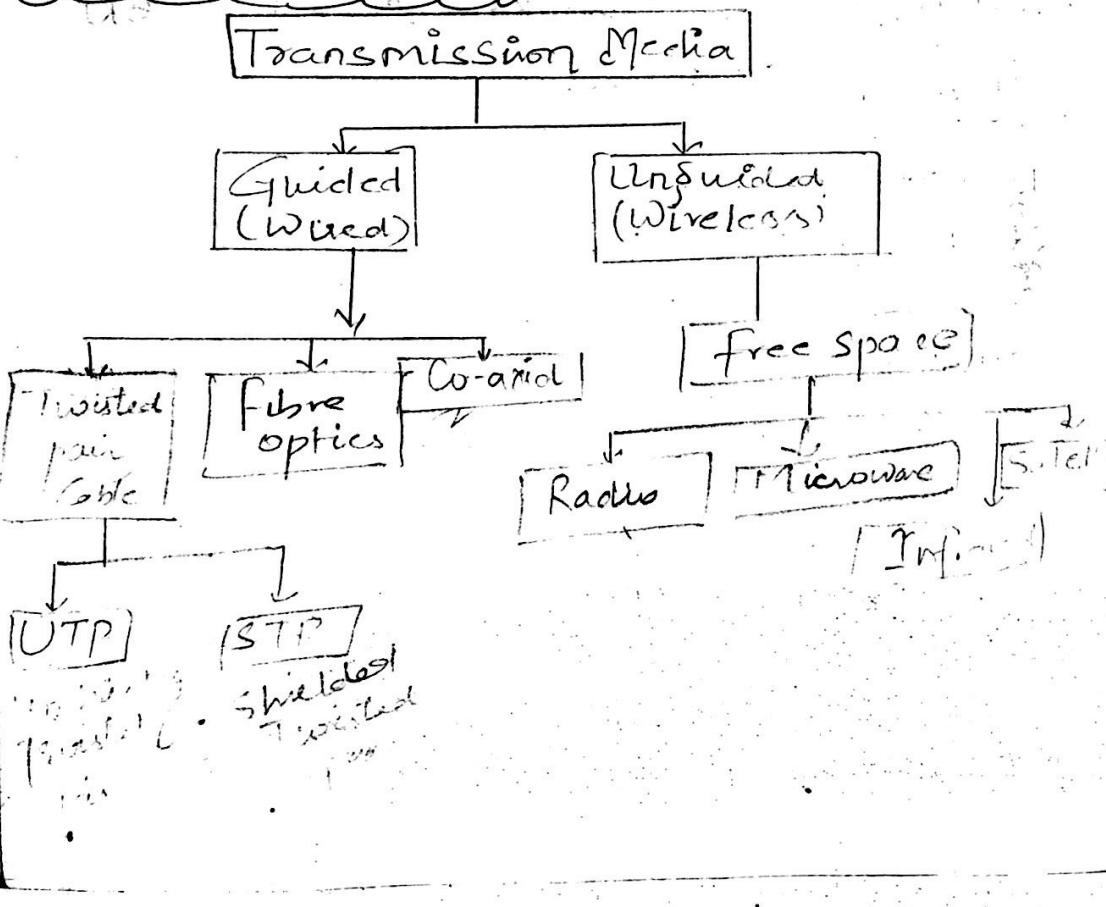


for 2.048 Mbps,
structure contains 30B + 16Kbps
=) 30B + 64D
=) 30X64 + 64
=) 2.048Mbps.

Overhead:- It is used for synchronizing and framing bits.

.Bit Synchronization:- The timing related to the data bit transfer is very important in Computer Commun. Physical layer governs the Synchronz" of bits by providing a clock which controls the transmitter as well as the reciever.

Transmission media:-



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7. Leads
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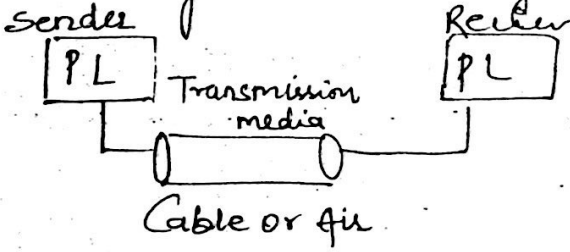
are actually located below the physical layer and directly controlled by the physical layer.



Comparision of Guided media and Unguided

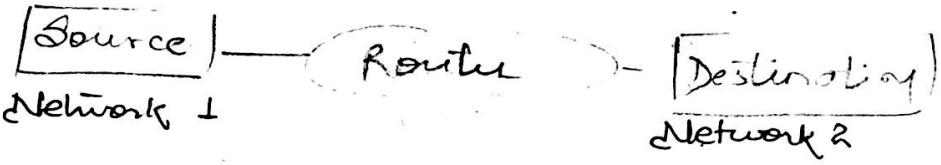
Guided media	Unguided media
1. The signal energy is Contained and guided with in a solid medium	1. The signal energy propagates in the form unguided electro magnetic Waves.
2. Twisted pair cable, Co-axial cable, fibre Cable are the example of guided media.	2. Radio wave, microwave, Satellite are the example of unguided media
3. It is used for point to point.	3. It is used for radio broad casting in all direc'
4. Installation is costly, time Consuming and Costly.	4. Installing needs less time and money.
5. Attenuation (Loss of Energy) depends exponentially on the distance. e^{-}	5. Attenuation is proportional to Square of the distance d^2
6. Additional transmission Capacity Can procured by adding more wires.	6. It is not possible to procured Capacity. ↓ addl'al
7. Leads to discrete network topology.	7. Leads to Continuous network topology.

-: Interconnecting devices :-

1. Hub
2. Switch
3. Router
4. Gateway
5. Bridge
6. Repeater

Hub	Switch
1. It is a broadcast device.	1. It is a point to point device.
2. It operates at physical layer.	2. It operates at data link layer.
3. It is not intelligent.	3. It is an intelligent device.
4. It simply broadcast the incoming packets.	4. It uses switching tables to find the correct destination.
5. It cannot be used as Repeater.	5. Can be used as Repeater.
6. Not very costly.	6. Costly.
7. It is not a Sophistical device.	7. It is a Sophisticated device.

Router:- used to connected two or more networks.



- It is also used to provide the best path to the destination.
- It operates at the network layer.
- It contains multiple routing tables to select the best path to reach the destination.

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Example:-
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Bridge:-
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Bridge
network.

• Collection of programs and softwares.

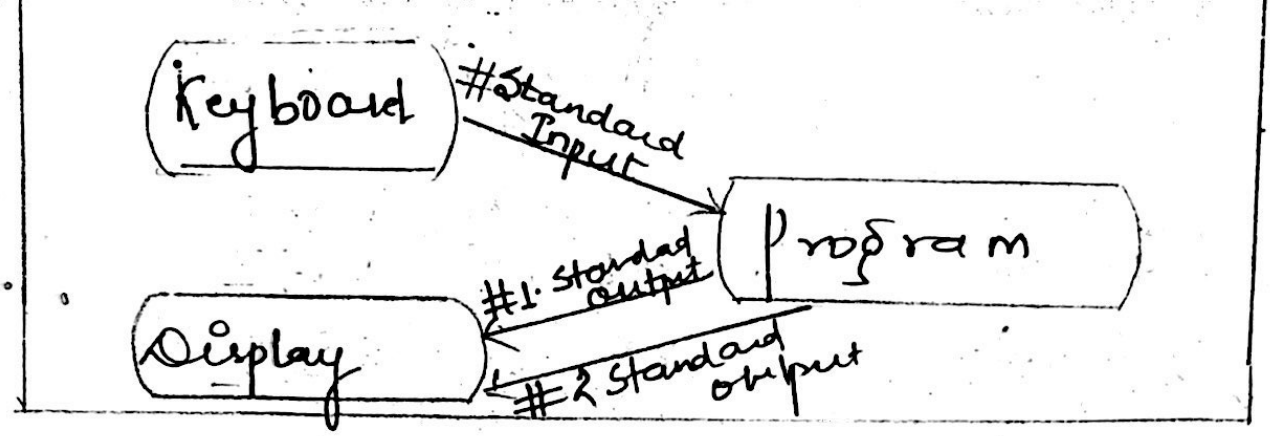
Gateway :- • Operates at the appⁿ layer of O.S.I.
• Used to Connect two Separate networks that use different Communication protocols.
• Gateway acts as a translater between networks using in compatible such as between T.C.P./I.P., SNA (System Network Architecture).
• A S/W applⁿ which Converts b/w different applⁿ protocol.

Repeater: It is used for amplifing the signals and also used for regenerating the signal.

• At the bottom of the physical layer we find the repeater
• These are the analog devices that are Connected to two Cable Segment.
• Repeater doesn't understands frames, packets, headers Only they understands the volts.

Example:- The length limit of the twisted Cable pair is 100mtr.

Bridge :- At the data link layer, we find bridge and switch.
Bridge Connects two or more Local area network.



Text terminal

- A Computer terminal is an ~~electromagn~~ electromechanical hardware device which is used for entering data information & displaying data from a Computer.

- Information is presented as an array of pre selected form characters.
- A text terminal is a Serial Computer interface for text entry and display.

Data Rate Limits:- (Maximum Capacity of Channel)

In the data communication, a large data is required to be transferred from one place to another.- (27)

It is necessary to transfer it as quickly as possible.

In the other words, the data rate in bits per second over a channel should be very high. bps should be high

The data rate depends on the following factors :-

1. Bandwidth
2. Quality of signal.
3. Level of signal, we can use.

* Two thms were developed to calculate the data rate :-

1. Nyquist's Thm for Noiseless channel.
2. Shannon's Thm for a Noisy channel.

1 (Nyquist Thm) :- Two important characteristics of a transmission channel are:-

a. Single to Noise Ratio (S.N.R.)

b. Bandwidth

These two characteristics will ultimately decide the maximum capacity of a channel to carry information.

Nyquist thm states that "If the bandwidth of a transmitting channel is B which carries a signal having L no. of levels then the

maximum rate R on this channel is given by

$$R = 2B \log_2 L$$

L = Level
B = transmission Chan
R = Rate,

If maximum data for reliable transmissing is defined as channel capacity C, the above expression can be written

$$C = 2B \log_2 L$$

2. Shannon's Channel Capacity is

- If the data rate or information rate R ~~are~~ and channel capacity C then $R \ll C$, no Confection and no noise.

→ This turm is Concerned with the rate of transmission of Information R over a Communicaton channel.

→ This channel capacity C is a rate of transmission in bits per Second. and

Negative Statement

- If $R > C$, then the probability of error is occured.

If the information rate R exceeded a specific value 'C', then the error probability will increase.

When $R > C$ Complexity of Coding is increased which results in an

increase in probability of error.

Shannon's extended Nyquist work. He included the effect of noise present on the transmission channel.

According to Shannon's Thm:-

$\left[\frac{S}{N}\right]$ (Signal to Noise), then maximum data rate is given by

$$R = B \log_2 \left[1 + \frac{S}{N}\right] \text{ bits/sec}$$

Q. The bandwidth of a channel 2MHz and its ~~Hz~~ its Signal/~~R~~Noise = 63. Calculate the appropriate bit rate and Signal travel.

$B = 2MHz$

$\frac{S}{N} = 63$

~~Bit rate~~

$\frac{S}{N} = 63$

$B = 2MHz$

$R = B \log_2 64$

~~$R = 64 \log_2$~~

$R = 2MHz \log_2 [64]$

$R = 2 \times 10^6 \log_2 [64] = 6.$

$\Rightarrow 12 Mbps$ This is an upper limit.

$R = B \log_2 L$

$\Rightarrow 2 \times 2 \times 10^6 \times \log_2 [64]$

$\Rightarrow 2 \times 2 \times 10^6 \times 6$

$\Rightarrow$

$\log_2 64$

$R = 2 \times 10^6 \log_2 L$

Lower value $= 8 Mbps$

$\Rightarrow 8 \times 10^{-6} = L$

$\Rightarrow 8 \times 10^6 = 2 \times 2 \times L$

$\Rightarrow \frac{8 \times 10^6}{4 \times 10^6} = 2 \times L$

$\Rightarrow 2 = \log_2 L$

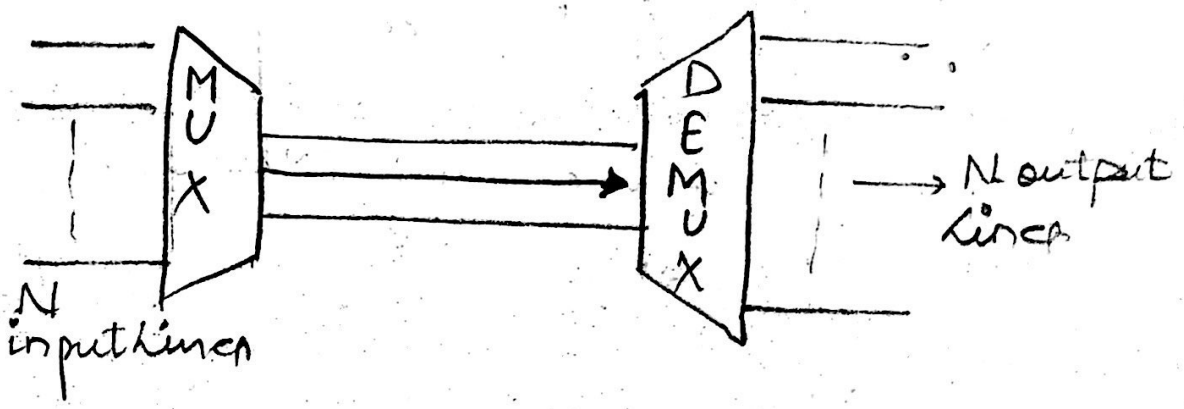
$\Rightarrow \boxed{L = 4}$

Physical Layer design issues ?-

Duties of the physical layer :-

1) Transformation of raw bits to signal.
2) Bit rate Control
3) Bit Synchronization
4) Multiplexing
5) Circuit Switching.

Band width



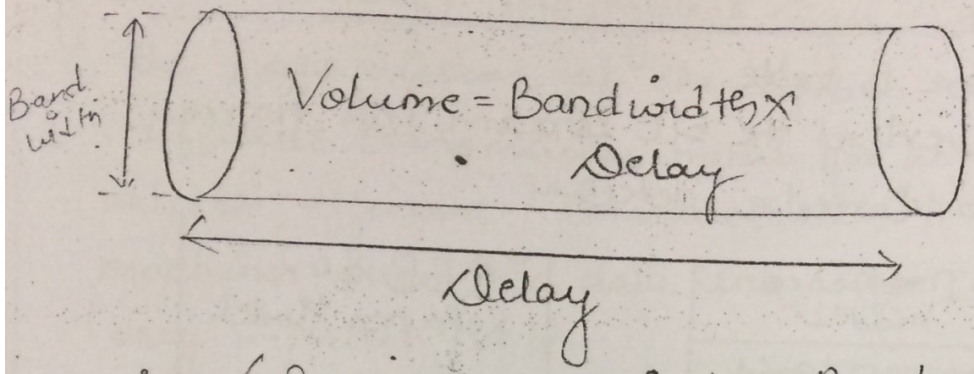
Types of Multiplexing

(1) Frequency Division Mux. [FDM]
(2) Time " " [TDM]
(3) Wave Length " " [WDM]

Note :- Multiplexing is the set of technique that allows simultaneous transmission of multiple signals accross a single data link.

At the receiving side, the stream is feed into the demultiplexer.

Remaining part of Delay Analysis &.

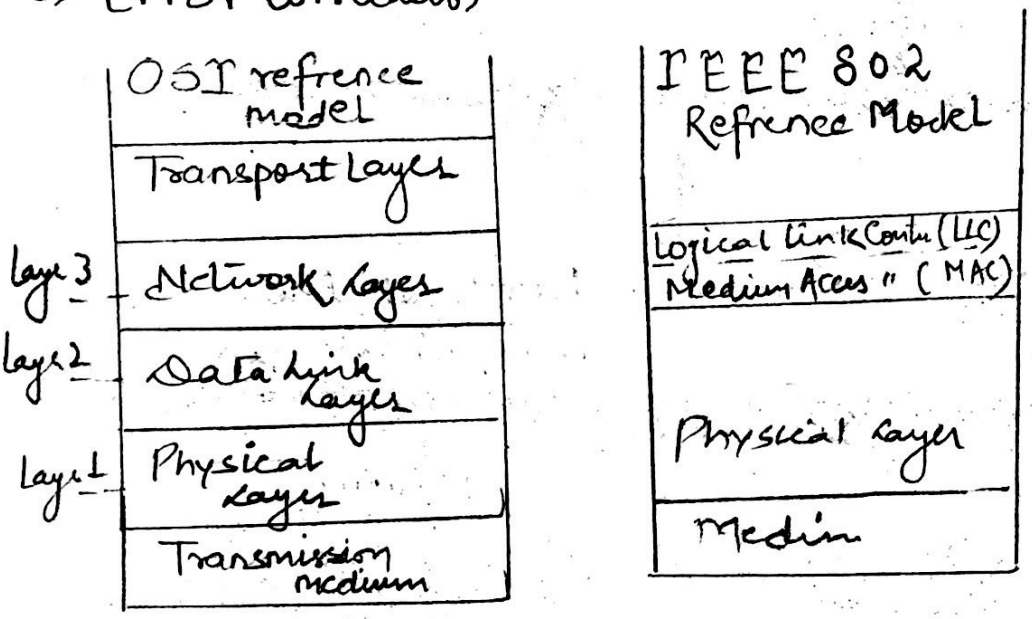


{ Bandwidth x Delay product }

Delay ∝ length of the communication channel.

Bandwidth ∝ $\frac{1}{\text{Delay}}$

→ Node to node
→ Converting the bit stream into frame
→ Error correction, detection



1) LLC:- • Error Control
• Flow Control

Ex. Error Correc^{n} & Detec^{n} technique

2) MAC:- • Responsible for resolving
→ Access to the shared Media.
• Responsible for Multiple Access resolution is called MAC.
ALOHA, TDMA, FDMA, CDMA.

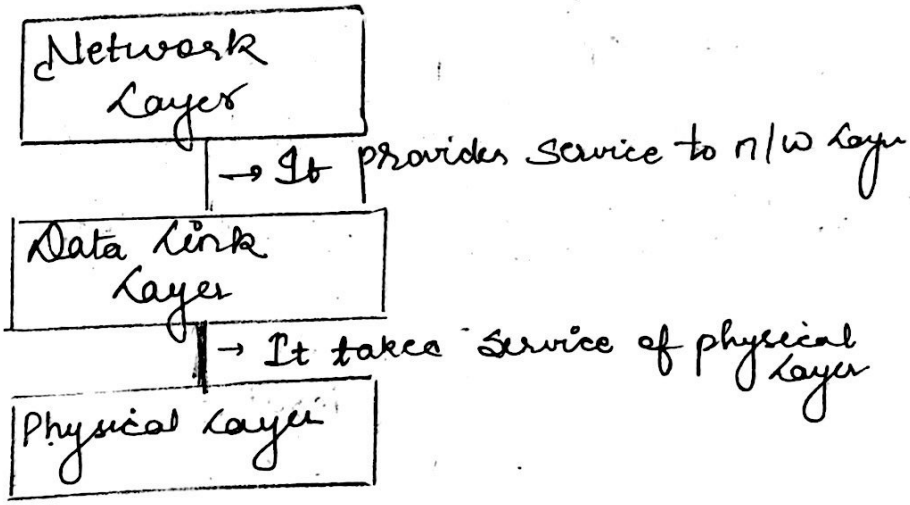
→ (We will not use dedicated Sender and reciever) not in point to point.
→
Simultaneous access have multiple user.
→ time slot lagana pdega.

Data Link Layer:-

Introduction:- The physical layer deals with the transmission of the signals over different transmission media for achieving reliable, efficient communication b/w two machines then the data link layer plays very important role.

Data Link Layer basically deals with frame information, error control, flow control, physical address.

It is the second layer of O.S.I. model.



Functions of Data Link Layer:-

1. Data transfer
2. Frame Synchronisation
3. Addressing
4. Flow Control
5. Error Control
6. Link Management

Frame Synchronizn:- Starting and ending Bt. of each frame should be recognized by each machine.

The source machine data in blocks called frame to the destination machine.

Addressing:- It provides the physical address to uniquely identify that machine.

Link mgmt:- Protocols or procedure are required for Link mgmt.

- The initialization, maintainance and termination of the link b/w source and destination is required for the effective exchange for the data.
- It requires Co-ordination and Co-operation b/w stations.

Types of Services provided :-

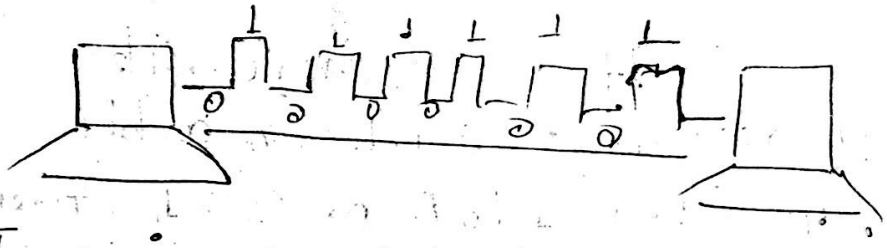
1. Unacknowledged Connectionless Service
2. Acknowledged Connectionless " (from receiver)
3. Acknowledged Connection oriented Service
   - Positive
   - Negative

1. Unacknowledged Connec^{n}less Service :-

- In this type of service the destination machine doesnot send back any acknowledgement of the receiving frames.
- It is a connectionless services then no Connection is established before Communc^{n}
- If a frame

Timing = acknowledgment + Sender to Reciever time + Reciever transmissing. processing. - ...

- Resends.
- timout.



The noise can introduce an error in the binary bits travelling from one system to other.
Zero may change to one or viceversa.

Types of error :-

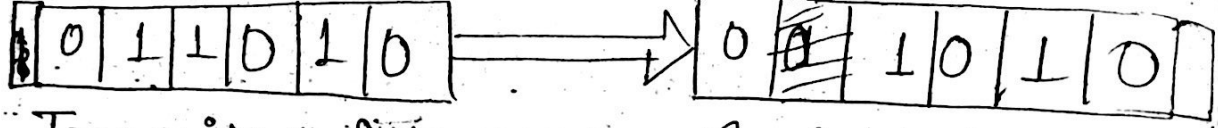
(1) Content error :- Zero may change to one or viceversa.

(2) Flow Integrity error :- Such errors are introduced due to missing blocks of the data.

- It has been delivered to a wrong destination.
- Data block may be lost in the network.

Note :- Depending on the number of bits in error, we can classify the errors into two types :-

(1) Single bit error
(2) Burst bit error.

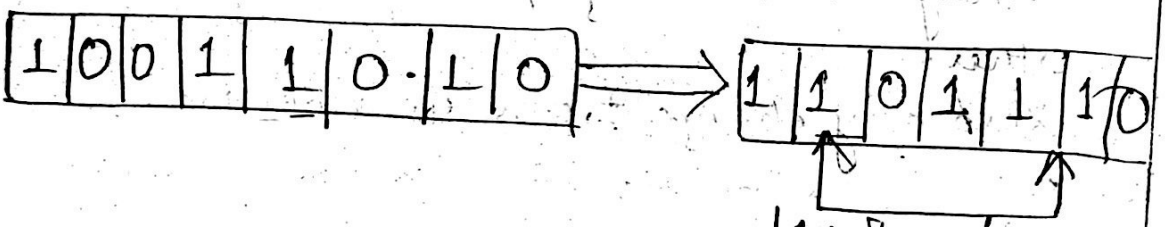


Transmitted Data Byte

Recieved Data Byte

Only one bit will change from 1 to 0 or 0 to 1.

(2) Burst error :- If two or more bits from a data unit such as a bit changes from 1 to 0 or 0 to 1, then burst error are said to be occured.



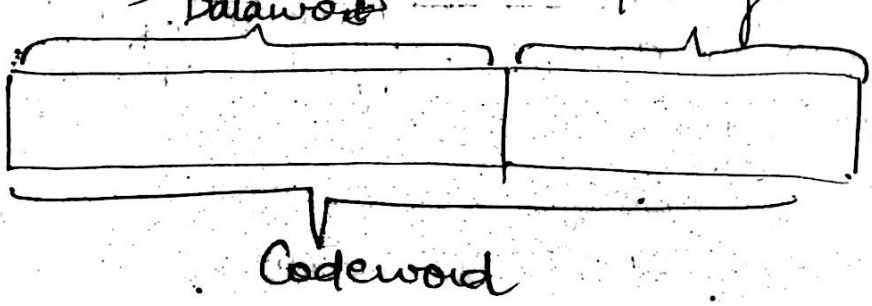
Send Data bytes

Length of Error mesage 5 bit

Recieved Data bytes

Length of the burst is measured from the first corrupted bit to the last corrupted bit.

Codeword :- Message bits + Parity bits



Hamm
define
element
Ex. >
W
Hammir
Transmi
Receiv
Redund
Data
1 0
Reject data
No
10.

Code Rate :- The ratio of ~~original~~ Data word to Codeword is the number of Mesg bits (K) to the total no. of bits (n) in a Code word then

$$\text{Code Rate } (r) = \frac{K}{n} \quad (3.2)$$

Hamming weight :- of a codeword is defined as the number of non-zero elements in the code words.

Ex. $X = 11010100$

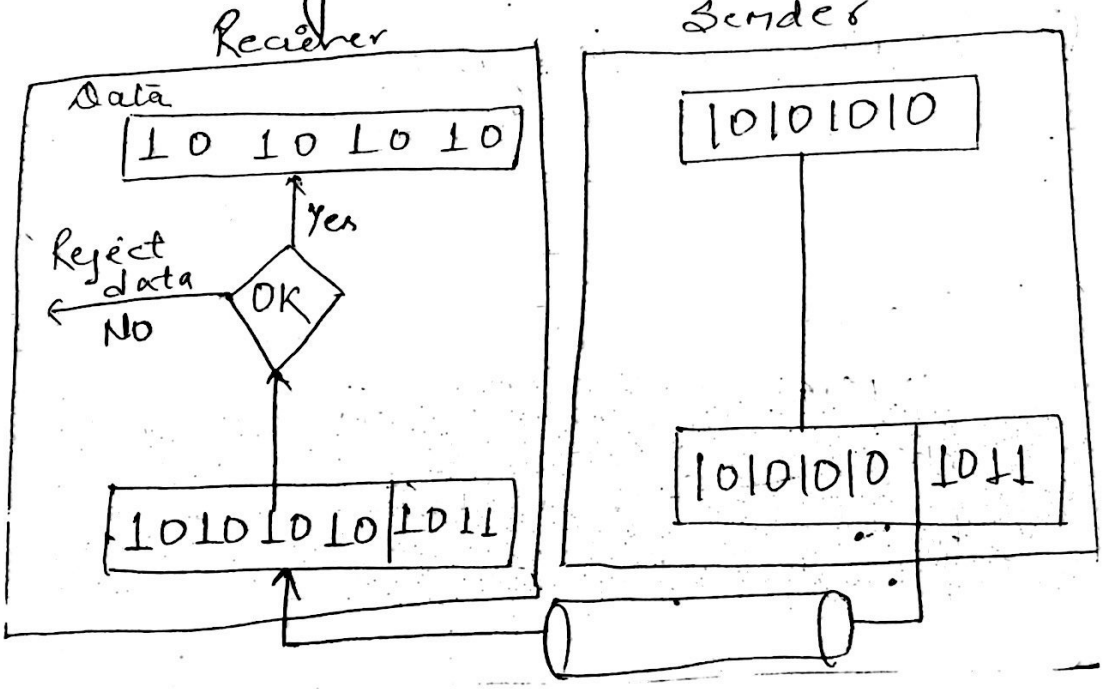
$W(X) = 4$ (non zero)

Hamming distance

Transmission codeword ⇒ 1 1 0 1 0 1 0 0

Received Codeword 2 ⇒ 0 1 0 1 1 1 1 0

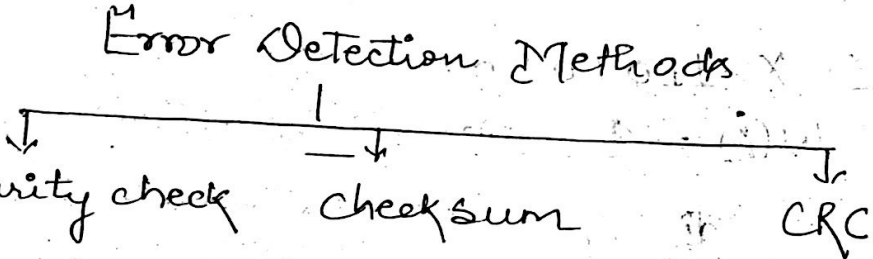
Redundancy :- is not the part of the data



Error detection uses the concept of redundancy which means adding extra bits for detecting errors at the destination.

The concept of including extra information in the transmission or the error detection is a good one. This technique is called Redundancy.

Parity bits are called the Redundant bits.



(1) Simply parity check
a. VRC (Vertical Redudancy Check).
b. L.R.C. (Longitudinal Redancy Check)

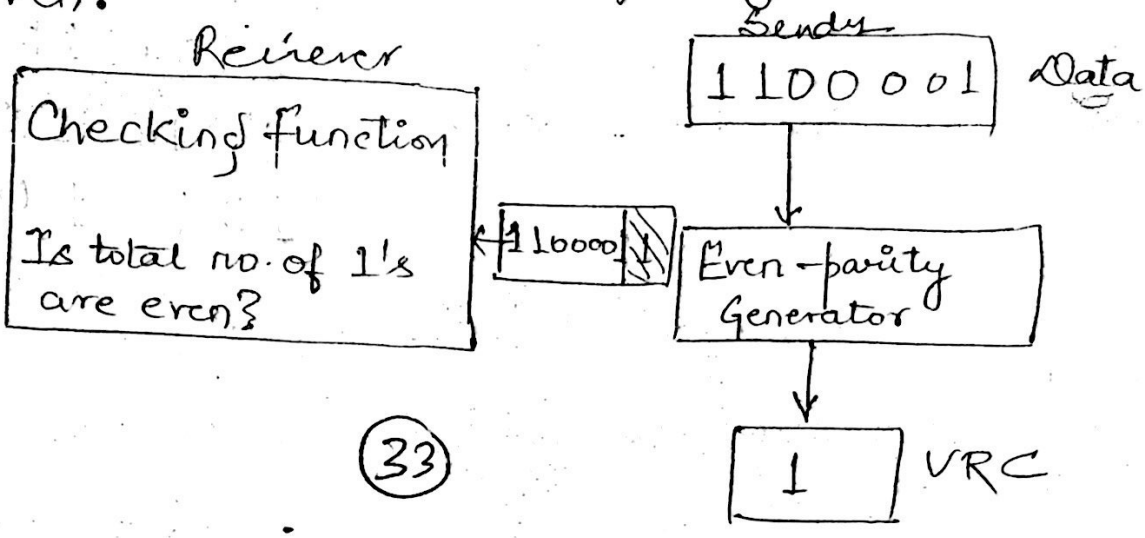
(2) Two dimensional parity check.

1. Simple parity check :-

a. V.R.C. (Vertical Redundancy Check)

The most common and least expensive mechanism for error detection is V.R.C. often called parity check.

parity is appended to every data unit so that the total no. of 1's in the unit (including the parity bit) becomes even.



V.R.C:- Suppose the sender wants to send the "World" in ASCII code by using even parity check.

~~The file characters~~

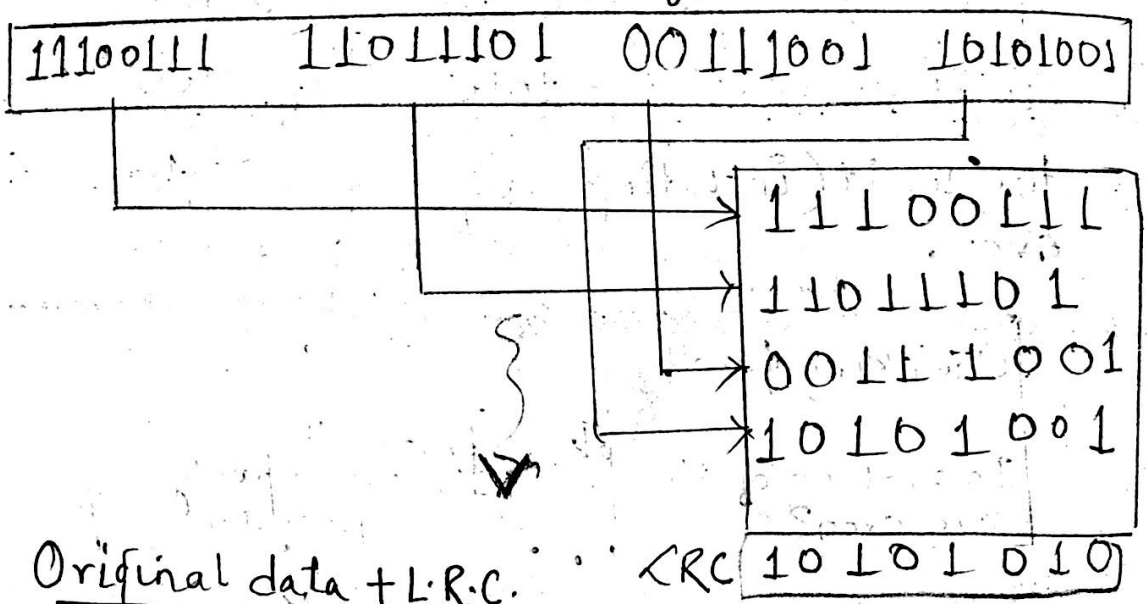
W = 1110111
O = 1101111
r = 1110010
l = 1101100
d = 1100100

1110111 0
1101111 0
1110010 0
1101100 0
1100100 1

Performance:-

- V.R.C can detect all single bit errors.
- It can detect burst errors only the total number of error in each data unit is odd.

(b) L·R·C (Least Recently Used)



Original data + L.R.C.

11100111 11011101 00111001 10101001 10101010

- L·R·C. Can be calculated after counting the number of 1's in each columns.
  If no. of 1's odd → Write 1.
  Otherwise → 0.
- In L·R·C., a block of bits is divided into rows and a redundant row of bits (8 bit) is added to the whole block.

Performance:-

- If two bits in one data unit are damaged and two bits in exactly the same position in another data unit are also damaged.
  Then the L·R·C. checker will not detect an error.

Example :- Suppose 2 data units are
11110000 & 11000011

If 1st and last bit in each ~~bit~~ of them are changed making the dataunit

01110001 & 01000010

then the error cannot be detected by C.R.C.

Example :-

← 10101001 00111001 11011101

11100111 10101010 (CRC)

If it is hit by burst noise of length 8 and same bits are corrupt, then we find

← 10100011 10001001 11011101 11100111

x x

whole is discarded. 10101010 (C.R.C).

Two-dimensional parity check :-

11001111	10111001	01110010	01010011
1 1 0 0 1 1 1	1
1 0 1 1 1 0 1	1
0 1 1 1 0 0 1	0
0 1 0 1 0 0 1	1

Row parity

0 1 0 1 0 1 0 1

Column parity

11001111	10111011	01110010	01010011	01010101

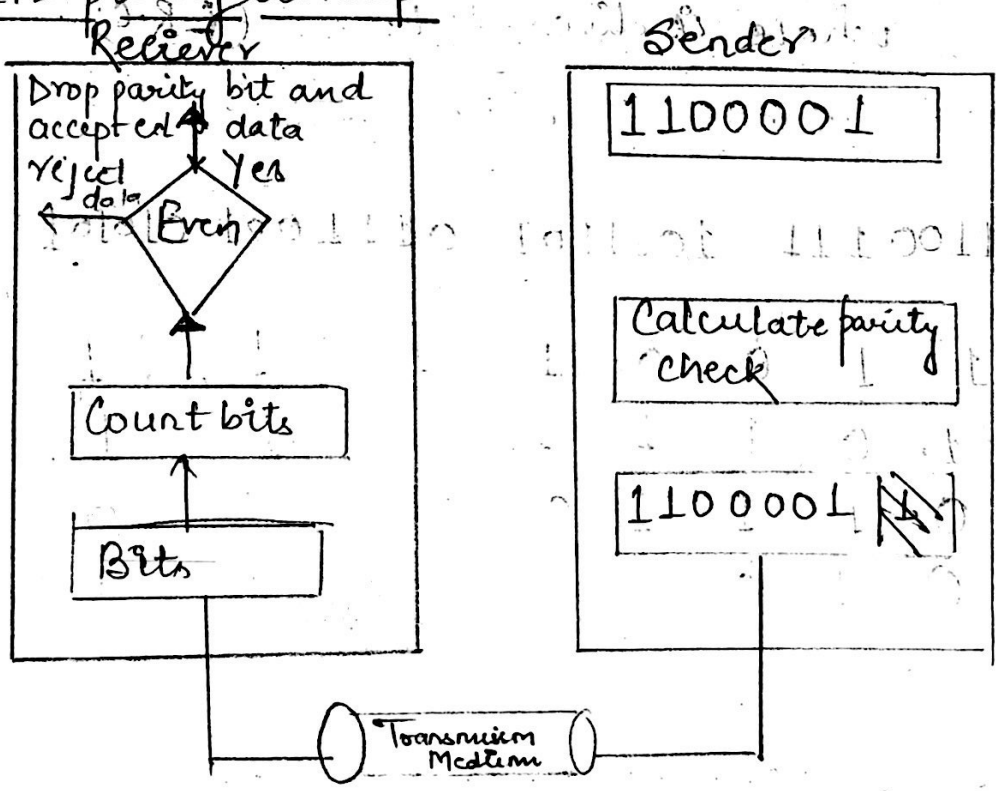
2-D parity check increases of detecting burst error

Performance:-

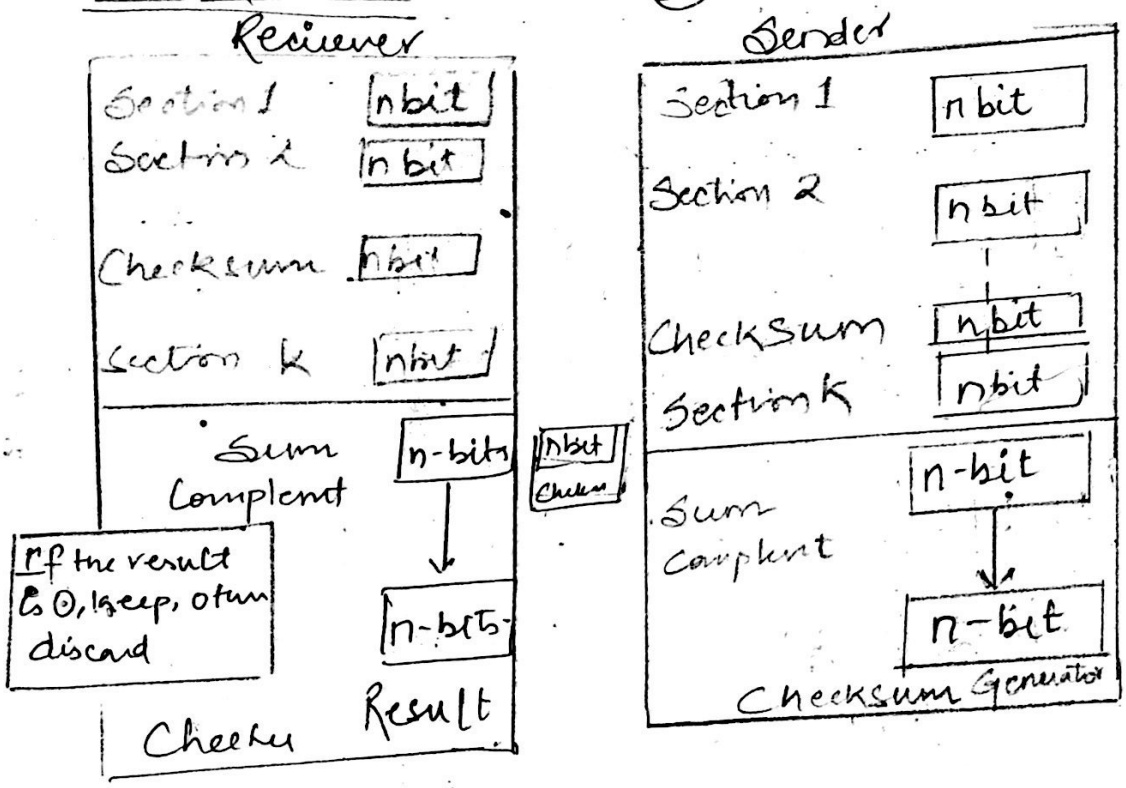
- A better approach is the 2-d parity check.
- In this method, the data word is organized in a table. (Rows & Columns).
- The 2-D parity check can detect upto 3 errors that occur anywhere in the table.

However, error effecting 4-bits may not be detected.

Even parity Concept



CheckSum :-



Error Correcⁿ :- Can be handled in several ways.

Hamming Code

- Retransmission
- forward Correcn.

1) **Error Correction by Retransmission** :-

In this, when an error is discovered, by the receiver, ~~Can Have~~ then sender retransmists the entire data units.

forward error correcⁿ

2) **Hamming Code** :-

$2^r \geq m+r+1$

- (Error correcting code, however, are more sophisticated, then error detecⁿ code and require more redundancy bits)

m = original message

r = Redundant bit

* (In forward error correcⁿ, a reciever can use an error correcting code) which automatically corrects certain errors).

m+r

⇒ 4+3=7 bit

r_1	1	0	1	r_3	1	r_2	r_1
7	6	5	4	3	2	1	

~~$d_1 d_2 d_3 d_4$ =~~

$r_1 d_1 d_2 d_4$

⇒ r_1 1 1 1

⇒ $r_1 = 1$

$r_2 d_1 d_3 d_4$

⇒ r_2 1 0 1

⇒ $r_2 = 0$

$r_3 d_2 d_3 d_4$

⇒ r_3 1 0 1

⇒ $r_3 = 0$

$2^2\ 2^1\ 2^0$

⇒ (001)$_2$

⇒ (1) error.

on 1st bit

d_7	d_6	d_5
11	10	9

1	0	1

1	0	1
11	10	9

~~$d_1 d_2$~~

= ~~1~~

⇒ 2

⇒ r_1 =

⇒ 23 1

⇒ r_2 1 0

⇒ r_2 =

~~r_3~~ =

⇒ ~~r~~

⇒ r

r_4 ⇒

=

If m = 7

$2^r \geq m + r + 1$

$2^r \geq 8 + 1$ (36)

$r = 4$

d_7	d_6	d_5	r_4	d_4	d_3	d_2	r_3	d_1	r_2	r_1
11	10	9	8	7	6	5	4	3	2	1

7+4 = 11

m = 1 0 1 1 0 1 1

1	0	1	r_4	1	0	1	r_3	1	r_2	r_1

1	0	1	r_4	1	0	1	r_3	1	r_2	r_1
11	10	9	8	7	6	5	4	3	2	1

~~$r_1 c_1 d_2 d_4$~~

= 1357

→ r_1 111

→ $r_1 = 1$

→ 23 67

→ r_2 1 0 1 01

→ $r_2 = 1$

r_3 → 4567

→ r_3 101

→ $r_3 = 0$

r_4 → r_4 101

→ $r_4 = 0$

~~0 0 0 1~~

0011

→ 3rd bit

1	1	1	0	1	0	1
d_7	d_6	d_5	r_4	d_3	r_2	r_1

$r_1 d_3 d_5 d_7$

1 1 1 1 → $r_1 = 0$

$r_2 d_3 d_5 d_6 d_7$

0 1 1 1 → $r_2 = 1$

$r_4 d_5 d_6 d_7$

0 1 1 1 → $r_4 = 1$

$r_4 r_2 r_1 \rightarrow 110$ ⇒ 6th bit

1 0 1 0 1 0 1

Q. A dataword to be transmitted is 1011. Construct even parity hamming code.

$2^r \geq m + r + 1$

$2^r \geq 5 + r$ $\quad r = 3$

$4 + 3 = 7$

7	6	5	4	3	2	1
d_7	d_6	d_5	r_4	d_3	r_2	r_1
1	0	1		1		

$r_1 d_3 d_5 d_7$

r_1 1 1 1 ⇒ $r_1 = 1$

$r_2 d_3 d_6 d_7$

⇒ r_2 1 0 1 ⇒ $r_2 = 0$

$r_4 d_5 d_6 d_7$

r_4 1 0 1 ⇒ $r_4 = 0$

1 0 1 0 1 0 1

11 10 9 8 7 6 5 4 3 2 1

1 0 0 1 1 1 0 0 1 0 1

1 0 0 1 1 0 1 0 0 1 0 1

1, 3, 5, 7, 11

1 1 0 0 1 = 1

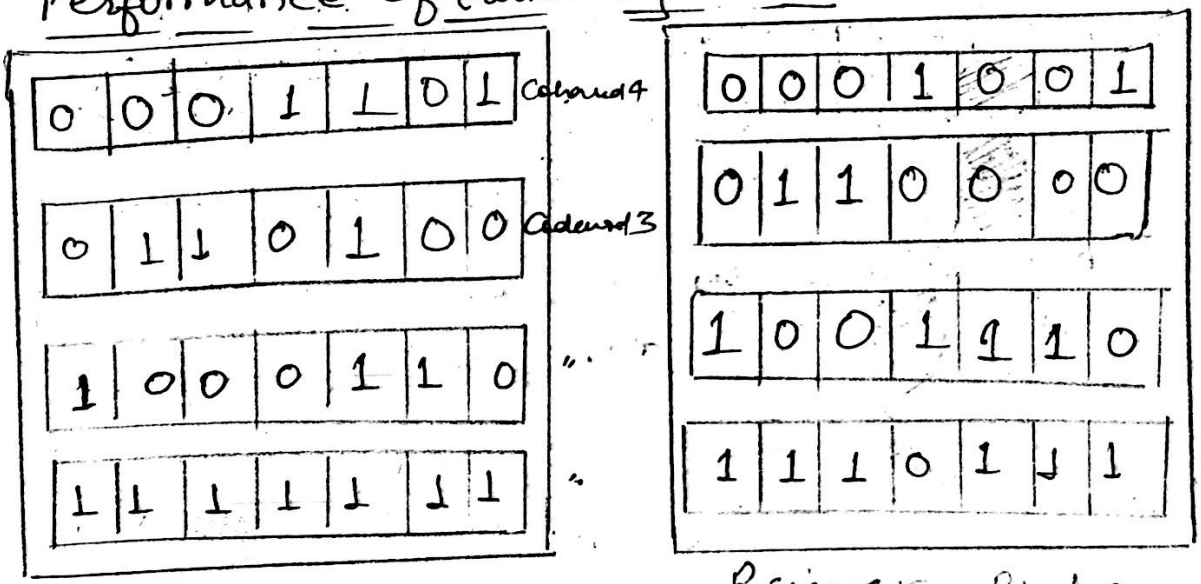
2, 3, 6, 7, 10, 11

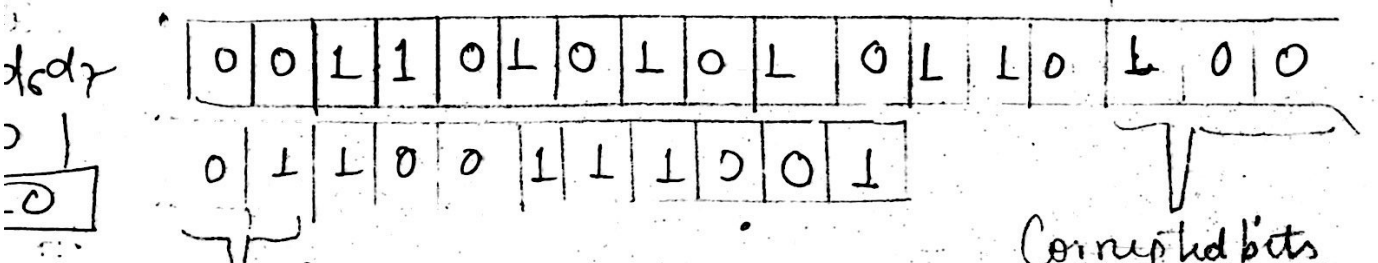
1 0 1 0 0 1 ⇒ 1

4 5 6 7 ⇒ 1

0 0 1 0

Performance of Hamming code :-





A Hamming code can only correct a single error or detect a burst error.

However, there is a way to make it detect a burst error solves in above ~~diff~~.

The key is to split a burst error b/w several codewords. one error for each code word.

- To make the hamming code respond to a burst error of size N then we need to make 'N' codewords out of our frame.

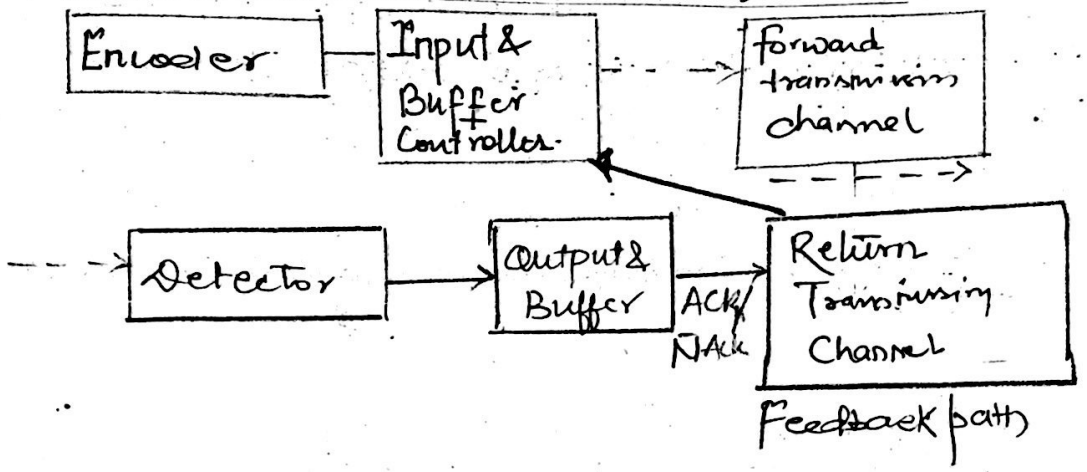
Instead of sending one code word at a time, we arrange the code words in a table and sends the bits in a table1 ~~a~~ columns at a time and then the bits are ~~send~~ columns by columns.

Figure shows that when a burst error of size 4 corrupts the frame only one bit from each code word ~~only one bit~~ is corrupted

The corrupted bit in each code word can then easily be corrected at the receiver.

"Error Control"

ARQ (Automatic Repeat Request)



~~In this~~ There are two basic system for error detection and Correction:-

a. Forward error Correction :- Hamming code.

Automatic Repeat Request

In ARQ, when an error is detected, a request is made for the retransmission of that signal.

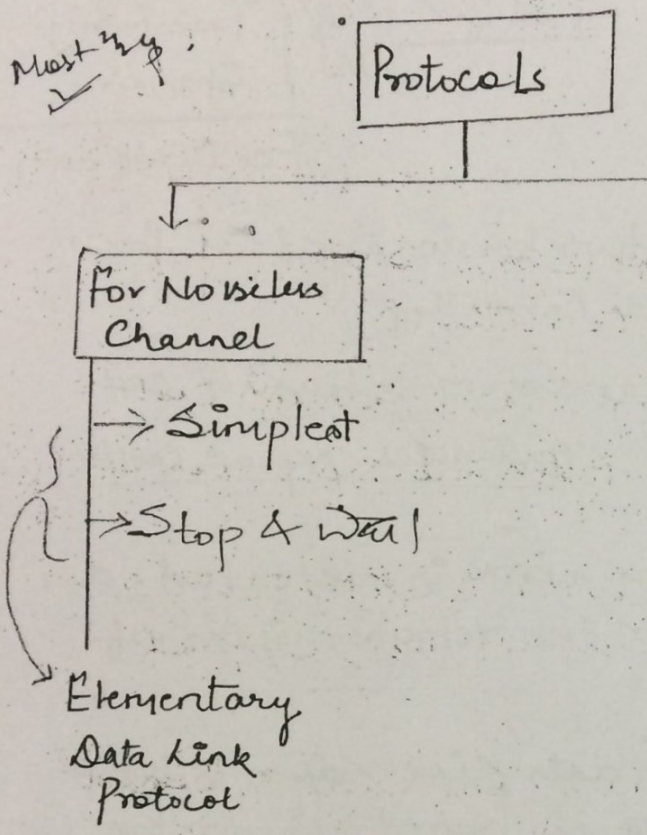
Error Control in the data link Layer is based upon the principle is ~~based upon the~~ Request for ARQ of the missing, lost or damaged frame.

Types of ARQ Systems:-

1) Stop and wait ARQ System

2) Go back N ARQ System

3) Selective Repeat ARQ System



Request

Request

In this p
overwhel

Design

Ge

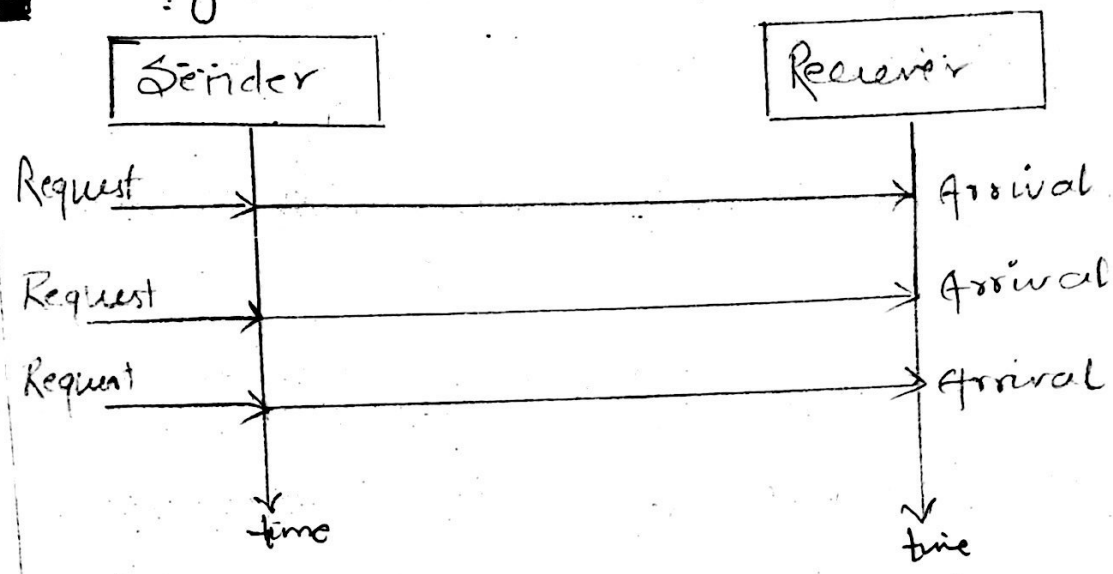
&

Noiseless channel:- An ideal channel in which no frames are lost, duplicated or corrupted.

(i) **Simplest**:— • Unidirectional protocol in which data frames are travelling in only one direction from sender to receiver.

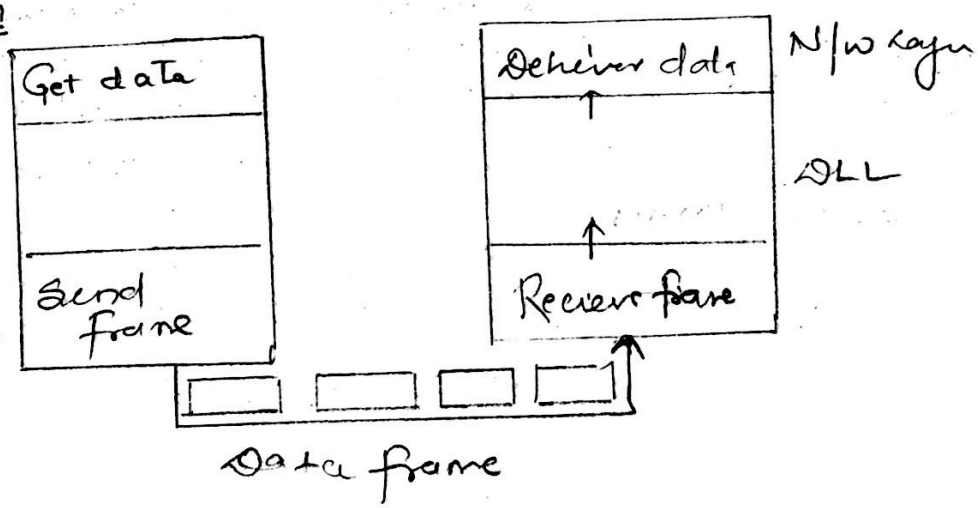
• We assume that the receiver can immediately handle any frame, it receives a frame with a processing time.

- DLL of the reciever immediately retrieves the Header from the frame and sends the data packet to its n/w layer.



In this protocol, the reciever cannever be overwhelmed.

Design



The Sender Side Cannot send a message unitill its

The reciever Side Cannot deliever the data packet to its n/w Layer untill a frame ~~exists~~ arrives.

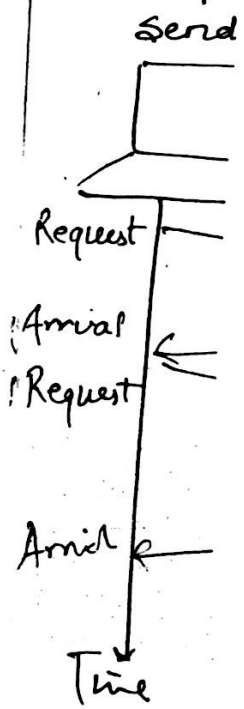
Sender Side Algorithm :-

```
1. while (true)                    // Repeat forever
2. {
3. wait for event();               // Sleep untill an event occurs.
4. If (Event (Request to Send))
5. {
6.     Get Data();
7.     Make frame();
```

Reci

1. whi
2. {
3. wa
4. If
5. {
6. Rec
7. Exac
8. Deli
9. }
10. }

2. STOP

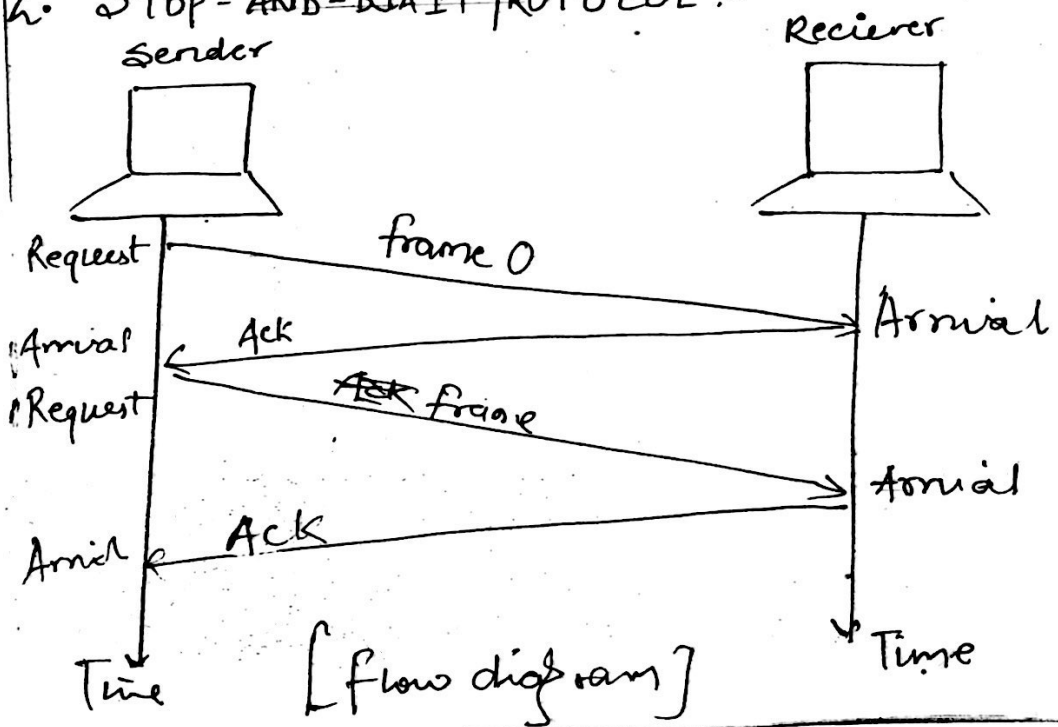


```
8. Send frame();        // Send the frame
9. }
10.}
```


Reciever Side Algorithm :-

```
1. While (true)          // Repeat forever
2. {
3. Wait for Event();
4. If (Event (Arrival Notification))
5. {
6. Receive frame();
7. Exact Data ();
8. Deliever Data ();
9. }
10.}
```

2. STOP-AND-WAIT PROTOCOL :-



[flow diagram]

The most unrealistic restriction in the previous protocol is the assumption that the receiving n/w layer can process the data with zero processing time.

But in this protocol it is assumed that a finite processing time is essential.

However, like the first protocol the communicating channel is assumed to be noise free and the communication is simplex.

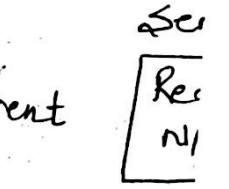
Ex. Only in one direction.

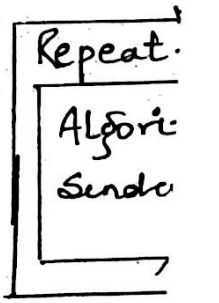
This protocol deals with an important problem.

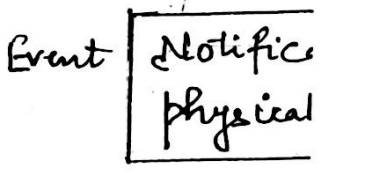
"How to prevent the sender from flooding and the Reciever with the data faster than its processing speed".

In this protocol, a small dummy frame is sent back from the Reciever to the transmitter to indicate that it can send the next frame.

Then the transmitter or sender sends one ph frame and waits for the dummy frame. It is called / acknowledgment.

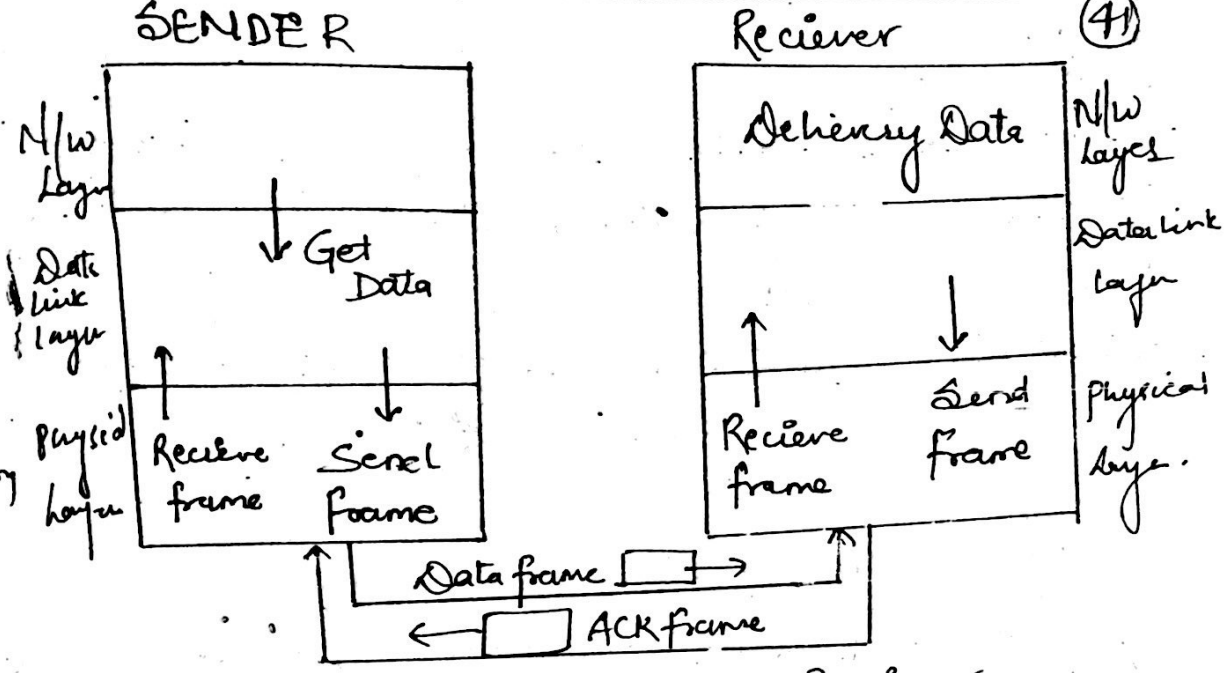


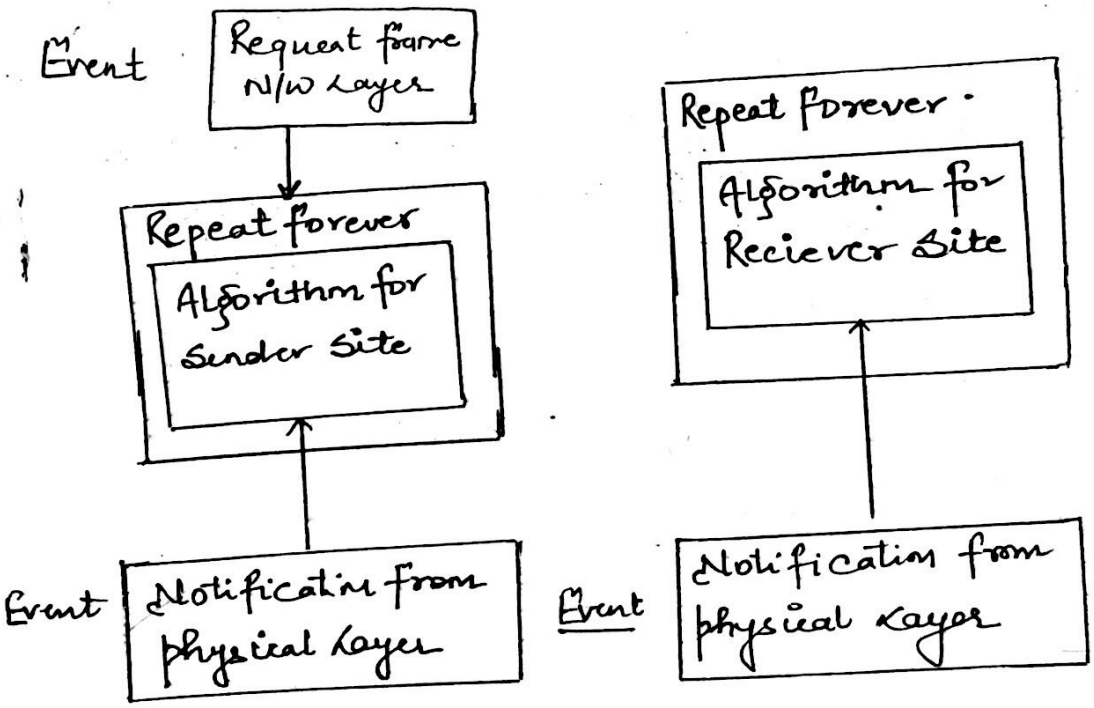




Note:- At a
a. A R
b. An
Lay

Design of STOP-AND-WAIT Protocol





Note:- At Sender two event can occur:-

a. A Request from the N/W Layer.
b. An arrival notification from the physical Layer.

Sliding Window :- refers to imaginary boxes at the transmissor and reciever.

This window holds the frame provides upper limit on the number of frames that can be transmitted before requiring an acknowledgment.

- The Sender maintains a seick of sequence numbers corresponding to the frames permitted to send are said to be falling in the sending window.

The reciever also maintain a reciever window.

Then it corresponds to the set of frames permitted to accept. The Sender's window and reciever window need not be of the same size.

They may be of same size or ~~the~~

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they. Can grow or shrink as the frames are sent or received.

Sequence Number :- Frame contains a sequence number ranging from 0 to 2^{m-1}.

m = no. of bits

Sliding window protocol :- There are three. protocol are most robust and bidirectional protocols.

- All these protocol belongs to a special class called sliding window protocols.
- They show different performance in terms of their efficiency, complexity and buffer Requirment.

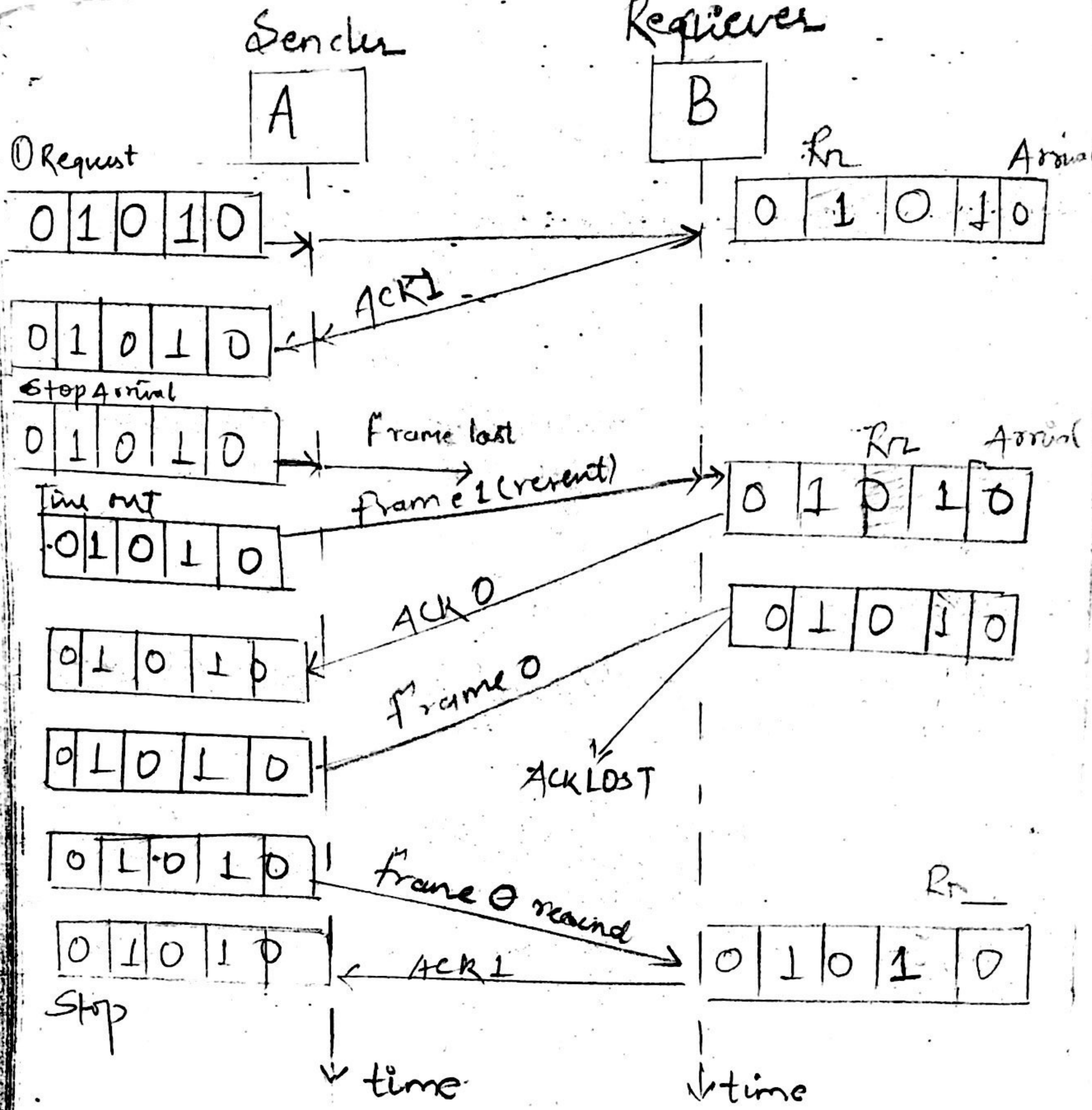
→ Stop and wait sliding window protocol.
→ Go back and ARQ.
→ Selective Repeat ARQ.

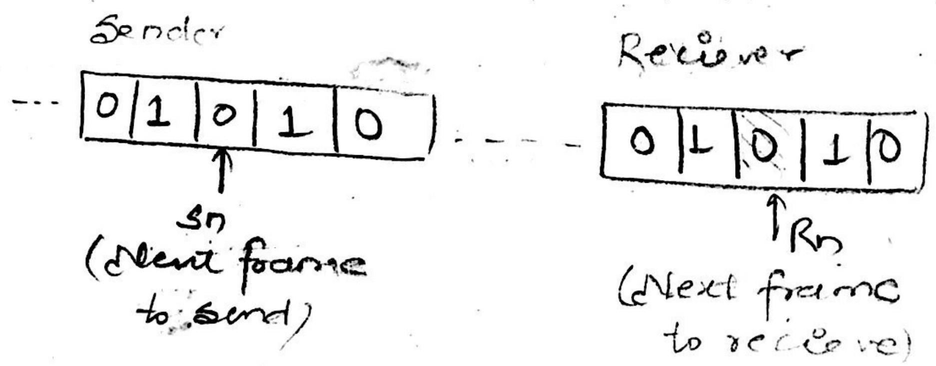
a) Stop and wait sliding window protocol :-

One bit sliding window protocol :-
(STOP-AND-WAIT ARQ)

Sequence no. $= 2^m - 1$ (0 TO $2^m - 1$)

Window Size = 1.





Sn, Rn are the control variables.

This protocol is called One bit protocol because the maximum window size is 1. (M = 1)

Window Size = $2^M - 1$

- It uses the stop and wait technique.
- The sender sends one frame and ~~waits~~ waits to get its acknowledgment.

- Only after receiving the acknowledgment, it transmitted the next frame. Then because of this one bit sliding window protocol is stop and wait protocol.

The operation of this protocol is based on the automatic repeat request principle because of this sliding window protocols are also called ARQ protocols.

Reason for retransmission:-

1. If the received frame is damaged.
2. If the transmitted frame is lost.
3. If the acknowledgment from the reciever is lost.
4. After a specified time if the transmitter doesn't receive ~~ACK~~ ACK or NACK frame then it retransmits the last frame.

Piggybacking :-

Advantages:-

- Better use of available channel bandwidth.

Disadvantages:-

- If the data link layer waits too long before transmitting acknowledgment then retransmission of the frame would take place.
- ~~Efficiency is less.~~

~~The disadvantages of piggybacking is the added~~ complexity.

Q - In a stop and wait ARQ system, the bandwidth of the channel or line is 1Mbps and 1 bit takes 20ms to make a Round trip (Delay).
- What is the bandwidth - delay product if the system data frames are 1000 bits in length. Then what is the utility of that

The bandwidth delay = $1 \times 10^6 \times 20 \times 10^{-3}$

$= \boxed{20 \times 10^3}$ bits

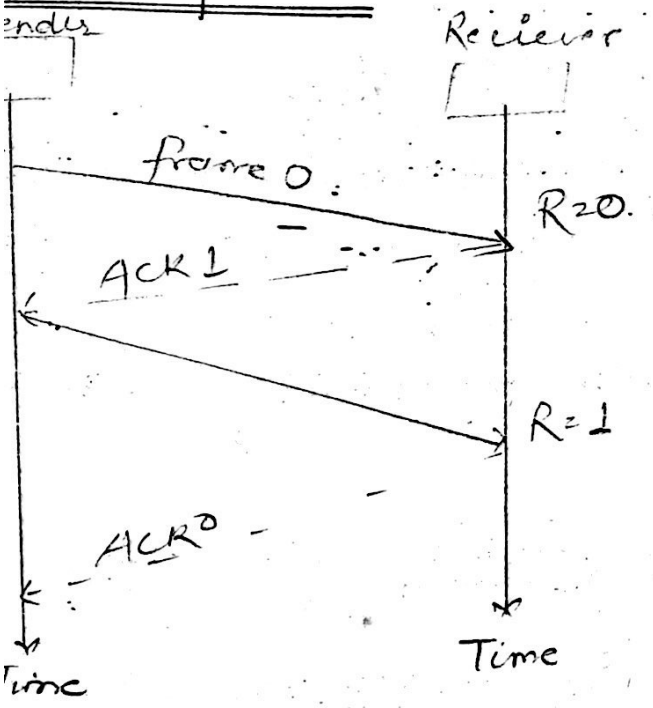
- System can send 20,000 bits at a time during the time it takes for the data to go from sender to reciever and then back again.

~~1000/20000 x 100 = 5%~~

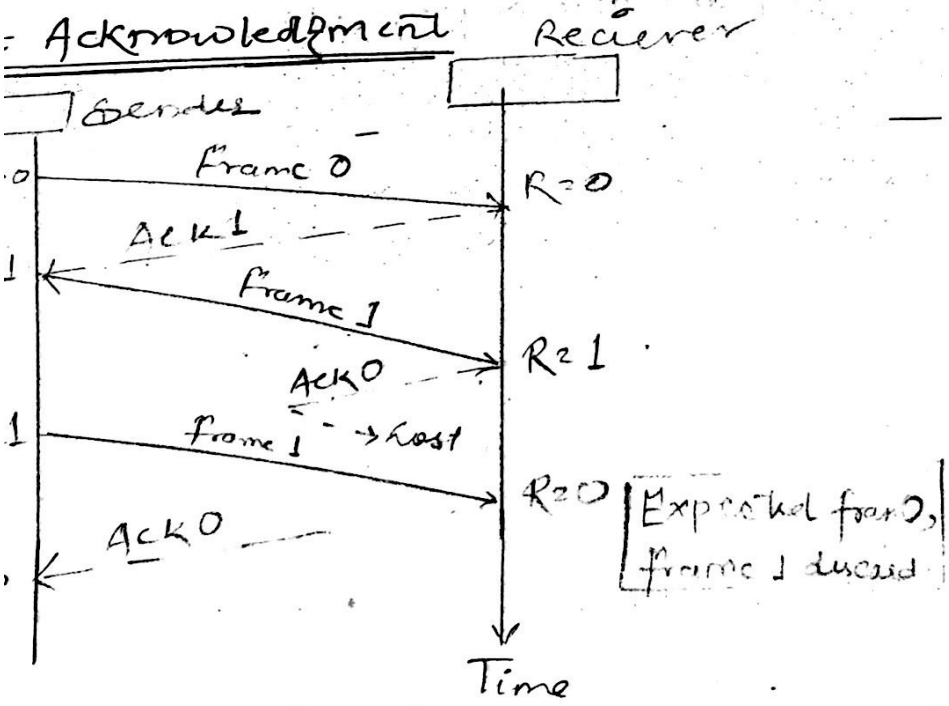
~~1000/100 x 20000~~ * for this reason, we can say a link with high bandwidths.

OR long delay, then use of stop and wait ARQ waste the capacity of the link.

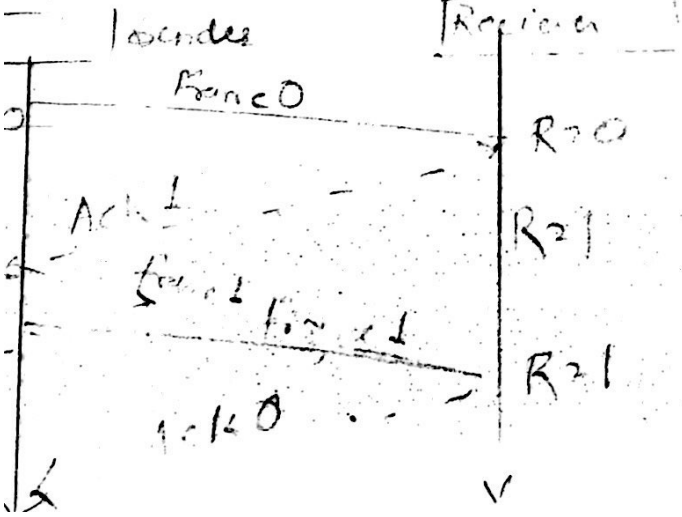
ormal Operation

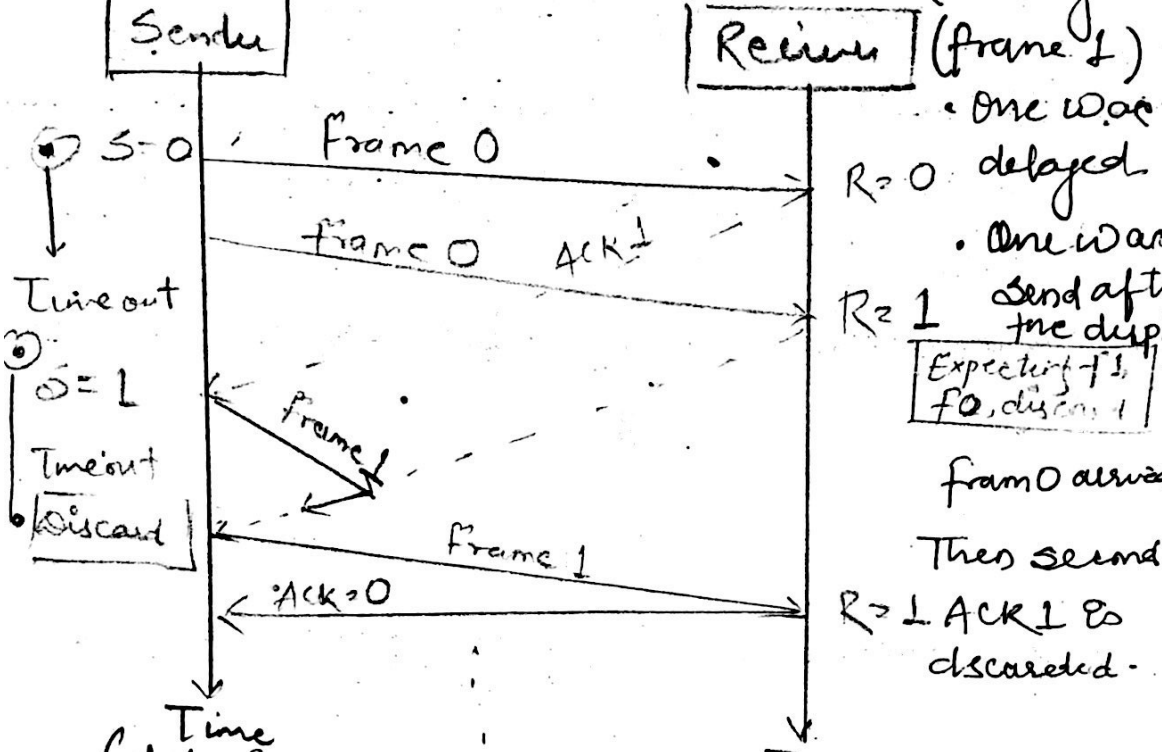


: Acknowledgment

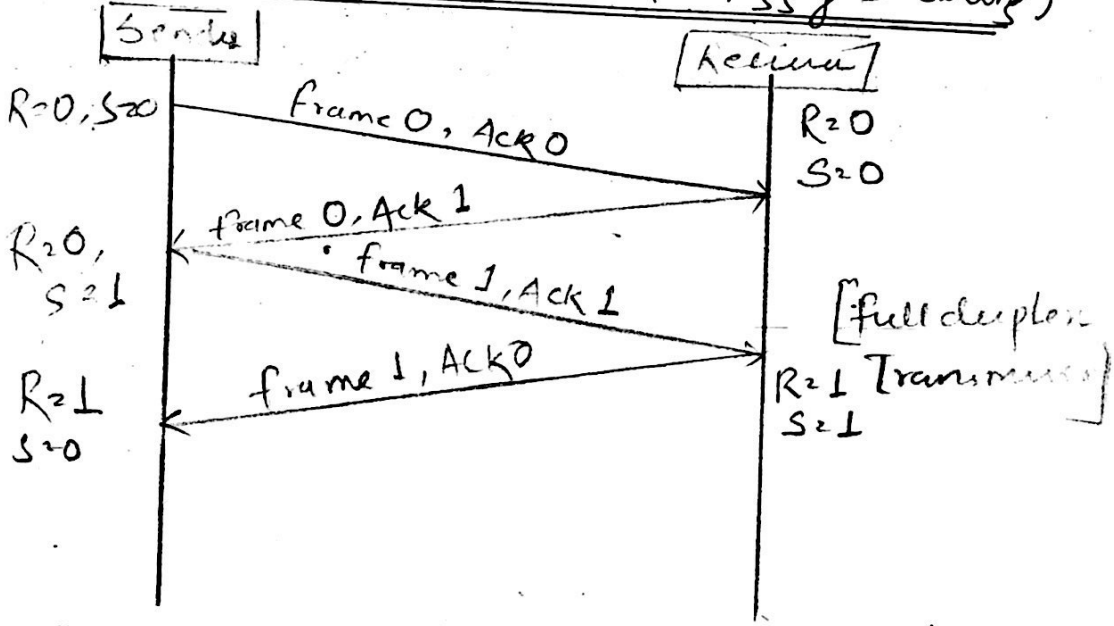


t OR Damaged frame :-





5. Bidirectional transmission (Piggy backing)



It is a method to Combine a data frame with an acknowledgment.

For Example :- from the fig. Station A and Station B both have data to sent.

- Instead of Sending separate data and acknowledgment frames,

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Station A sends a data frame that includes an acknowledgment. Station B behaves in a similar manner.

- Piggybacking can save bandwidth because the overhead from a data frame and an acknowledgment frame can be combined just on frame.

Note:- The stop and wait mechanism, we have discussed is unidirectional.
However, we can have bidirectional transmission if the two parties share two separate channel for full duplex transmission or share the same channel for half duplex transmission.

In this case, each party needs both a send & receive variable (send and expected)

* Back (Advantage & disadvantage)

Stop and wait (Disadvantage)

- Sender will have to wait atleast one round trip time before sending next frame.
- The waiting can be long for a slow network such as a satellite link.
- At any movement, only one frame is in transition.
- Protocols with Stop & Wait are very in-efficient.

Go-Back-N-ARQ

In stop and wait ARQ, at any point in time for a sender there is only one frame i.e send and waiting to be acknowledgement. This is not a good use of the transmission medium.

To improve the efficiency, multiple frames should be in transitory while transition file.

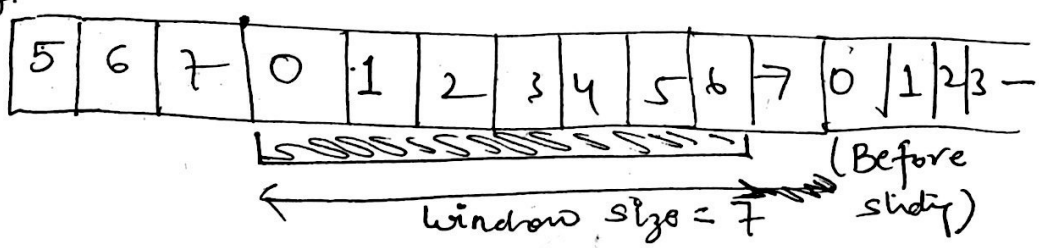
* Two protocol use this concept :-
  - Go Back & ARQ -
  - Selective repeat and ARQ.

V. Imp.

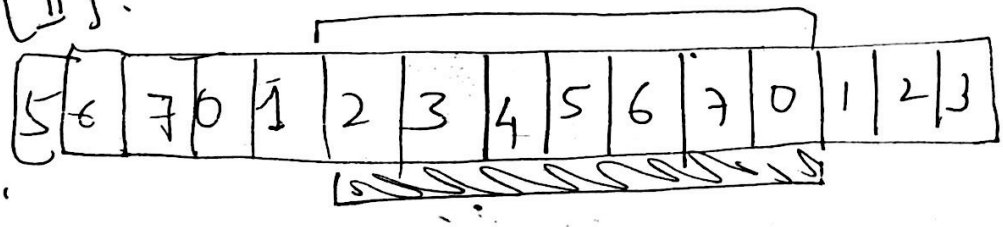
$2^3 - 1 = 7$

Sender sliding window for $n = 3$, $2^n - 1 = 2^3 - 1 = 7$

[I]:-



[II]:-



After sliding two frame

→ Sending window size = 7

→ Receiving window size = 1

Control

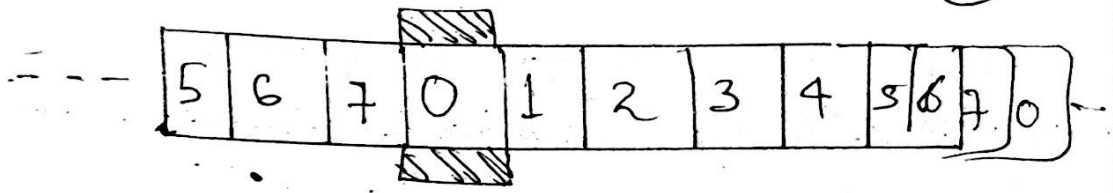
Frame Ack

Frame received

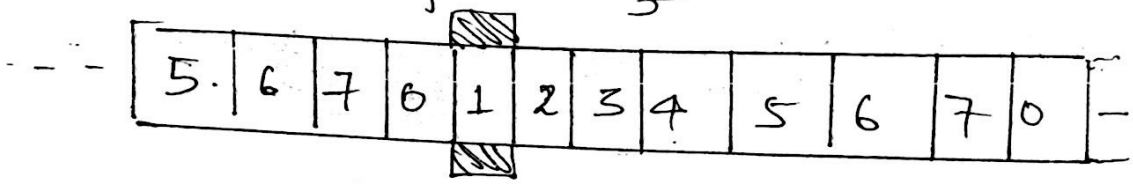
S_f = first f window

S_L = Last window

Receiving Sliding Window :-

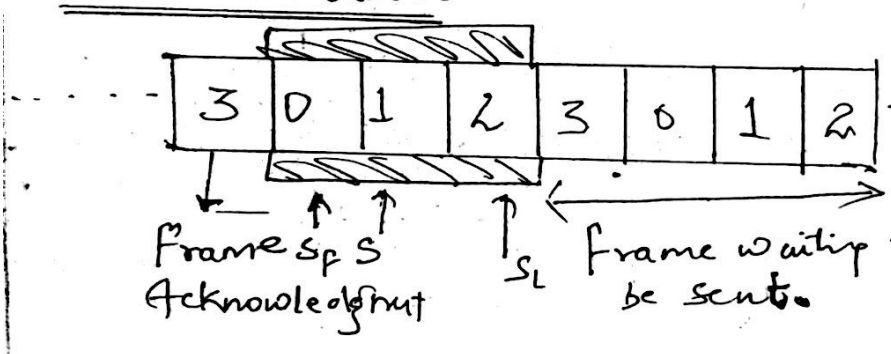


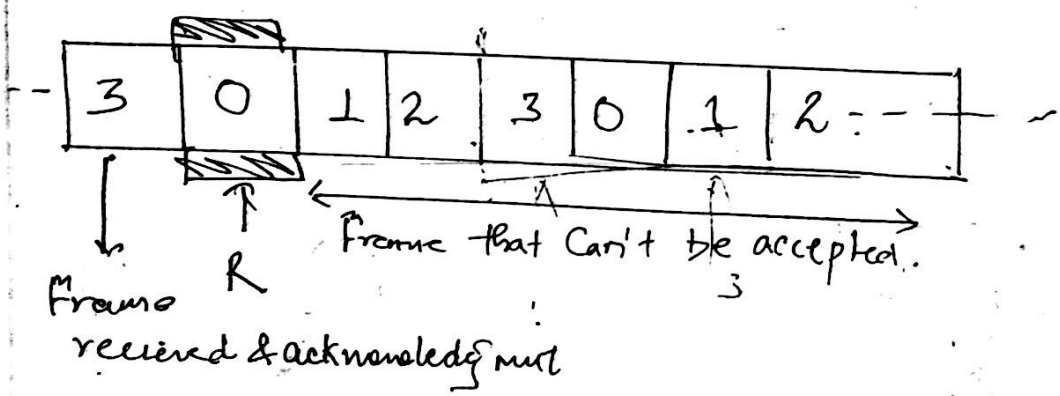
[Before sliding]



[After one frame sliding]

Control Variable :-





S = Control variables Sender has, holds the no. of the recently sent frame.

S_f = first frame in the window.

S_L = Last frame in the window.

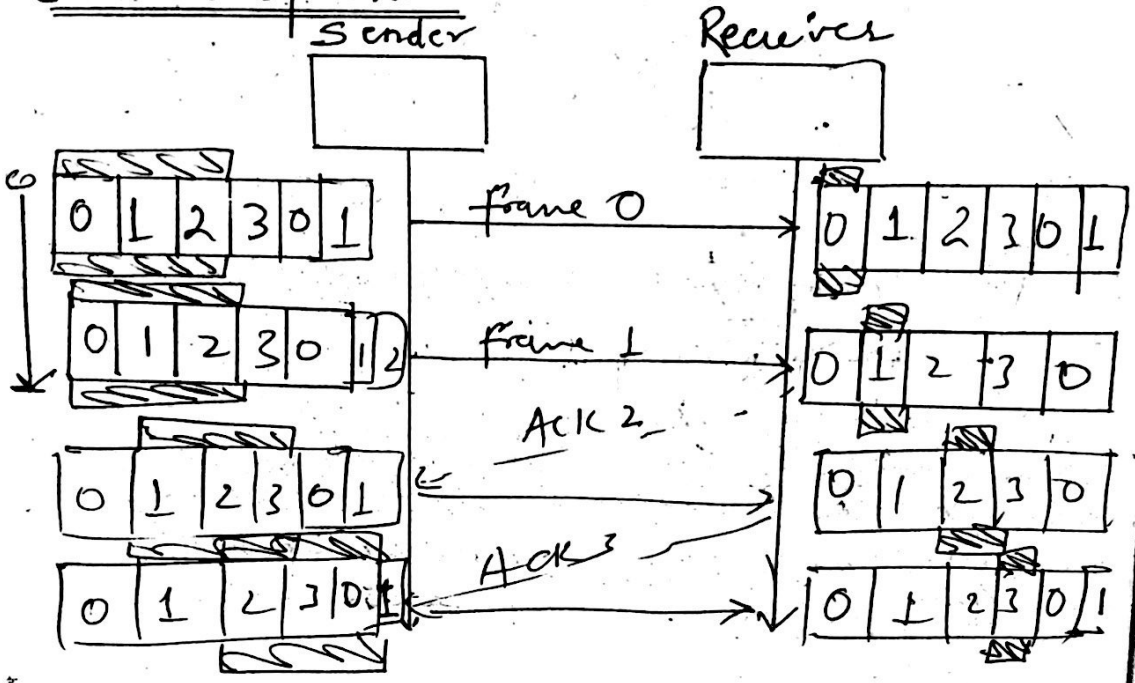
R = Receiver has control variable, holds the no. of next frame expected.

Then, Size of the window, we can Calculate :-

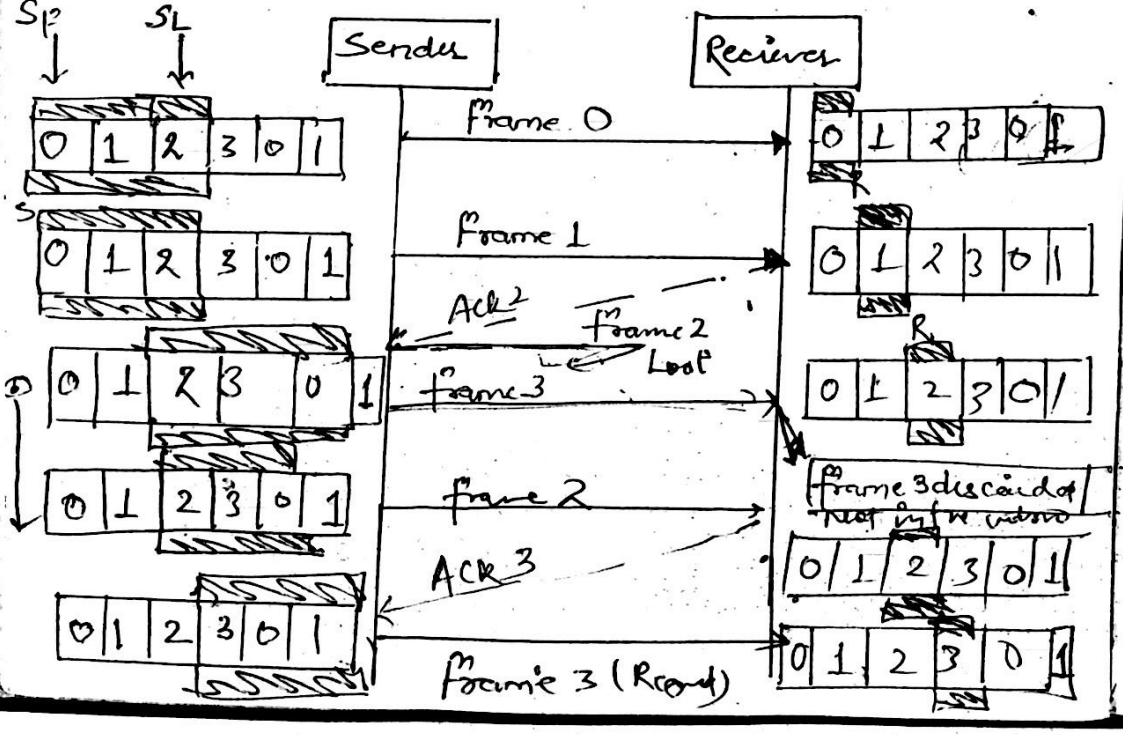
$$Wl = Sl - Sf + 1$$

Operations :-

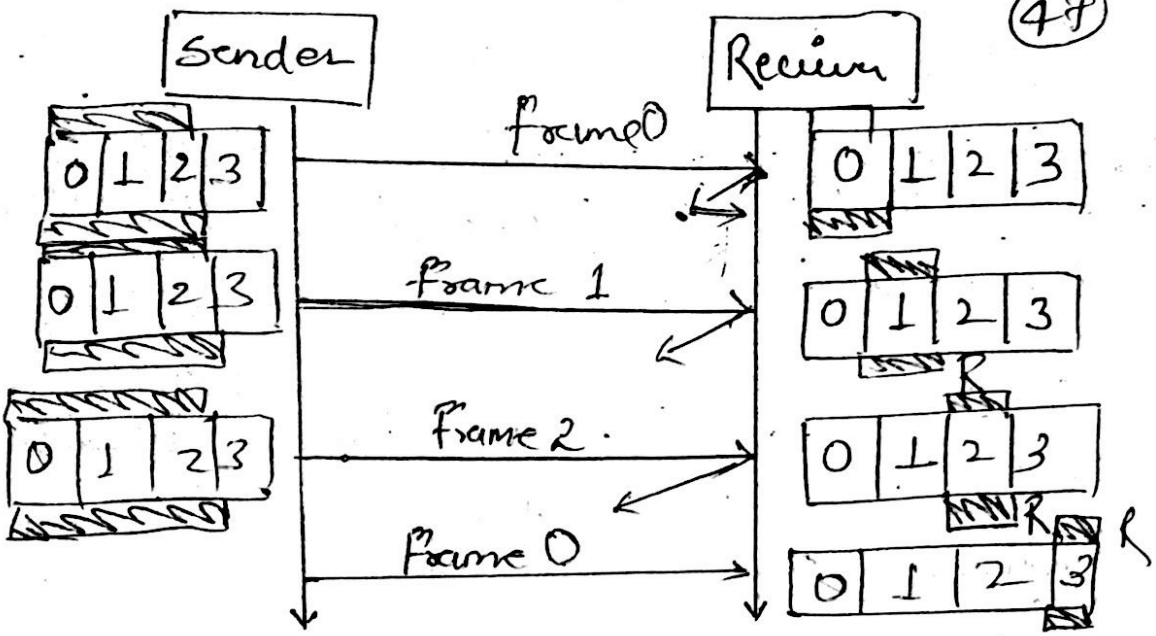
Normal Operation :-



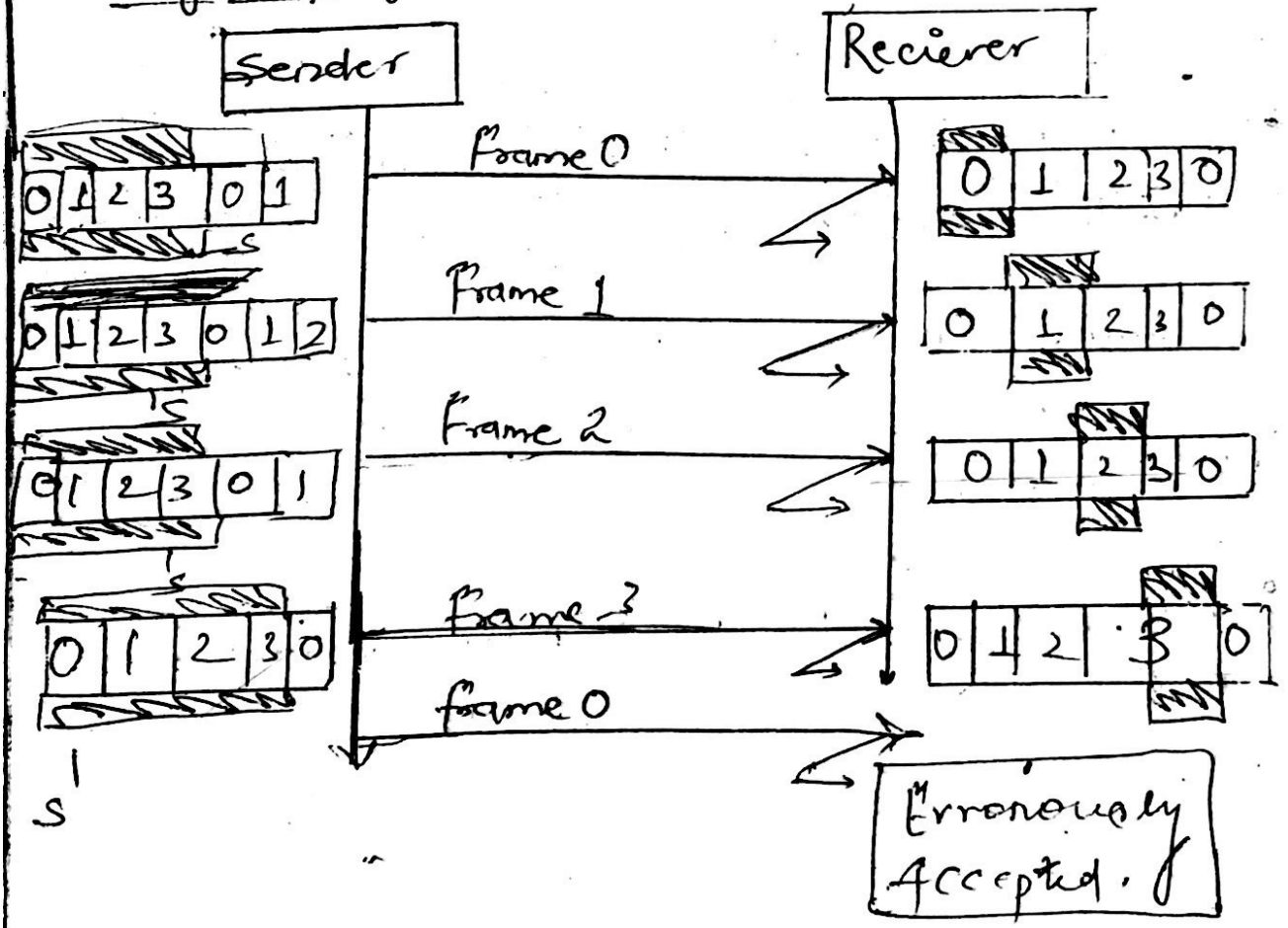
Damaged a lost frame :-



Damaged or Lost Acknowledgment



Why the Size of Window is less than 2^m.



Note :- In GO back ~~and~~ -N-ARQ size of Sender must be less 2^m it means that the window is

As in case of Stop-N-Wait ARQ, go back-N-ARQ can also be bidirectal.

- We can also use piggy-backing to impose the efficiency of the transmision
- However, note that each direction needs both a sender window and a reciever window.

Disadvantages of Go-back-N-ARQ:-

- It retransmits all the frame if one frame is damaged or lost.
- The error can get introduced if a [N.A.K] is lost.
- It retransmits frames continously as long as it doesn't reciene the N.A.K. signal.
- The negative acknowledgment signal takes some time to reach the sender till that time the sender has already send some frames.

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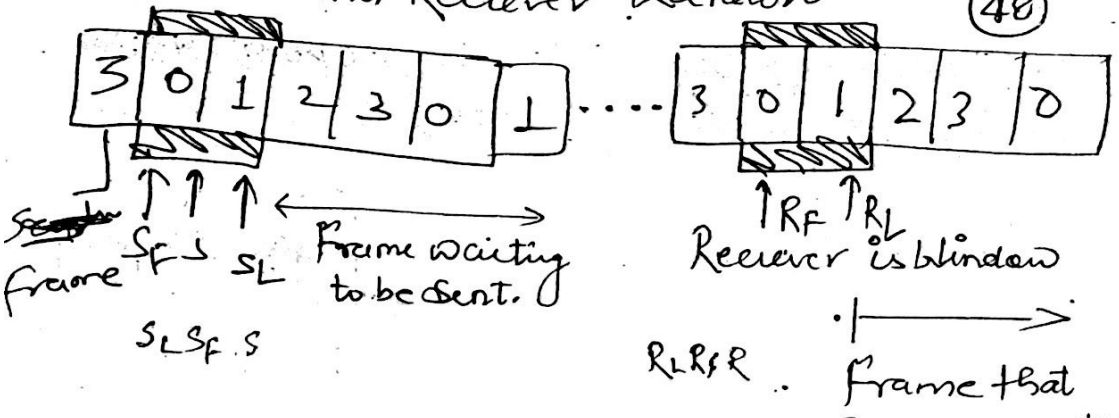
Selective Repeat ARQ :-

Window size = $\frac{2^M}{2}$

Sender and Reciever Window



- Go-back-N-ARQ

Simplifies at the reciever side -

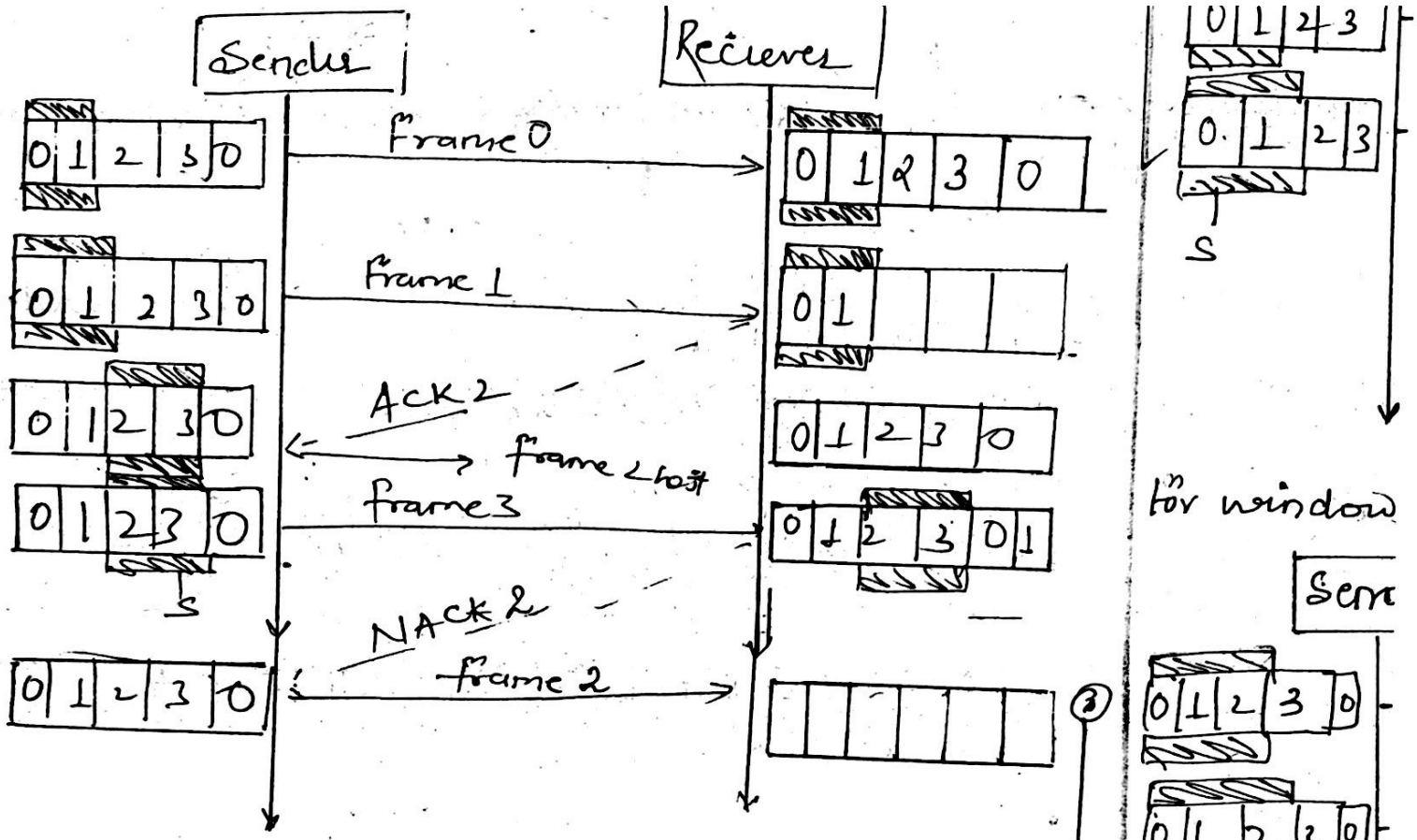
- Reciever keeps track of only one variable and there is no need to buffer out of order frame.
- However this protocol is very inefficient for a noisy link.
- In " " , a frame has a higher probability of damage which means resending of multiple frames.

This resending uses up the bandwidth and slow down the transmission.

- for noisy link :-

"there is another mechanism that doesn't resend N frames when just one frame is damaged; only the damaged frame is resend.

This mechanism is called selective repeat ARQ".



Why the size of window in Selective Repeat ARQ is $2^m/2$? One half of (2^m)

For Ex. if $(m=2)$

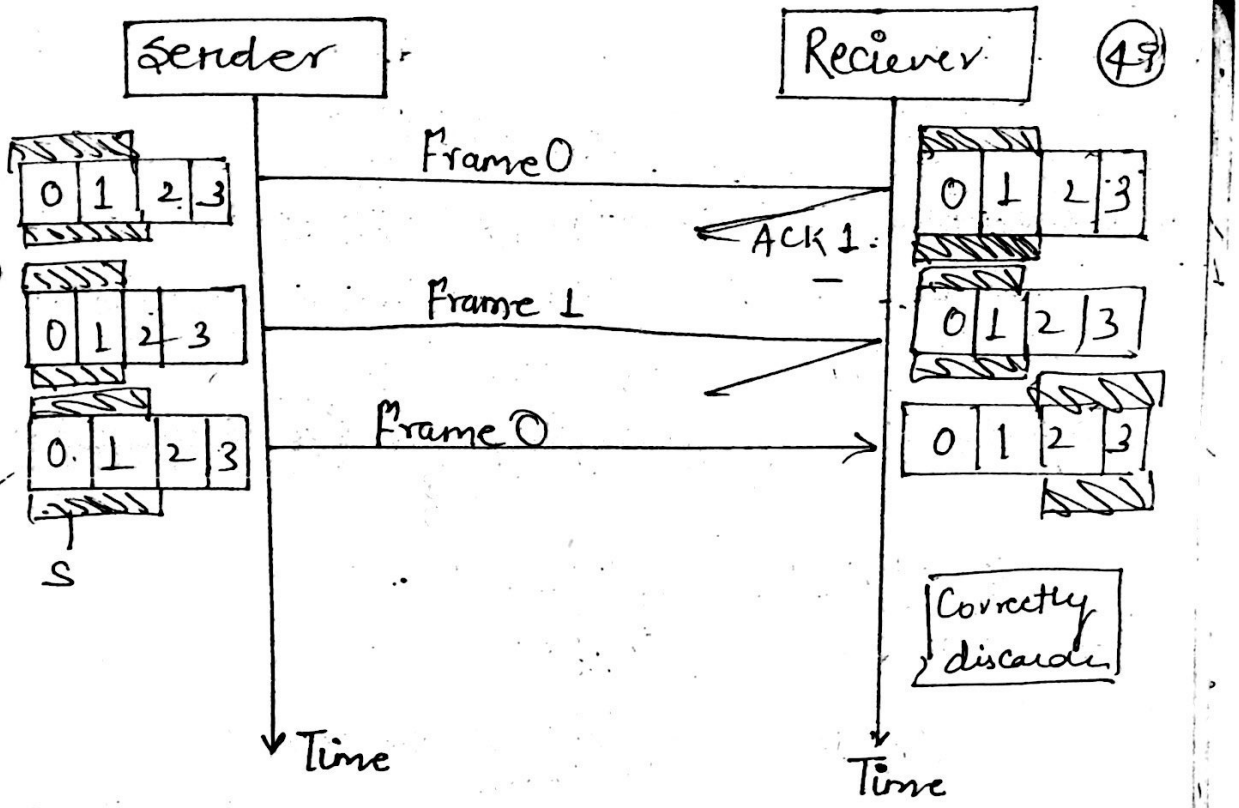
$$\frac{2^2}{2} = (2)$$

Compares a window size $\frac{2^m}{2}$ with a window size of $2^m - 1$.

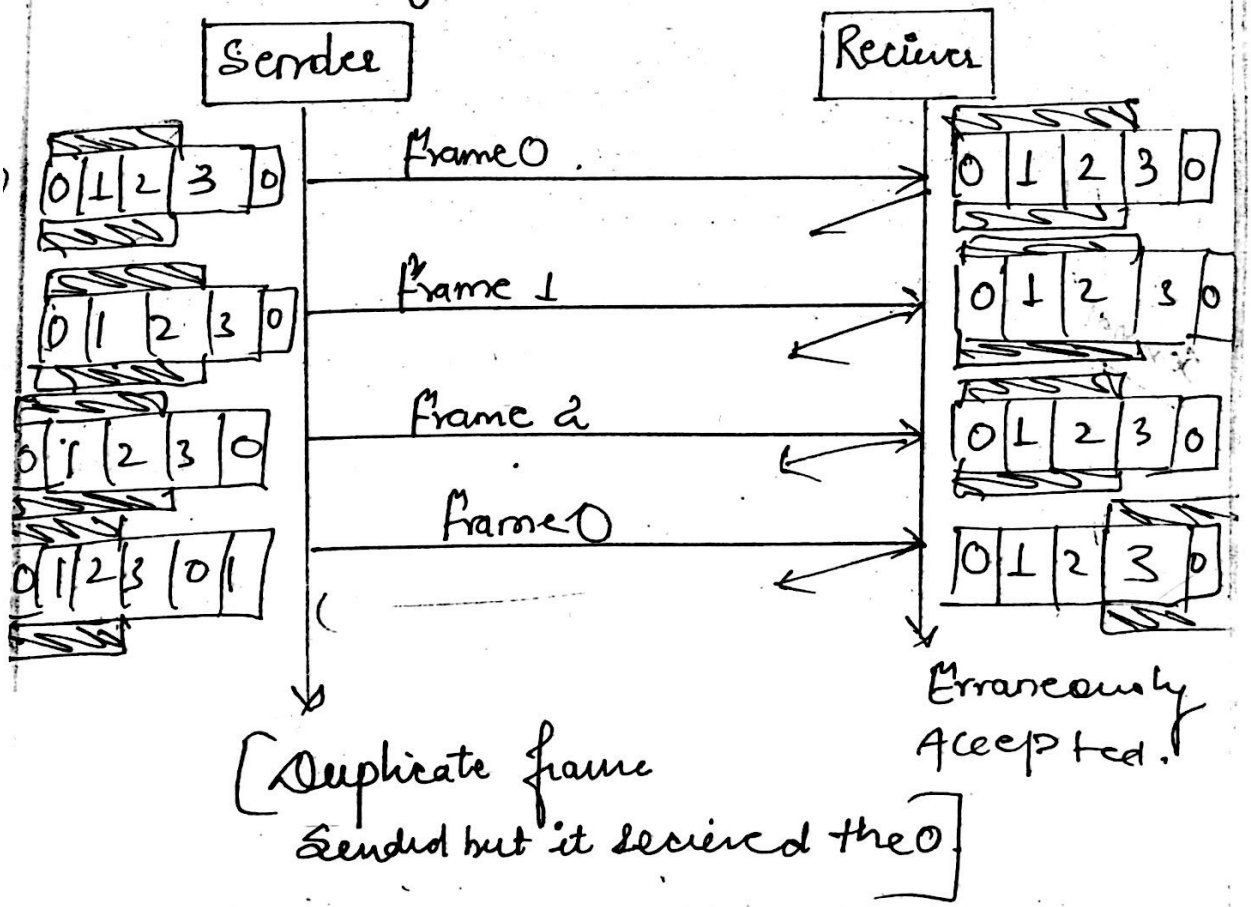
I For $\frac{2^m}{2}$, Size of window = 2

Bidirection

Scanned by CamScanner



for window size $2^m - 1$ => 3.



Sequence No

Range 0 to $2^m - 1$.

Bidirectional transmission (Piggy Backing)

Q. In a Go back-N-ARQ System, the bandwidth of the line is 1Mbps and 1 bit takes 20mS to make a round trip (delay). What is the utilization %age of the link if the link uses Go-back-N-ARQ with 15 frame sequence? (1000 bits)

0	1	2	3	0

Bandwidth = $1 \times 10^6 \times 2 \times 10^{-3}$

= 20×10^3 bits

15 frames $\Rightarrow 15 \times 1000$

$\Rightarrow$ 15000 bits utilization

$\frac{15000}{20000} \times 100 = 75\%$

Most Imp.

Q. Two nodes A and B uses sliding window serial protocol with three bit sequence number.

As the ARQ mechanism, GO BACK N is used window size of 4.

Assume Node A is transmitting and Node B is Receiving.

Show window position for the following events:-

a. Before node A sends any frame.

b. After node A " " frame 0, 1, 2. and Receive acknowledge from Node B 0 and 1.

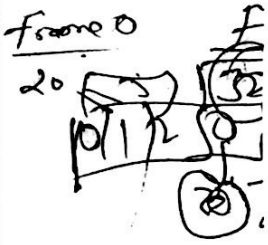
Seq = 3

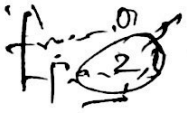
window size is go back = 4

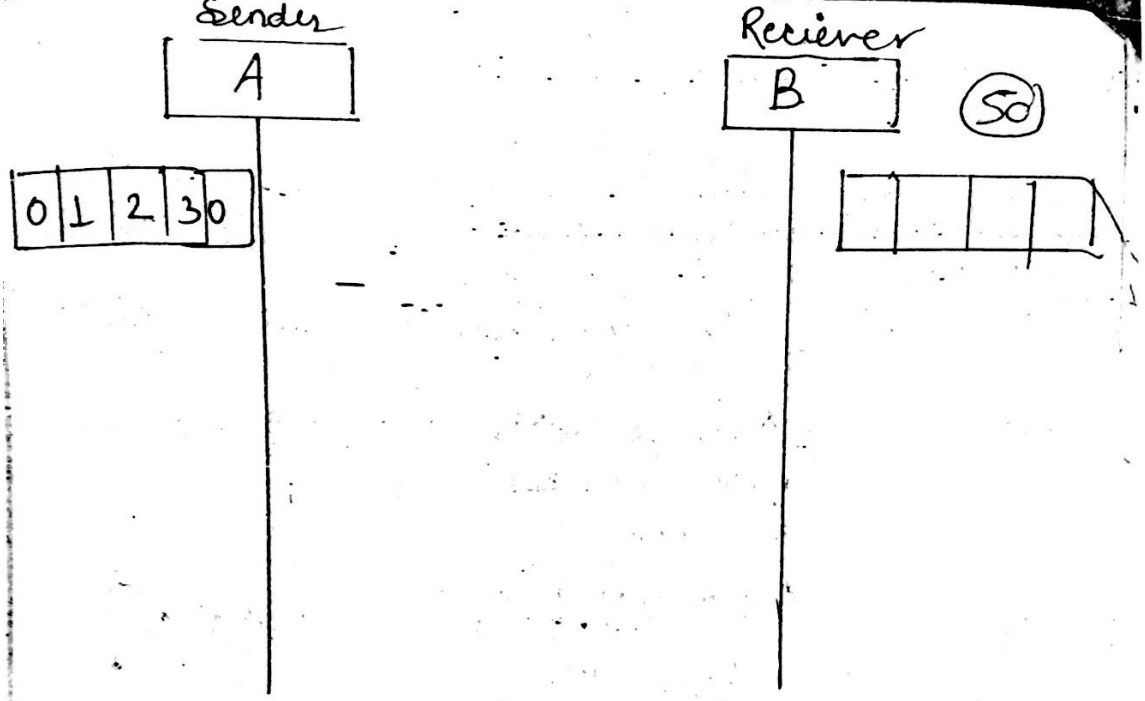
duplicacy

Frame 0

20



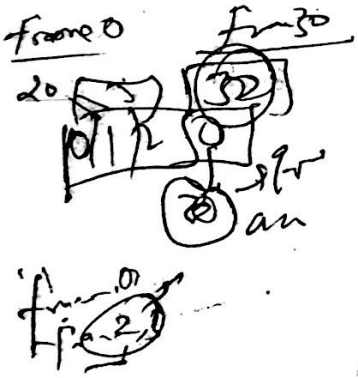




0, 1, 2, 3.

Window Size = 4 = M

duplicacy



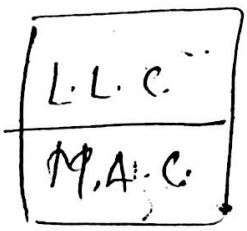
Medium Access Sublayers

Data link layer is divided into two sublayers:-

L.L.C. [Logical link control] (Top)

* Error control, flow control.
* User addressing.
* Detect of Errors
* Error Reporting.

This is the upper layer.



M.A.C. (Medium Access Sublayer)

* Lower Sublayer.
* Responsible for resolving access to the shared media.
* Also Responsible for multiple access Resolution.
* If channel is dedicated, then we don't need the M.A.C. Layer.
* Broadcast channels are also called multiple access channels.
* In broadcast n/w, most imp. point is the Criteria to determine who is allowed to use the channel when more than one users want to use it.
* A protocol is used to make this decision. Such a protocol belongs to a Sublayer of the data link layer called the Medium Access layer.

Control

Channel Allocation :-

Static channel Allocation

Dynamic channel Allocation

Static Channel Allocation

- FDM and TDM are the examples of the static channel allocation
- In this method, either a fixed time slot allocat to each user. The problem in this method is that if all the 'N' numbers are not using the channel then the channel bandwidth is wasted. N < bandwidth waste
- And if there are more than N users who want use the channel, they can't do so. due to lack of bandwidth. N > b/w lack
- The static channel allocation has a poor performance with worst bursty traffic and hence generally dynamic channel is used for the Computer n/w where the traffic is bursty nature.

Dynamic channel Alloc^{n}:-

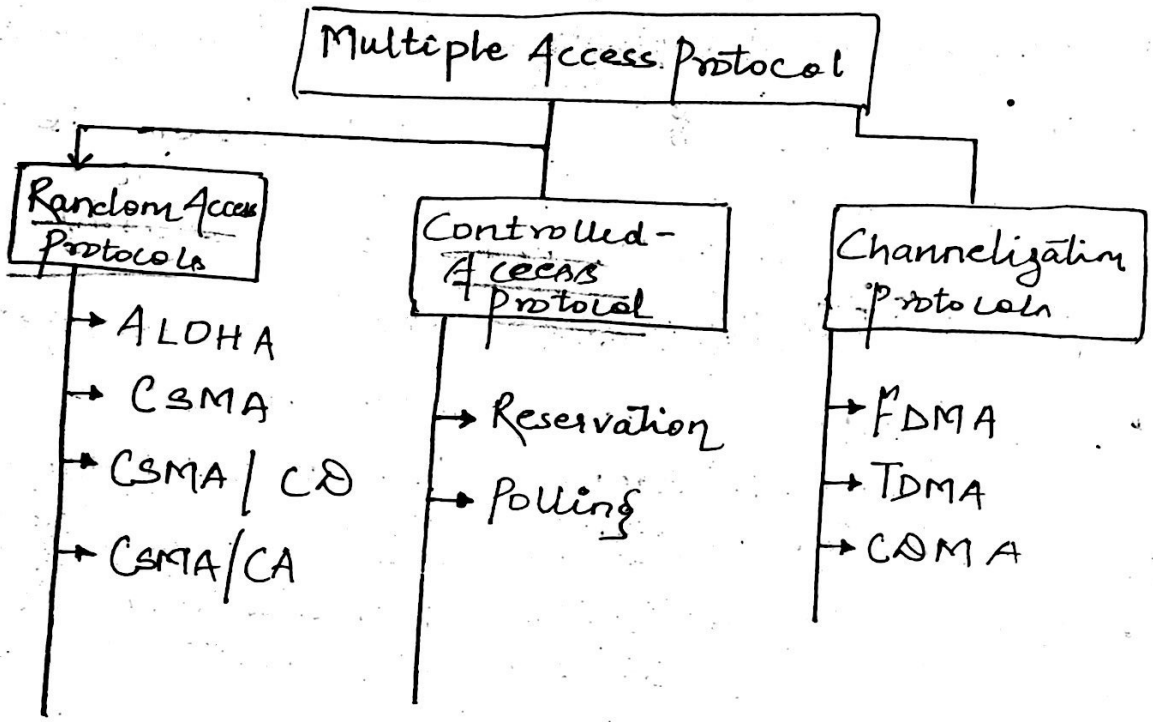
- In this method, no fixed frequency or time allocated to the user.
- The user can use the single channel as per the requirement.

Single channel is available for all Communications.

Collosion If frames are transmitted at the same time by two or more stations there is an overlap in time and

the resulting signal called an event is Collosion.

Continous or slotted time :- There is no master clock dirding time into the discrete time intervals.



Random Access Protocols :- In random access there is no control station.
Each station will have to word right to use the common mechium without any control over it.
With increase in no. of users, probability of collosion is increase or access Conflict.

- The collosion will occur when more than one users tries to access the common medium simountaneously :
As a Result of such collosion some

frames can be either modified or destroyed.

In order to avoid collision we have to set up a procedure. (52)

a. When can the station access the medium?
b. What can the station do, if medium is busy?
c. How can the station determine the success or failure of the transmission?
d. What can the station do, if there is an access conflict?

Evaluation of Random Access Methods:-

The first method is known as ALOHA used a simple procedure called multiple access It was improved to developed to C.S.M.A. (Carrier Sense multiple Access)

The C.S.M.A. is further evolved into two methods:-

C.S.M.A/C.D. C.S.M.A/C.A.

Abraham's Logic of Hiring Access (A.L.O.H.A.)

ALOHA System:-

is the earliest Random-Access method was developed by. at the University of Hawaii in 1970. It was designed for a wireless L.A.N. (radio transmission) but it can be used on any shared medium.

ALOHA system has two versions:-

1. Pure ALOHA :- doesn't Require global time synchronization.

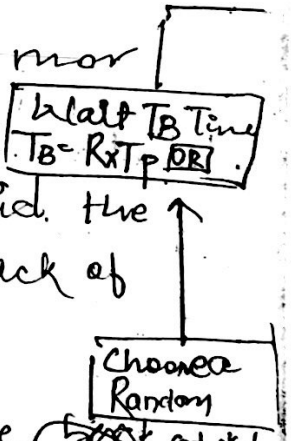
2. Slotted ALOHA :- time Synchronization.

K :-
Tp :-
Tfr :- A
TB :- B
N :- M
G :- Tra
S :- Thr
Po :- Prob
Suf
e. 2. Fil

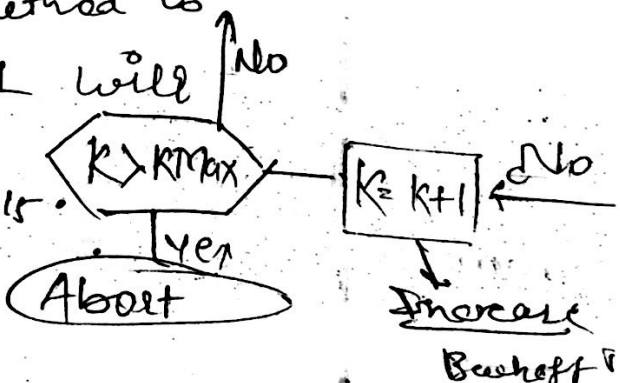
And resend the frames.

- Now a collision involves two or more stations.

The randomness will have avoid the more collision. We call this back of time.



- ~~The Randomness will have avoid the~~
- Pure ALOHA has a second method to prevent Corrupting the channel will retransmitting frame.



K :- No. of attempts or transmission attempts

Tp :- Max. propogation time including per frame time

Tfr :- Average transmission time for a frame

TB :- Back of time; Depends on transmission attempt (K)

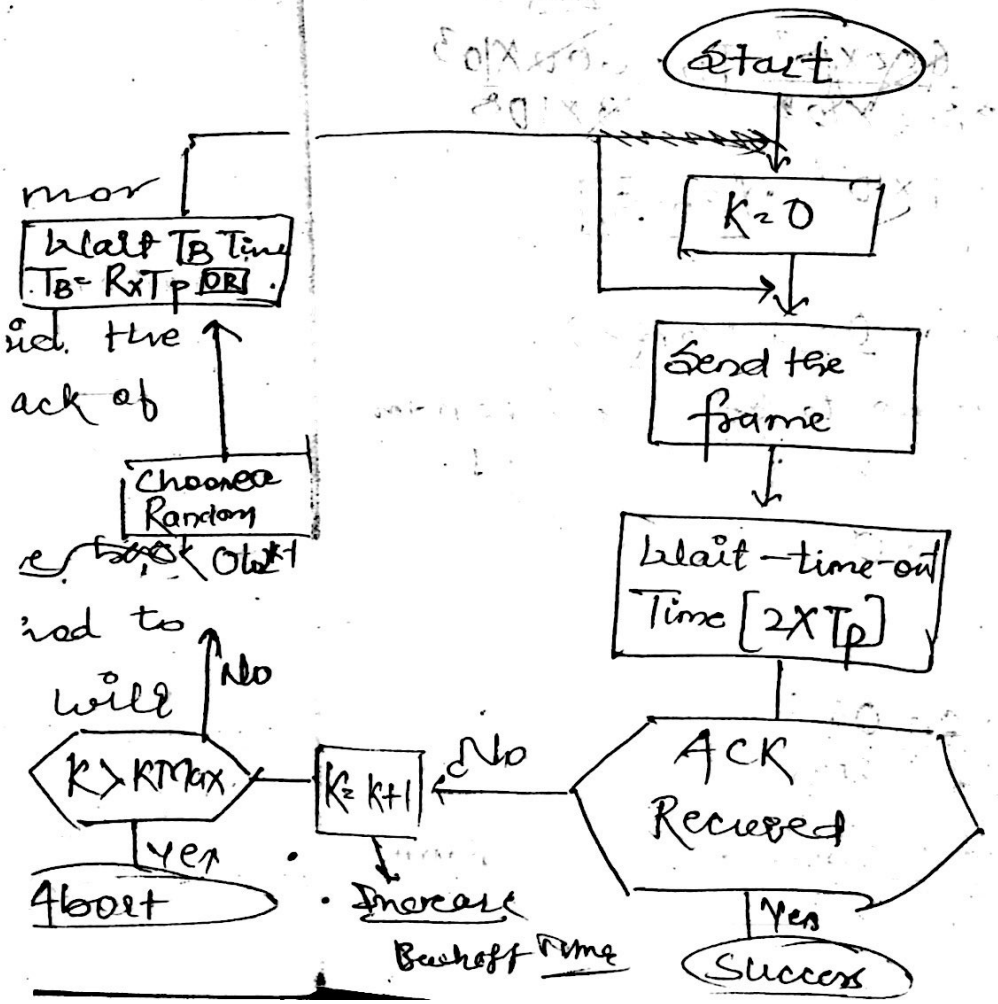
N :- Mean of frame per frame time. which are generated by infinite no. of users.

G :- Traffic Rate measured as the average no. of frame per Slot.

S :- Throughput (Succcefully Recieved)

Po :- Probability that a frame that does not Suffers from a Collision

e :- 2.718 (mathematical Constant)



Po = [ ]

Q. The station of a wireless ALOHA n/w are a maximum of 600km apart. If we assume that signal propogate at 3×10^8 m/s we find ~~$Tp = 600 \times 10^5$~~.

T_p = time Required to Send a frame b/w the two most widely Separated Stations.

Given:- Wireless ALOHA = 600km

$= 600 \times 10^3$ m/s

Signal propogation = 3×10^8 m/s

$T_p = \frac{\text{Frame Size (length)}}{\text{Bit Rate}}$ m/s

$T_p = \frac{600 \times 10^3}{\text{Bit Rate}}$

$T_p = \frac{600 \times 10^3}{3600 \times 10^5}$ $T_p = \frac{600 \times 10^3}{3 \times 10^8}$

$T_p = 1 \times 10^{-2} = 1$ RMS

a. for k=1, for 0 & 1 (range).

The station needs to generate a random number with a value of 0 and 1.

$T_B = 0 \times 2 = 0$

$T_B = 1 \times 2 = 2$

This means for 0 = 0MS

" " 1 = 2MS

Based on the outcome of the Random variable. -

Cartesian

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frame

Frame-li

- It denot transmit
- ble ass generat poisoni's

for $\underline{K=2}$

$0 \times 2 = 0$ MS

$1 \times 2 = 2$ MS

$2 \times 2 = 4$ MS

$3 \times 2 = 6$ MS

$\underline{K=3}$ $2^K - 1 \Rightarrow 2^3 - 1 = 7$

$0 \times 2 = 0$ MS

$1 \times 2 = 2$ MS

$2 \times 2 = 4$ MS

$3 \times 2 = 6$ MS

$4 \times 2 = 8$ MS

$5 \times 2 = 10$ MS

$6 \times 2 = 12$ MS

$7 \times 2 = 14$ MS

upto $\underline{K=15}$

~~Cartesian~~

Efficiency of a PURE-ALOHA

* Efficiency is the fraction of all transmitted frames which escape collision.

$$\text{Frame-time} = \frac{\text{frame length}}{\text{Bit Rate}}$$

- It denotes the amt. of time required to transmit the standard fixed length frame.
- We assume that infinite no. of users generates new frames acc. to the poison's distribution :-

with mean 'N' frames per frame time :-

If $N > 1$, collision occurs, users are generating frame at a rate higher than can be handled by the channel. So every frame will face collision.

Hence, $\boxed{0 < N < 1}$

Let the mean of the no. of transmission be G.

If $G \geq N \rightarrow$ Collision

$N \approx 0$ _ $G \approx 0$

A low load $N \approx 0$ and there will be less no. of collision so less number of retransmission $\boxed{G \approx N}$.

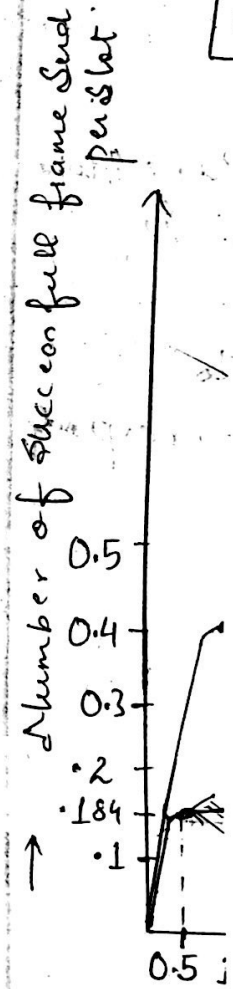
With the increase in load, there are many collisions.

For all the loads, the throughput

$\boxed{S = GP_0}$

The probability that K frames are generated during a given frame time is given by :- the following Poison's distribution

$$\boxed{P[K] = \frac{G^K \cdot e^{-G}}{K!}}$$



If $\underline{k=0}$: (no. of retransmission attempt)

$$P[k=0] = \frac{G^0 \cdot e^{-G}}{0!} \Rightarrow e^{-G}$$

$$\frac{e^{-G}}{1} \quad \underline{k=0}$$

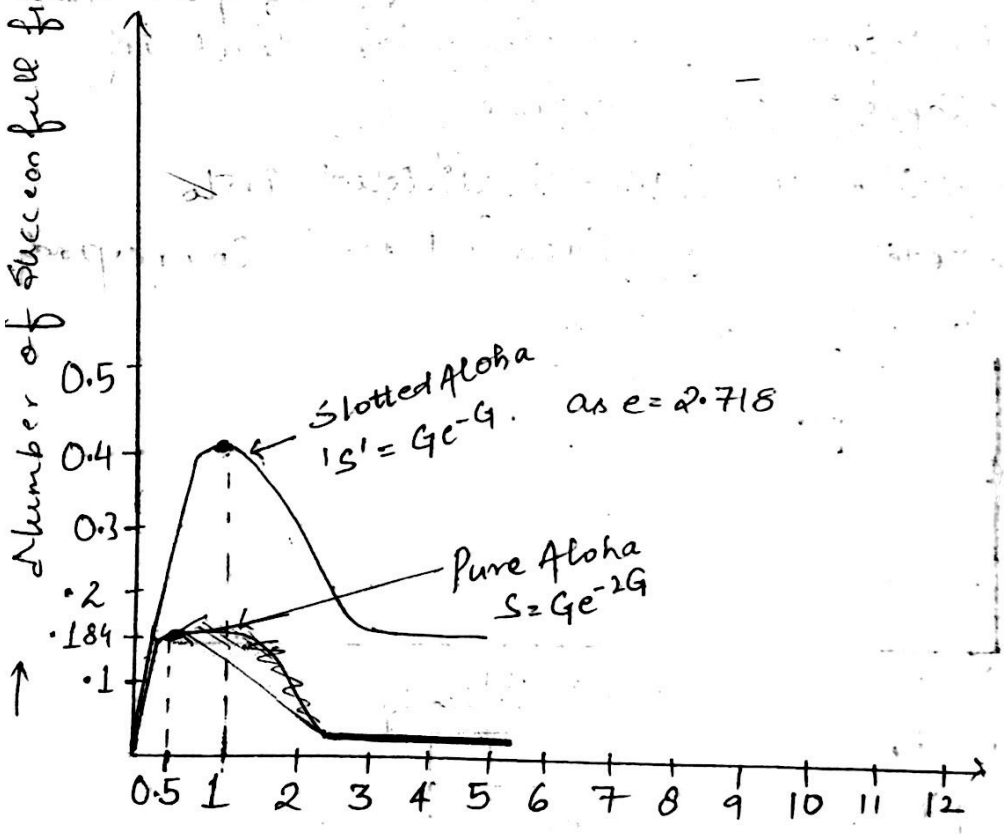
Note:- If any interval is 2 frame time long, the mean number of frame generated:

$$= 2G.$$

The probability that no other frame is transmitted during vulnerable time is

$$P_0 = e^{-2G}$$

$$S = G \cdot e^{-2G} \qquad (55)$$



[G traffic rate measured as the average number of ~~Succesfull~~ frame/slot]

$S = Ge^{-2G}$

$= 0.5 * 2.718^{-2 \times 0.5}$

$= 0.5 * 2.718^{-1}$

$= \frac{0.5}{2.718} = 0.184$

$= \frac{1}{2.718^2} = \frac{1}{7.38752} = 0.135$

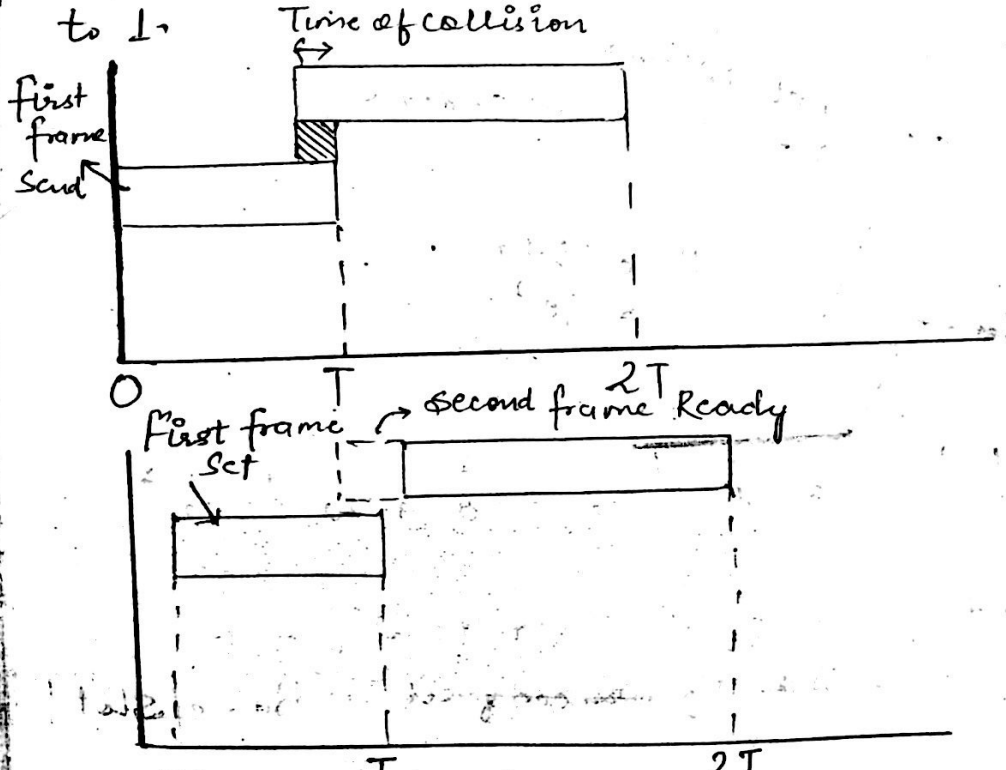
The max. throughput occurs at 0.5 and $S_{max} = \boxed{0.184}$

Total load on the channel.

SLOTTED ALOHA

To overcome the disadvantages of Pure Aloha. Robert proposed a method for doubling the capacity of the channel.

In this method, time is divided into discrete interval. Each interval corresponds to 1.



Transmission using Slotted ALOHA

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If G = 1

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In this method, collision occurs if any part of two transmission overlaps.

Suppose that T is the time required for one transmission and that two stations must transmission.

Then the total time Required for both station to do Successfull = 2T.

So slotted Aloha is discrete time System whereas pure aloha is a Continous time System.

The vulnerable time has been reduced to half of the pure ALOHA, the throughput for slotted ALOHA $S = G \cdot e^{-G}$

If $G = 1$, $S = e^{-1}$ We find the max. throughput

$S = 0.368$

The probability of Success is 37%.

And " " Collosion is 24%.

Measurement of slotted aloha with an infinite no. of users.

Show that 20% are idle :-

1. What is the channel load?
2. What is the throughput.
3. Is the channel underload or overload.

Show with graph.

Given 20% slots are idle.

$P_0 = 20\%$

$\Rightarrow 0.2$

~~$S = G \times e^{-G}$~~

~~$\Rightarrow S = G \times 0.2$~~

$\log_a b = \log_a a^b$

$\Rightarrow P_0 = e^{-G}$ $\log .2$

$\Rightarrow 0.2 = 2.718^{-G}$

$\Rightarrow -G = \lg 0.2$

$\Rightarrow \boxed{G = 1.6094}$

$2.718 \times 0.2 = 4.436$

$S = G \times e^{-G}$

$= 1.6094 \times 2.718^{-1.6094}$

$= .3218$

OR $= P_0 G = 1.6094 \times 0.2 = 0.3218$ (Throughput)

Overload.

Can only be find out by G.

Not by throughput.

Throughput (S)

0.368
0.32 0.3
.2
0.1

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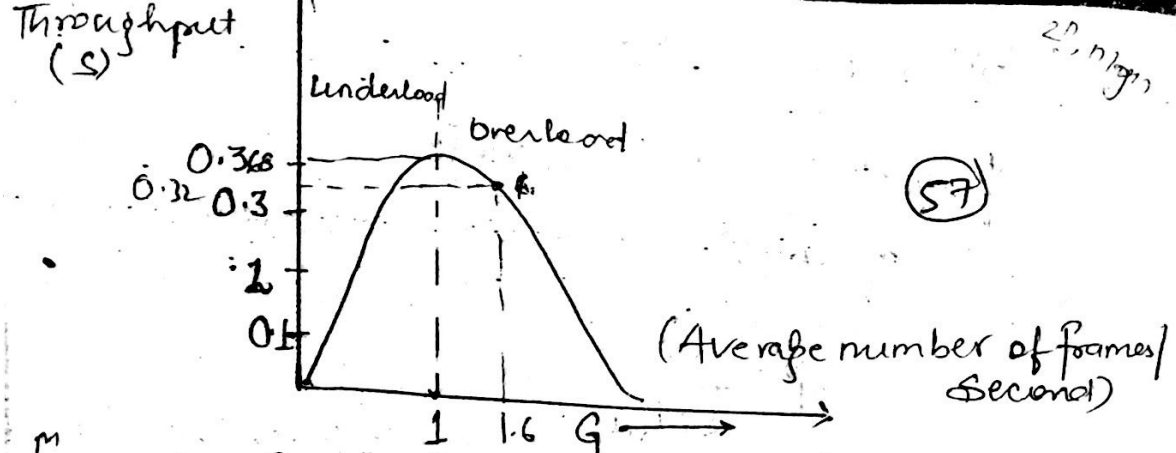


from the fig., the max. throughput = 0.368

Corresponds to G = 1.

Since, the value of G = 1.6094 which is greater than 1, channel is overload.

Q. Why is the time doubled of Slotted aloha compared to pure aloha. Compare Pure aloha and Slotted aloha.

Q. Performance of Protocol.

Q. A channel has a bit rate of 4KBps and propogation on delay of 20ms. For what range of frame size does stop and wait gives an efficiency of atleast 50%.

$$\text{Throughput efficiency } (\eta) = \frac{T_f}{T_f + 2T_p}$$

T_f = Transmission Time to transmit a frame

T_p = Propagation time to reach to destination for a transmitted bit.

N = frame size (bits) or frame length

R = Data Rate.

Bit rate = 4 kbps

⇒ propogation delay = T_p = 20 ms.

η = 50%.

$$T_p = \frac{N}{\text{Bit rate}}$$

$$0.5 = \frac{T_f}{T_f + 2 \times 20 \times 10^{-3}}$$

$$\Rightarrow (T_f + 2 \times 20 \times 10^{-3}) \times 0.5 = T_f$$

$$\Rightarrow 0.5 T_f + 20 \times 10^{-3} = T_f$$

$$\Rightarrow 0.5 T_f = 20 \times 10^{-3}$$

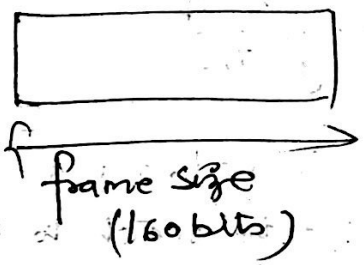
$$\Rightarrow \boxed{T_f = 40 \times 10^{-3}}$$ for one frame

Step 2:- Calculate the frame size

$$4 \times 10^3 \times 40 \times 10^{-3} = T_p$$

$$\Rightarrow \boxed{160}$$

$$\Rightarrow \boxed{T_p = 160 \text{ bits}}$$



Q. A channel has a bit rate of 4.8 Kbps and propogation delay of 20 ms. for

Diagram

What range of frame size does Stop and wait gives an efficiency of 50%.

$\eta = 50\% = 0.5$

Bit Rate = 4.8X

If channel capacity is B bits/sec

frame size = L bits

Round trip propogation time = Tsec

then the efficiency $= \frac{L}{L + BT}$

$$\Rightarrow 0.5 = \frac{L}{L + (4.8 \times 10^{-3} \times 20 \times 10^{3})}$$

$$\Rightarrow (0.5)(L + 96) = L$$

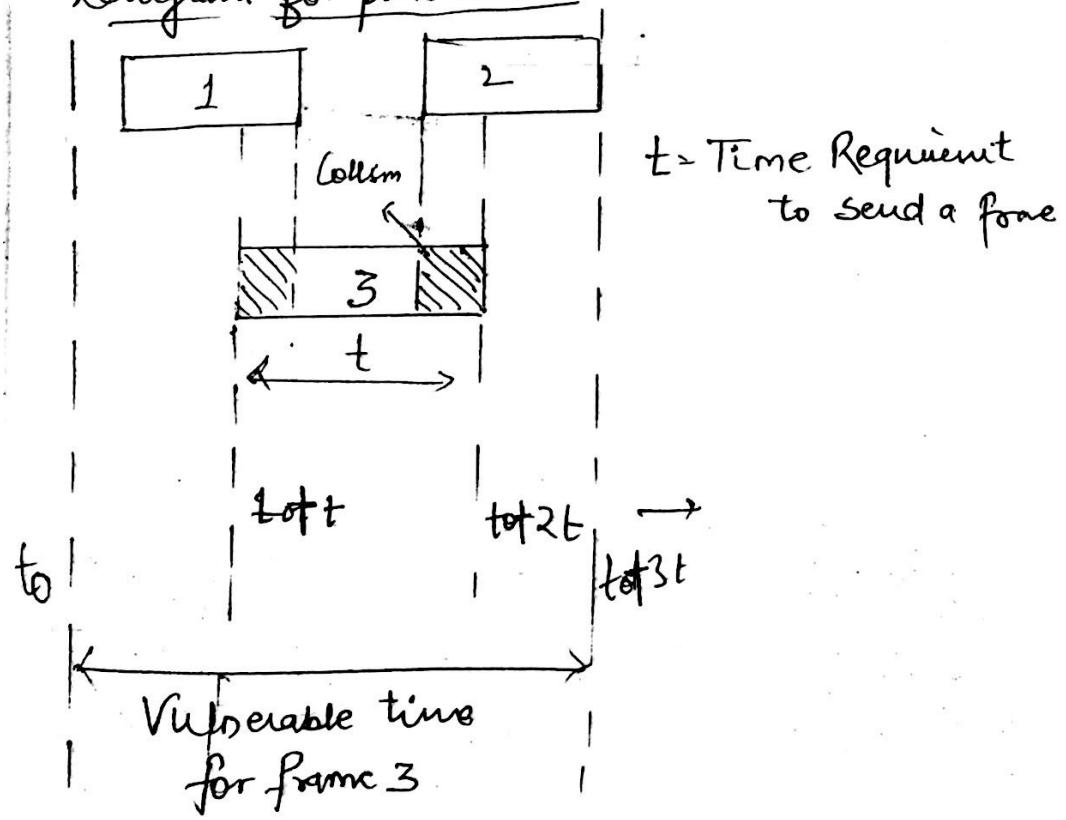
$$\Rightarrow 0.5L + 96 \times 0.5 = L$$

$$\Rightarrow 48 = 0.5L$$

$$\Rightarrow \frac{96}{0.5} = L$$

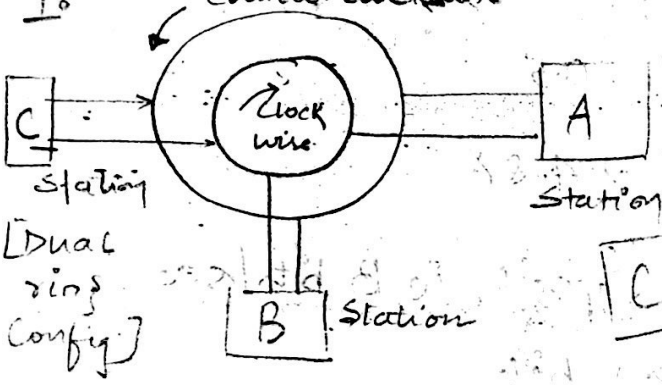
$$\Rightarrow \boxed{96 \text{ bits}}$$

Diagram for pure aloha

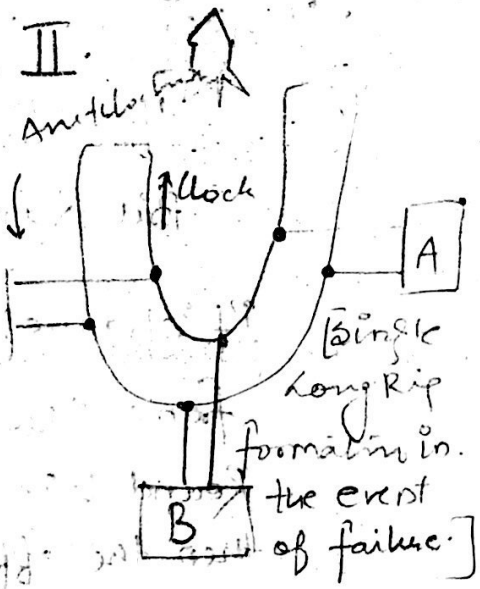


FDDI (Fibre distributed data Interface)

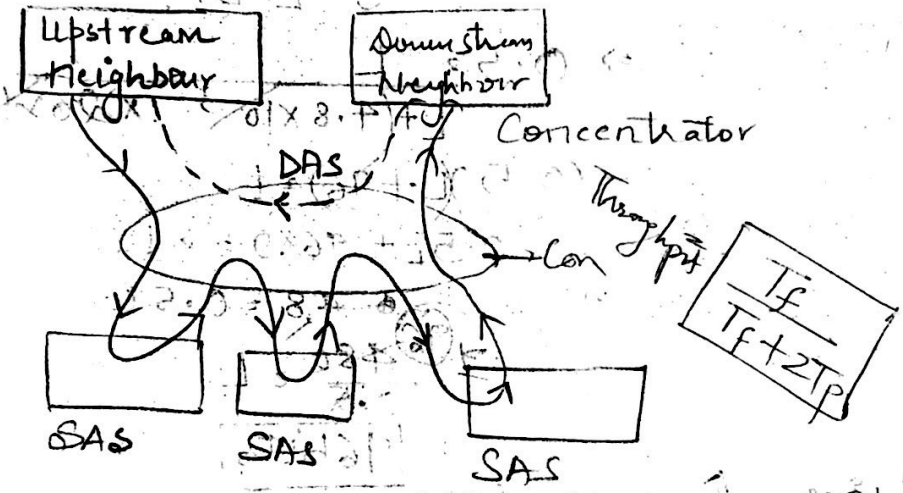
I.



II.



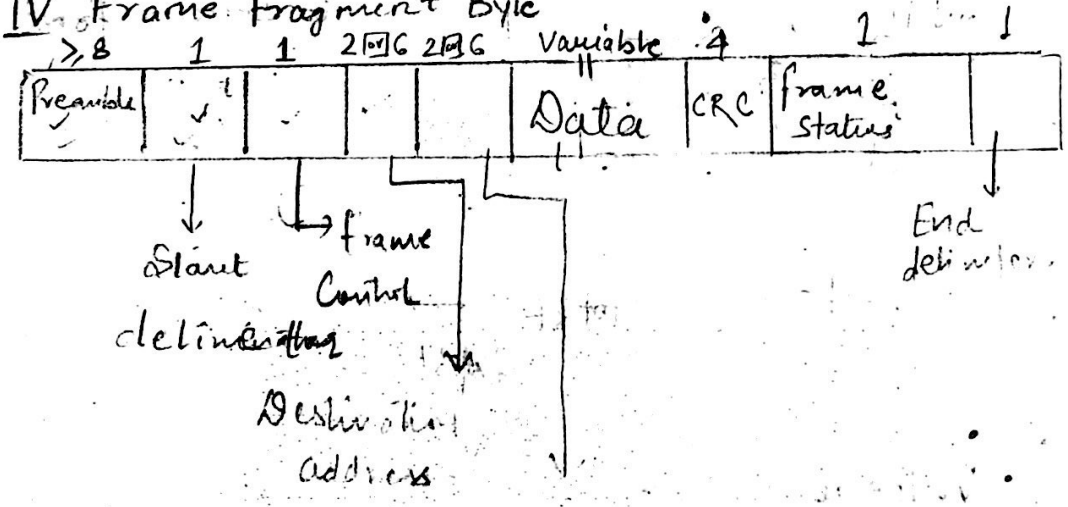
III.



SAS :- Single attachment station

DAS :- Dual attachment station

IV. Frame fragment Byte



It stands for fibre distributed data Interface (802.5) and I.B.M. token ring but don't use copper. (59)

Two fibre rings are here from the fig. 1. 1 is clockwise and other is anticlockwise.

- If one ring is break then second ring is used for backup. If both rings are break, each station contains relay that can join two rings into single ring. (59)
- ~~Two rings can be~~.
- To transmit the data first of all station Capture token and then it it transmits a frame and removes it when it comes a round again.
- It is expensive because it use dual ring configuration of fibre.

FDDI also allow to attach the n/w by a single cable called SAS (single attachment station)

Dual attachment station can be done by double cable.

Concentrator is used to attach several SAS to the dual ring.

Types of traffic :-

Synchronous traffic :- • Delay Sensitive and Used for Sending voice and video.

Asynchronous traffic :- • More intrested in throughput than delay.
for Ex. file transfer application.

FDDI use

Timer used in FDDI.

(1) Token holding timer :- how a long station may continue to transmit, once it has acquired the token.

This timer prevent a station from hogging the ring.

T

(2) Token Rotation timer :- This timer is restarted everytime when the token is seen.

• If this timer expires, it means that the token has not been sighted for too long on interval, it has been lost than the token recovery procedure is initiated.

(3) Valid transmission timer :- finally this timer is used to time out and recover from certain transient errors.

Note :- FDDI also has a ~~priority algo~~ priority algorithm. It determines which " classes may transmit on a given token pe