

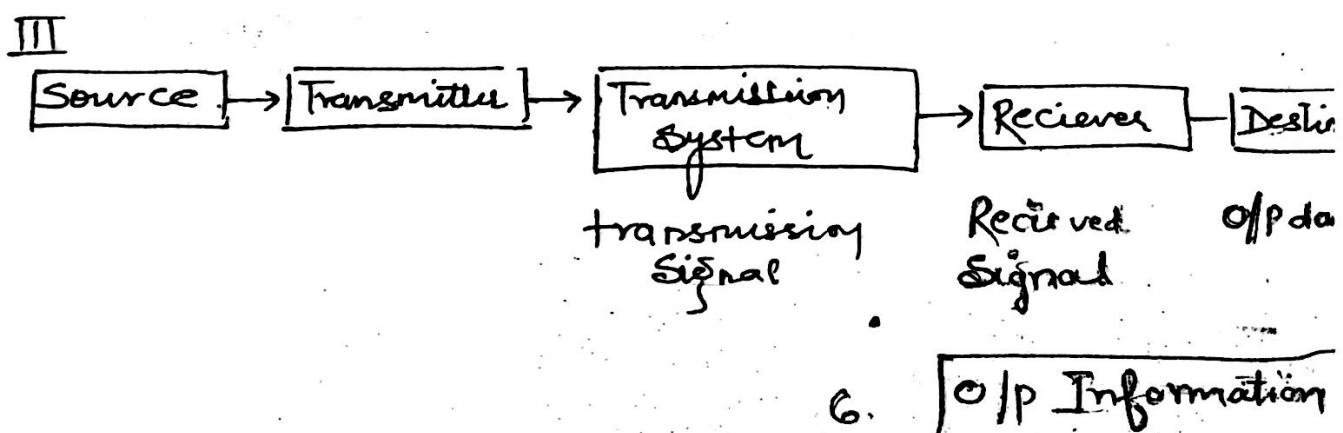
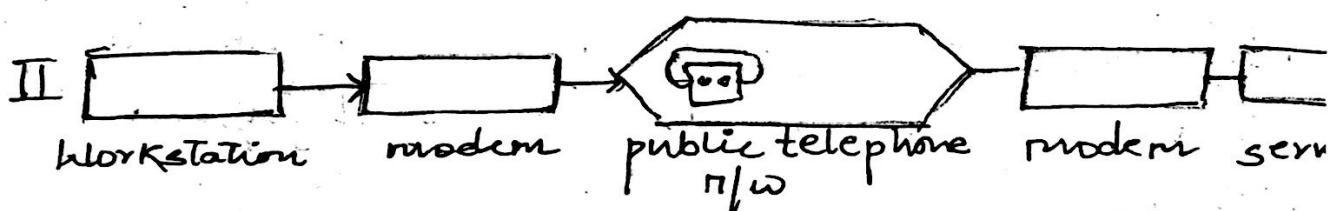
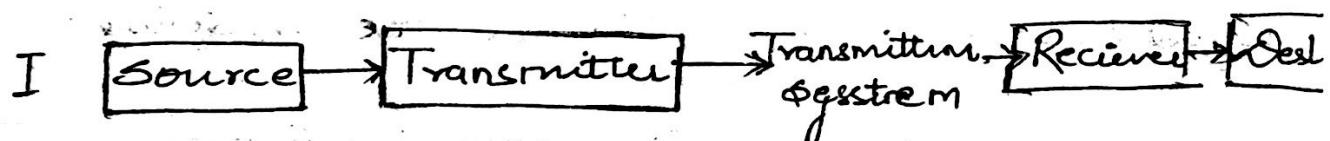
Unit - I

①

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 receiving 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 together by media links, so that they can exchange the information.

(Data Communication Model)-



Key elements of CN:-

Source:- Link device generates 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 transmitting line or a complex n/w which is used to connect the source or destn.

Receiver :- The receiver 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 receiver.

Goals and Application of Computer Network :- (25)
Basically there are 4 goals of Computer Network
They are as follows :-

1. Security goal :-

(a) Virus

(b) Unauthorized access

At lowest level - user name password

At higher level - encryption technique

(c) Substitution technique

Each element are mapped into another element

Transposition technique

Each element is type are rearranged.

Ex. A → D.

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 ms.

(b) Response time - Enquiry response time must be ms.

(c) N/w transmission mechanism → fibre optic 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 : Maintenance Cost.

App's of Computer Network (I)

- (i) Exchange file between systems.
- (ii) Exchange emails with user on other computer.
- (iii) Execute program on another computer.
- (iv) Remote login.
- (v) Share peripheral devices.
- (vi) Teleconferencing.

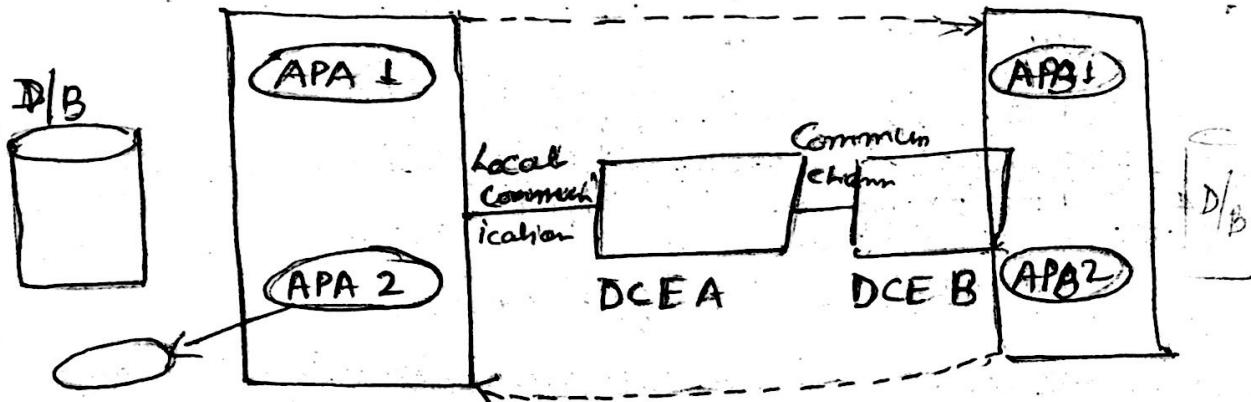
(vii) N/w for companies :-

- 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. powerful communication medium.
- h. Local payroll.

(viii) N/w for people :-

- a. Access to remote information.
- b. Home Shopping.
- c. Person to person communication.
- d. Interactive entertainment.
- e. from www we can fetch information about arts, business, health, science, sports, travel, etc.

Network Structure and Architectures - ③



DTE :- Data terminal equipment or 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 or terminal , mobile phone, p.c., a workstation for the railway , reservation counter.

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

from the fig site A could execute an applicⁿ process (APA₁) in the form of a s/w program to access an appⁿ process at Site B (APB₁)

The best example DCE is modem.

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

1. channel/networking configuration

2. Transmitting 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 communicating devices.

→ The entire channel capacity is for transmission b/w only those two communicating 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 configurations devices are connected to the same channel.

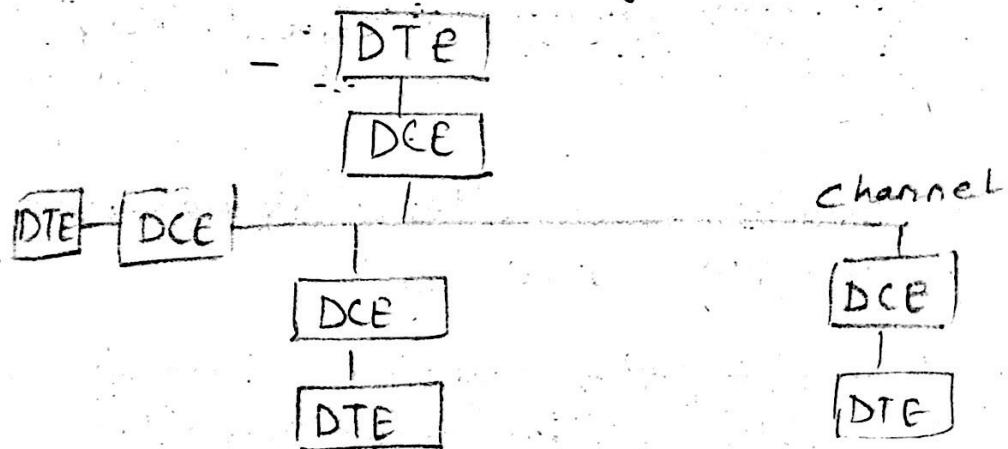
It is also known as point to multi drop channel Configuration.

Time division:- If several devices are sharing the

channel one by one.

④

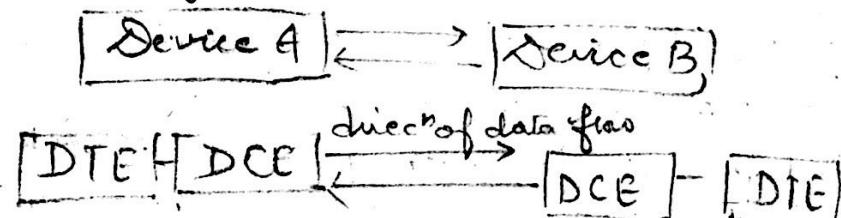
Spatial division:- If several devices are sharing channel simultaneously.



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

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

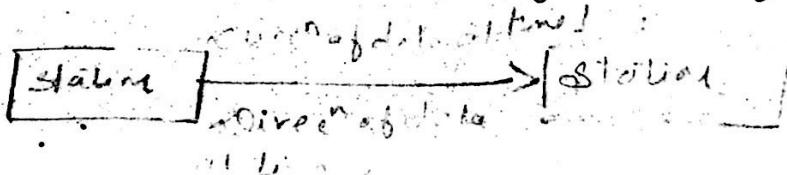
Ex. keyboards and printers.



Half Duplex:- It permits transmission in both directions 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 communication are Eg. of half duplex.



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

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

3. N/w Topology design

[Station] ----- [Station]

circles of
data all in one

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

The network design has 4 measures :-

(a) Throughput :- Ratio of successfully received packets and total no. of transmitted packets in percentage. $\frac{\text{Successfully Received}}{\text{Transmitted}}$

(b) N/w reliability :- It refers to the availability to deliver 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 receiving 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 leased line.

(5)

Minimising Response time, it includes minimising delay b/w the transmission and the receipt of the data b/w source to destination.

Types of N/w topology :-

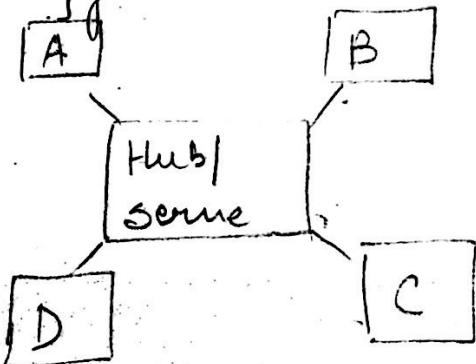
- Star
- Ring
- Mesh
- Bus
- Tree
- Hybrid

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 device 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 diagnosis removal is easy.
- (iv) Better control and security over data flow as entire data passes from central side.

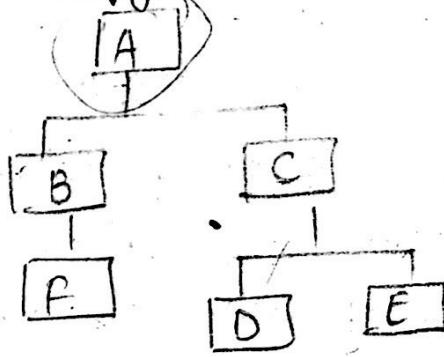
Disadvantages:-

- (i) single site is responsible for routing of all the traffic.
- (ii) Bottleneck 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 useful for centralized areas.



2. TREE Topology :- Hierarchical topology



(6)

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 backed 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)

- 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.

Dropping:- It is the connection b/w the devices and the main bus capable.

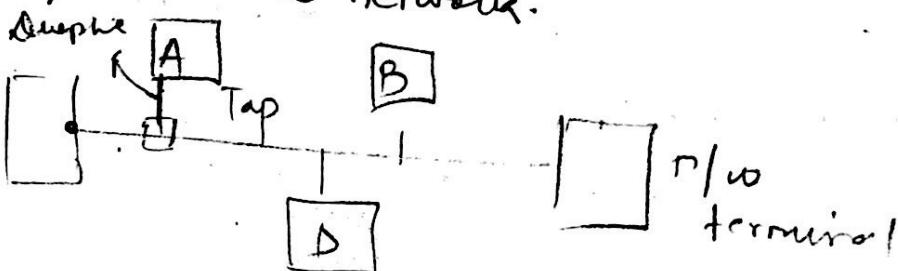
TAP :- It is a connector used to connect to the case of main bus.

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 successful when broadcasting is required on a network.



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

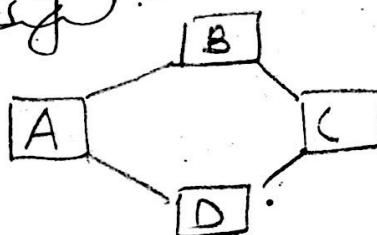
• There is no security control on the flow of data as information transmitted is

available to each DTE

If main bus fails, it results in network failures

(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 repeater.

When a device receives a signal then repeater regenerates and amplifies the signal of other devices.

Advantages :-

Consecutive Systems are connected hence making a loop.

No bottleneck problem arises.

Low cost need for cabling.

Unidirectional so, no contention and suitable for using optical fibre as a medium of transmission.

Disadvantages :-

Failure of any node causes link failure.

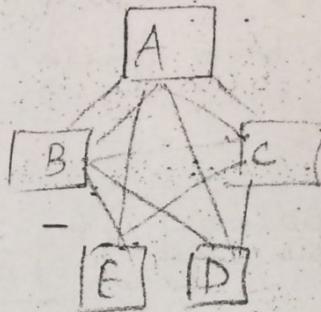
Difficult to diagnose fault

Mesh Topology

Advantages:-

No traffic problem.

Better security.



Fault identification once fault isolation

This topology is robust to link failure.

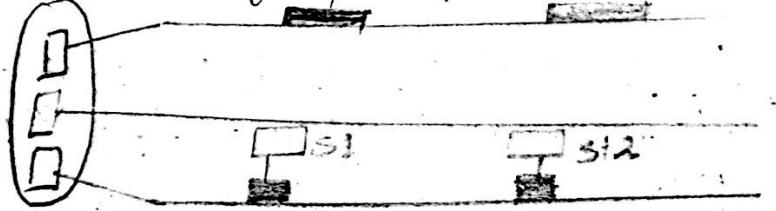
Disadvantages:-

- Cost of n/w is very high because every device is to be connected to every other device, amount of cabling and no. of I/p, O/p ports required is very high which in turns 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 or an office.

Leases operate on a ~~way~~ high speed buses from (1 Mbit ps) to 400 Mbit ps .

~~Bus Ring and star Topology~~ are basically used for the L.A.N.

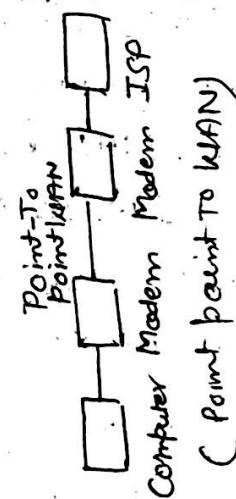
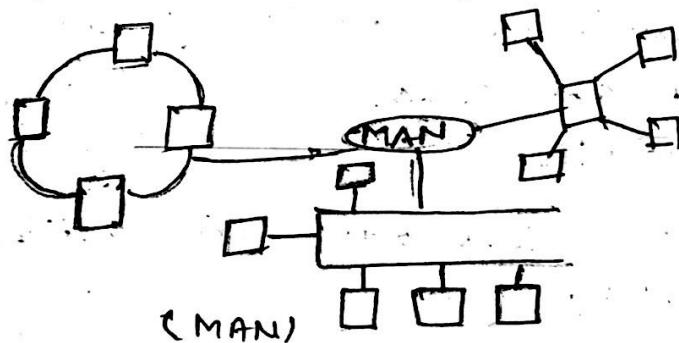
IEEE (Institute of electrical and electronic Engineers) IEEE-802.5 is a popular ring based LAN operation at 4Mbps.

Single building LAN with Ring Topology

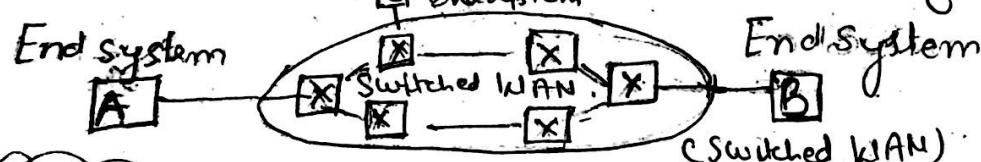
Single building LAN with Bus

MAN (Metropolitan 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 normally to the internet.
- 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 provider long distance transmission of data, images, audio and video info. Over large geographic area that may compress a country.

from the fig 1 point to point WAN
Connects end systems which usually
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 Releigh.

X.25

1. X.25 N/W's work at
speed upto 64 kbps.

2. More reliable.

3. frames are delivered
in order.

4. Provides flow control.

5. provides acknowledgement Does not provide
signal. acknowledgement signal.

6. Connection oriented Connectionless Services
Services.

frame Releigh

It operates at high speed
of 1.5 Mbps.

unreliable.

frames are not delivered
in order.

Does not provide flow
control.

A good Eqⁿ of switched. W/T a ~~high speed~~
made transfer code, which is a n/w with fixed
size data with packets called cells.

Mumbai

V.35

Delhi

V.35

Voice and data enabled

2Mbps

Basic orbit

2Mbps

Basic operator

2Mbps

Basic Operator

Basic operation

V.35

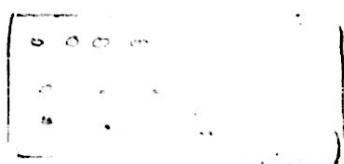
Banglore

V.35

Calcutta

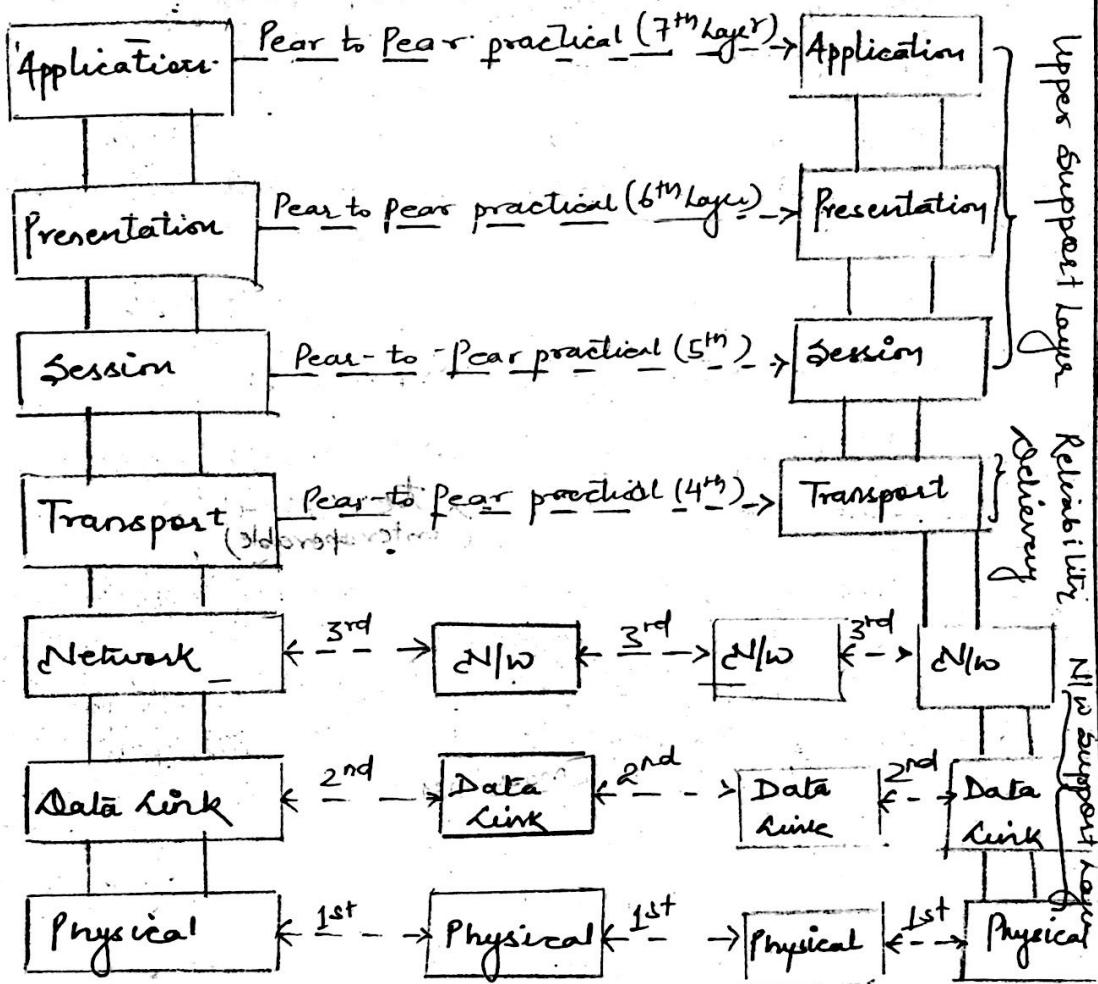
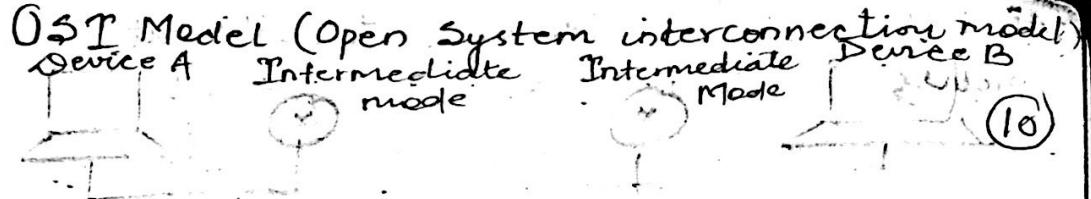
V.35 interface is used to connect high speed routers to ~~choice~~ ^{Channel} service unit / data service unit, for communication over leased line. It is one of the popular DTE / DCE interface is used today for LAN / WAN connectivity.

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



(V.35 connector)





OSI model was established in 1978 by the International Standard Organization.

It is a multi-national body dedicated to world wide agreement on International Standards.

- An ISO standards that covers all aspects of n/w communication is the 'Open System Interconnecting 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 ^{is} interoperable. (interoperable)

Note:- ISO is an organization while OSI is a model.

Peer:- The entities comprises the corresponding layers at different m/c's are called Machines peer.

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 made in the n/w.

- Header includes Control information such as sequence number.
- The header added to the peer (Data Configuration) layer at the transmitting site are used to inform symmetrical & compatibility funcⁿ at the receiving side.

Information flow
are
Layers
through
is made
each p
Note:-
each
process
network

Responsibilities

a. Physical

- Config

- Deal
- Speci

- Data
- Ex. 1

b. Physical

- Repre

- Line C

b. Data

- Secor

- Data

- Error c
(Parc)

c. Physical

- Tailor in

to de

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 receiving device is made possible by an interface between each pair of adjacent layers.

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 transmission media.
- Data rate is the responsibility.
Ex. No. of bits / second.
- Physical topology : Ex. Bus, Star.
- Representation 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
- Trailer is used for error control.
↳ NIC
- to define the sender and receiver of the frame
↳ Network Interface Card

- Retransmission of the damaged frame.
- Flow Control :- Data rate must be controlled according to the receiver.

3. Network :- If two systems are connected to same link then there is no need for a network layer.

- 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 congestion also belongs to this layer.

4. Transport :- 4th Layer of O.S.I model.

- Process to process delivery of data (entire message).
- Provides the services to the session layer.
- It provides two types :-

← →
Connection Connectionless
Oriented

However if two systems are attached to different network with connecting devices (routers) between the networks then there is a need (12) for the network layer to accomplish source to destination delivery of the data.

Connection oriented

→ Reliable.

→ Ex. T.C.P.

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

Connect :- Set up a Connⁿ b/w ports.

Data :- Deliver a sequence of msg in correct order and without error.

Delivers an urgent msg by making them jump ahead of non-urgent msg.

Disconnect :- Release the connection.

• It provides the guarantee of delivery of data from source to Destinⁿ
* All packets follow the same route

- Segmentation and reassembly of the msg.
- Flow control.
- Connection Control.
- Port address. (Transport Layer works with the port address to differentiate b/w)

Connectionless

→ Non-Reliable

→ Ex. ~~T.C.P.~~, U.D.P., IP

• It doesn't provide guarantee to delivery of msg from source to destination.

• Speed or data rate is fast in comparison to the connection oriented.

- No acknowledgement from Receiver.
- Unreliable.
- Packets are not joined in sequence
- All the packets follow the different route

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 received and acknowledged independently.

If further crash happens during the transmission of P1, P2, P3, the only pages that need to be resent 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.

• Pr.
• PreSENTATION
• Basic

(Encryption)
a system

Encrypts
Original
and Sen.

Decrypts
Side to

(Compression)
Contains
data in the
and vice

(Translation)
two sys.
in the
The info
before b

(Application)
→ Use
→ 7th
Applic
servic

(Presentation Layer) :- 6th layer of O.S.I. model.

- provides services for Appⁿ.

13

- Basic features are:-

- Encryption
- Compression
- Translation

(13)

Encryption:- To carry sensitive information a system must be able to ensure privacy.

Encryption means the sender transforming the original information to another form and sends the resulting msg over the network.

Decryption technique is used at the Receiving 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 informⁿ in the form of character strings, numbers

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

Application Layer provides service

- User Support Layer.

- 7th Layer of Application Layer.

Applicⁿ 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 SW

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

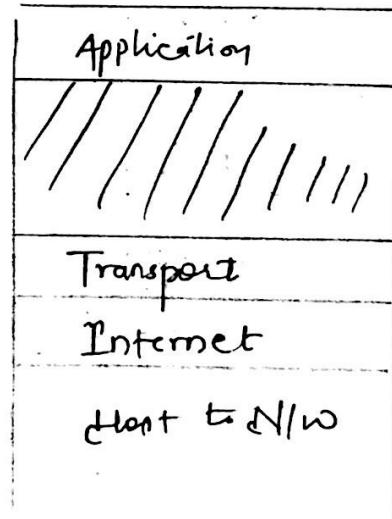
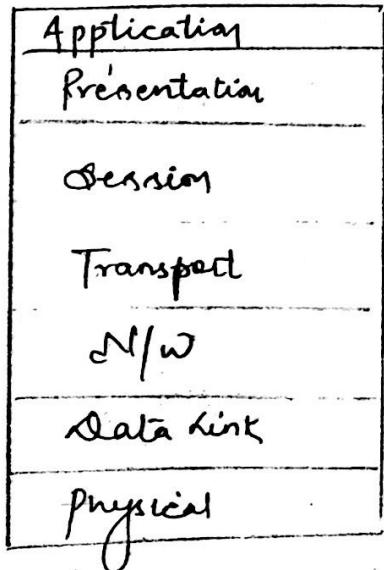
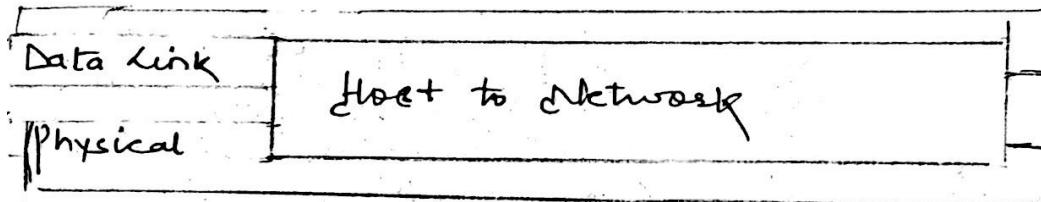
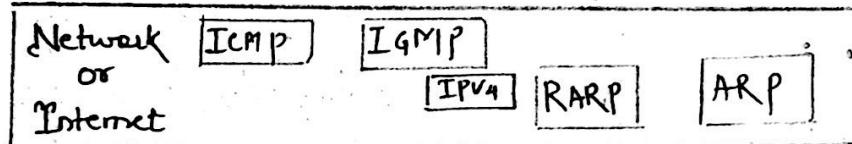
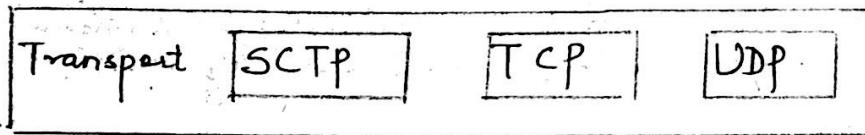
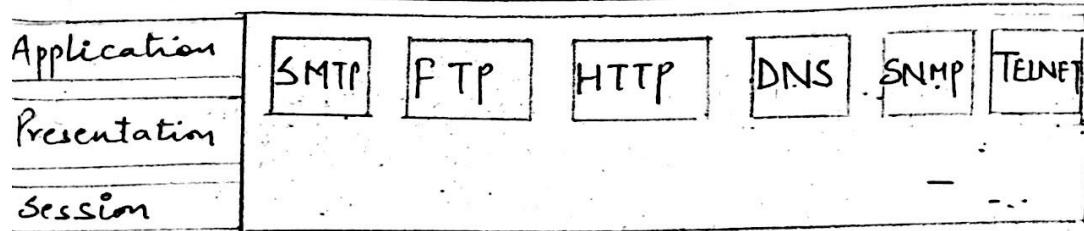
c. Mail Services :- This appⁿ provides the basis for e-mail forwarding and storage.

d. Directory Services :- This appⁿ provides

distributed databases, sources and access for global information about various objects and services.

TCP/IP Reference Model :-

(14)



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 installation using Leant line.

Later Satellite and radio network were added. Later then the existing protocols in the OSI model had trouble interworking with them so a new reference architecture 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 protocol suite as having 4 layers.

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

At the
doesn't
It supp
A netwo
LAN o.

Network

At the
play re
a. IP: u
rd
✓r
✓fa
✓Al
(Ec
✓La
✓No
✓No

b. ICMP
✓Comp
✓ICM/
report
• ICM/
• It si
for E.

At the physical and data link layers, TCP/IP doesn't define any specific protocol.

It supports all the standard protocols.

A network in the TCP Internet can be LAN or WLAN.

Network Layer or Internet:-

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

a. IP: Non-reliable.

- ✓ Doesn't provide guarantee to delivery of data.
- ✓ No acknowledgement from Receiver.
- ✓ fast service.
- ✓ All the packets of the data follows diff. path.
(Each packet moves independently).
- ✗ Lack of Error Control.
- ✗ No error reporting.
- ✗ No error Correcting.

b. ICMP: (Internet Control Message Protocol)

Companion of IP.

- ✓ ICMP sends query reporting msg and error reporting msg 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 Mgmt Protocol

Used to facilitate the simultaneous transmission of a message to a group of Recipients.

• Three types of Casting :-

1. One to one - Unicasting

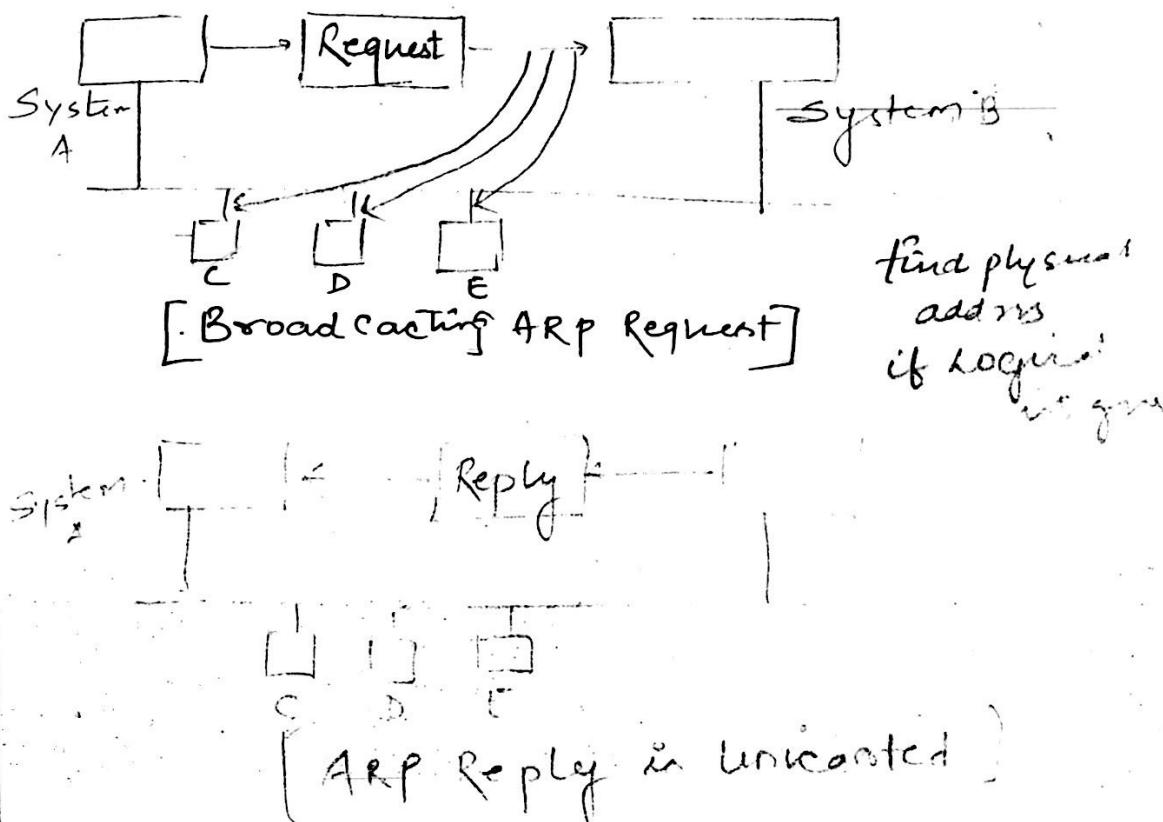
2. One to many - Multicasting

3. One to all - Broadcasting

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

d. ARP (Address Resolution Protocol)

It is used to find the physical address of the node whenever its internet address, logical address of IP is known.



e. R.O.
It's address &
its physi

Transport sc
and H

a. T.C.P.:

✓

da.

• Lee

• Era

b. U.D.P.

process
port c

✓ Conne

✓ Perfor

✓ I.D.

a fix

• Sendin
much &
Recieve

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~~ plays very imp. role.

a. T.C.P :- Reliable

✓ Connection oriented -

• All packets follows same path.

✓ Provides acknowledgement

✓ Provides guarantee to delivery 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 msg by U.D.P. takes much less interaction b/w sender and receiver than using T.C.P. / S.C.T.P

↳ (Stream Control
Transmision
Protocol)

C. ~~HTTP~~

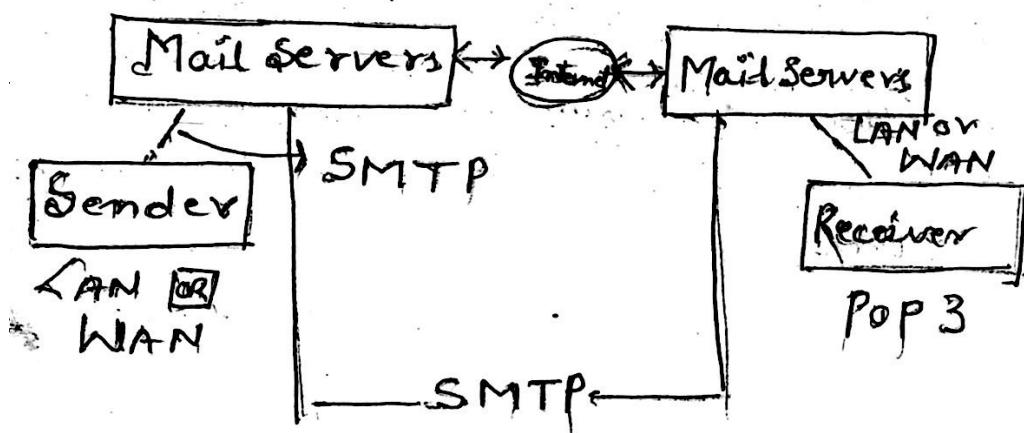
C. S.C.T.P :- (Stream Control Transfer protocol)

- Supports for newer appⁿ suppose voice over the Internet.

Application layer :-

(a) S M T P (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.



- As SMTP is a delivery protocol only while POP and IMAP
 - ↳ (Internet Message Access Protocol) for retrieving message.

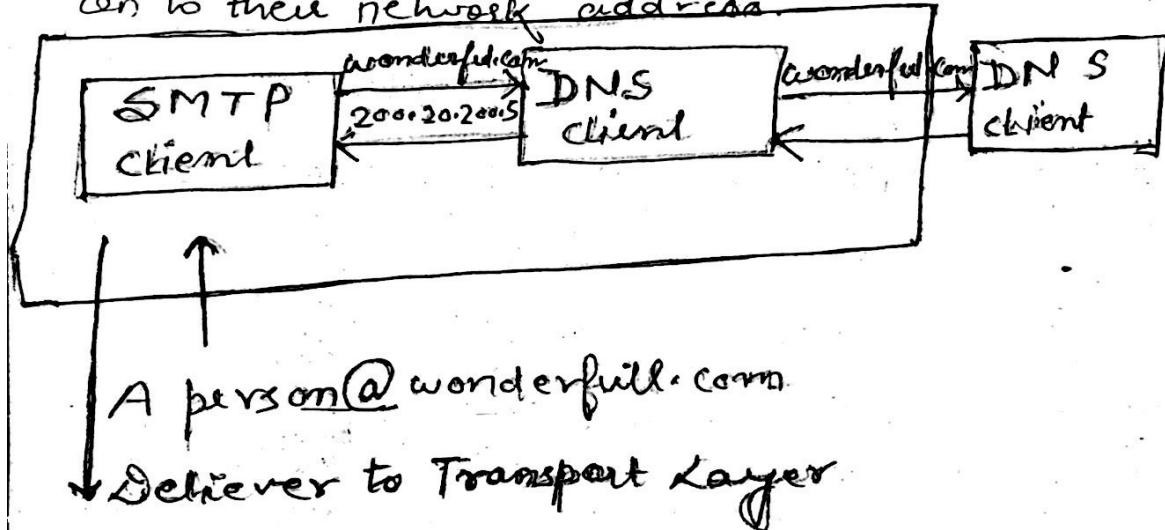
b. F T P (File Transfer Protocol)

- 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.
- (17)
- c. Http :- (Hyper text transfer protocol)
- It is used for fetching the web pages from www.

d. DNS :- (Domain Name Service)

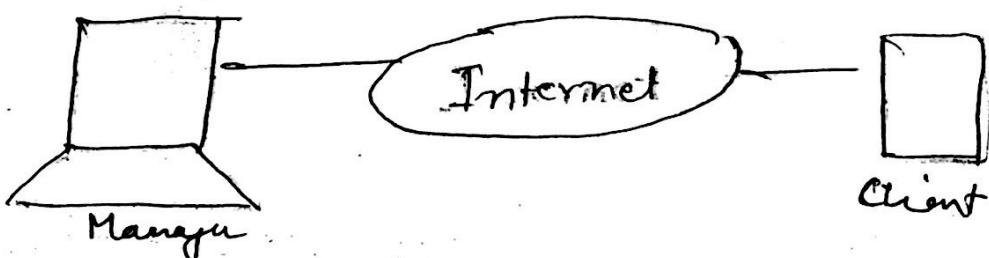
- It is used for mapping host name (rediffmail.com) on to their network address.



SNMP: (Simple Network Management protocol)

It provides a systematic way for monitoring and managing Computer Netw.

- * SNMP uses the concept of manager and agent.



- * Manager section is called Manager.
- * It is a host that runs SNMP client.
- * A managed section is called Agent, is a router that runs SNMP server program.

- * Management is achieved through a manager 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 machine to log on to a distant machine and work there.

S.O.S.I.
model

9. It has a protocol with a r

"O"

ser

Delay Analysis

OSI model

1. It has 7 layers.
2. Horizontal Approach
3. Transport Layer takes the guarantee to delivery of packets
4. Separate Session Layer
5. Separate "Presentation"
6. Network Layer provides both Connectionless and Connection Oriented Service
For Ex. TCP - Con. Oriented
IP/UDP - Connection less
7. It defines Services, Interfaces and protocols very clearly.

TCP/IP Model

1. It contains 4 layers.
2. Vertical Approach
3. Transport layer doesn't guarantee to delivery of packets.
4. No Session Layer.
5. No presentation Layer.
6. Network Layer provides only Connectionless Service
For Ex. IP.
7. It doesn't clearly distinguish Services,

H6

H5 D1

H4 D4

H3 D3

D2

010 0101

and makes a clear distinction b/w them.

8. O.S.I. is truly a general S.T.C.P./I.P. Can't be used for any other appⁿ.

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

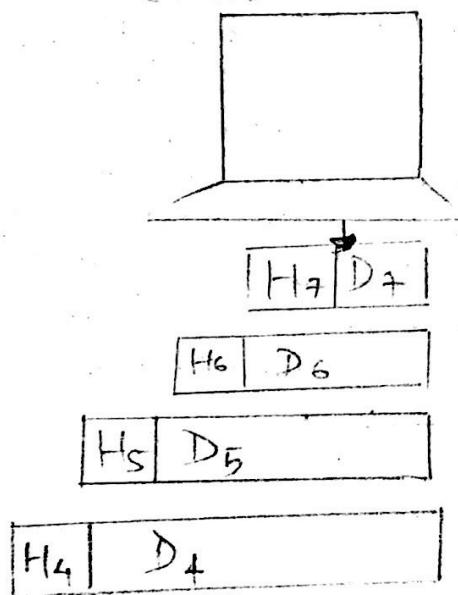
interfaces and protocol

(18)

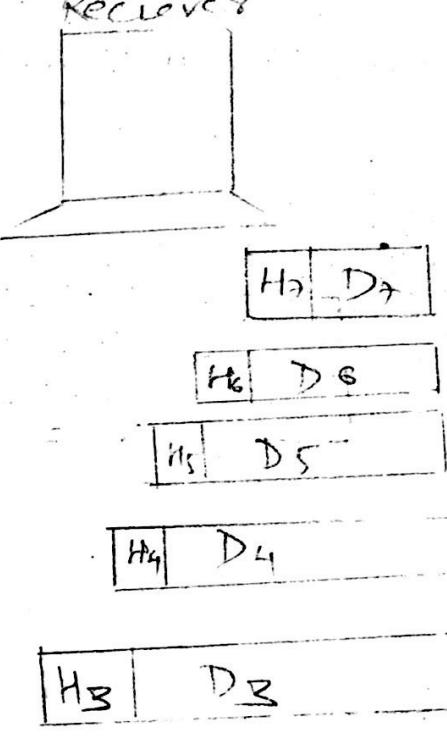
The model doesn't fit for any other protocol stack.

"Organization of Layers"

Sender



Receiver



D2

T2

Trailer

H2 D2

010 [010101010111001100]

Final Bit Stream

| Transmission |

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/Communication Channel.
- 4. Latency / Delay

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

2. Throughput :- is the successfully Received packets out of total no. of sending packets in % age.

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

OR

It is an actual measurement 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. In this each frame carrying an average of 10,000 bits. What is the throughput of network.

$$1 \text{ frame} = 10,000 \times 10^3$$

$$10 \times 10^6 = \text{bits per second}$$

1 frame =

$$10,000 \times 12000$$

$$= 120000000$$

$$60$$

$$\times 10^3 = 1200000000$$

3. Media/Communication Band

If we use fibre instead of coaxial then optical

4. Latency:-

$$\text{Latency} = \text{Propagation} + \text{Transmission} + \text{Queuing}$$

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

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

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

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

In a vacuum, light is propagated with the speed $3 \times 10^8 \text{ m/s}$.

It is slower in air.

& much slower in cable.



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

$$\text{Propog.} = \frac{12000 \times 10^3}{2.4 \times 10^8 \times 10^9} = \frac{12 \times 10^6}{24 \times 10^9} = 0.5 \text{ ms}$$

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 receiver.

Q. What the propagation time and transmission time for a 2.5 KB msg (e-mail) if Bandwidth of $17/10$ is 1 Gbps? Assume that the distance b/w the sender and Receiver is 12000 km and the light travels at 2.4×10^8 m/s.

$$\text{Propagation} = 0.5 \text{ ms}$$

$$\text{Transmission} = \frac{2.5 \times 10^3 \text{ Byte}}{1 \text{ Gbps}} =$$

$$1 \text{ kg} = 10^3$$

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

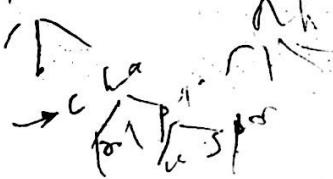
1/10
del
redundancy

$$1 \text{ KB} = 1000 \text{ Byte}$$

$$\Rightarrow \frac{2.5 \times 10^4 \times 8}{10^9}$$

shape
etc

→ For



$$= 2.0$$

Queuing time :- The time needed for each intermediate and devices to hold the msg it can proceed. It is not a fixed factor. (20)

It can be changed with the load imposed on N/W.

BACK BONE 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 LANs.

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 considerations for the backbone

decisions are:-

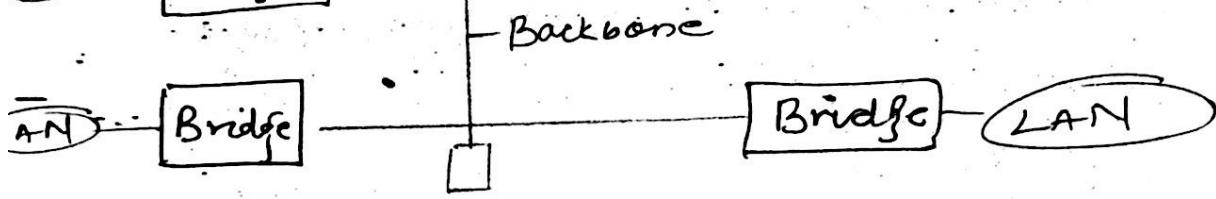
(1) Reliability :- network failure

(2) Capacity of channel :- same data rate

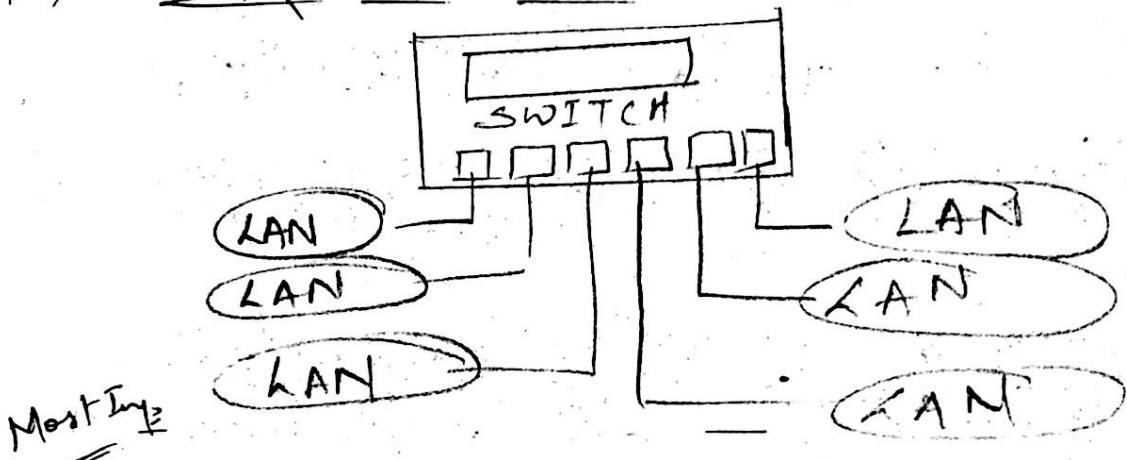
(3) Distributed backbone :-

It refers to the using Cables to join different departmental network topology, mesh topology or star topology.

This Cabling refers to as back bone Cabling and it connects HUB, switch, router of each network into a single whole.



(2) STAR BACKBONE:-



What is switching?

Switching methods:-

- A series of interlinked nodes are called Switches.
- Switches are devices capable of creating temporary connecting.

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

a. Circuit Switching: In telephonic system,

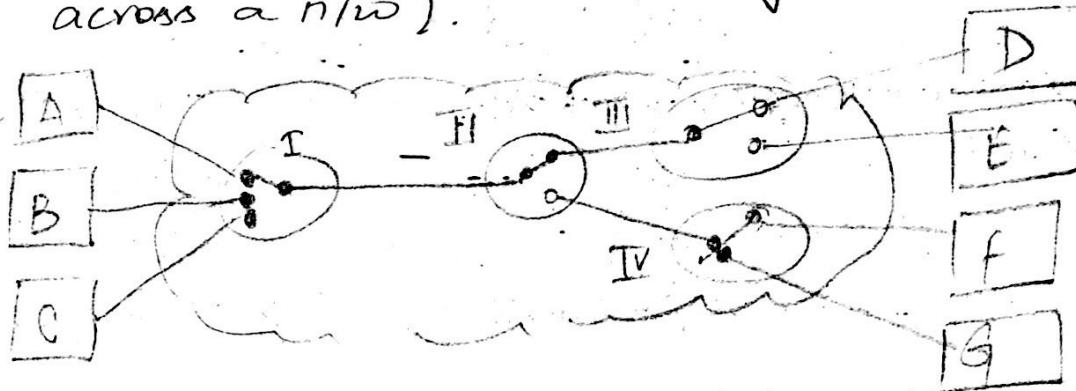
" " is used.

- In ckt " , path is established b/w sender and receiver 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 before the actual transfer of

information can take place.

(2)

- Realtime transmission (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.

• Computer establish a link with the receiving links.

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

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

Disadvantages :-

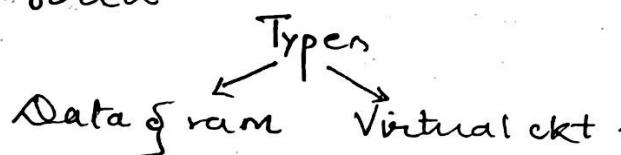
- The connections are dedicated, then it cannot be used to transmit any other data even if the channel is free.
- Dedicated channels more bandwidth.
- It takes long time to establish the connection.

Packets Switching & Connectionless services

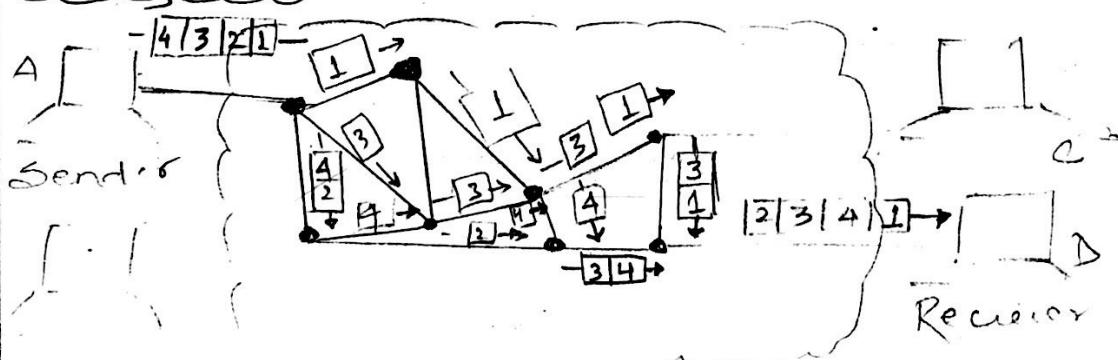
- Messages are broken into packets each of which includes a header with source and destination and intermediate node address information.
- Individual packets takes different routes to reach the destination.

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.



Datagram:-



Datagram packet by rechomg.

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.

Message

In tele transmit office to

- At the tel takes the the dec info

- The oper a comm or store like bee

- Message path blu

- In mes an Ind destinal Each is and sti

Virtual ckt packet switching:- It establishes logical address Connection b/w the sending and receiving device called virtual ckt. (22)

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

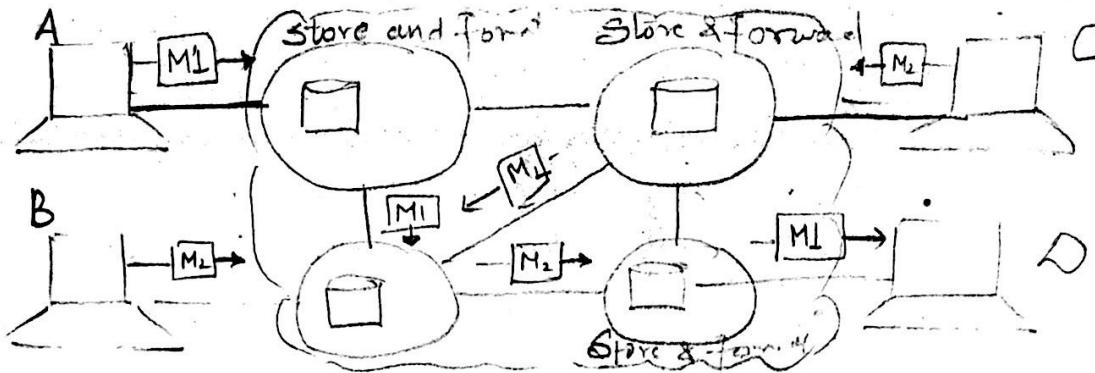
Message Switching:

In telegraph networks, the text msg 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 ~~decisio~~ of ~~out~~ 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 receives the message and store it until the next devices are

ready to receive it and then forwards it to the next device. So msg switching networks is called as a Store and Forward networks.



[Message Switching]

Advantages :- • Congestion reduced because it is able to store msg until a communication 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 appn like voice and video.

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

It is a
IP over
Amd
User)

→ It is a
→ ISDN :
include !
Correction

N:
Narrow

[ISDN]

- It has support
- ✓ Due to provided
- ✓ Quality also f
- ✓ It is Example

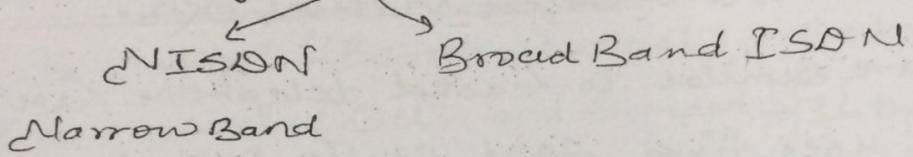
- It
- It p Latenc
- It Ca

ISDN:- (Integrated)

(23)

- ISDN provides many services text, videos, audio, fax (multiple services to multiple user).
- It is a WAN becoming available widely.
- ISDN supports a variety of app's that include both switched and non switched connection.

Types of ISDN



N-ISDN, first generation of ISDN.

- It has small bandwidths and can support data rate 64 Kbps.
- Due to low bit rates the quality of service provided by an ISDN is poor.
- Quality of video signal in N-ISDN 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 length packets called cells.
- Atm works in range of 1 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 channel
2. D channel

3. H channel

a. Basic

It is

$$= 2B + 1D + 1H$$
$$= [2 * 64] + 1$$

b. Primary

for

=

=

=

National code	National Design. Subscriber code	Subscriber number	Subaddress
			Maximum 4 digits

← →
International ISDN number (15 digits)

ISDN Address

ISDN Address Structure (24)

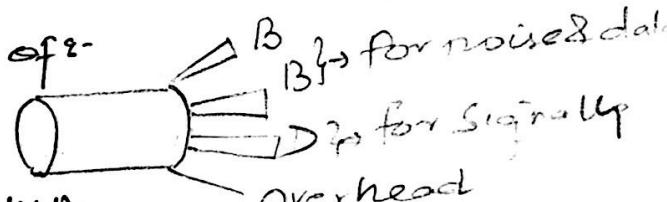
Type of ISDN channels

1. B channel (Bearer channel) \rightarrow 64 kbps
2. D channel (Delta and Demand channel) \rightarrow 16 to 64 kbps

3. H channel (High Capacity channel)
 $: 384(H_0), 1536(H_1) \& 1920(H_{12})$
 Rbps.

a. Basic Access : (Basic Rate Interface) BRI

It is composed of :-

$$\begin{aligned}
 &= 2B + 1D + \text{Overhead} \\
 &= [2 * 64] + 16 + 48 = 192 \text{ kbps}
 \end{aligned}$$


b. Primary Access (Primary Rate Interface) PRI

for 1.544 Mbps

$$= 23B + LD$$

$$= 23 * 64 + 1 * 64$$

$$= 1.544 \text{ Mbps}$$



for 2.048 Mbps,
structure contains 30B + 164 bps

$$\Rightarrow 30B + 64D$$

$$\Rightarrow 30 \times 64 + 64$$

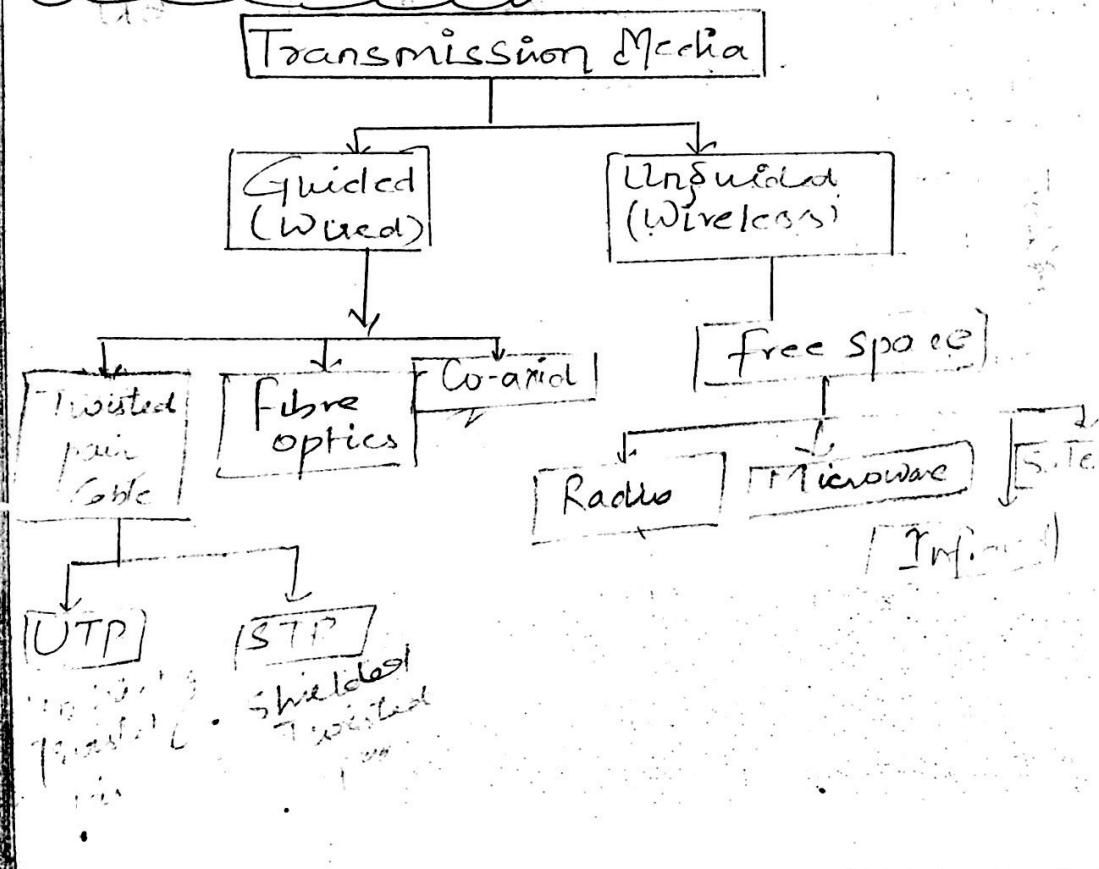
$$\Rightarrow 2.048 \text{ Mbps}$$

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

Bit Synchronization :- The timing
related to the data bit transfer
is very important in Computer Communik.

Physical Layer governs the synchroniz.
of bits by providing a clock which
controls the transmitter as well as the
receiver.

Transmission media



Compa

Guided

1. The sig
contains
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2. Twisted
Co-axial
Cable are
of guid

3. It is
to point

4. Install
time Con
Costly.

5. Attenu
Energy
on the

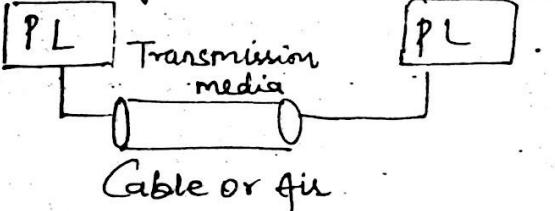
6. Additi
Capacity
by add

7. Leade
topol

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

sender

Receiver



(25)

Comparison of Guided media and unguided

Guided media

1. The signal energy is contained and guided with in a solid medium.
2. Twisted pair cable, Co-axial cable, fibre cable are the example of guided media.
3. It is used for point to point.
4. Installation is costly, time consuming and costly.
5. Attenuation (Loss of Energy) depends exponentially on the distance. $e^{-\alpha d}$
6. Additional transmission capacity can be procured by adding more wires.
7. Leads to discrete network topology.

Unguided media

1. The signal energy propagates in the form unguided electromagnetic waves.
2. Radio wave, microwave, satellite are the example of unguided media.
3. It is used for radio broadcasting in all directions.
4. Installing needs less time and money.
5. Attenuation is proportional to square of the distance d^2 .
6. It is not possible to procure additional capacity.
7. Leads to continuous network topology.

-8 Interconnecting devices :-

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

Hub

- 1. It is a broadcast device.
- 2. It operates at physical layer.
- 3. It is not intelligent.
- 4. It simply broadcast the incoming packets.
- 5. It cannot be used as Repeater.
- 6. Not very costly.
- 7. It is not a Sophisticated device.

Switch

- 1. It is a point to point device.
- 2. It operates at data link layer.
- 3. It is an intelligent device.
- 4. It uses switching tables to find the correct destination.
- 5. Can be used as Repeater.
- 6. Costly.
- 7. It is a Sophisticated device.

Gateway

- used that is
- Gateway between architectures
- A S/W or appr pr

Repeater

- and also
- At the b/w the repeat
- There are two C
- Repeater c Only the

Example:-

Cat

Bridge

- bridge c
- Bridge network.



- 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.

- collection of programs and softwares.

Gateway :-

(26)

- operates at the appⁿ layer of O.S.I.
- used to connect two separate networks that use different communication protocols.
- Gateway acts as a translator between networks using incompatible such as between T.C.P./I.P., SNA (System Network Architecture).
- A SW appⁿ which converts b/w different appⁿ protocol.

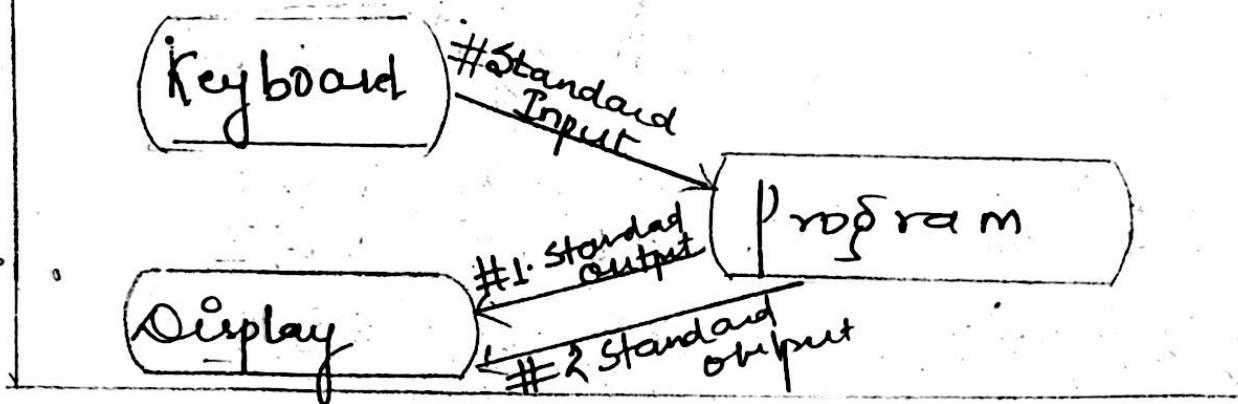
Repeater: It is used for amplifying the signals and also used for regenerating the signals.

- 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 understand frames, packets, headers. Only they understands the volts.

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

Bridge:- At the datalink layer, we find bridge and switch.

Bridge connects two or more local area network.



Text terminal

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

- Information is presented as an array of preselected 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 other words, the data rate in bits per second over a channel should be very high. b/s should be very

The data rate depends on the following

factors :-

1. Bandwidth

2. Quality of Signal

3. Level of Signal we can use.

* Two theorems 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. Signal 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 transmitting is defined as channel capacity C , the above expression can be written

$$C = 2B \log_2 L$$

2. Shannon's Channel Capacity

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

→ This term is concerned with the rate of transmission of Information R over a communication 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 occurred.

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:-

(28)

$\left[\frac{S}{N} \right]$ (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 2 MHz and
its ~~H~~ its signal/noise = 63.
Calculate the appropriate bit rate and
Signal travel. $\log_2 64$

$$B = 2 \text{ MHz}$$

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

$$R = B \log_2 64$$

$$R = 64 \log_2$$

$$R = 2 \text{ MHz} \log_2 [64]$$

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

$$\Rightarrow 12 \text{ Mbps}$$

Bit rate

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

$$B = 2 \text{ MHz}$$

$$R = B \log_2 L$$

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

This is an upper limit.

2

Y0.3020

~~2x10⁶~~
~~6x40~~

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

~~2x10⁶~~

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

$$\Rightarrow 8 \times 10^6 = 2 \times 2 \times 1$$

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

Lower value
= 8 Mbps

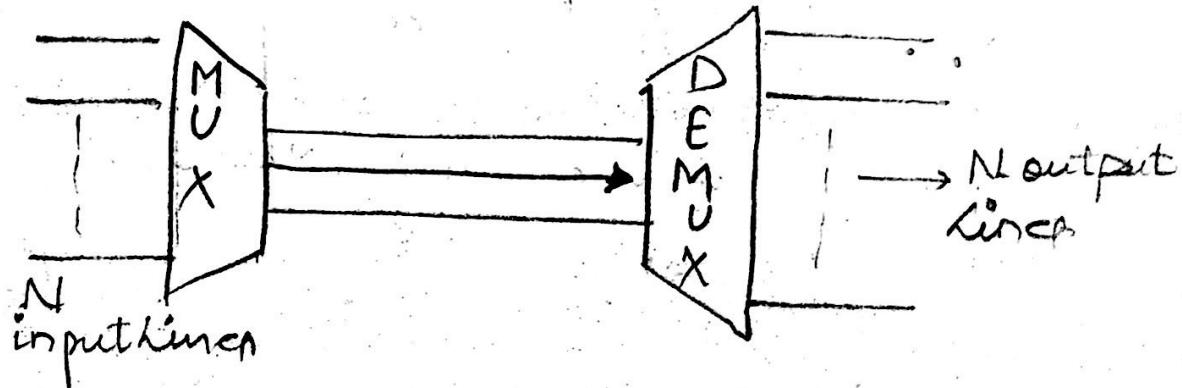
$$2 = \log_2 L$$

$$L = 4$$

Physical Layer design Issue 9-

Duties of the physical layer:-

- 1> Transformation of raw bits to signal.
- 2> Bit rate control
- 3> Bit synchronization
- 4> Multiplexing
- 5> Circuit switching.



Types of Multiplexing

- (1) Frequency Division Mux. [FDM]
- (2) Time " " [TDM]
- (3) Web Lengths " " [WDM]

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

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

Remaining part of Delay Analysis :-

Band width \downarrow

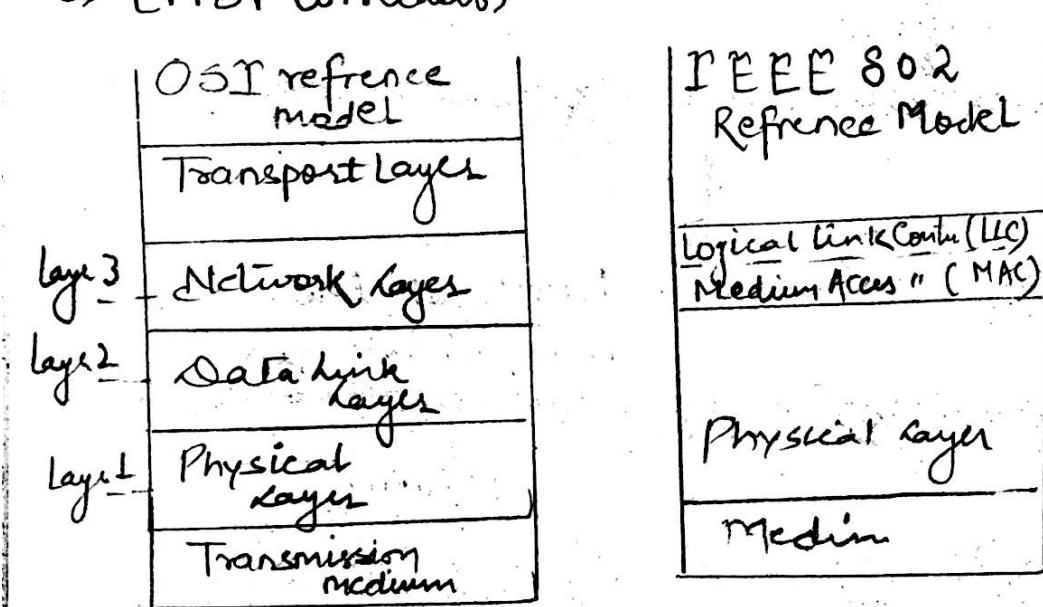
$$\text{Volume} = \text{Bandwidth} \times \text{Delay}$$

(29)

$\langle \frac{\text{Bandwidth} \times \text{Delay Product}}{\text{Delay} \times \text{length of the communication channel}} \rangle$

$$\text{Bandwidth} \propto \frac{1}{\text{Delay}}$$

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



- 1) LLC :-
- Error Control
 - Flow Control

Ex. Error Correction & Detection technique

- 2) MAC :-
- Responsible for regulating
 - Access to the shared Media
 - Responsible for Multiple Access resolution
 - is Called MAC.
 - ALOHA, TDMA, FOMA, CDMA

- (We will not use dedicated Sender and receiver)
 → not in point to point.

Synchronous access have multiple user
 → time slot sharing pdefa.

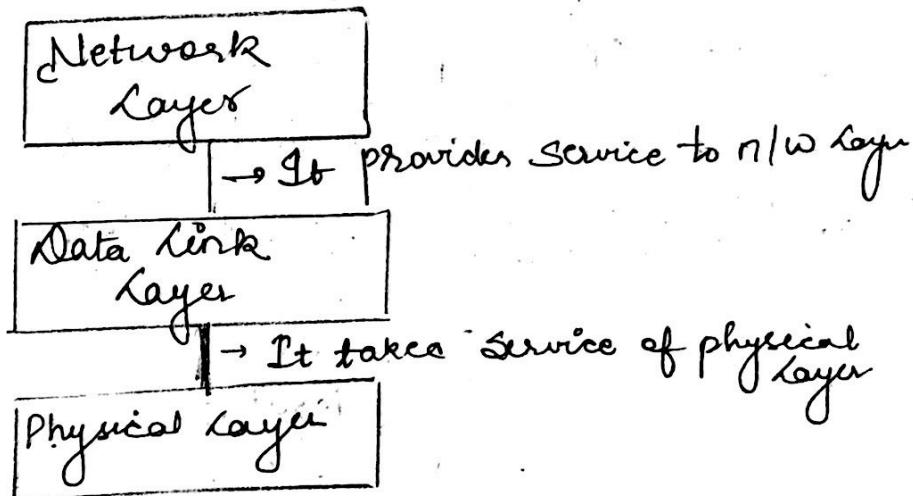
Data Link Layer :-

(30)

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 synchronization
 3. Addressing
 4. flow Control
 5. Error Control
 6. Link Management
- frame synchronization :- 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.

Level

old.

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

(Link Layer):- Protocols or procedure are required for link layer.

- The initiation, maintenance and termination of the link b/w source and destination is required for the effective exchange of the data.

- It requires Co-ordination and Co-operation b/w stations.

Types of services provided :-

1. Unacknowledged Connectionless Services

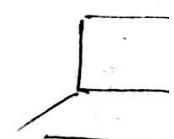
2. Acknowledged Connectionless

3. Acknowledged Connection oriented Service

- └ Positive
- └ Negative

1. Unacknowledged Connectionless Service :-

- In this type of service the destination machine does not send back any acknowledgement of the receiving frame.
- It is a connectionless service when no connection is established before communication.
- If a frame



The no is
binary
Other
Zero me

Type of E
1. Cont
2. Cont
3. Cont

Flow

introdu
data -

- It ha
- Data

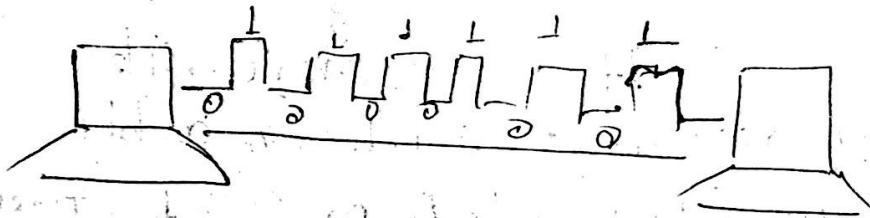
Note:- 1

error
two -

Timing = acknowledgement +
 Sender to Receiver time +
 Receiver transmission
 processing.

- Resends.

- timeout.



The noise can introduce an error in the binary bits travelling from one system to other.

Other

Zero may change to one or vice versa

Types of error:-

(1) Content error: Zero may change to one or vice versa.

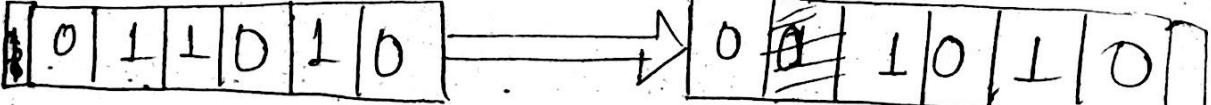
(2) Flow integrity error: Such errors are introduced due to missing blocks of the data.

- 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

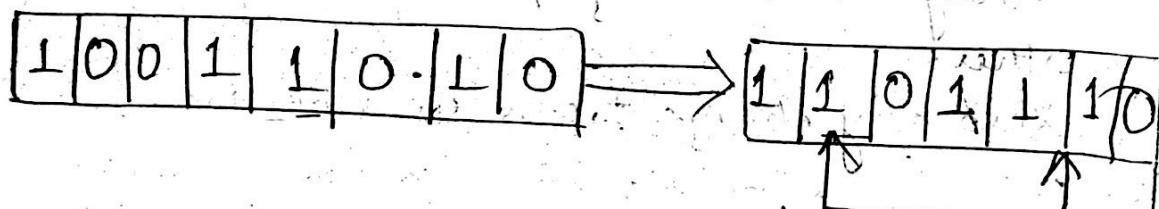


Transmitted Data
Byte -

Received Data Byte

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

13) Burst errors - 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 occurred.



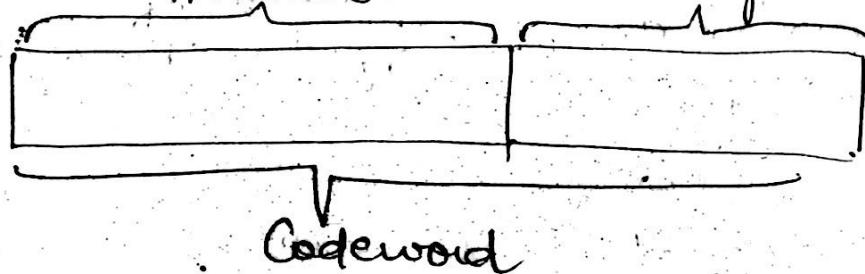
Second Data bytes

Length of
Error message
5bit

Received 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

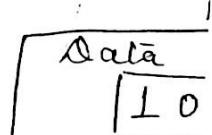
Ex.)

w

Hammur

Toansuu
Receive

Redund



Reject
data
No



Code Rate :- The ratio of original data word to the number of msg bits (k) to the total no. of bits (n) in a code word then

$$\text{Code Rate } (r) = \frac{k}{n}$$

Ques. 32

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

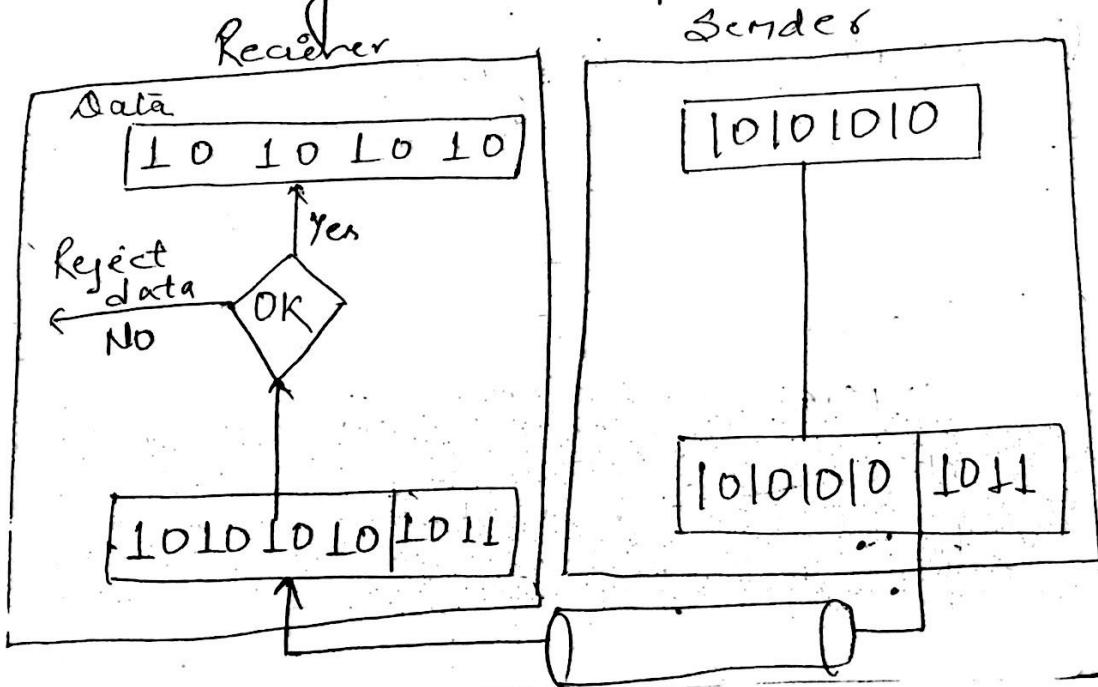
Ex. $X = 11010100$

$$w(X) = 4 \text{ (non zero)}$$

Hammimg distance

Transmission codeword $\Rightarrow 11010100$
 Received Codeword $\Rightarrow 01011100$

Redundancy r - 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.

Error Detection Methods

↓
Parity check Checksum CRC

① Simple parity check

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

b. L.R.C (Longitudinal Redundancy Check)

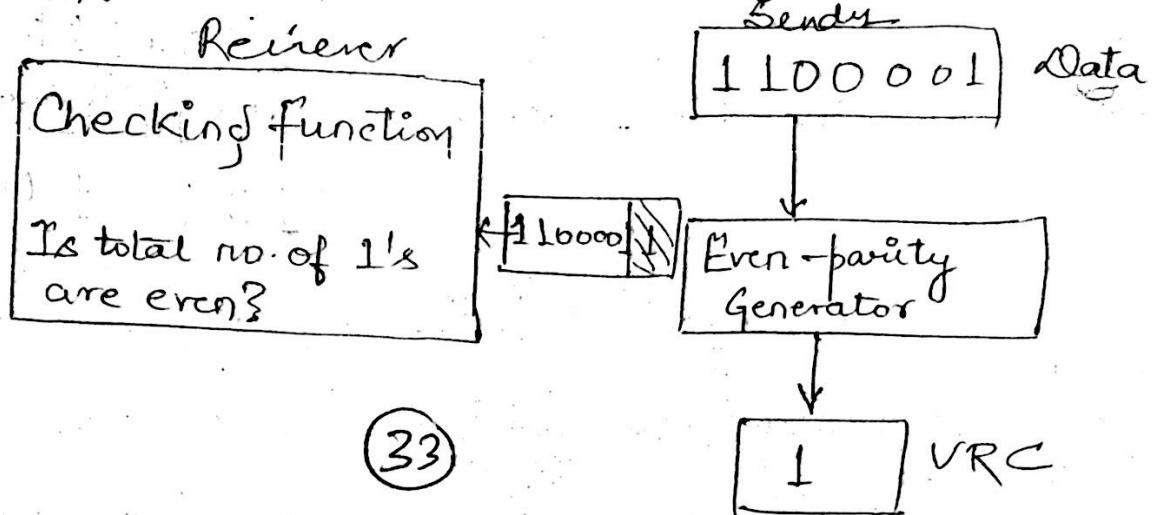
② Two dimensional parity check

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.

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



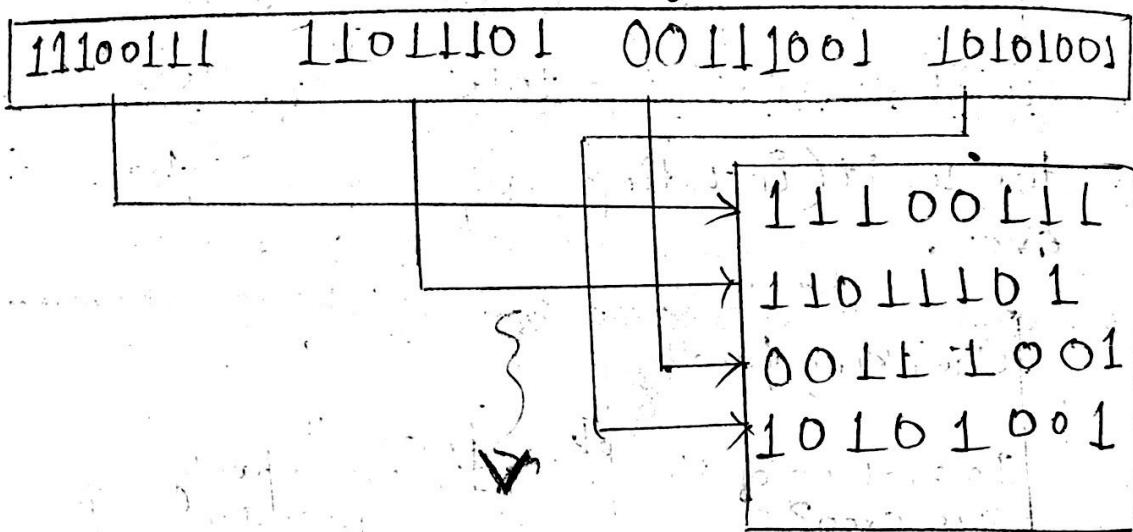
V.R.C:- Suppose the Sender wants to send the "World" in ASCII code by using even parity check.

$$\begin{array}{l}
 \text{W=1110111} \\
 \text{O=1101111} \\
 \text{R=1110010} \\
 \text{L=1101100} \\
 \text{d=1100100}
 \end{array}
 \quad \left\{
 \begin{array}{l}
 11101110 \\
 11011110 \\
 11100100 \\
 11011000 \\
 11001001
 \end{array}
 \right.$$

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. L.R.C. 10101010

11100111 11011101 00111001 10101001 10101010

- L.R.C. can be calculated after counting the number of 1's in each column.
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 data unit

01110001 & 010000010

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

(34)

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 X 101010

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

Two-dimensional Parity check

1100111 1011101 0111001 0101001

Row parity	1	1	0	0	1	1	1	1
Row parity	1	0	1	1	1	0	1	1
Row parity	0	1	1	1	0	0	1	0
Row parity	0	1	0	1	0	0	1	1

0 1 0 1 0 1 0 1

Column Parity

1100111 1011101 0111001 0101001 TOTOTOT

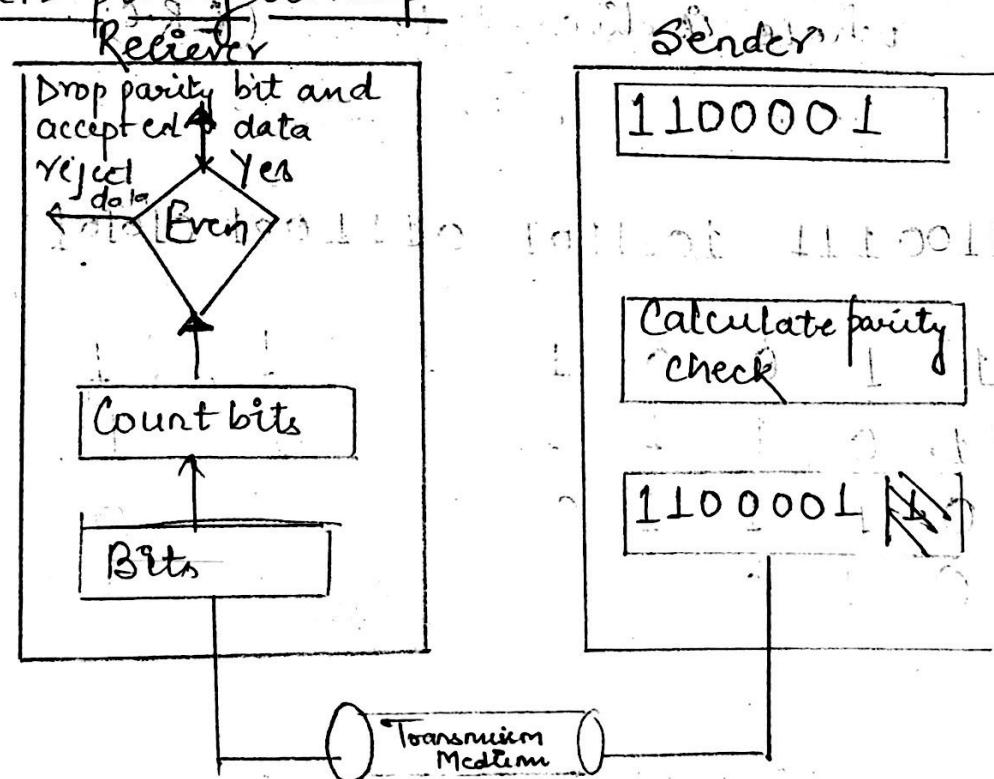
2-D parity check increases of detecting burst error

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.

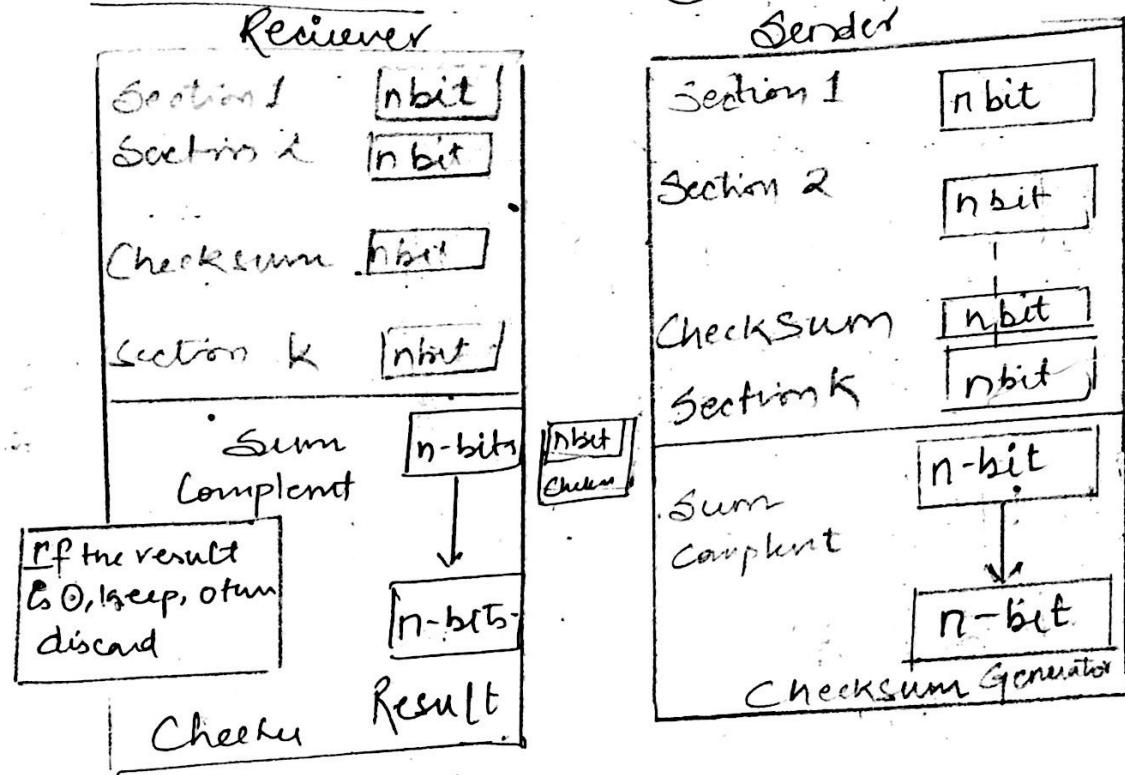
However, error effecting 4-bits may not be detected.

Even parity concept



Checksum 8-

(35)



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, ~~the~~ ^{byte} receiver, ~~can~~ ^{more} then sender retransmits the entire data units.

forward error correct

2 (Hamming Code) :-

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

m = original message

r = Redundant bit

• Error correcting code, however, are more sophisticated than error detection code and require more redundancy bits.

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

$m+r$
 $\Rightarrow 4+3=7 \text{ bit}$

d_1	1	0	.1	y_3	1	y_2	y_1
	7	6	5	4	3	2	1

1	0	1	d_7	d_6	d_5
11	10	9			

$$d_1 d_2 d_3 d_4 =$$

~~$d_1 d_2 d_3 d_4$~~

$$\Rightarrow y_1 1 1 1$$

$$\Rightarrow \boxed{y_1 = 1}$$

$$y_2 d_3 d_3 d_4$$

$$\Rightarrow y_2 1 0 1$$

$$\Rightarrow \boxed{y_2 = 0}$$

$$y_3 d_2 d_3 d_4$$

$$\Rightarrow y_3 1 0 1$$

$$\Rightarrow \boxed{y_3 = 0} \quad \begin{matrix} 2^3 & 2^2 & 2^1 & 2^0 \\ \cancel{1} & \cancel{0} & \cancel{0} & 0 \end{matrix} \quad (001)_2$$

\Rightarrow  error.

on 1st bit

1	0	1
---	---	---

1	0	1
11	10	9

= ~~1~~ 1

= 1 2

= $\boxed{y_1 = 1}$

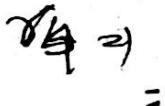
= 2 3 1

= $y_2 + 0$

= $\boxed{y_2 = 0}$

 =

= 0
= $\boxed{y_3 = 0}$

 =

$$+ \frac{m=7}{}$$

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

$$2^r \geq 8+1$$

(36)

$$r=4$$

d ₇	d ₆	d ₅	y ₄	1	d ₄	d ₃	d ₂	y ₃	d ₁	y ₂	y ₁
1	1	0	9	8	7	6	5	4	3	2	1

$$7+4=11$$

$$m=1.0110111$$

1	0	1	y ₄	0	01	0 ₃	1 ₂	y ₂	y ₁
---	---	---	----------------	---	----	----------------	----------------	----------------	----------------

1	0	1	y ₄	0	1	0	01	y ₃	1	y ₂	y ₁
1	1	0	9	8	7	6	5	4	3	2	1

$$\cancel{d_7 d_6 d_5} = 1357$$

$$\Rightarrow y_1 = 1$$

$$\Rightarrow [y_{12}]$$

$$\Rightarrow 23 \text{ B67}$$

$$\Rightarrow y_2 + 0101$$

$$\Rightarrow [y_{22}]$$

$$\cancel{y_3} \Rightarrow 4567$$

$$\Rightarrow y_3 = 101$$

$$\Rightarrow [y_3 = 0]$$

$$\cancel{y_4} \Rightarrow y_4 = 101$$

$$\Rightarrow [y_4 = 0]$$



0011

3rd bit

1	1	1	0	1	0	1
d_7	d_6	d_5	y_4	d_3	y_2	y_1

$y_1 d_3 d_5 d_7$

$$1 \ 1 \ 1 \ 1 \rightarrow \boxed{y_1=0}$$

$y_2 d_3 \cancel{d_5} d_6 d_7$

$$0 \ 1 \ 1 \ 1 \rightarrow \boxed{y_2=1}$$

$y_4 d_5 d_6 d_7$

$$0 \ 1 \ 1 \ 1 \rightarrow \boxed{y_4=1} -$$

$$y_4 y_2 y_1 \rightarrow 110 \Rightarrow \underline{\text{Get bit}}$$

$$1010101$$

Perform

$$\begin{array}{|c|c|c|} \hline 0 & 0 & 0 \\ \hline \end{array}$$

$$\begin{array}{|c|c|c|} \hline 0 & 1 & 1 \\ \hline \end{array}$$

$$\begin{array}{|c|c|c|} \hline 1 & 0 & 0 \\ \hline \end{array}$$

$$\begin{array}{|c|c|c|} \hline 1 & 1 & 1 \\ \hline \end{array}$$

Q. A data word to be transmitted ! A bit
JDDLL. Construct even parity having code.

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

$$2^r \geq 5 + r \quad \underline{\underline{r=3}}$$

$$\frac{4+3+7}{5+4}$$

7 6 5 4 3 2 1

	d_7	d_6	d_5	y_4	d_3	y_2	y_1
	1	0	1	1	1	0	1

$y_1 d_3 d_5 - d_7$

$$y_1 1 \ 0 \ 1 \ 1 \rightarrow \boxed{y_1=1}$$

$y_2 d_3 d_6 d_7$

$$\rightarrow y_2 1 0 1 2 \rightarrow \boxed{y_2=0}$$

$y_4 d_5 d_6 d_7$

$$y_4 1 0 1$$

$$\rightarrow \boxed{y_4=0}$$

$$\begin{array}{|c|c|c|} \hline 0 & 0 & 1 & 1 \\ \hline \end{array}$$

$$\begin{array}{|c|c|c|} \hline 0 & 1 & 1 & 0 \\ \hline \end{array}$$

$$\begin{array}{|c|c|c|} \hline 1 & 1 & 1 & 1 \\ \hline \end{array}$$

A han
Or detect

1010101

10011100101
 10010100101

(37)

1, 3, 5, 7, 11
 $11001 = \underline{\underline{1}}$

2, 3, 6, 7, 10, 11
 $101001 \Rightarrow \underline{\underline{1}}$

4, 5, 6, 7, 9, 10
 $0010 = \underline{\underline{1}}$

Performance of Hamming code :-

<table border="1"> <tr><td>0</td><td>0</td><td>0</td><td>1</td><td>1</td><td>0</td><td>1</td></tr> </table>	0	0	0	1	1	0	1	Column 4	<table border="1"> <tr><td>0</td><td>0</td><td>0</td><td>1</td><td>0</td><td>0</td><td>1</td></tr> </table>	0	0	0	1	0	0	1
0	0	0	1	1	0	1										
0	0	0	1	0	0	1										
<table border="1"> <tr><td>0</td><td>1</td><td>1</td><td>0</td><td>1</td><td>0</td><td>0</td></tr> </table>	0	1	1	0	1	0	0	Column 3	<table border="1"> <tr><td>0</td><td>1</td><td>1</td><td>0</td><td>0</td><td>0</td><td>0</td></tr> </table>	0	1	1	0	0	0	0
0	1	1	0	1	0	0										
0	1	1	0	0	0	0										
<table border="1"> <tr><td>1</td><td>0</td><td>0</td><td>0</td><td>1</td><td>1</td><td>0</td></tr> </table>	1	0	0	0	1	1	0	..	<table border="1"> <tr><td>1</td><td>0</td><td>0</td><td>1</td><td>1</td><td>1</td><td>0</td></tr> </table>	1	0	0	1	1	1	0
1	0	0	0	1	1	0										
1	0	0	1	1	1	0										
<table border="1"> <tr><td>1</td><td>1</td><td>1</td><td>1</td><td>1</td><td>1</td><td>1</td></tr> </table>	1	1	1	1	1	1	1	..	<table border="1"> <tr><td>1</td><td>1</td><td>1</td><td>0</td><td>1</td><td>1</td><td>1</td></tr> </table>	1	1	1	0	1	1	1
1	1	1	1	1	1	1										
1	1	1	0	1	1	1										

Sender

Receiver Burst :-

16d7

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

Corrupted bits

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

However, there is a way to detect a burst error. Solves in above step.

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

- 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 codeword at a time, we arrange the codewords in a table and send the bits in a table 1 column at a time and then the bits are send column by column.

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

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

In this
error det

a. Forward

In ARI
request,
that si
Error Co
upon fi
Request -
damaged

Type of

1) Stop c

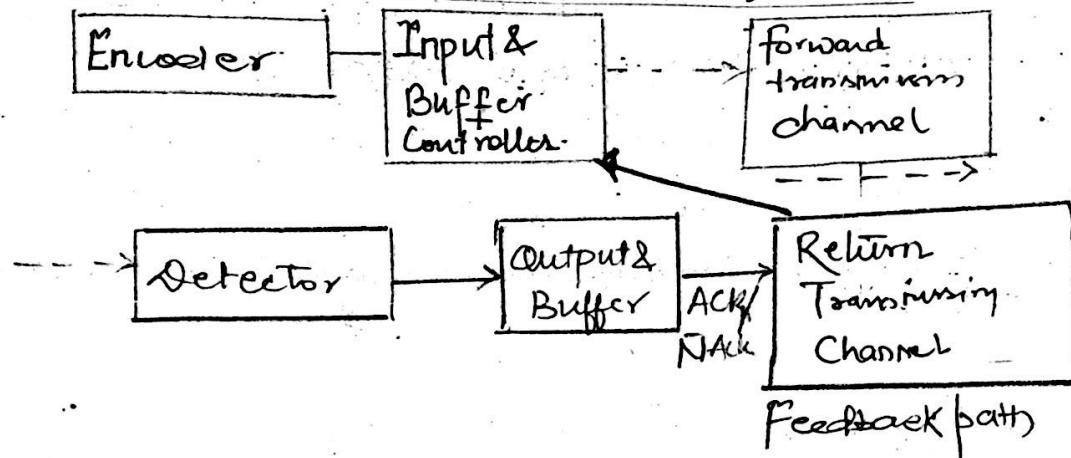
2) Go b

3) Select

"Error Control"

(38)

ARQ (Automatic Repeat Request)



note

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.

Type of ARQ Systems-

- 1) Stop and wait ARQ System
- 2) Go back N ARQ System
- 3) Selective Repeat ARQ System

most my

Protocols

↓

For Noisless
Channel

→ Simplet

→ Stop & Wait

Elementary
Data Link
Protocol

for Noise
channel

→ Stop-&-wait ARQ

→ Go-Back-N-ARQ

→ Selective-
repeat ARQ

Sliding Window
Control

Request →

Request →

↓

Ge

S

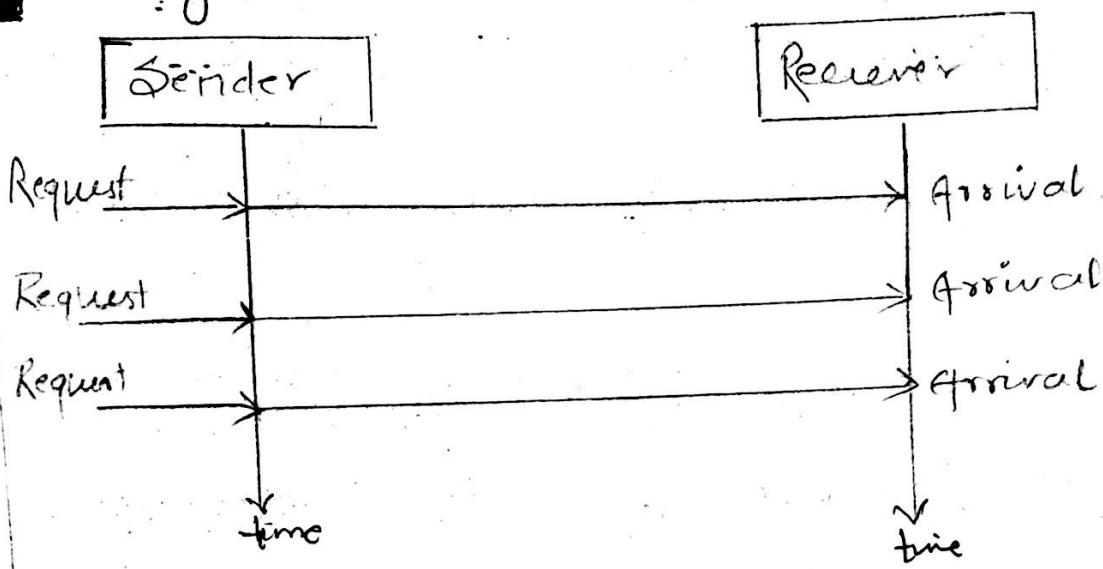
(Noisless channel) :- An ideal channel in which no frames are lost, duplicated or corrupted.

(i) Simplet :- • 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 receiver immediately removes the header from the frame and sends the data packet to its N/w layer.

(39)



p-&-wait ARQ In this protocol, the receiver can never be overwhelmed.

Back-N-ARQ

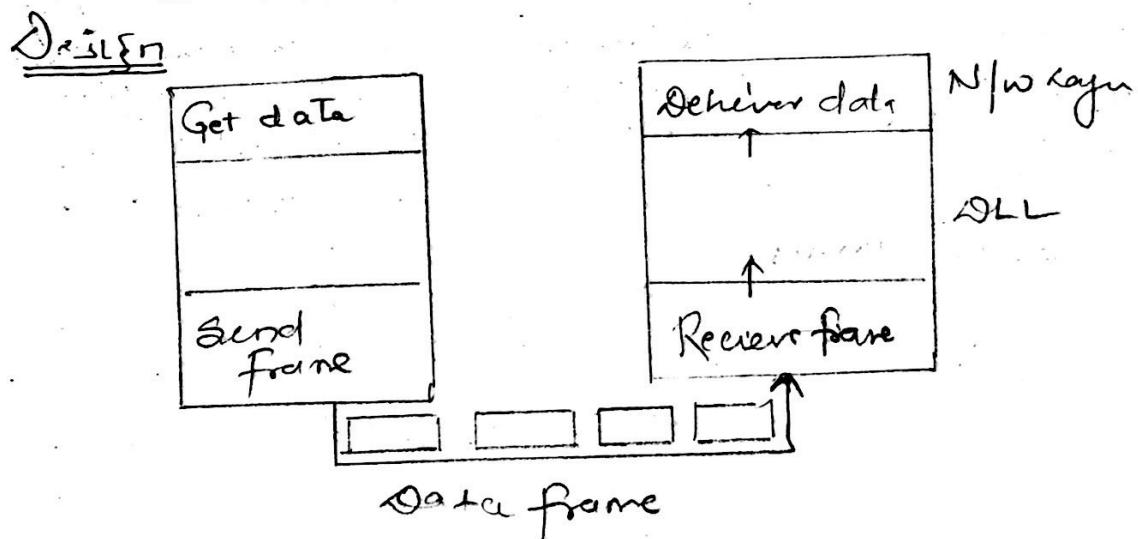
Active-ack ARQ

Sliding window

in
tak

cel in
ring
order

n
rc,



Recie

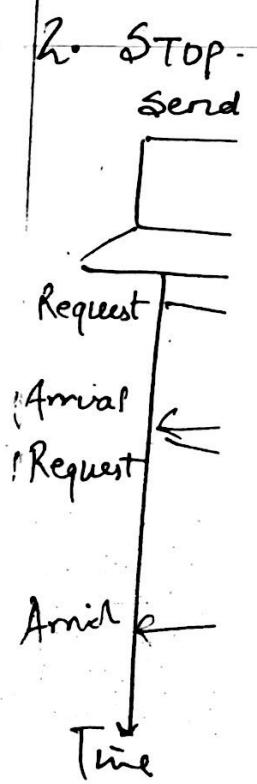
1. while
2. {
3. Recie
4. If,
5. {

The sender side cannot send a message until its.

The receiver side cannot deliver the data packet to its n/w layer until a frame ~~error~~ arrives.

Sender Side Algorithm :-

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



8. Send frame(); //Send the frame

9. }

10. }

(48)

Receiver Side Algorithm :-

1. While (true) //Repeat forever

2. {

3. Wait for Event();

4. If (Event (Arrival Notification))

5. {

6. Receive frame();

7. Extract Data();

8. Deliver Data();

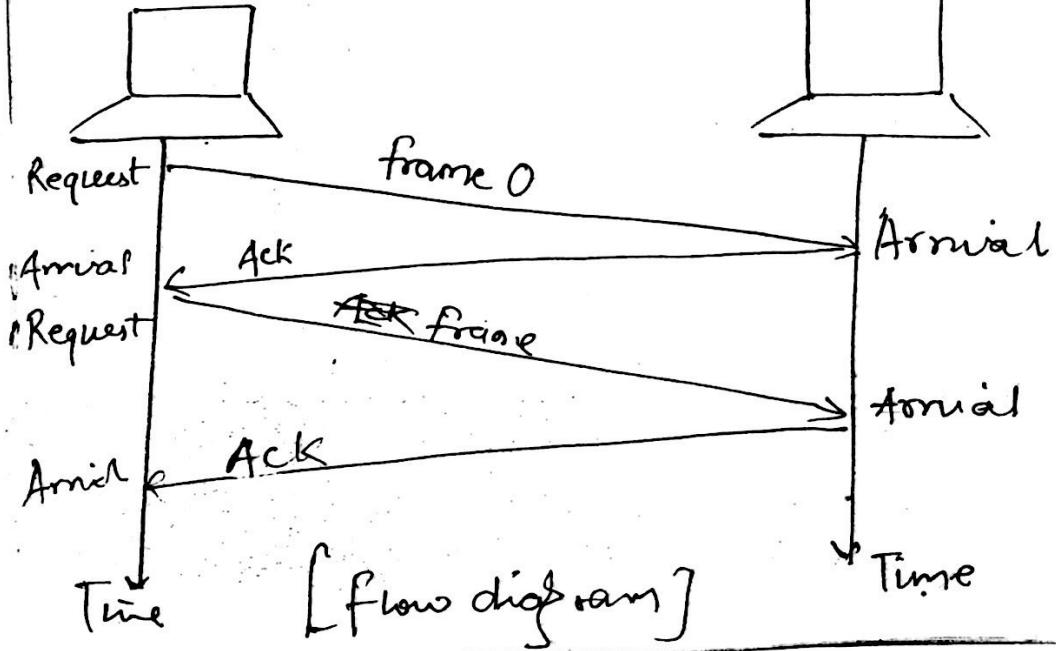
9. }

10. }

2. STOP-AND-WAIT PROTOCOL :-

Sender

Receiver



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 communication channel is assumed to be noise free and the communication is simplex.

Ex. Only in one direction.

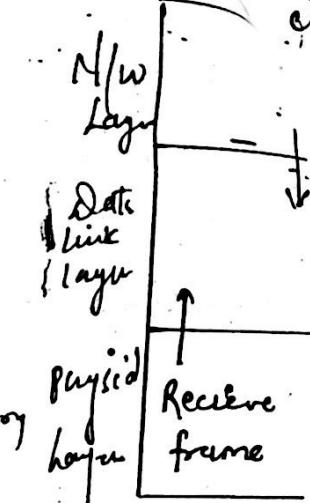
This protocol deals with an important problem.

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

In this protocol, a small dummy frame is sent back from the Receiver 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.

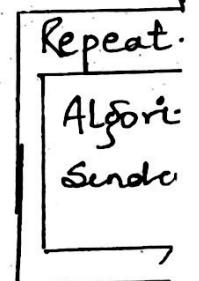
It is called Acknowledgment.



scr

Event

Rec
n/



Event

Notifies
physical

Note:- At 2

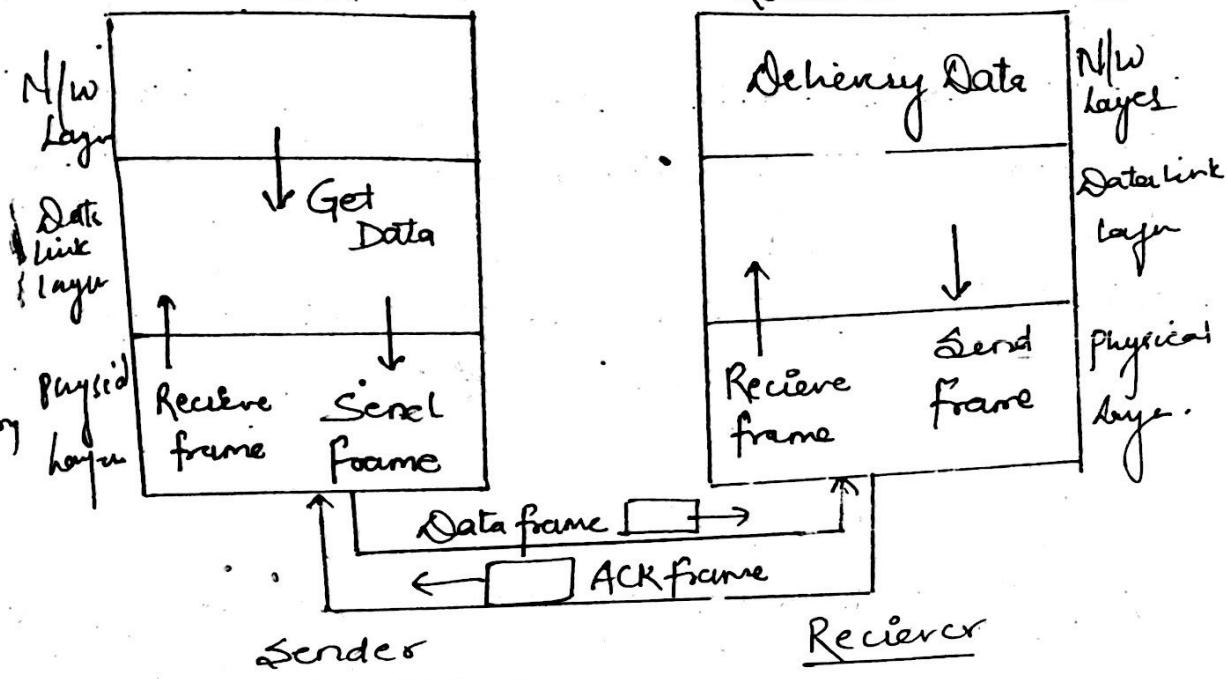
- a. A R
- b. An
say

Design of STOP-AND-WAIT Protocol

SENDER

Receiver

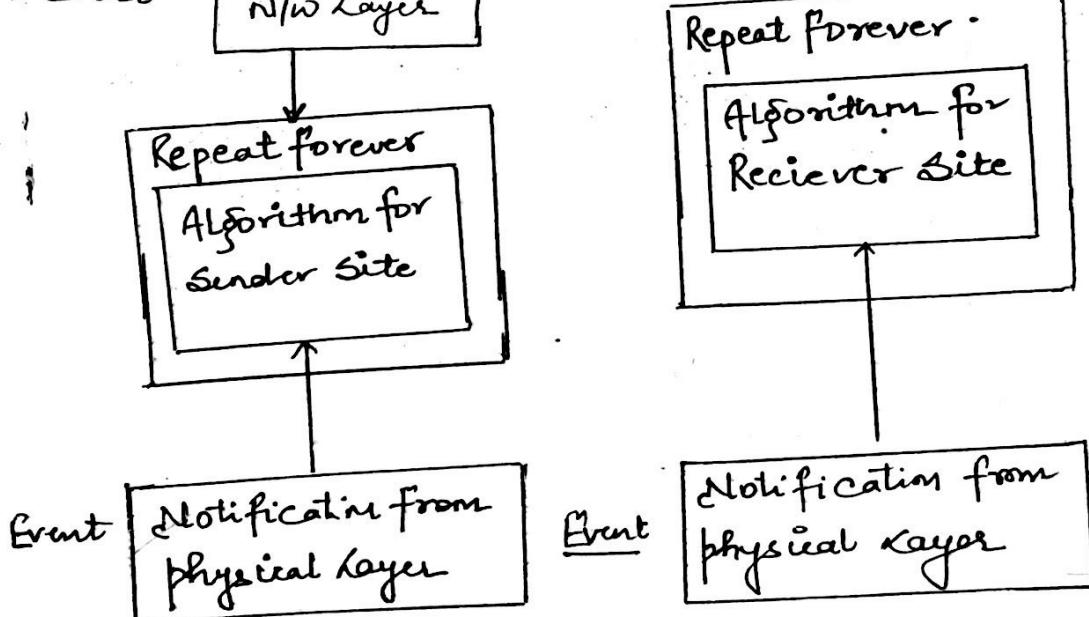
(4)



Event

Request frame
N/w layer

Receiver



Note:- At Sender two event can occur:-

- a Request from the N/w layer.
- b An arrival notification from the physical layer.

Sliding window :- refers to imaginary boxes at the transmitter and receiver.

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

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

The receiver also maintains a receiver window.

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

They may be of same size or the

Called

- They all their Receiver

→ S

→ G

→ Se

a [Stop]

One
(57)

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

(42)

Sequence Number:- Frame Contains a sequence
number ranging from $0 \text{ to } 2^{m-1}$.

$$m = \text{no. of bits}$$

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

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

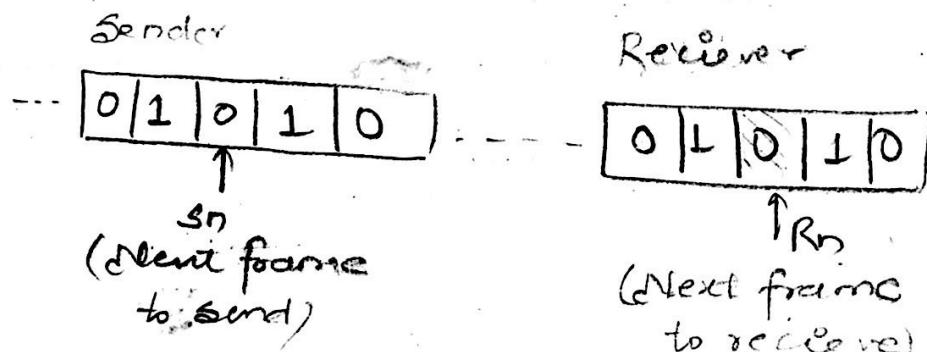
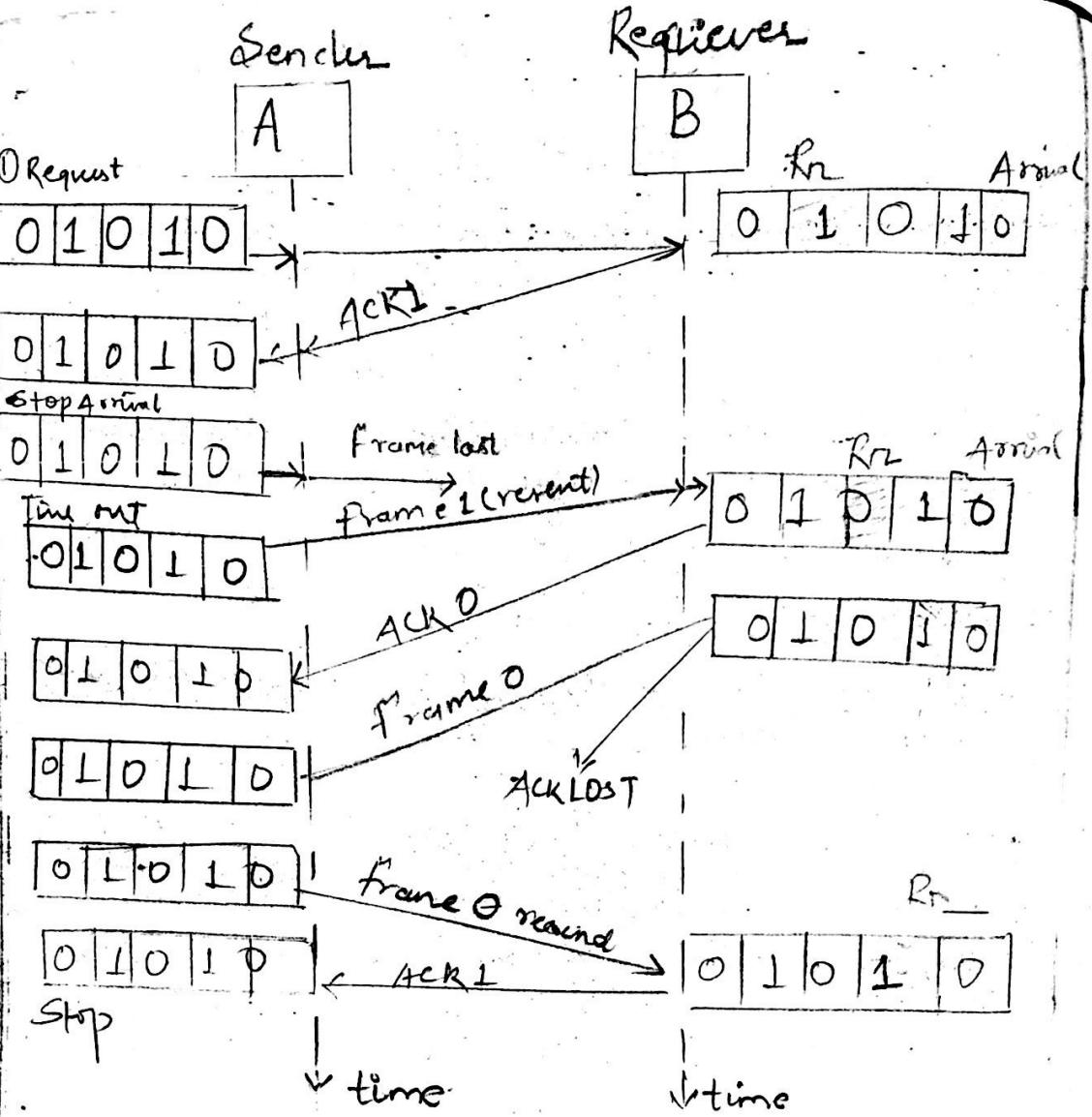
- Stop and wait sliding window protocol.
- Go back and ARQ.
- Selective Repeat ARQ.

a) Stop and wait sliding window protocol

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

Sequence No. - $2^m - 1$, ($0 \text{ to } 2^{m-1}$)

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)

$$Window Size = 2^M - 1$$

• Only transfer of file is static. The o the a because are a reason.

1. If
2. If
3. If + lost.
4. After clear then

Piggyback
flag

• Be

- Disadv
- If + frame of t
 - Effici

The disa

- It uses the Stop and Wait technique.
- The sender sends one frame and waits to get its acknowledgement.

(43)

- Close after receiving the acknowledgement, it transmits the next frame, then because of fair & 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 transmission:-

1. If the received frame is damaged.
2. If the transmitted frame is lost.
3. If the acknowledgement from the receiver is lost.
4. After a specified time if the transmitter doesn't receive ACK or NAK 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 acknowledgement then retransmission of the frame would take place.
- Efficiency is less.

The disadvantage of piggybacking is the additional 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 utilization of that

~~1M~~

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

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

~~$\frac{1000}{20000} \times 100\% = 5\%$~~

* ~~$\frac{1000}{20000} \times 20000$~~ * for this reason, we can say a link with high bandwidth.

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

{2} lost

T

S=0

S=1

S=1

S=0

{3} lost

T

S>C

S=1

S=1

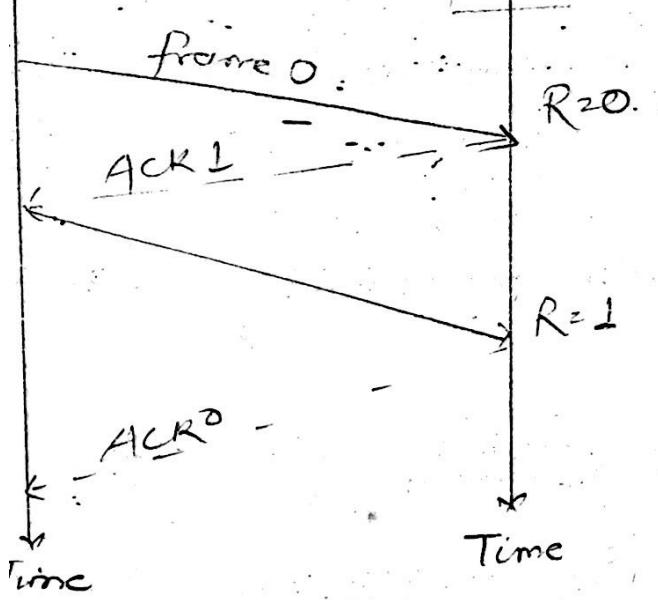
S=0

Normal Operation

Sender

Receiver

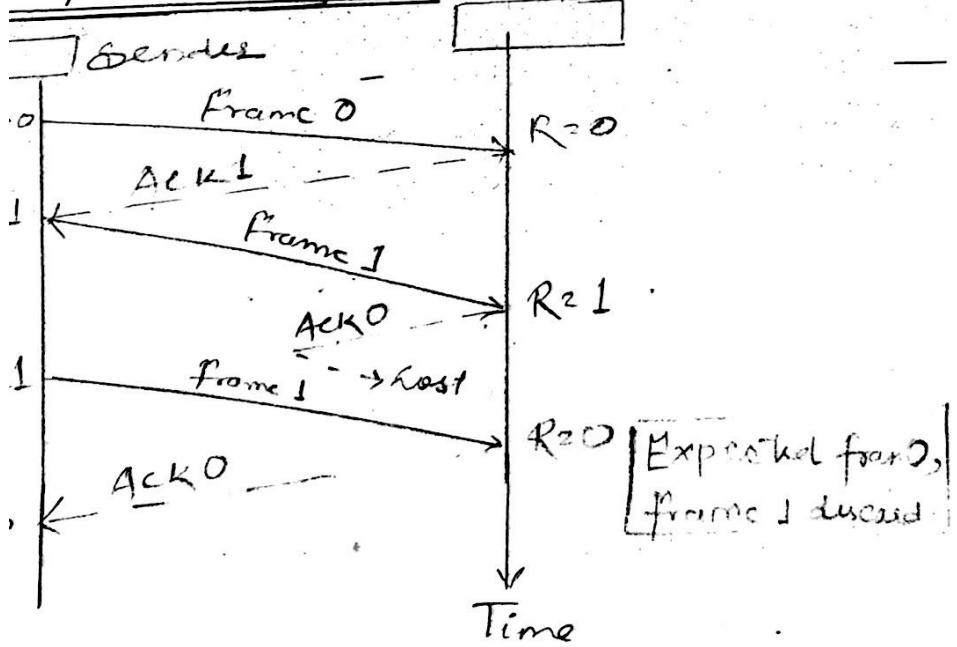
(44)



Acknowledgment

Sender

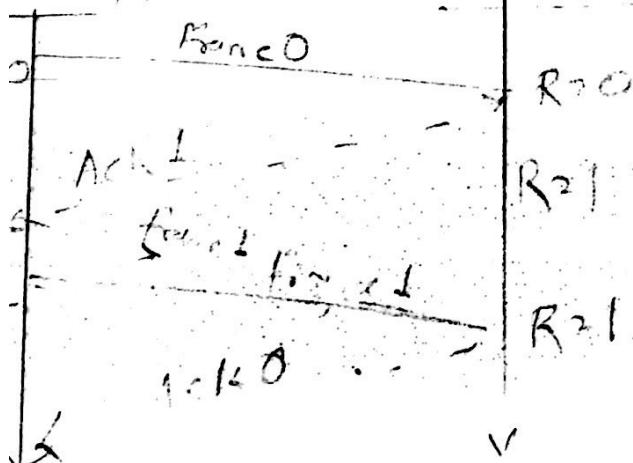
Receiver

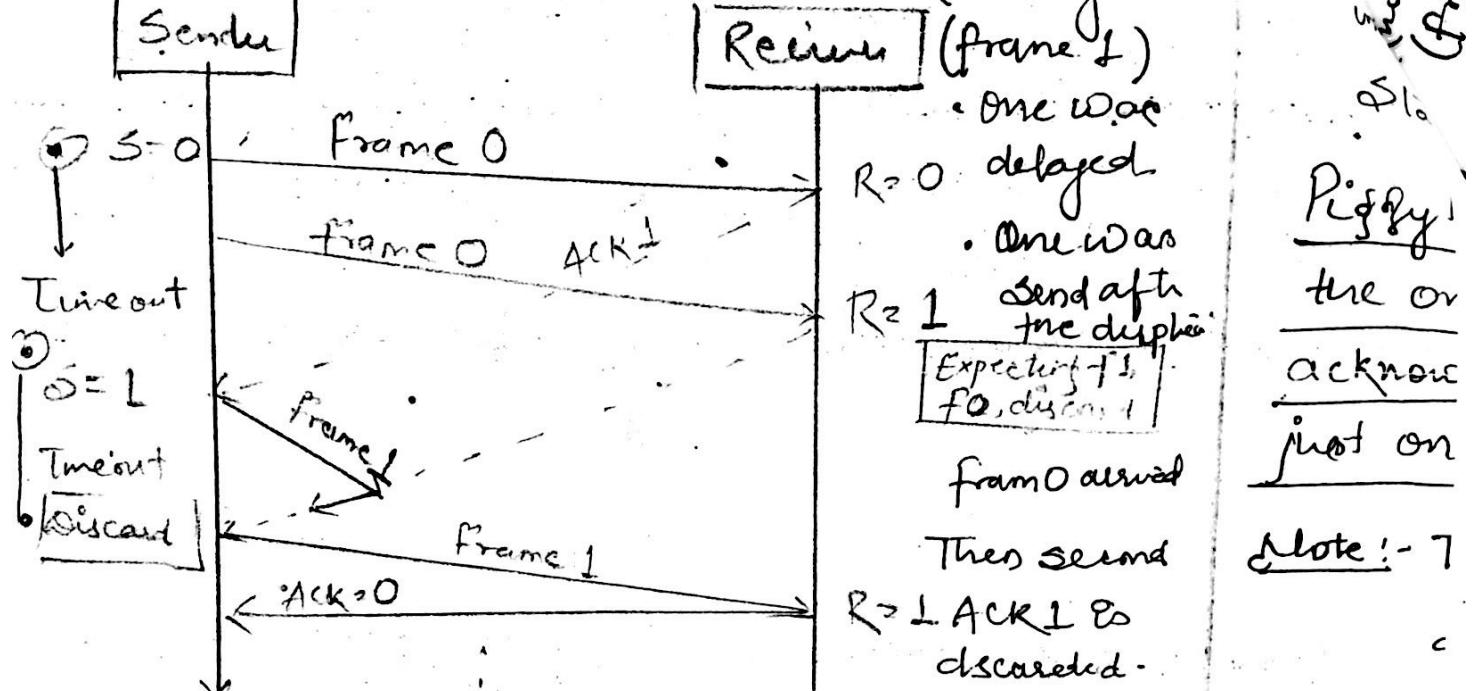


OR Damaged frame:-

Sender

Receiver





It is a method to combine a data frame with an acknowledgement.

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

- Instead of sending separate data and acknowledgement frames,

Stop and wait

- Sender trips to the receiver
- At any transmission protocols

Station A sends a data frame that includes an acknowledgement. (45)

Station B behaves in a similar manner.

- Piggybacking can save bandwidth because the overhead from a data frame and an acknowledgement frame can be combined into one 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 channels for full duplex transmission or share the same channel for half duplex transmission.

In this case, each party needs both S and R variables (Send and expected).

X Back (Advantage & Disadvantage)

Stop and Wait (Disadvantage)

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

GB-BACK - N-ARQ

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

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

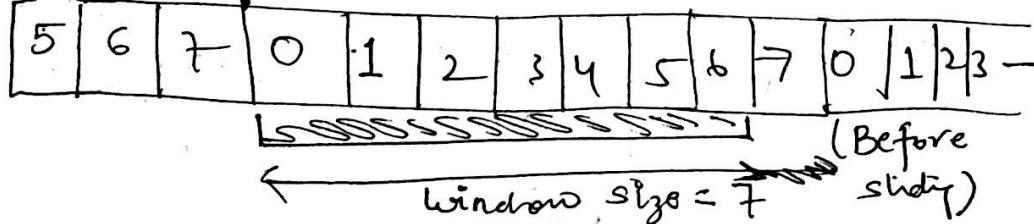
* Two protocol use this concept :-

- Go Back & ARQ -
- Selective repeat and ARQ .

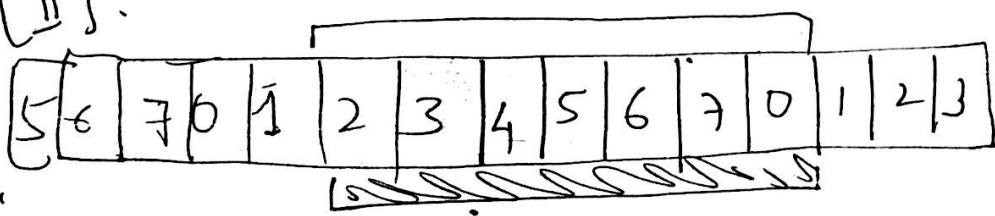
V. contd.

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

[I]:



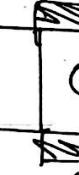
[II]:



After sliding two frames

- Sending window Size = 3
- Receiving window Size = 1

Control

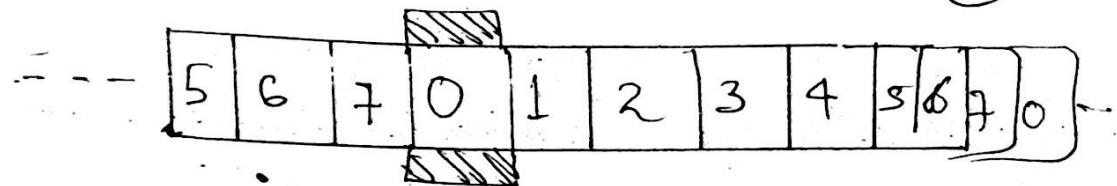


S_f = first window

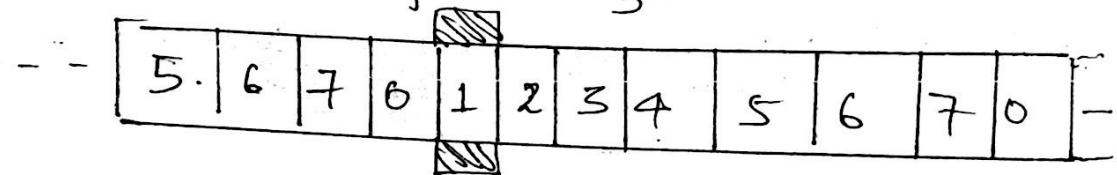
S_l = last window

Receiving Sliding Window :-

(46)

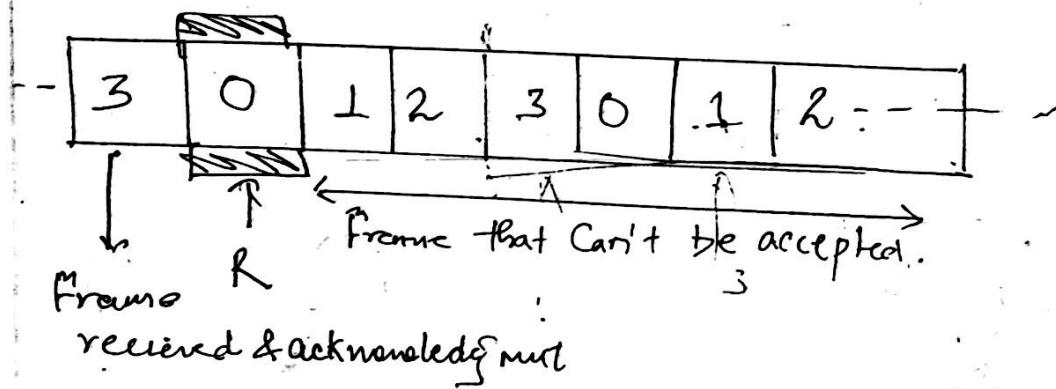
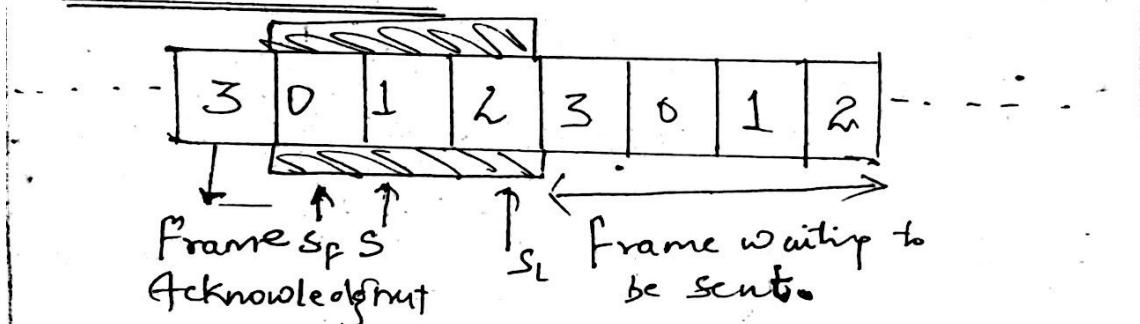


[Before Sliding]



[After one frame slip]

Control Variables :-



S_f :- first frame in the window.

S_L :- last frame in the window.

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

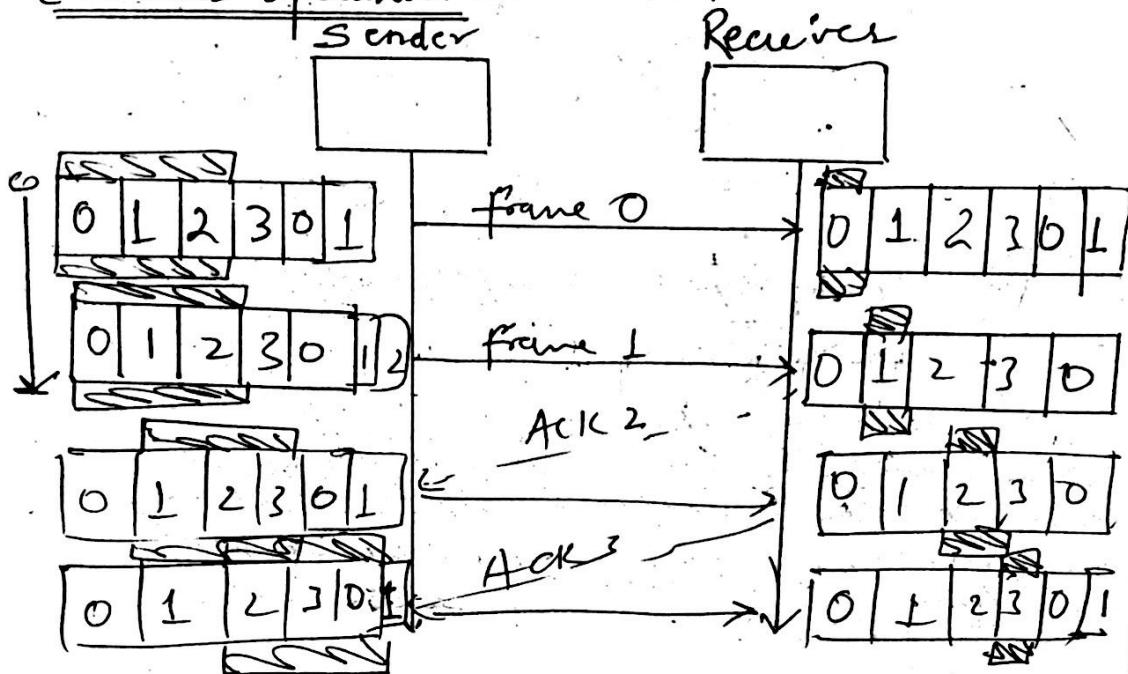
R :- Receiver has control
variables, holds the
no. of next frame
expected.

Then, Size of the window, we
Can calculate:-

$$W = S_r - S_p + 1$$

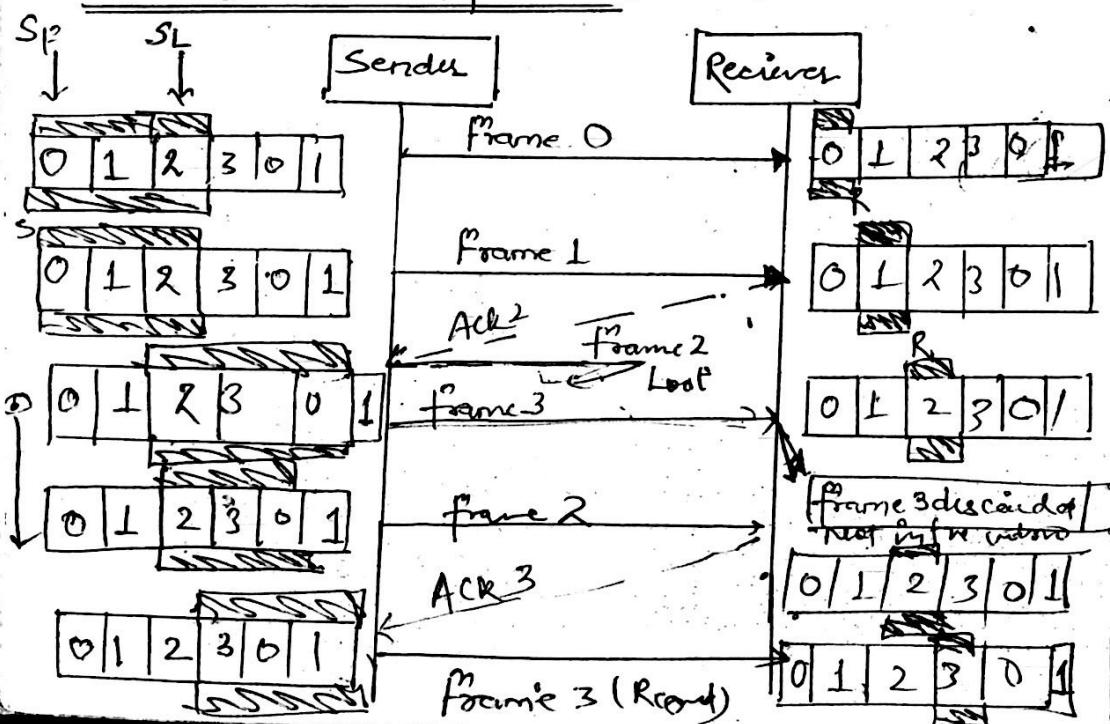
Operations :-

Normal Operation :-



Why thi

Damaged a lost frame :-



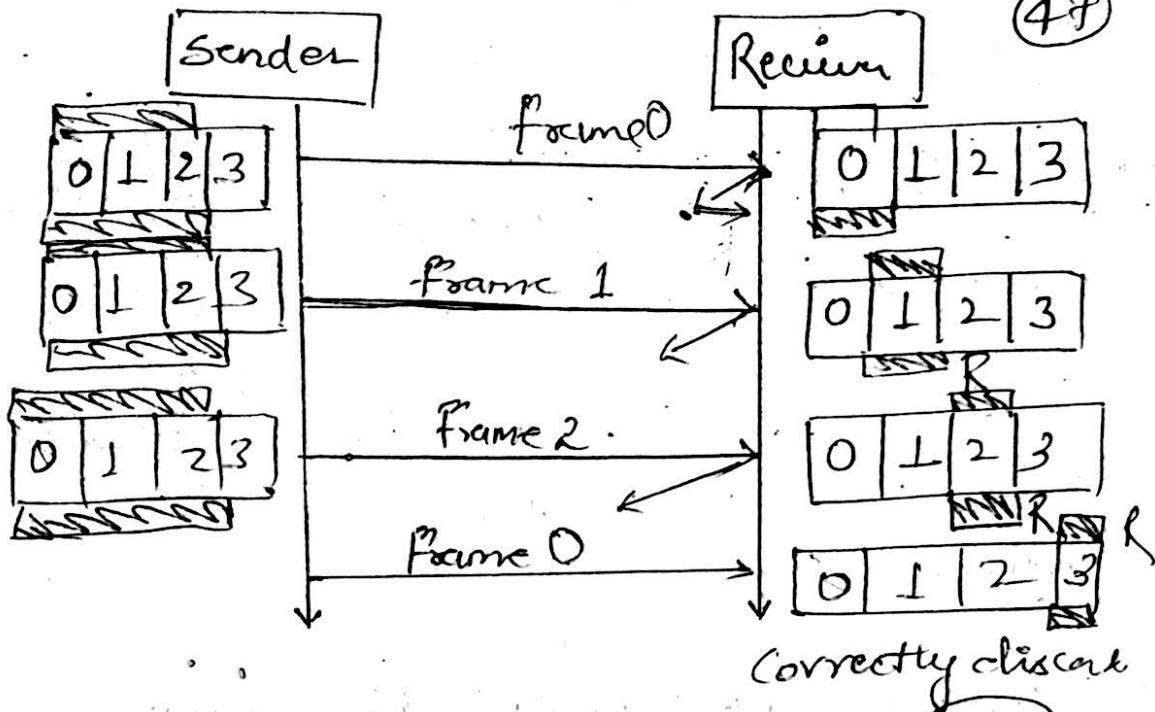
Note :-

me

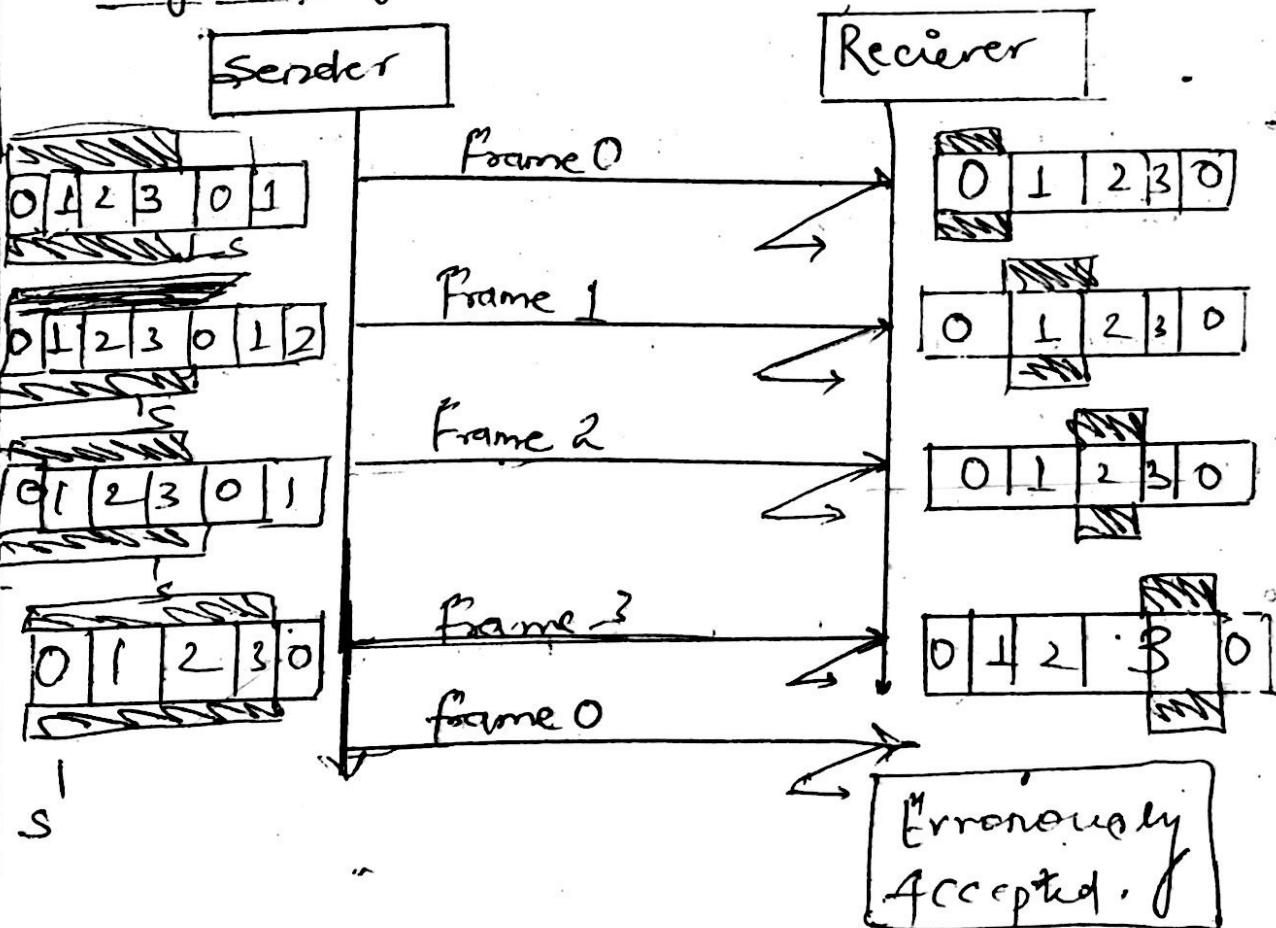
Size
ah

Damaged or Lost Acknowledgment

(47)



Why the size of window is less than 2^m .



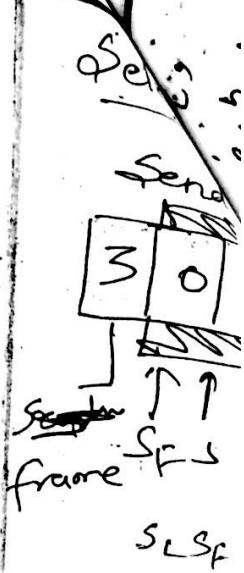
Note:- In Go-back-N-ARQ size of Sender must be less 2^m it means that the maximum window is

As in case of Stop - N-Wait ARQ,
Go back - N-ARQ can also be bidirectional.

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

Disadvantages of Go-back-N-ARQ:-

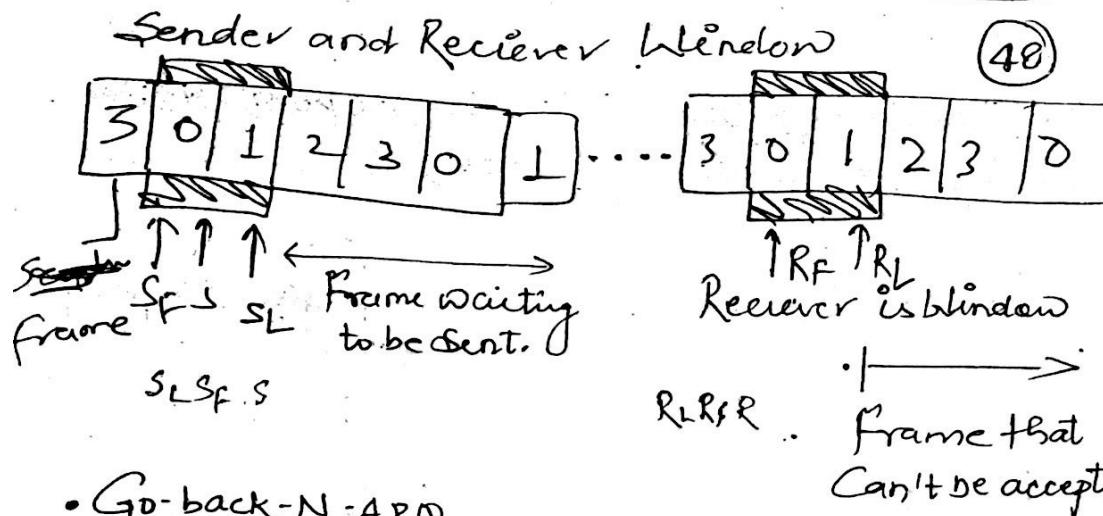
- It retransmits all the frame if one frame is damaged or lost.
- The error can get introduced if a [N.A.K] is lost.
- It can't transmit frames continuously as long as it doesn't receive the N.A.K. signal.
- The negative acknowledgement signal takes some time to reach the sender till that time the sender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



- Go-back-N simplifies receiver and order delivery.
- However, a round trip delay is involved.
- In case of a multi-hop network, this results in a large delay.
- For no ACK, the sender will wait for a long time.

Selective Repeat ARQ :-

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



- Go-back-N-ARQ

Simplifies at the receiver side -

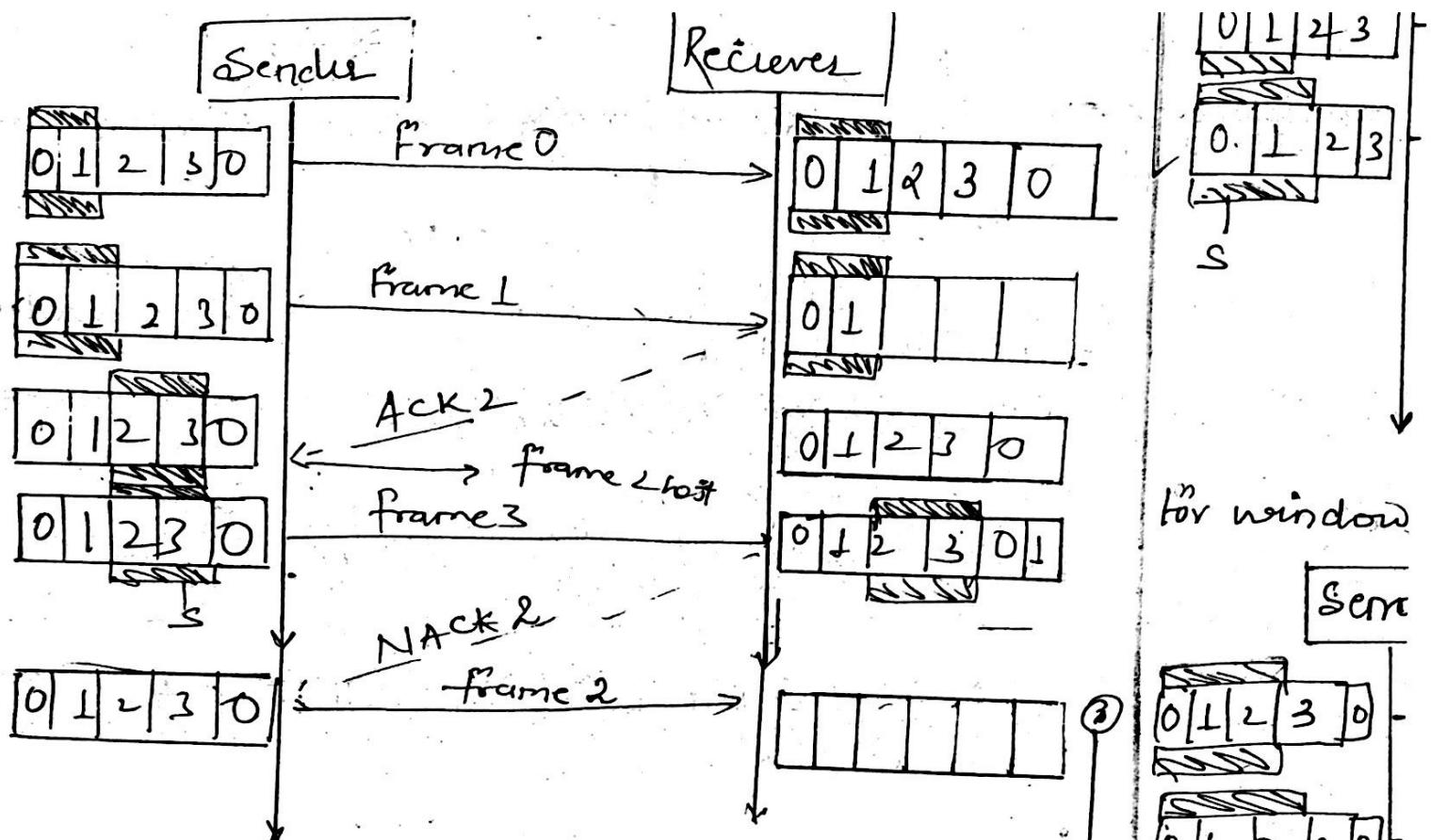
- Receiver keeps track of only one variable and there is no need to buffer out of order frame.
- However this protocol is very inefficient for a noisy link.
- In .. " , a frame has a higher probability of damage which means resending of multiple frames.

This resending uses up the bandwidth and slows 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 resent.

This mechanism is called selective repeat ARQ".



Why the size of window is selective

Repeat ARQ is $\frac{2^m}{2}$:? One half of (2^m) .

For Ex. if $m=2$

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

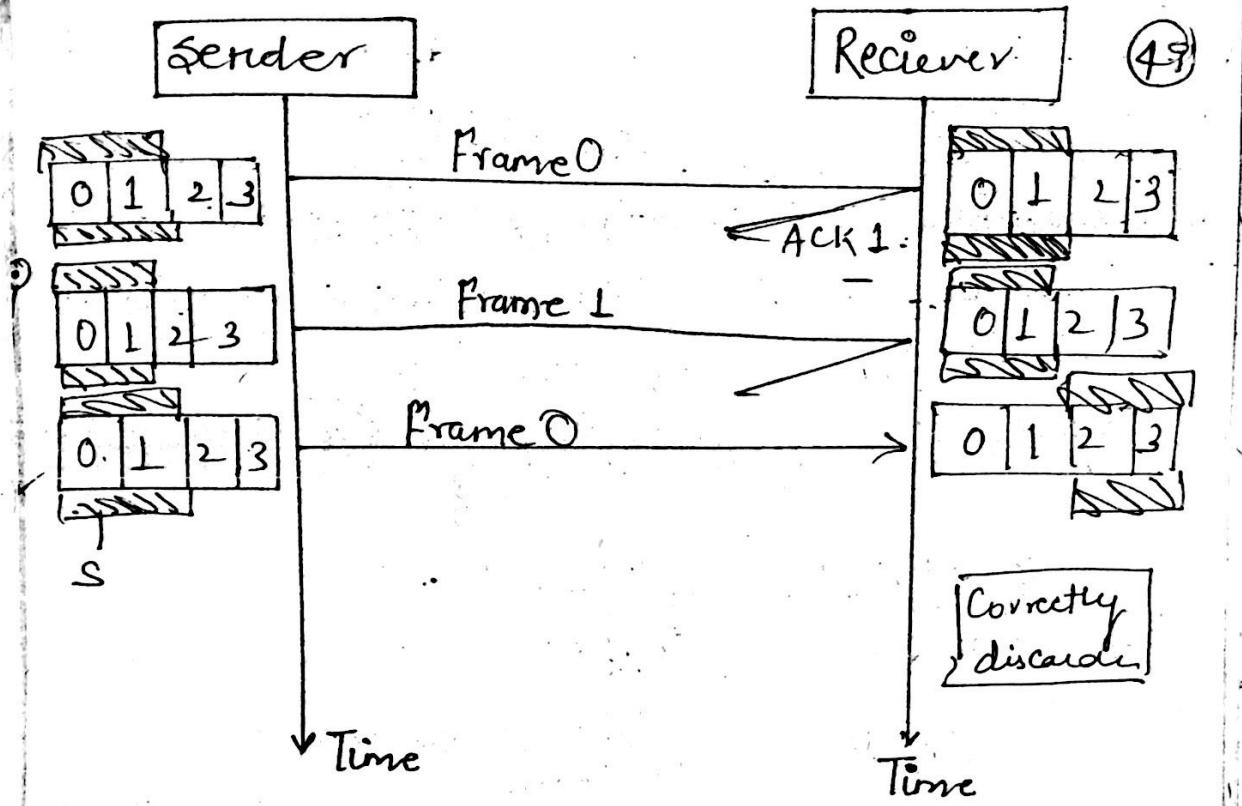
Compares a window size $\frac{2^m}{2}$ with a window size of 2^{m-1} .

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

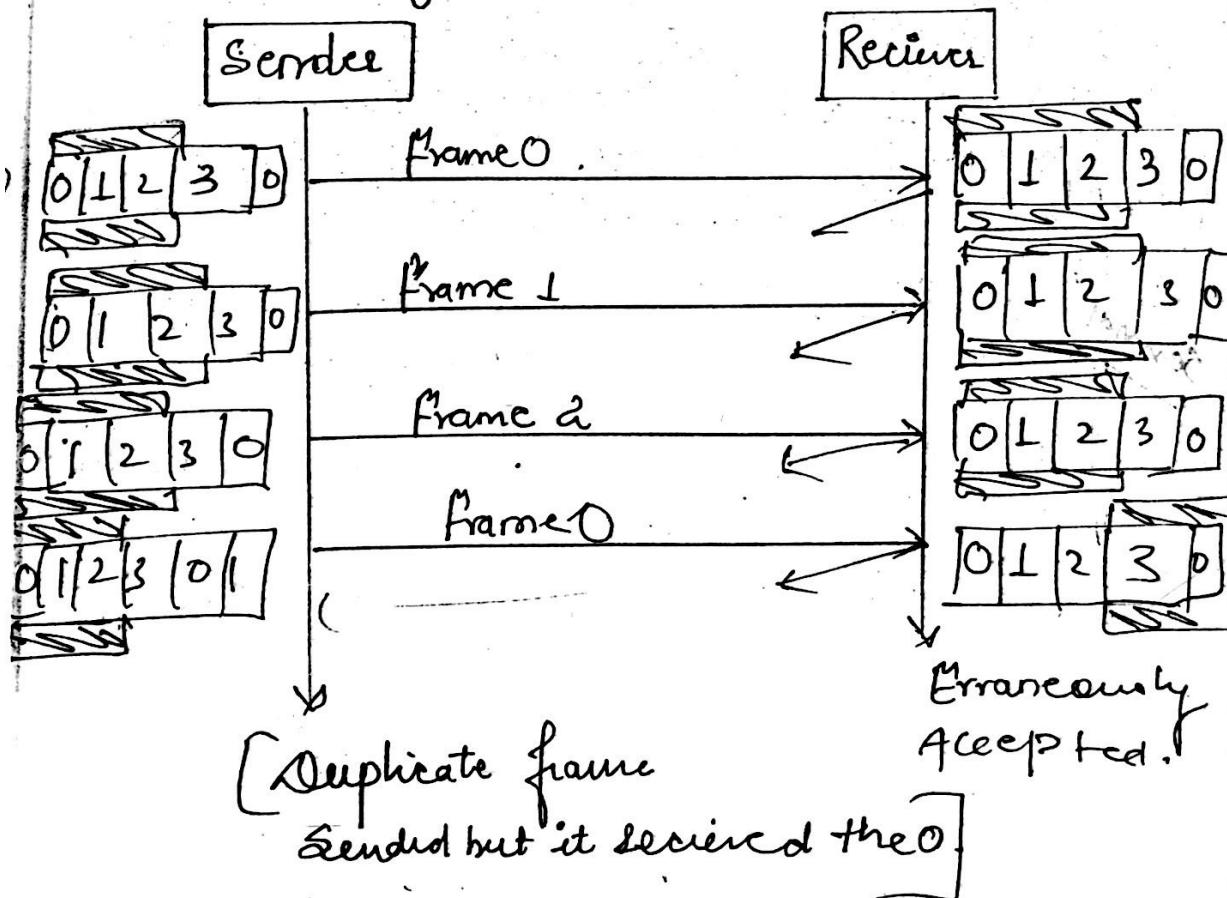
Topic

As in Case of ARQ and Go-BACK-ARQ, selective Rep can also be bidirectional

Bidirectional



for window size $2^m - 1 \Rightarrow 3$.



Sequence No.
Range $0 \text{ to } 2^m - 1$

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

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

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

15 frames \Rightarrow 15 x 1000
 \Rightarrow 15000 bits utilization

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

Most Imp

Q. Two roads A and B uses Sliding window protocol with three bit sequence number.

As the ARQ mechanism, Go Back N is used with window size of 4.

Assume Node A is transmitting and Node B is Receiving.

Show window position for the following events:-

- a. Before node 4 sends any frame.
 - b. After node 4 " " frame 0, 1, 2.
and receives acknowledgement from Node 3
0 and 1. window size is

Seq. 3

window size is
80 back = 4

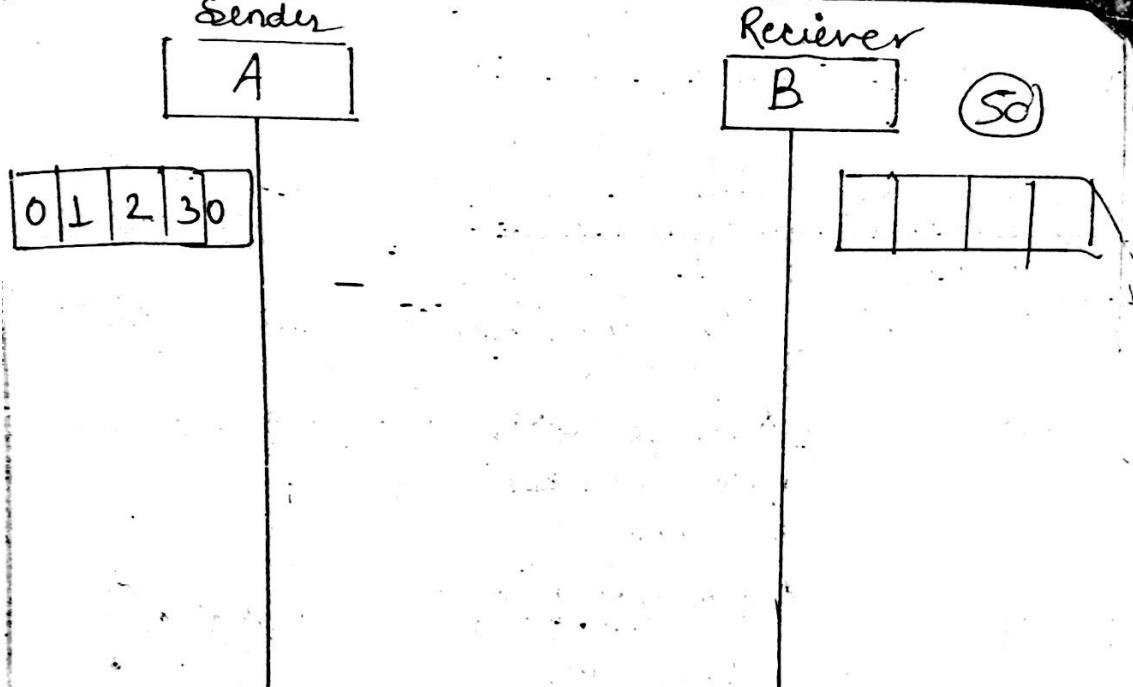
O,
Kinder

frame 0

~~20~~ ~~10112~~ ~~32~~

frame 0

~~10112~~

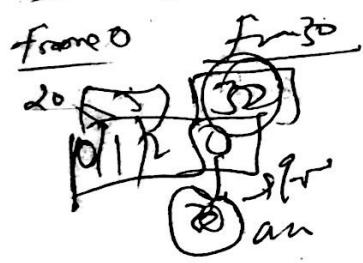


0, 1, 2, 3.

Window Size \leftrightarrow $4 = M$



Duplication



frame 0
frame 2

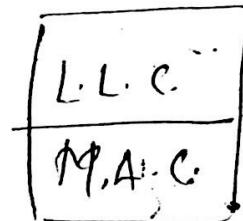
Medium Access Sublayers

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

↓
Static Alloc
Static Ch
• FOM a

Static

- In this to each is that the ch is was.
- And if want due to

• The static performs and hence used for & bursty

Dynamic

- In this allocates
- The user requires

Simi

C
t
t

Channel Allocation :-

(51)

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 is allocated 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.
- And if there are more than N users who want to 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 I/O where the traffic is bursty nature.

Dynamic channel allocn:-

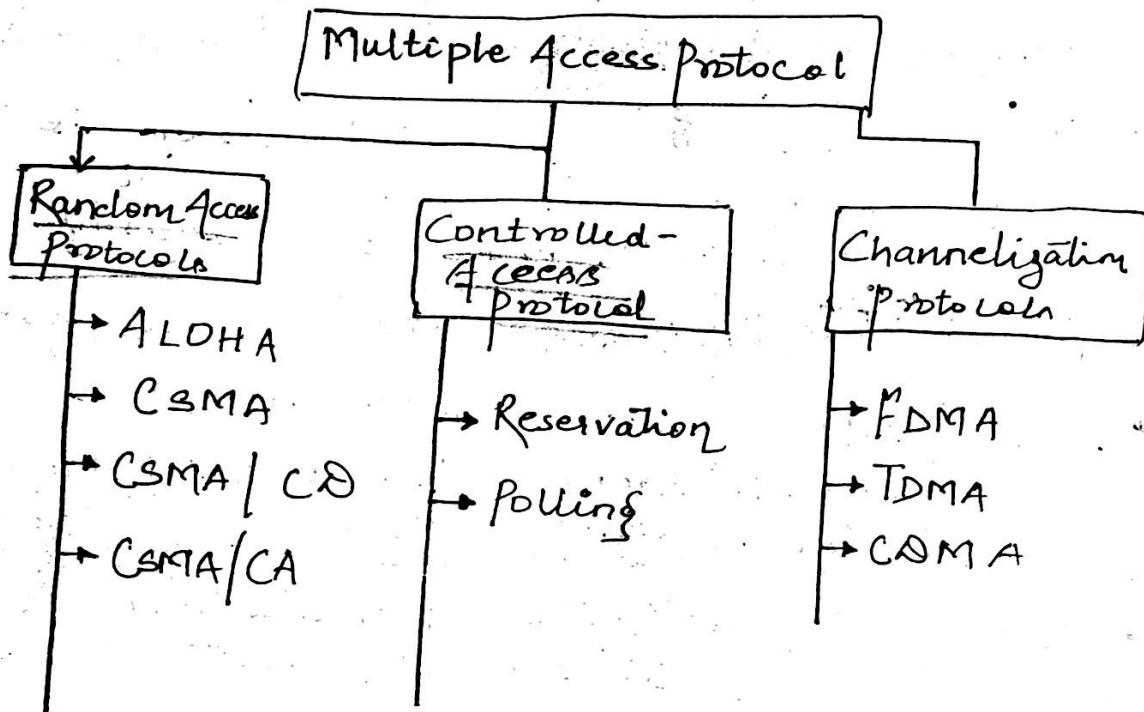
- In this method, no fixed frequency or time allocated to the user.
- The user can use the single channel as per the requirement.

Single channel is available for all communications.

Collision 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
Collision.

Continuous or slotted time: There is no master clock dividing time into the discrete time intervals.



Random Access Protocols: In random access there is no control station.

Each station will have to wait right to use the common medium without any control over it.

With increase in no. of users, probability of collision to increase or access conflict.

- The collision will occur when more than one user tries to access the common medium simultaneously.

As a result of such collision some

In order to set up a. When (b) What can go wrong Can failure? d. What can conflict? Evaluation The first simple p It was (Carrier) The C.S.R

C.S. Raja Abraham's ALOHA is the developed in 1970. L.A.N. based on ALOHA, I.P.

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?

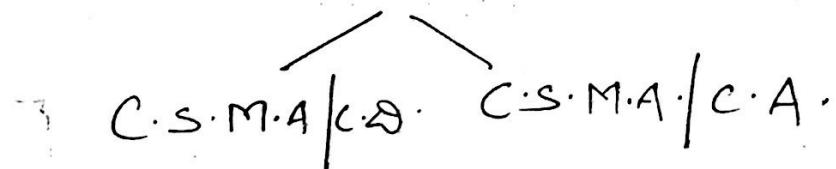
Evaluation of Random Access Methods:-

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:



Abraham's logic of sharing 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 LAN (radio transmission) but it can be used on any shared medium.

ALOHA system has two version:-

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

2. Slotted ALOHA :- time Synchronization.

~~Ki~~
~~Tp~~ :- $\frac{1}{2} \mu$
~~Tfr~~ :- A
~~TB~~ :- B
~~N~~ :- M
~~u~~
~~u~~

~~G~~ :- T_{ar}
~~. . .~~
~~S~~ :- T_{hr}
~~Po~~ :- P_{ar}
~~Self~~
~~E~~ :- E_{ar}

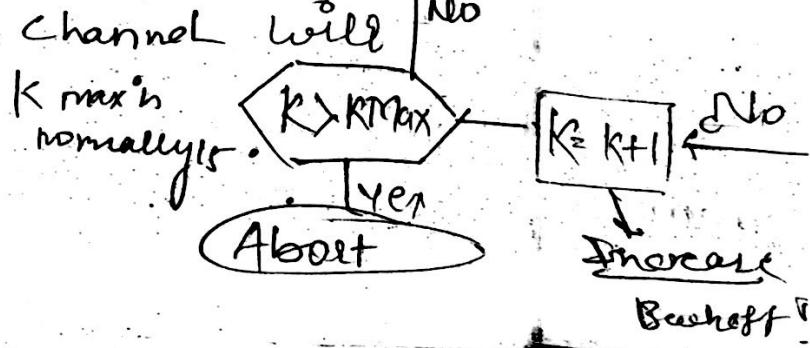
And resend the frames.

- Now a collision involves two or more stations -

The randomness will have avoid the more collisions we call this back off time.

- ~~The randomness will have avoid the back off~~

- Pure ALOHA has a second method to prevent Congesting the channel will retransmitting frame.



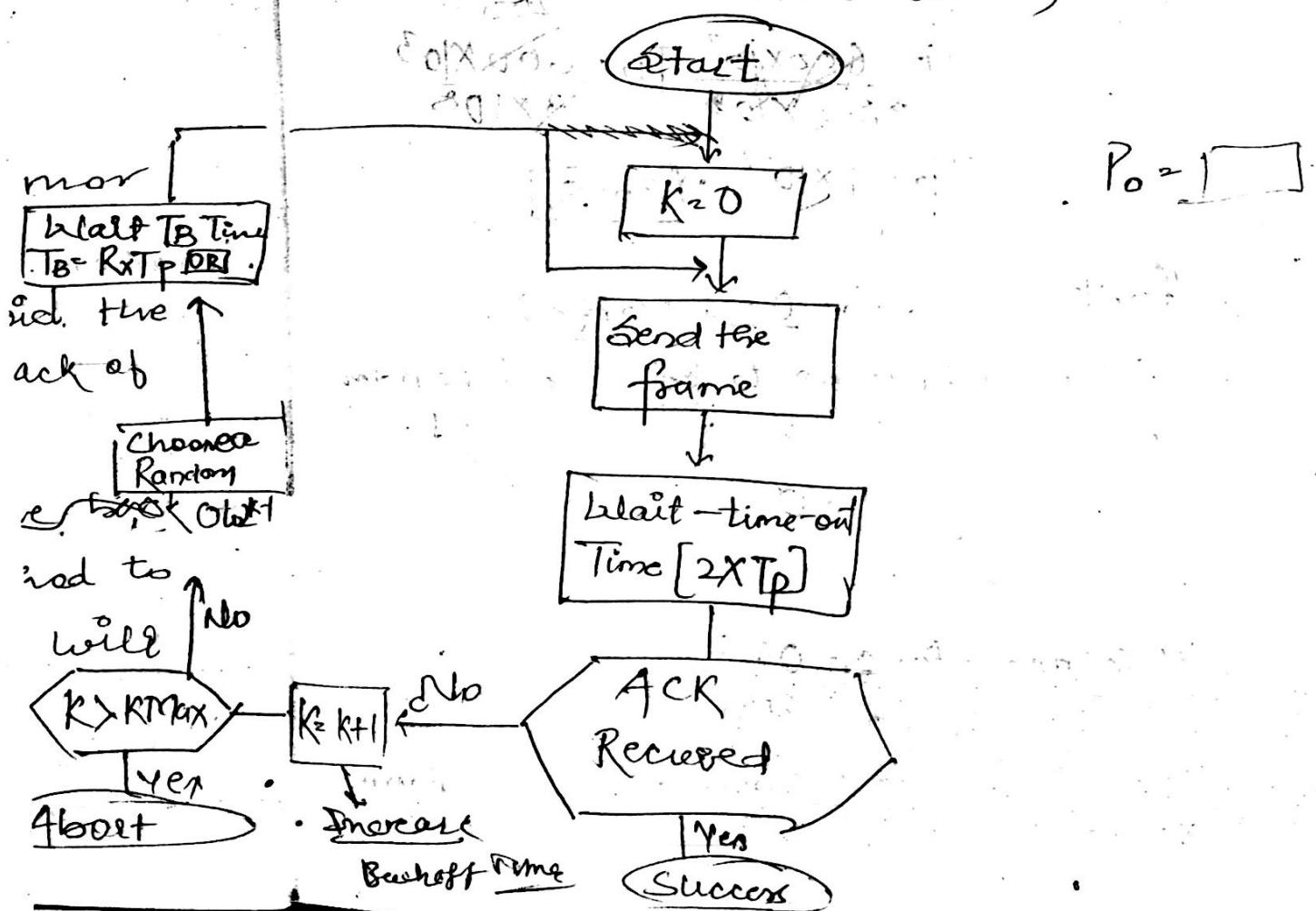
- K: No. of attempts or transmission attempts including per frame time
- T_p : Max. propagation time
- T_{fr} : Average transmission time for a frame
- T_B : Back off time; Depends on transmission attempt (K)
- N: Mean of M frames per frame time which are generated by infinite no. of users.

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

S: Throughput (Successfully Received)

P_0 : Probability that a frame that does not suffers from a collision

L: 2.718 (mathematical constant)



Q. The stations of a wireless ALDHA n/w are a maximum of 600km apart. If we assume that signal propagate at 3×10^8 m/s. We find $T_p = 2 \times 10^{-3}$.

T_p = time required to send a frame b/w the two most widely separated stations.

Given:- In wireless ALDHA ≈ 600 km

$$\Rightarrow 600 \times 10^3 \text{ mtr}$$

Signal propagation = 3×10^8 m/s

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

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

$$T_p = \frac{600 \times 10^3}{3600 \times 10^5} \quad T_p = \frac{600 \times 10^3}{200 \times 10^8}$$

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

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 . -

K

Conte

Efficien

* Efficiency
frame =

Frame-h

- It denotes transmitible area
- Generation of poisson's

for $k=2$

$$0 \times 2 = 0 \text{ ms}$$

$$1 \times 2 = 2 \text{ ms}$$

$$2 \times 2 = 4 \text{ ms}$$

$$3 \times 2 = 6 \text{ ms}$$

(54)

$$\underline{k=3} \quad 2^{k-1} = 2^3 - 1 = 7$$

$$0 \times 2 = 0 \text{ ms}$$

$$1 \times 2 = 2 \text{ ms}$$

$$2 \times 2 = 4 \text{ ms}$$

$$3 \times 2 = 6 \text{ ms}$$

$$4 \times 2 = 8 \text{ ms}$$

$$5 \times 2 = 10 \text{ ms}$$

$$6 \times 2 = 12 \text{ ms}$$

$$7 \times 2 = 14 \text{ ms}$$

~~Conversion~~ up to $k=15$

Efficiency of a Pure-ALOHA

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

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

- It denotes the amt. of time required to transmit the standard fixed length frame.
- We assume that infinite no. of work 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.

Note - if
the

Hence,

$$0 \leq N \leq 1$$

The p
trans

$$[P_c]$$

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

If $G > N \rightarrow$ Collision

$$N=0, G=0$$

Also load $N \approx 0$ and there will be less no. of Collision so less number of retransmission

$$G \approx N$$

With the increase in load, there are many collisions.

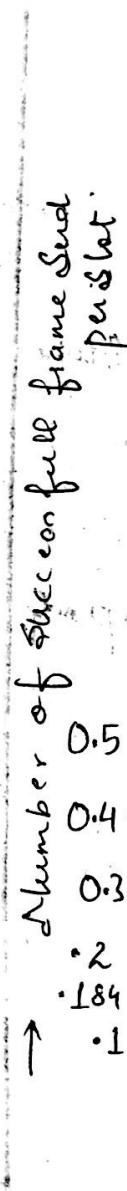
For all the loads, the throughput

$$[S = G P_o]$$

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

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

$$[G +$$



If $k=0$: (No. of retransmission attempt)

$$P[k=0] = \frac{(G^0)e^{-G}}{0!} \rightarrow e^{-G}$$

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

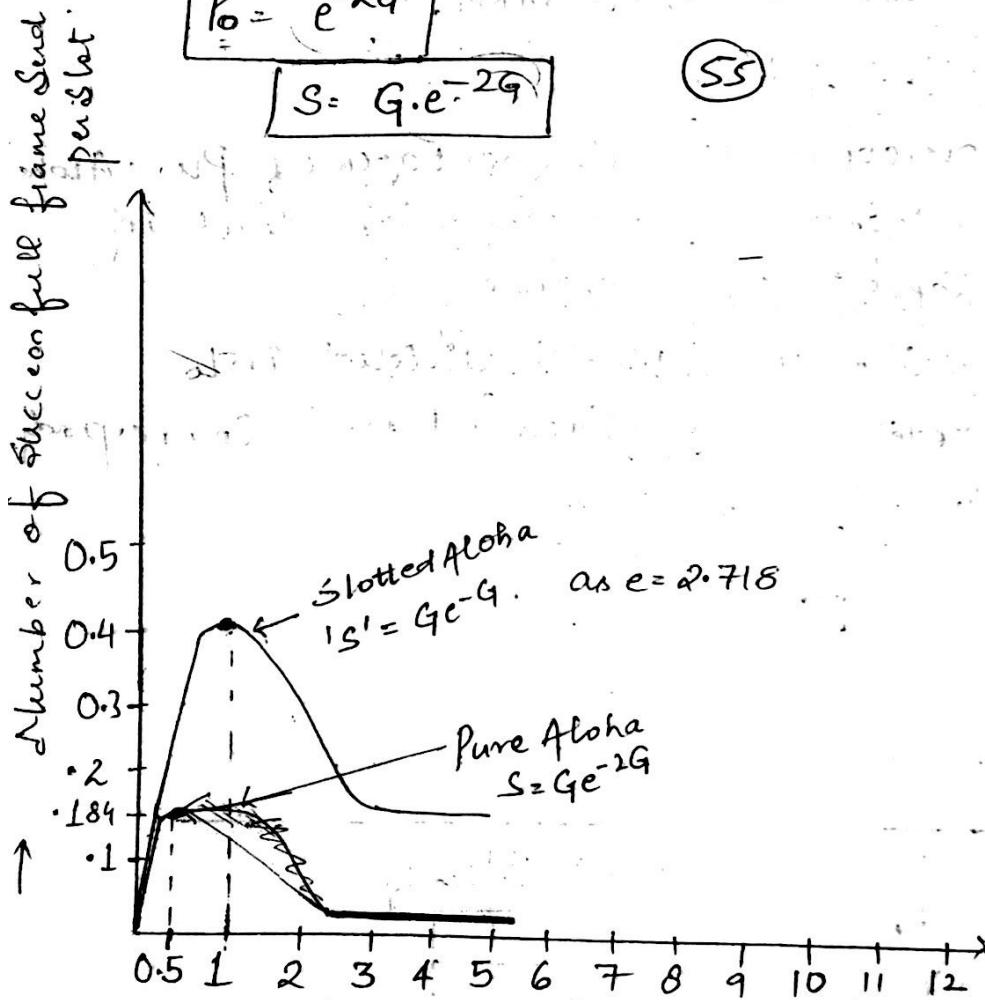
$$= 2G.$$

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

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

$$\boxed{S = G \cdot e^{-2G}}$$

(55)



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

$$\begin{aligned}
 S &= Ge^{-2G} \\
 &= 0.5 * 2.718^{-2 \times 0.5} \\
 &= 0.5 * 2.718^{-1} \\
 &= \frac{0.5}{2.718} = 0.184
 \end{aligned}$$

$$= \frac{1.076}{2.718^2} = \frac{1.076}{7.38752} = 0.135$$

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

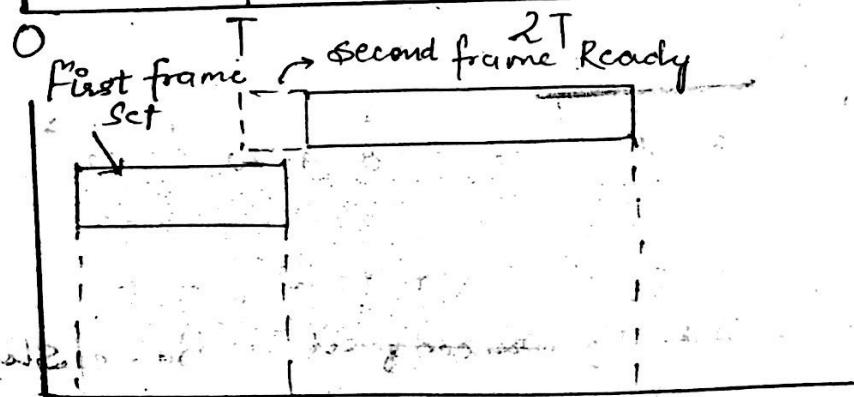
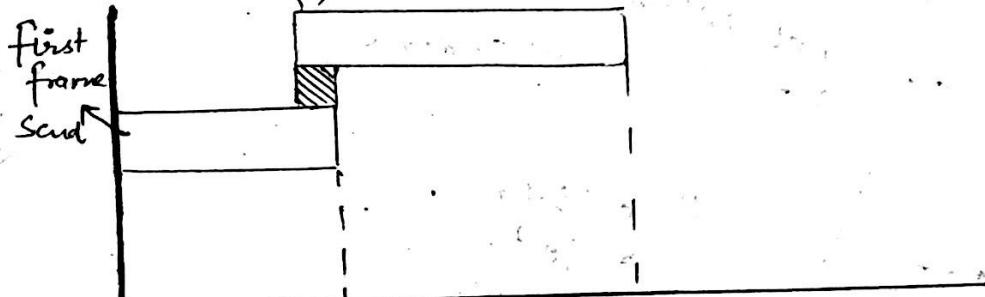
Total load on the channel.

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 intervals. Each interval corresponds

to 1. Time of collision



Transmission using Slotted $2T$ ALOHA

~~In the~~
 of two
 suppose
 transm
 transm

Then the
 do succ.

So slot
 where as
 System.

The rest
 half of
 for slot

If $G = 1$

The proba
 And "

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 transmit.

Then the total time required for both station to do successful = $2T$.

So Slotted Aloha is discrete-time System whereas pure aloha is a continuous time system.

(56)

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 " " Collision is 24%.

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

Show that 20% are idle :-

Throughput (%)

0.368

0.32

0.3

1

0.1

1. What is the channel load?

2. What is the throughput?

3. Is the channel underload or overload.

Show with graph.

from the fi

Corresp.

Since,

than 1

Given: 20% slots are idle.

$$P_0 = 20\%$$

$$\Rightarrow 0.2$$

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

$$\rightarrow S = G \times 0.2$$

$$\rightarrow S = P_0 \cdot e^{-G}$$

$$\begin{array}{l} a \\ b \\ \log_2 \end{array}$$

$$\Rightarrow 0.2 = 2.718 \cdot G$$

$$\Rightarrow -G = \lg 0.2$$

$$\Rightarrow G = 1.6094$$

$$\begin{array}{r} 2.718 \\ \times 0.2 \\ \hline 14.476 \end{array}$$

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

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

$$= 0.3218$$

$$OR = P_0 G = 1.6094 \times 0.2 = 0.3218$$

(Throughput) ↓

Sessional

Q. Perform

Q. 4 cha

propo

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and w

SD%.

Thr

Overload.

Can only be found out by G.

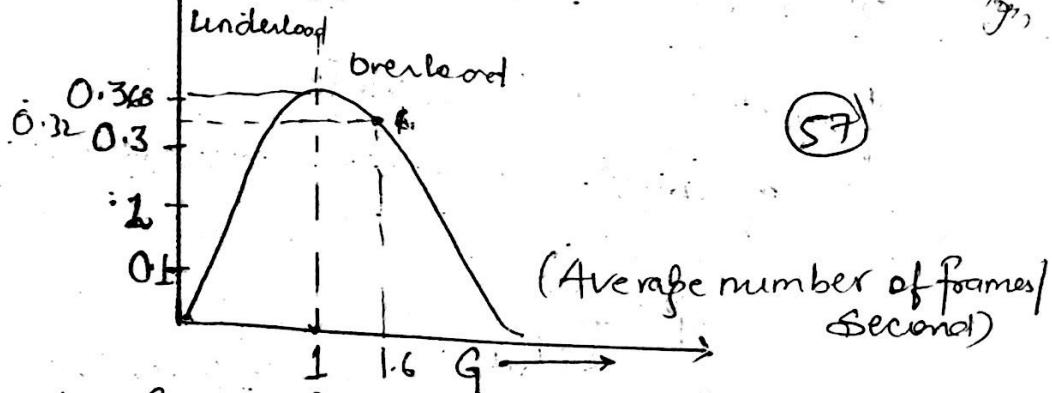
Not by throughput.

T₁

d

F

Throughput
(S)



From the fig., it is 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 4 Kbps and propagation delay of 20ms.

For what range of frame size does stop and wait gives an efficiency of atleast 50%.

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

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

\Rightarrow

propagation delay = $T_p = 20 \text{ mfs}$.
 $\eta < 50\%$.

format of frame
(DTE to DCE)

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

bit rate

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what range of frame size does Stop and Wait gives an efficiency of 50%.

$$\eta = 50\% = 0.5$$

Bit Rate $\Rightarrow 4.8 \times$

(58)

If channel capacity is B bits/sec

frame size = L bits

Round trip propagation time = T sec

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

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

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

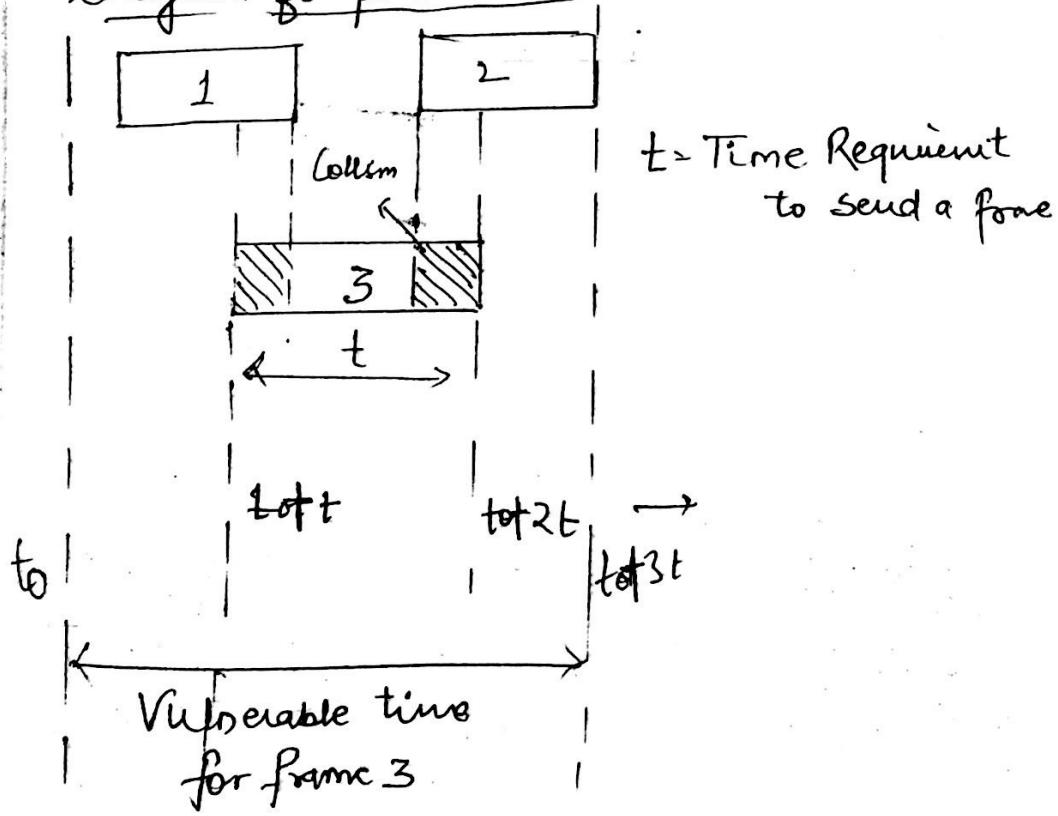
$$\Rightarrow 0.5L + 96 \times 0.5 = L$$

$$\Rightarrow 4.8 = 0.5L$$

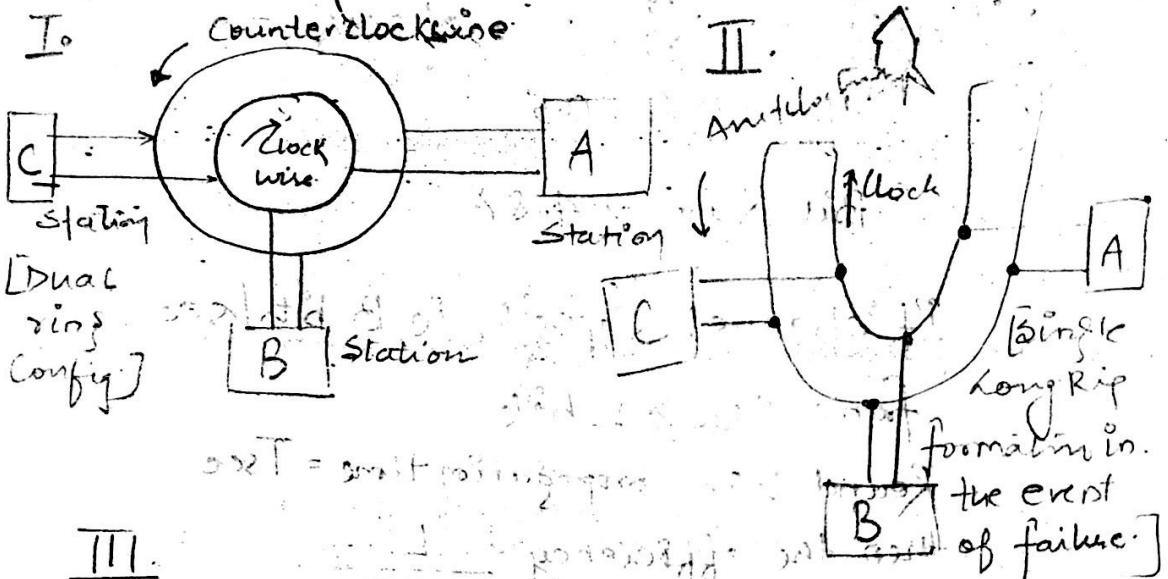
$$\Rightarrow \frac{4.8}{0.5} = L$$

$$\Rightarrow [96 \text{ bits}]$$

Diagram for pure aloha



FDDI (Fibre distributed data Interface)

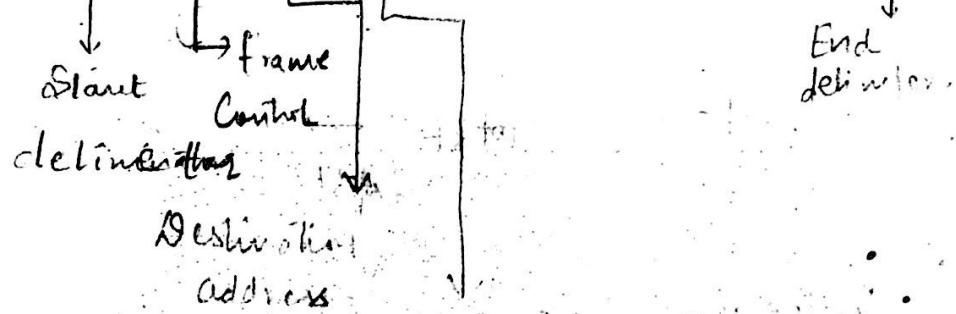


SAS :- Single attachment station

DAS :- Dual attachment station

IV. Frame fragment Byte

≥ 8	1	1	2	2	Variable	1	1
Preamble					Data	CRC	frame status



It stands for fibre distributed data

Interface (802.5) and P.B.M. token ring

but don't use Copper.

(59)

Two fibre rings are here from the fig. 1.

One 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 captures token and then 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 I/O 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 interested 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_h

(2) Token Recovery 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 intervals, if it has been lost than the token recovery procedure is initiated.

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

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