TCP/IP protocol OR Internet protocol

~~Transmission~~ ~~Transport~~ control protocol

OSI model

Open Systems Interconnection

TCP/IP protocol

OSI		4 layer	
Application Layer	Data	Application Layer	Process to Process
Presentation Layer			
~~Session Layer~~			
Transport Layer	Segment	Transport Layer	Host to Host
N/W Layer	~~Frame~~ Packet	Internet Layer	Source to destination
Data Link Layer	~~Packet~~ Frame	Network Access Layer	Node to Node
Physical Layer	bits		

Forouzan, Tanenbaum

* Developed by ARPANET
* Supports client - Server
* Supports peer to peer
* TCP/IP is practical approach of internet implementation
* LIFO → stack
* Peer to Peer means in a connection the node can send data ~~do~~ to each other without the use of the server

Guided Transmission Media :-

(Wired or Bounded transm

* is the physical medium throug which the signals are transmit

* Transmitted signals are direc and confined in a narro pathway using physical li

Guided media

Twisted pair

* pair of cables twisted together

* Freq. range :- 0 to 3.5 KHZ

Unshielded
↳ Category 1
2
3
4
5

Shielded Twisted Pair

Coaxial Cable

* copper cable with metal shield,

* Applied in television n/w.

Optical fibre cable

* glass - based cable that transmits light signal

* Can transmit signal over longer distance with greater bandwidth.

Physical Layer

Functionalities

1. Cables & connectors
2. Physical topology → Star, Mesh, Bus, Point to
3. Hardwares (Repeaters, Hu
4. Transmission mode → Sim, Half, Full.
5. Multiplex
6. Encoding

Repeaters → used for annetuat
to uplift the signal
signal is distorte

Simplex :- Transmission only i
1 mode. Ex → T.V Tr

From data link layer

To data

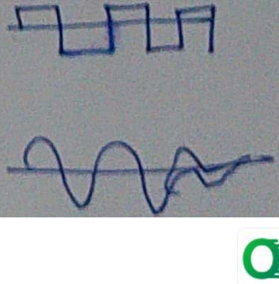
bits 1 0 1 0 1 1 0 1 1 1 0 1 0000

1 0 1 1 0 1 1 1

signals

digital signal

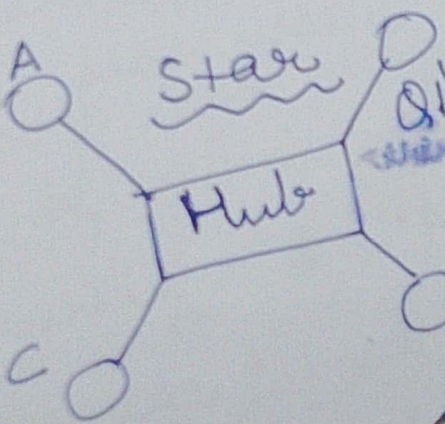
Analog signal



Topology

(1) Mesh (2) Star (3) Bus (4) Ring
(5) Hybrid

Star

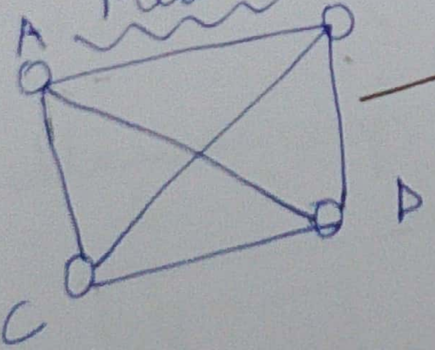


Imp

Q1) No. of cables used to connect 'n' devices

$$\boxed{{}^{n}C_2 = \frac{n*(n-1)}{2}}$$

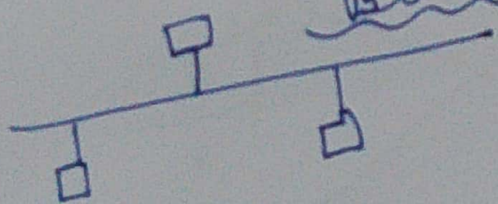
Mesh



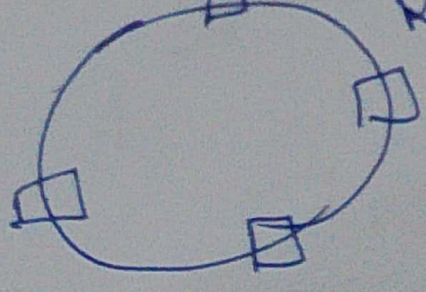
Q2) No. of ports required is $(n-1)$

Ex: If 4 nodes then 3 ports required

Bus



Ring



Method

ing

Tp

...time / Total cycle time $= \frac{T_t}{T_t + 2 \times T_p}$

Mesh Topology

* No. of cables :- $n * (n-1)/2$

* No. of ports :- $(n-1)$ at each node

* Reliability ↑ → Highest critia... the "Mesh" ...

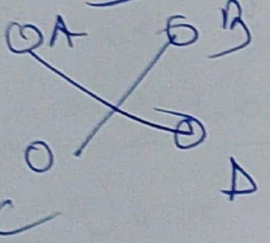
* Cost ↑

* Security ↑ → because each no... has to be comm... with each oth...

Yes

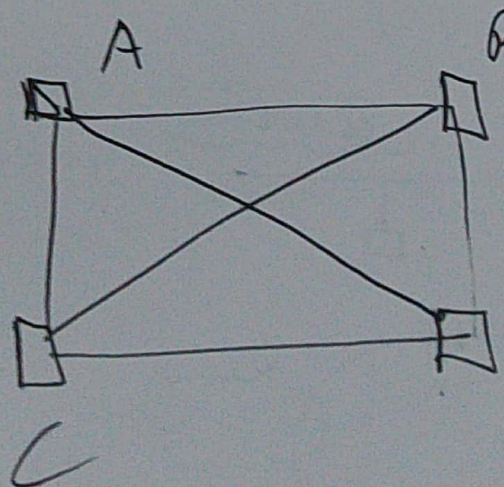
If A & D are communicating then C will not known.

because



* Point to Point communicati...
(Dedicated)

* Applicable for small offi...



Mesh

St...

...o. of cables ...

...o. of ports ...

...the channel

...reliability ↓

...fails then the ...

...ost ↓ less ...

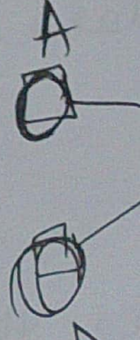
no. of wires ...

Security = ...

because ...

intelligent ...

the data ...



Star Topology

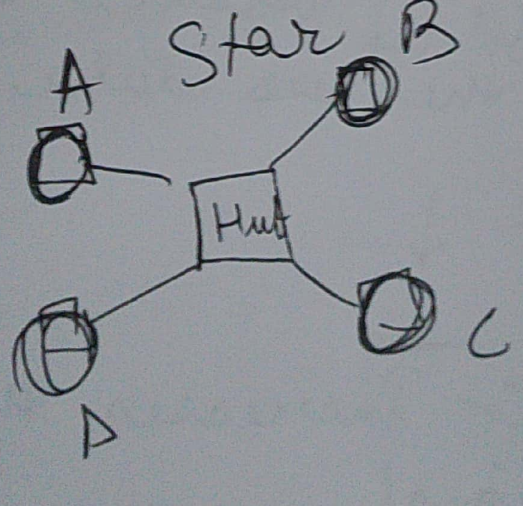
o. of cables used = 'n'

o. of ports = 'n'
n the channel

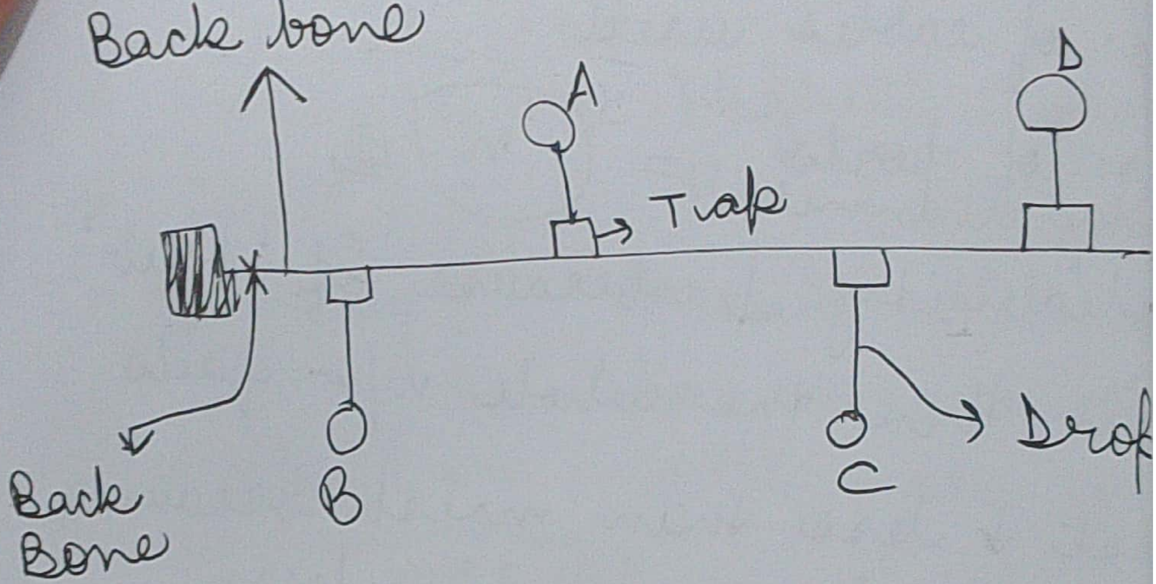
eliability ↓ because if 'Hub'
ails then the whole n/w fails

ost ↓ less than mesh because
no. of wires used is less.

Security = ↓ point to point
because 'Hub' is not an
intelligent device & sends
the data to every node.



Bus Topology



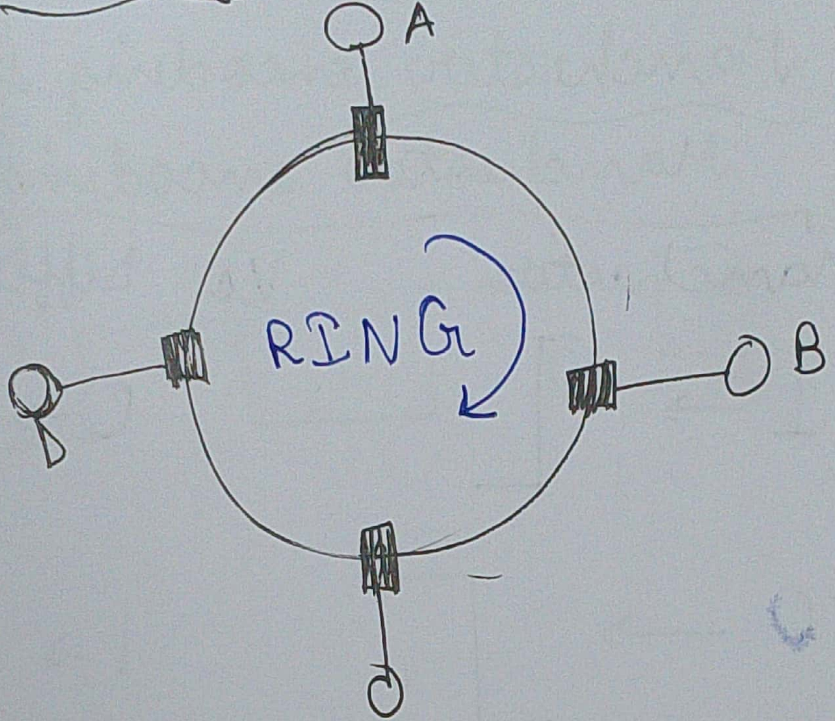
1. No. of cables :- $n+1$
2. No. of ports in the channel :- n
3. Reliability :- ↓ because d
on 1 cable 'B

4. Security :- ↓ because the ca
sends the ~~was~~ data to every

5. Cost :- ↓

Repeater :- Increases the str
of the signal

Ring Topology



It is unidirectional

Uses 'token ring' to reduce collision

no. of cables = 'n+1'

Reliability ↓ because depends on the single cable

Cost ↓

Lec - 7

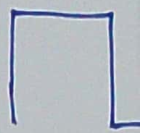
Manchester encoding & diff

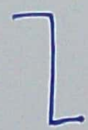
Manchester encoding

Manchester Vs Differential

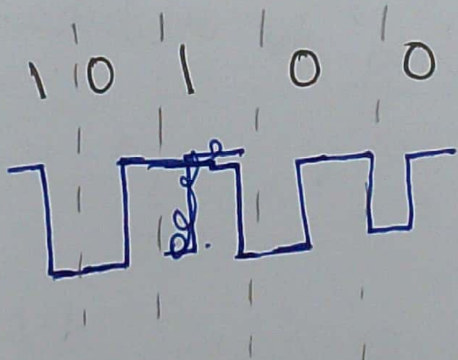
1 → 

0 → 

0 → 

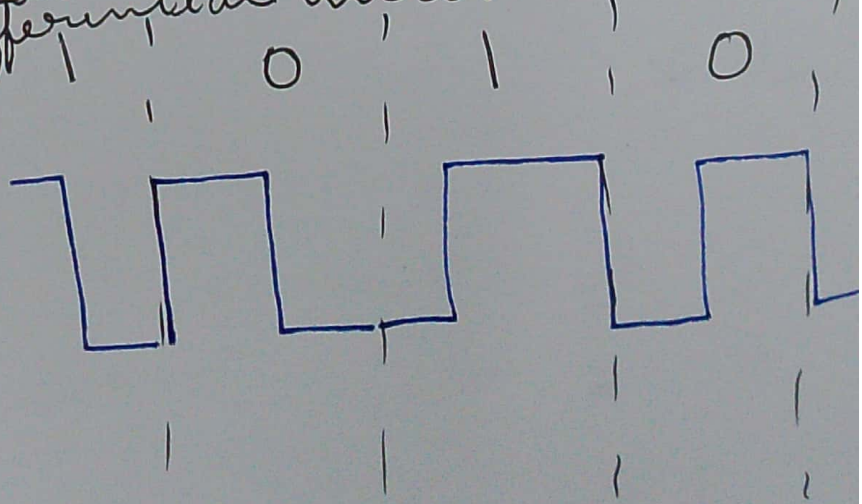
1 → 

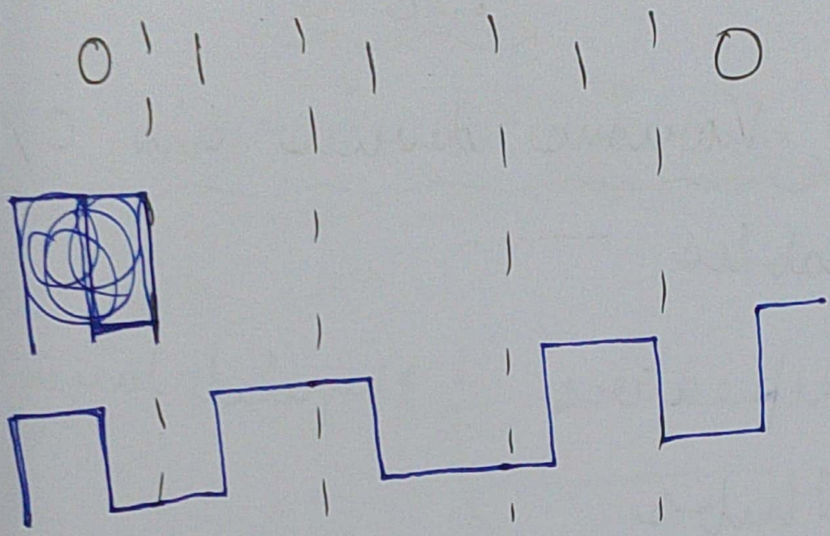
Q1.) 1 0 1 0 0 Data represe according to

Ans.) 

Q2.) Data representation accord differential manchester enc

1 0 1 0

Ans.) 


0 1 1 1 0

Lec - 8

Various devices in C

1.) Cables
2.) Repeaters
3.) Hubs

H/W devices
Physical layer

4.) Bridges → Data Link
5.) Switches
6.) Routers → N/W layer

H/W + S/

7.) Gateway → 2 diff n/w joins where different ~~p~~protocols are used
8.) IDS (Intrusion detection syst
9.) Firewall → Controls internet traffic. It ca be S/W or H/W that selectively bl or allows data packets.
10.) Modem Modulator/Demodulator (~~Modulator~~ (Modu~~l~~la

Converts digital signal to analog & vice versa. It also connects the computer to the wireless router

→ It is a device or node that connects n/w by translating communications from one protocol to another.
They act as the entry / exit point for n/w

Lec-9

Types of cables
(Coaxial, twisted, optical fibre)

Cables

…ielded
…ted pair
…T
…m
…s, 100 m

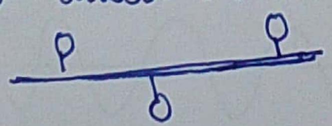
② Coaxial cable

10 Base T

10 Base 2 means 10 Mbps, 200 mt

10 Base 5 10 Mbps 500 m

* used in LAN



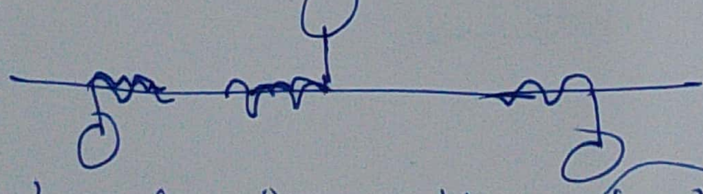
* Electrical signal

③ Fibre optic

* 100 Base FX means 100 Mbps $\simeq$ 2 Km
* signals travels at the speed of light.

If 'n' no. of devices the how many collisions devices can participate

…n'

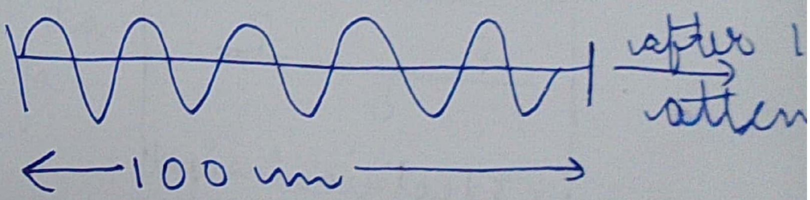


So, 'n' devices then 'n'

* Cables are used at

* Can cables filter the d
↳ No because simpl
transfer the data, they cann
the address of the data

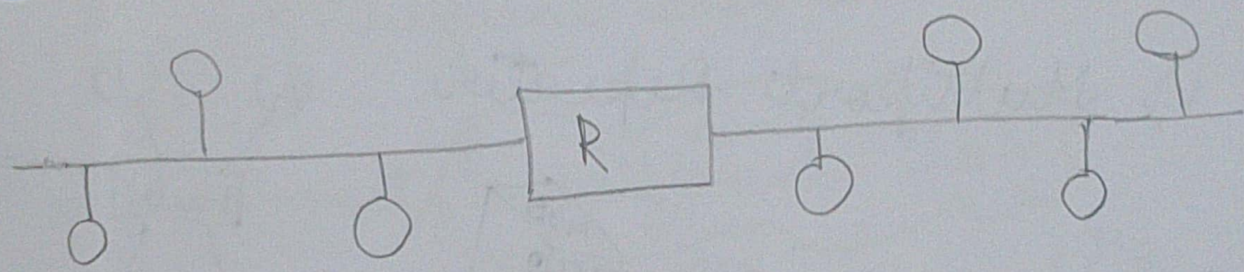
Attenuation :- Weakning
electrical signal.



15 - 18, 19 Thu
22 - Monday

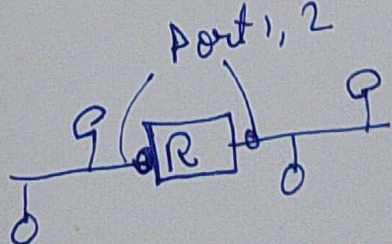
Lec - 10

Repeaters



Repeaters works on the physical layer
Regenerates the signal

Amplifier	Repeater
regenerates the original value may be greater than original signal by 2x or 4x etc.	Original signal = signal generated by the repeater

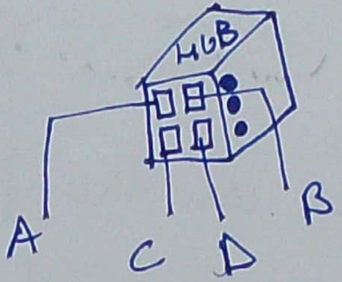


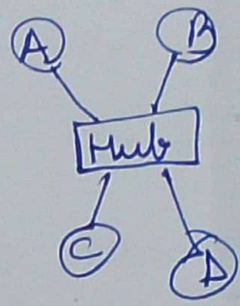
* 2 Port Device
* Forwarding
* No filtering
* Collision Domain :- 'n' where n is the no. of devices connected

Lec - 11

Hub (Physical Layer device)

1.) Multiport Repeater





2.) Forwarding
3.) No filtering
4.) Collision Domain {Traffic is hig
5.) Maximum collision is 'N'
6.) Can connect 2 LANs.

Scanned with OKEN Scanner

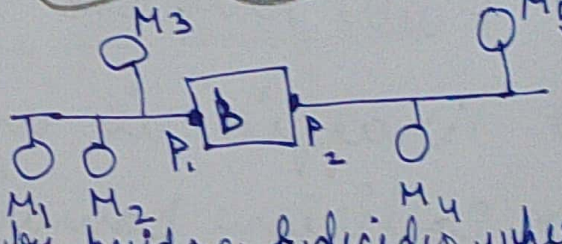
Lec -12

Bridges

{Physical and Data Link layer}

Can connect 2 ~~different~~ same LAN

Forwarding :-



It checks the table by bridge & decides where to forward.

Filtering :- They can check the MAC address & it will decide the packet has to be forwarded or not

Store & forward :- The buffer present in bridges.

Bridge

- Static → done manually
- Dynamic → done dynamically

able with Bridge

MAC	Port
M_1	P_1
M_2	P_1
M_3	P_1
M_4	P_2
M_5	P_2

Collision domain :- ↓ because of buffer

Bridge data unit protocol :- They create spanning tree.

L-14

~~Routers~~ Switch

* Layer-2 (Data Link Layer) Devi
* Multiport Bridge
* Full Duplex Links :- ⇄ Data can t
  in both di
* Traffic is minimal :- because o
* Collision Domain is Zero (0)

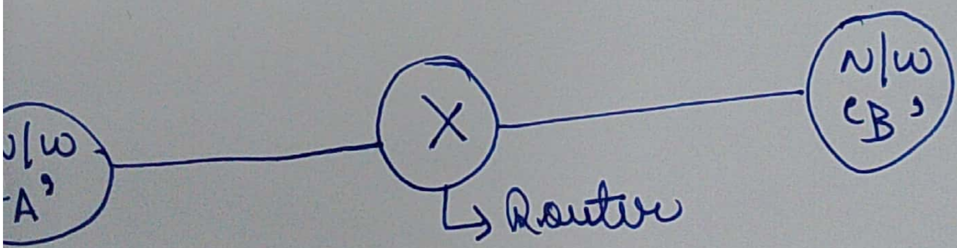
MAC address is used with

L-15

Routers

{Physical, Data link
Network layer

- Layer-3 (N/W layer)
- Connects 2 different n/ws.
- It can check MAC address & IP addre[ss]
- Forwarding :- done with Routing table
- ✓ Filtering
- ✓ Routing
- ✓ Flooding
- Collision :- 'NO' collision because the packet is stored in buffer. → 'Store & forward'



L-16

Collision Domain Vs. Broadca

Sr. No	Device Name	Collision Domain	Broadca
1.	Repeater	No change	No ch
2.	Hub	"	"
3.	Bridge	Reduce	"
4.	Switch	Reduce	"
5.	Router	Reduce	Reduce

35 6 1

L-17

What is circuit switching?
↳ used for telephonic circuit

orks on physical layer
ontiguous flow
No headers
efficiency less
Delay less

It uses dedicated path

N/w Layer → Source IP, Destination IP

Transport Layer → Source MAC, Destination MAC

$\boxed{\text{Total time} = \text{Setup time} + TT + PD + \text{Tear down time}}$

$= \quad " \quad + \frac{M}{BW} + \frac{D}{V}$

L-18

Packet Switching

1. Data link and N/w layer
2. Store & forward
3. Pipelining used
4. Efficiency ↑
5. Delay ↑ because of store & forward

Packet Switching

Datagram Circuit	Virtual Circuit
* Used at N/w layer	* Data link layer
*	

Transmission time

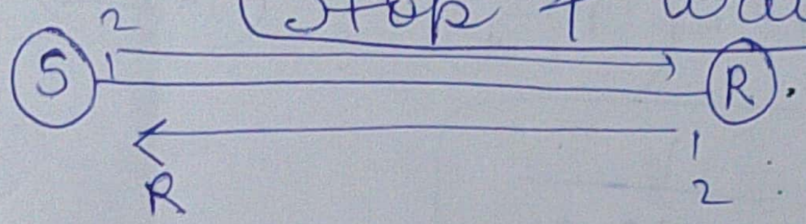
$$\boxed{\text{Total time} = x*(TT) + P\Delta}$$

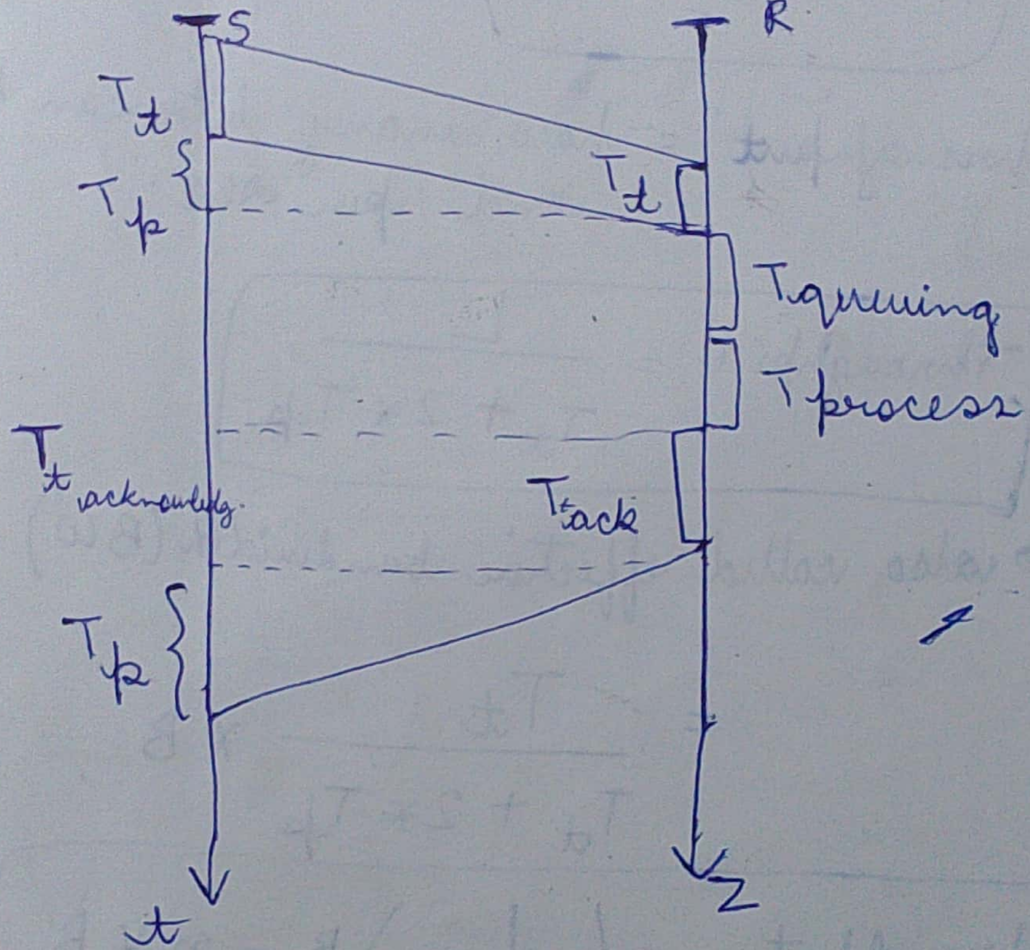
x — no. of switches

$P\Delta$ is propagation time

Flow Control Method

Stop & Wait





* The total time $= T_{t\,data} + T_p + \cancel{T_q}^{\,0} + \cancel{T_{process}}^{\,0} + T_{t\,ackn} + T_p$

Total time $= T_{t\,data} + 2 * T_p + \cancel{T_{t\,ack}}^{\,0}$

$$\boxed{\text{Total time} = T_t + 2 * T_p}$$

Efficiency $= \dfrac{\text{useful time}}{\text{Total cycle time}} = \dfrac{T_t}{T_t + 2 * T_p}$

$$= \frac{1}{1+2\left(T_p/T_t\right)} = \left(\frac{1}{1+2a}\right)$$

$$\boxed{\eta = \frac{1}{1+2a}}$$

Throughput = how many bits can b[e] send per sec.

$$\boxed{\text{Throughput} = \frac{L}{T_t + 2 * T_p}}$$

→ also called effective bandwidth (BW)

$$= \frac{T_t}{T_t + 2 * T_p} * B$$

$$\boxed{\text{Throughput} = \left(\frac{1}{1+2a}\right) B = \eta * B}$$

x ———————— x

Formula :- $\boxed{T_t = \frac{L}{B} \; ; \; T_p = \frac{d}{v}}$

Q) $T_t = 1$ m sec ; $T_p = 1$ msec

$\eta = ?$

Ans) $\eta = \frac{1}{1+2a} = \frac{1}{1+2*\frac{1}{1m}}$

$= (1/3)$ Ans

$$\boxed{\text{Round Trip Time} = 2 * T_p}$$

2.) $T_t = 2$ msec ; $T_p = 1$ msec

$\eta = ?$

Ans) $\eta = \dfrac{1}{1 + 2 * T_p / T_t} = \dfrac{1}{1 + \cancel{2} * \left(\frac{1}{\cancel{2}}\right)}$

$\boxed{\eta = \dfrac{1}{2}}$ = 50% effaciency

Q3) $\eta \geq 0.5$; then what is relationship b/w T_p & T_t.

Ans) $\eta = \dfrac{T_t}{T_t + 2 * T_p / T_t} \geq \dfrac{1}{2}$

$\Rightarrow 2T_t \geq T_t + 2 * T_p$.

$\Rightarrow \boxed{T_t \geq 2 * T_p}$ Ans.

If $\boxed{L \geq 2 * T_p * B}$ then we can say that we have 50% effi

$\eta =$

Q4.) $B = 4$ mbps ; $T_p = 1$ msec ; th
what should be the length the packet so that the η is

$\boxed{\eta}$

Interfere

① d ↑
② L ↑

Ans)
$$L \geq 2 * T_p * B$$
$$\geq 2 \times 10^{-3} \times 4 \times 10^{6}$$
$$\boxed{L \geq 8 \times 10^{3} \text{ bits}}$$

Factors that affects effeciency

Q5.) If $\eta = \frac{1}{2}$; $B = 4$ mbps
Effective bandwidth = ?

Ans) $\boxed{\text{Throughput} = \eta \times \text{Bandwidth}}$
$$= \frac{1}{2} \times 4 \text{ mbps}$$
$$= 2 \text{ mbps}$$

* effective bandwidth = Throughput

$$\eta = \frac{1}{1+2a}$$

$$= \frac{1}{1+2 * T_p/T_t}$$

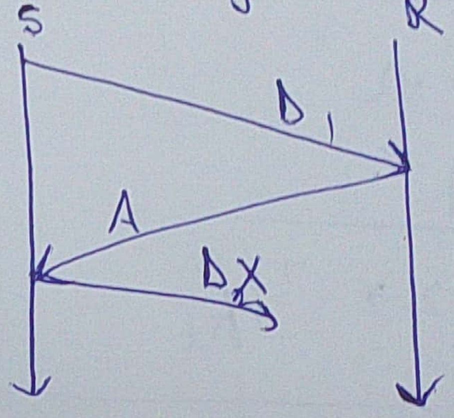
$$\boxed{\eta = \frac{1}{1+2 * \frac{d}{v} \times \frac{B}{L}}}$$

Inteferences :-

① $d \uparrow$ $\eta \downarrow$ $\rightarrow$ good for Lan ✓ | WAN ✗

② $L \uparrow$ $\eta \uparrow$ $\rightarrow$ Big packet ✓

Disadvantage



If Data is lost

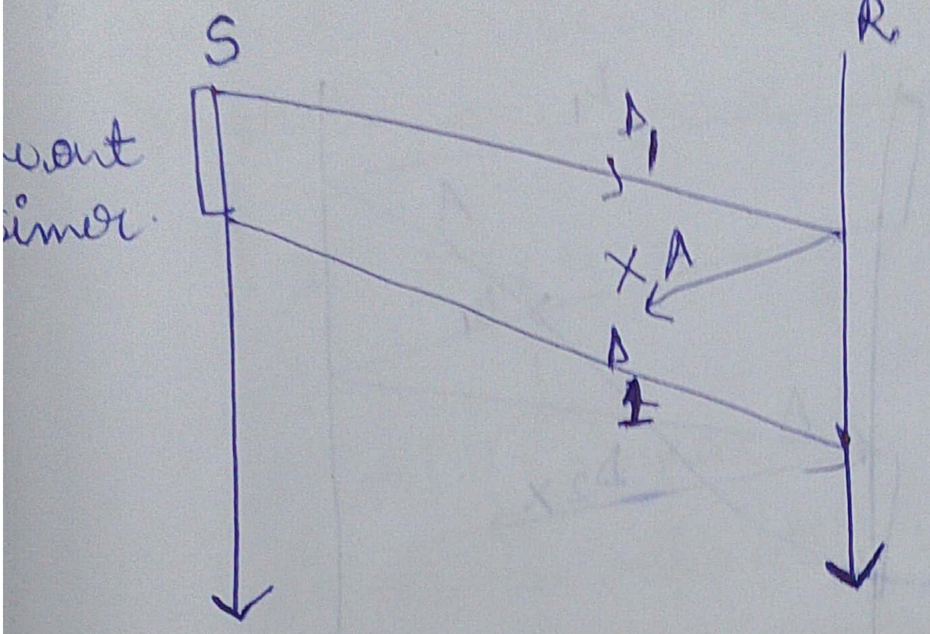
Situation 1:- If D_2 is lost in transmi
then sender thinks that receiver
buffer is full & so it is not se
the acknowledgment. Receiver will
think that no data has been sen
the sender.

* To avoid this problem we
$\boxed{\text{Time out}}$ i.e Automatic
request.

Stop & Wait + Time out

= $\boxed{\text{S\&W ARQ}}$

Situation 2:- If Ack. is lost



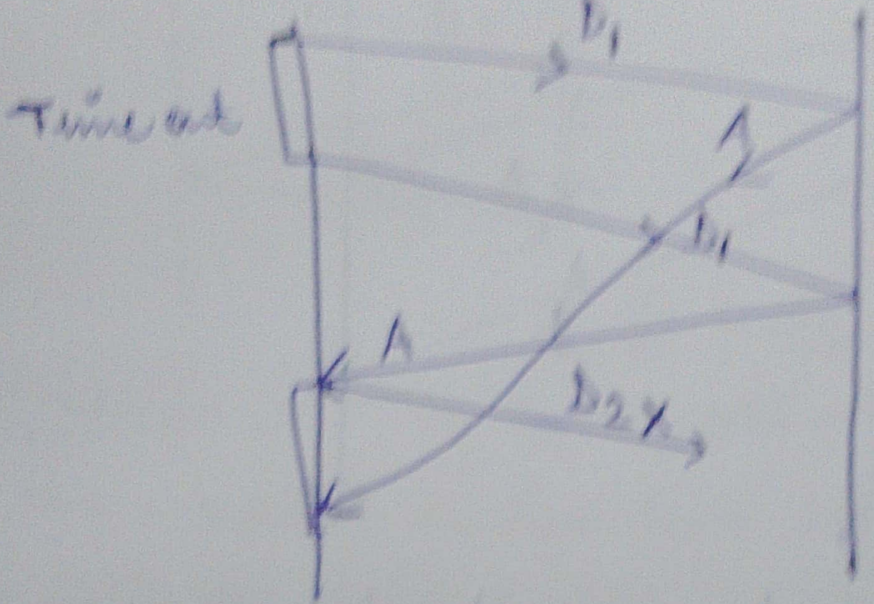
• **Duplicate packet problem:-**

Since ~~receiver~~ acknowledgement has not been received by the sender, so it will send data 'D_1' again but receiver has already received the data. when receiver will get the data 'D_1 again' then it will thinks that 'D_1 is again in the data packet.

• To eliminate this problem we use $\boxed{\text{'Sequence Number'}}$ to data

∴ $\boxed{\text{S\&W + TO + Seq. no}}$

Situation 3:- Delayed acknowledg



This is missing packet problem

Sender send 'D_1' & receiver send
but it is not received. So, after
out Sender sends 'D_1' again. The
now sends the ack for D_1 agai
The ~~receiver~~ sender sends → 'D_2' & her
delayed ack of 'D_1' which was
send is received by the sende
it will assume that it has re
the ack. for D_2 but ~~a~~ receive
not send the ack since D_2 i

Solution:- Add acknowledgment n

1.) In S & W in every 10 packets 4th packet is lost; then how many packets are send in total?

Ans.) 1 2 3 4 4 5 6 7 7 8 9 10 10

$\therefore$ Total 13 packets are send

Packet no repeated = $\boxed{4, 7, 10}$

2.) If the loss probability is 20%, then if 400 packets are send in this links then total how many packets will be lost.

Ans.) $400 + 400(0.2) + 80(0.2) + \cdots$

$= n + np + np^2 + np^3 + \cdots$

$= n(1 + p + p^2 + p^3 + \cdots)$

$= n\left(\frac{1}{1-p}\right)$

$= 400\left(\frac{1}{1-0.2}\right) = \frac{4000}{98}$

$= \boxed{500}$

Lecture -12

Capacity of pipe & pipelinin

Capacity of the channel depends o

① Bandwidth (BW) & propagation delay (T_p)

$\boxed{\text{Capacity} = BW * T_p}$ This is fo half dup

For full duplex:-

$\boxed{\text{Capacity} = BW * T_p * 2}$

If the channel capacity is very hig then it is called "Thick pipe".

SQ, S&W in Tick pipe, efficiency is

In, thin pipe, S&W, efficienc is more.

$$\eta = \frac{1}{1+2a} = \frac{1}{1+2*\left(\frac{T_p}{T_t}\right)}$$

$$\eta = \frac{1}{1+\frac{2*T_p*B}{L}}$$

It is the ... of sending multiple data units without waiting for an acknowledgment for the 1st frame sent

Pipelining :-

T_t sec = 1 packet

1 sec = $\frac{1}{T_t}$ packets

packets send in $(T_t + 2*T_p)$ sec $= \frac{T_t + 2*T_p}{T_t}$ packets

$= (1+2a)$ packet

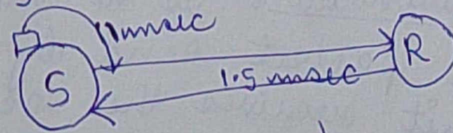
$\left(\eta = \frac{1}{1+2a}\right) \rightarrow$ for S&W

To increase the efficiency η we have to increase the no. of packets send.

When we send more than 1 packet it is called windowing. By allowing windowing, TCP aims to achieve a balance b/w maximising data throughput & avoid congestion or data loss

$T_t = 1$ msec

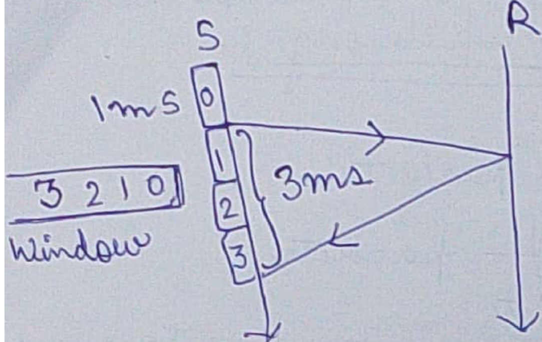
$T_p = 1.5$ msec



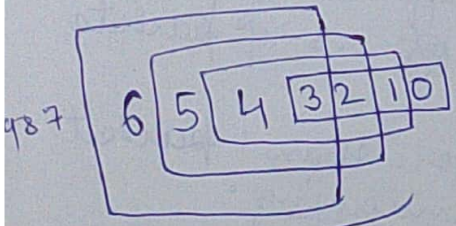
$$\eta = \frac{1}{1+2a} = \frac{1}{1+2*\frac{1.5}{1}} = \frac{1}{4}$$

$\boxed{\text{Round trip time} = 2 * T_p}$

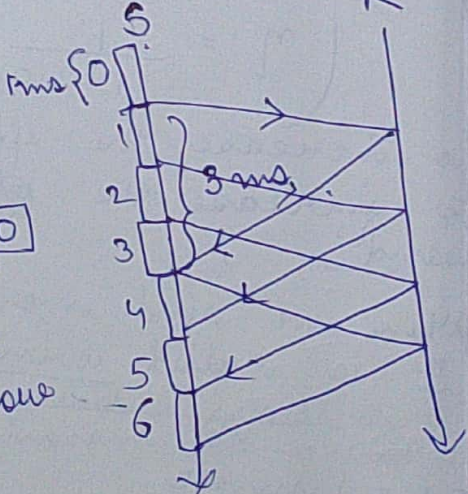
Sliding Win



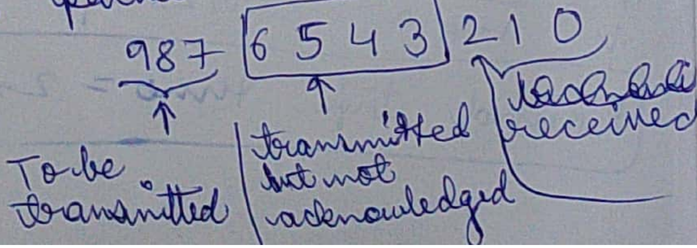
When ack. of packet 0 is received we have to eliminate packet 0 & packet 4.



Sliding window



Sliding window :- is a buffer w stores the packet send by the sen ~~it~~ till it receives the acknowl of the packet.



In sliding window protocol for max^m utilization : $\boxed{W_S = (1+2a)}$

min seq. $= 1+2a$

bits sequence number field $= \lceil \log_2(1+2a)$

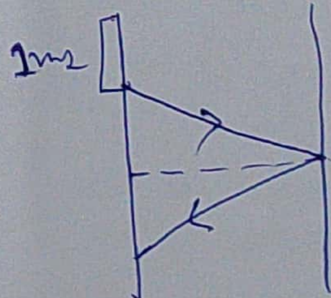
~~1544815514~~

) $T_t = 1ms$; $T_p = 49.5$ msec.
What should be the sender window size to have max^m window size?

$W_S = 1+2a$
$= 1+2\times 49.5$
$= 100$

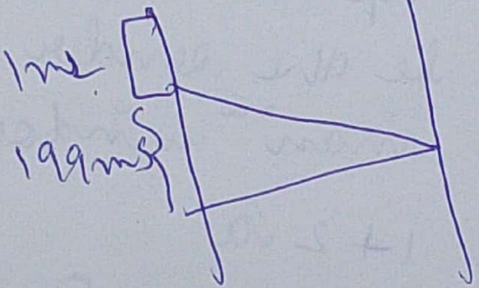
Seq. num = 100

Min. no. of bits in seq. number field $= \lceil \log_2 100 \rceil$
$= \lceil 6.8 \rceil = 7$



$$\boxed{W_s = \min(1+2a, 2^n)}$$

Q2.) $T_t = 1$ msec ; $T_p = 99.5$ ms



Ans.) $W_s = 1+2a$

$= 200$ packets

minimum Seq no. = 200

Gateway :- a device that connects n/w by translating communications from protocol to another

unidirectional/bidir-

16

6)100

6

40

36

4

134

0.40518

0.2357

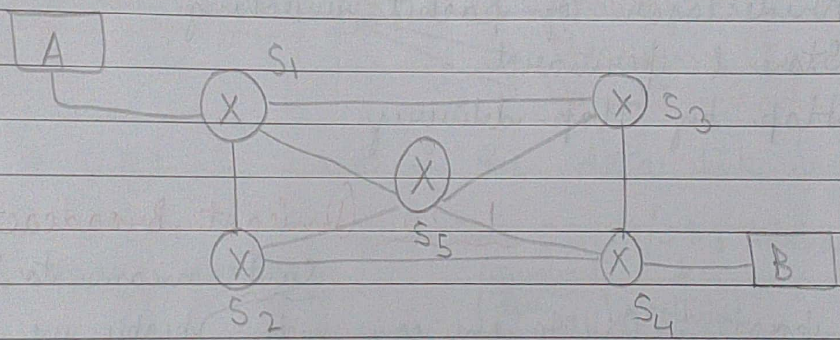
010 011 101

Circuit Switching

L-16

* used in the telephone connection
* based on the physical layer
* 'No' out of flow
* $\boxed{\text{Total time} = \text{Setup time} + TT + PD + \text{Tear Down time}}$
* Physical layer
* Contiguous flow
* 'No' header
* Efficiency less
* Delays less

L-17 (Packet Switching)



Packet Switching

Dataframe | Virtual Circuit

1. Data link & N/W layer
2. Store & forward
3. Pipelining used
4. Efficiency ↑
5. Delay ↑

L-18

Datagram Switching	Virtual Circuit
* Connectionless	* Connection Oriented
* No reservation	* Reservation
* Out of order	* Same order
* High overhead	* Less overhead
* Packet lost ↑	* Packet Lost ↓
* Used in internet	* X.25, ATM (Asynchronous)
* Cost ↓	* Cost ↑
* Efficiency ↑	* Efficiency ↓
* Delay ↑	* Delay ↓

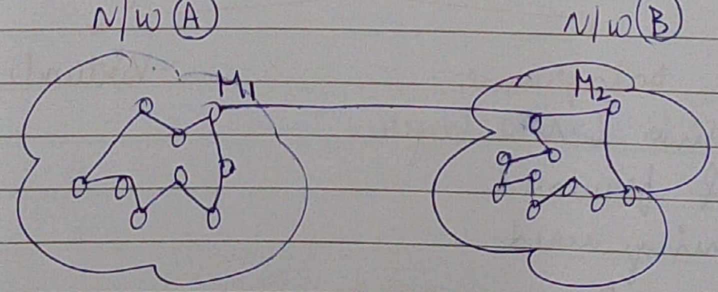
L-19 (Message Switching)

* Predecessor of packet switching
* Store & forward
* Hop by Hop delivery

L-20 (Unicast, Broadcast, Multicast)

Cast :- means to how many people we are sharing

① **Unicast** :- One to one communication



② **Multicast** :- To specific group.

③ Limited **Broadcast** :- To send the message to every host within a n/w then it is limited broadcast

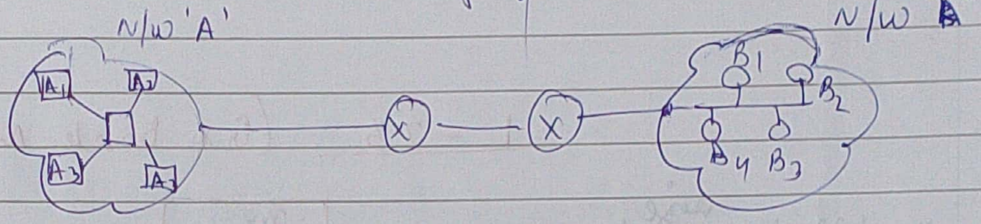
④ **Direct broadcast** :- If M_1 wants to send ~~messages~~ msg to every host in the other n/w then it is direct broadcast address

Data Link Layer

L-20

Responsibility of Data link layer :-

1.) Hop to Hop (node to node) delivery
2.) It works within one n/w.
3.) It decides where to go from 1 node to other.



(3) Flow control :- It decides how many packets to be send to the router.

① Stop & Wait ② Sliding window → Go back N

(4) Error control → CRC (Cyclic redundancy check) → Data Link Layer
→ Parity
→ Checksum (Transport layer)
→ Hamming code

* CRC is used in the data link layer.

(5) Access control → ~~CRC~~ CSMA/CD, Aloha, Token
(carrier sense multiple access) (collision detection)

(6) Physical address

* MAC address is used to communicate b/w the system of the same n/w.
* 48 bits address.
* It is constant

(7) Use of 'frames' for reliability.

~~Go-Back-N ARQ~~

DATE

L-25 Selective repeat ARQ

Window size of sender = $\boxed{2^{m-1}}$

Window size of receiver = $\boxed{2^{m-1}}$

Flow control in Data Link Layer :-

	Stop & Wait	Go back N	Selective Repeat
①	Only 1 frame transit	Multiple frame	Multiple frame
②	Sender Window = 1	Sender Window = $\boxed{2^{K}-1}$ K = no. of bits to rep. WS	Sender Window = $\boxed{2^{K-1}}$
③	Receiver Window = 1	Receiver Window = 1 (Packets accepted Inorder)	Receiver Window = $\boxed{2^{K-1}}$ (Out of Order packet accepted)
④	$\eta = \frac{1}{1+2x}$; $x = \frac{T_p}{T_t}$	$\eta = (2^K - 1) \times \frac{1}{1+2x}$	$\eta = 2^{K-1} \times \frac{1}{1+2x}$
⑤	Retransmission = 1	Commutative ACK	Commutative & individual ACK
⑥	ASN = $W_S + W_R$	Retransmission $\boxed{2^K - 1}$	Retransmission = 1 * It can also send negative ack. for the packets in which there is error

Rabindra Babu

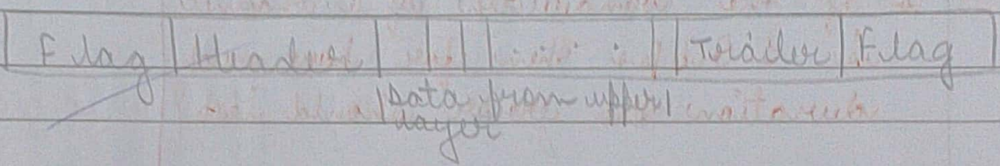
	Stop & Wait	G B N	S R
Efficiency	$\frac{1}{1+2a}$	$\frac{N}{1+2a}$	$\frac{N}{1+2a}$
Buffers	1 + 1	N + 1	N + N
Seq. NO.	1 + 1	N + 1	N + N
Retransmission	1	N	1
BW	Low	high	moderate
CPU	Low	moderate	high {because at the receiver end sorting is req.}
Implementation	Low	moderate	complex

Framing in Data Link Layer

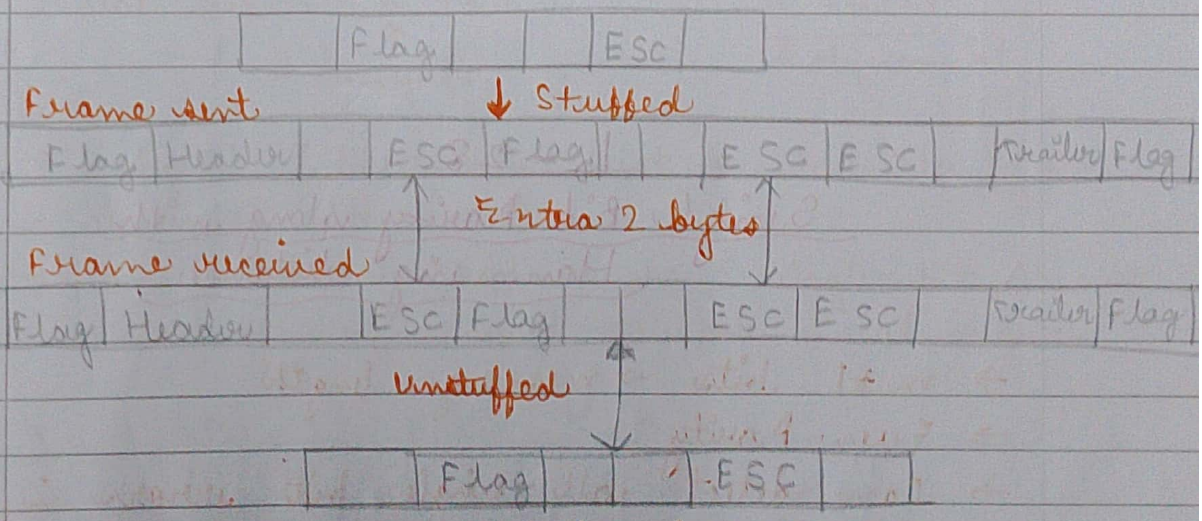
L - 26 (Bit Stuffing Vs Byte Stuffing)

The data link layer needs to pack bits into frames, so that each frame is distinguishable from another. Our postal system practices a type of framing. The simple act of inserting a letter into an envelope separates one piece of information from another; the envelope serves as the delimiter.

* A frame in a character-oriented protocol.



Byte stuffing and unstuffing



Data to upper layer

Byte stuffing is the process of adding 1 extra byte whenever there is a flag or escape character in the text.

Error Detection & Correction

L - 27

DATE

* Single bit Error :- Only 1 bit change

  Ex:- 10(1) $\xrightarrow{\text{Error}}$ 10(0)

* Burst Error :- more than 1 bit change

  Ex:- 1(0)10(1)(0) ⟶ (1)1 0 (1)...

  Length of error :- 5 bits
  { 2nd bit to 5th bit }

Detection
→ Simple Parity (Even, odd)
→ 2D Parity check
→ Checksum
→ CRC (cyclic Redundancy check)

Correction :
→ Hamming Codes

* If the bandwidth of a channel is 1 Gbps then for how much duration the error should last?

L - 28

Single Bit Parity along with Hamming distance

→ m+1 bits → message length
→ Even Parity
→ Can detect all single bit errors in code word
→ Can detect all odd no. of errors also.

XOR = Different bit → 1
same bit → 0

Ex① 0000 → Sender Signal
1111 → Signal Received by Receiver

1111 → Hamming distance

No-of 1 = 4 → Hamming distance

Ex 2:-
$$\begin{array}{r} 0101 \\ 1000 \\ \hline 1101 \end{array}$$
Hamming distance = 3

No. of error detected by the hamming code is $\boxed{D-1}$ {distance − 1}

Imp ✓ L - 29 (CRC) error detection

CRC :- Cyclic redundancy check

* Based on binary division

Total bits = $(m + r)$ ↑ redundant bits, ↑ message bit

$\underbrace{x^4+x^3+1}_{\text{Polynomial}}$

→ Polynomial should not be divisible by x.
→ also not with $(x+1)$
→ can detect all odd errors, single bit, burst error of length equal to polynomial degree

Ex:- Polynomial − x^4+x^3+1 → Binary conversion for this polynomial is

$1x^4 + 1x^3 + 0x^2 + 0x^1 + 1$
= 11001

Code to be send is 1010101010. F ind the CRC bits.

Sol. Binary conversion of polynomial x^4+x^3+1 is 11001

DATE add 4 bits because n' is 4

```
11001) 10101010100 0 0 0
   XOR 11001
        011000
         11001
          00001101 0
              11001
               0001100 0 0
                  11001
                   000010
```

CRC bits: 0010

Code which has to be send is

$\underbrace{1010101010}_{data}\ \underbrace{0010}_{CRC}$

$$\eta = \frac{10}{14} \times 100$$

10 → data

14 → total no. of bits (data + redundant bits)

L - 31 (Hamming Code)

for error detection

* Hamming code is of 7 bits then data bit is of 4 bits whereas 3 bits is for hamming parity bits.

	$2^0=1$	$2^1=2$		$2^2=4$			
Bit	P_0	P_1	D_0	P_2	D_1	D_2	D_3
Position	1	2	3	4	5	6	7

Since $2^3 = 8$ But here there is no 8th position

* Parity bits are always at the position of 2^n

Q) If data bit is - 1010 ; Parity bit ?

Sol:

1 + 4 + 6 +

$P_0 = D_0 \oplus D_1 \oplus D_3 = 1 \oplus 0 \oplus 0 =$

$P_1 = \oplus D_1 \oplus$

$P_2 = D_1 \oplus D_2 \oplus D_3 = 0 \oplus 1 \oplus 0 =$

DATE

Q1) Ex:- of redundancy bit calculation

d	d	d	r8	d	d	d	r4	d	r2	r1

I/P data 1001101

Sol)

1	0	0	r_8	1	1	0	r_4	1	r_2	r_1
11	10	9	8	7	6	5	4	3	2	1

r_1 (Parity 1) = 1, 3, 5, 7, 9, 11
r_2 (Parity 2) = 2, 3, 6, 7, 10, 11
r_4 (Parity 3) = 4, 5, 6, 7,
r_8 (Parity 4) = 8, 9, 10, 11,

$r_1 = 1 \oplus 0 \oplus 1 \oplus 0 \oplus 1 = 1$

$r_2 = 1 \oplus 1 \oplus 1 \oplus 0 \oplus 1 = 0$

$r_4 = 0 \oplus 1 \oplus 1 = 0$

$r_8 = 0 \oplus 0 \oplus 1 = 1$

11	10	9	8	7	6	5	4	3	2	1
1	0	0	1	1	1	0	0	1	0	1

O/P = 10011100101 → data to be send

Case 1 :- If while transmission 9^{th} bit is changed from '0' to '1'.

Detection at the receiver end:-

$r_1 = 3^{rd}(1) + 5^{th}(0) + 7^{th}(1) + 9^{th}(1) + 11^{th}(1)$

No. of 1's = 5 (odd) ∴ $\boxed{r_1 = 1}$

$r_2 = 2^{nd}(0) + 3^{rd}(1) + 6^{th}(1) + 7^{th}(1) + 10^{th}(0) + 11^{th}(1)$
= no. of 1's = 4 (even) $\boxed{r_2 = 0}$

$r_4 = 4^{th}(0) + 5^{th}(0) + 6^{th}(1) + 7^{th}(1) = 2$ $\boxed{r_4 = 0}$

$r_8 = 8^{th}(1) + 9^{th}(1) + 10^{th}(0) + 11^{th}(1)$ $\boxed{r_8 = 1}$

∴ $r_1 r_2 r_4 r_8 = 1001 = 9$ ∴ the 9^{th} bit is incorrect

L - 31

Multiple Access Protocols (MAC)

1. Random Access Protocols
   - Aloha
   - CSMA
   - CSMA/CD, CSMA/CA
2. Control Access
   - Polling
   - Token Passing
3. Channelization Protocols
   - FDMA — Freq. Division Multiple Access
   - TDMA — Time division Multiple Access

L - 32 (Pure Aloha)

1. Random Access Protocol
2. Acknowlegment is there
3. LAN based
4. Only transmission time ; No progation time
5. Vulnerable time = $\boxed{2 \times T_t}$
6. Efficiency η = $\boxed{\eta = G \times e^{-2G}}$; G is the no. of system which wants to transmit at that time.

L - 33 (Slotted Aloha)

We have to assume that T_t is same for all the msg by the nodes.

Pure Aloha	Slotted Aloha
1. Any time transmission can be done by node.	Starts transmission at begining of T_t. Time is divided in slots of T_t.
2. $VT = 2 \times T_t$	$VT = T_t$
3. $\eta = G \times e^{-2G}$	
4. Efficiency = 18.4 %	$\eta = 36.8\%$

Throughput: amount of something that passes through something

L-34

Carrier Sensor Multiple Access (CSMA)

$$\text{CSMA} \rightarrow \text{1-Persistent},\ \text{0-Persistent},\ \text{P-persistent}$$

* If any node wants to transmit data then first it senses the carrier whether it is transmiting any data or not.
* We don't sense the entire part of the carrier. We check only at the point near node which want to transmit.

1-Persistant :- It continoqusly senses the data whether ~~it~~ it is transmitted on the carrier or not. If ~~it is the~~ carrier is present with data then it doesnot send data. Chance of collision is ↑.

0-Persistant :- It randomly waits for sometime then it senses the carrier for the presence of any signal. ~~Changes~~ Chance of collision is less.

P-Persistent :- Probability value. If the carrier is free then it waits for the probibility value 'P' & then only it starts to transmit. If the carrier is busy then it continously senses the just like 1-Persistant.

L-34 (CSMA/CD)

* Used in wired connection { If any node is transmit ing & meanwhile receives any other signal it is collision detection
* No Acknowledgment
* $TT \geq 2 * PD$

$$\frac{L}{BW} \geq 2 * PD$$

$$\boxed{L \geq 2 * PD * BW}$$ V.V. Imp

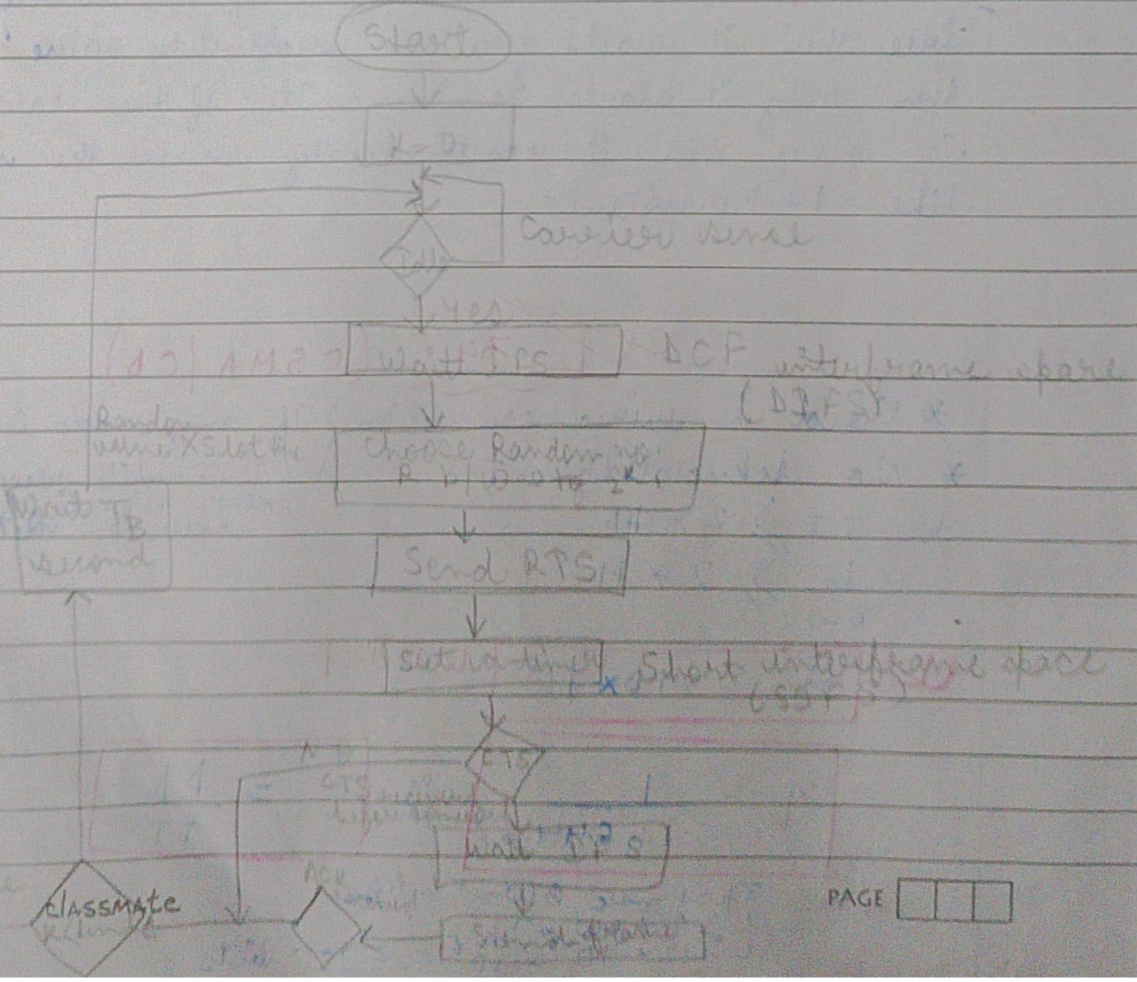
$$\boxed{\eta = \frac{1}{1 + 6.44a}} \; ; \; \boxed{a = \frac{PD}{TT}}$$

$T_p = 1$ msec ; $BW = 1$ mbps

CSMA/CA → collision Avoidance
↓ (WLAN) Wifi

* interframe space
* used in wireless connection
* In wireless we use 'collision Avoidance' instead of collision detection because in wired n/w if any node in transmitting signal & meanwhile it receives another signal of collision then meanwhile it is going to have twice the strength of the signal being transmitted. Hence, it is able to detect the collision.

~~But~~ In wireless communication if any signal is transmitted, the strength of the signal decreases after sometime. So, if after collision the signal is send back to the sender, the signal is not of double strength as in the case of wired transmission. ∴ in wireless communication we use 'Collision Avoidance'.



L-37

$K = 10^3$, $M = 10^6$, $G = 10^9$

Consider a CSMA/CD n/w that transmits data at a rate of 100 Mbps (10^8 bits per sec) over 1km cable with no repeaters. If the minimum frame size required for this n/w is 1250 bytes. What is the signal speed (km/sec) in the cable?

(a) 8000 (b) 10,000 (c) 16,000 (d) 20,000

Ans: $T_t \geq 2\,PD$

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

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

$$= \frac{2 \times 1 \times 10^8}{1250 \times 8} = 20{,}000 \text{ Ans.}$$

($\times 8$: conversion into bit)

$$\eta = \frac{1}{1+6.44\,a} = \frac{1}{1+6.44\left(\frac{PD}{T_t}\right)} = \frac{1}{1+6.44\left(\frac{D/v}{L/BW}\right)}$$

** L-38 (Ethernet Frame format)

IEE-802.3 in Data Link Layer

* Used in Data link layer
* " " LAN
* 10 Base 2 – Thin
  10 Base 5 – Thick
  10 Base T
  100 Base-FX – Fast
  10 G Base T – Gigabit
  Topology – Bus, Star

Bit of pattern 1010....10

Contains 10101011 to alert the receivers

Preamble 7B	SFD 1B	DA 6B	SA 6B	Length 2B	Data 46B 1500B	CRC 4B

This is added by physical layer

MAC address 48 bits

Source address of the next node

PAGE

classmate

→ CRC → 4B → 32 bits

→ Frame (Min) size = 46B + 4B(CRC) + (Length) 2B + 6B (SA) + 6B (DA)

= 46B + 18 B = 64 B

$\boxed{\text{Min. frame size = 64B}}$

L-39 Token Ring (IEEE 802.5)

* Ring topology
* Access control method used is token passing.
* Token ring is unidirectional.
* Data rate used is 4 Mbps & 16 Mbbps.
* Piggybacking acknowledgement is used.
* Differential Manchester encoding is used.
* Variable size framing.
* Monitor station is used ~~because~~ so that corrupted frames could be removed from the n/w.

⇒ Piggybacking acknowledgement :- When acknowledgment is send along with the data & not seperately it is called piggybacking.

Frame Format :-

SD(1)	AC(1)	FC(1)	DA (6)	SA (6)	Data	CRC(4)	ED(1)	FS(1)

SD: Start Delimiter

ED: End Delimiter

Token - | SD(1) | ED(1) | FS(1) | - 3 bytes