8 Jan, 2023
Monday

[Lec-1] :-

- how different computers, internet interact with each other, how message is passed.

IPC. is different → us mein process in same computer system the.

we need some set of rules for that, o/w can be chaos in network.

So, protocols are required to pass message smoothly, to make them feel that they are connected.

Some requirements (or protocols) are Essential and some are Optional.

Essential:
(i) Error checking/control
(ii) flow control

Optional:
(i) Routing (how msg passed from one network to another) → can use routers, shortest path etc.; or can broadcast it
(optional, as like bina also msg can be recieved)

end-end → use IP + Port No. = Socket No.

① Protocol Stack :- Application layer
Transport layer
Network layer
Data link layer
Physical layer.

↓ TCP/IP

Use IP ← Host to Host

↓ mostly used

↓ Hop to Hop
↳ use MAC

② ISO-OSI Protocol Stack :-

(OSI layers) →
Application layer
Presentation layer
Session layer
~~Network~~ Transport
Network
~~Data link~~
Physical

↓ conceptual

Application layer
↓
User layer, where u can have your own program (like whatsapp, mail etc.)

Port No. → is something by which can uniquely identify the process ~~from which mess~~ within computer.

x = port no. of process jisse msg gya
y = _____ jiske pass jaana

say application layer → msg 'm' pass krna chahti hai.

(Application) m

(Transport) | m | x | y |

Some unique id is required to make every computer unique:
↓
IP address. → like normal person address → isse pta chlta hai whether destination belongs to ur own network or not!

(Network) | m | I_A | I_D | x | y |

I_A → IP address of source
I_D → IP address of destination

Adhaar no. → can't give all info. to find that person.
↳ why not to encode it in such way that it gives info!
↓
bcoz it does not change, while address can change!

MAC address :- given / hardcoded in device & won't change!

google.com → returns IP address

Socket No. = IP + port No.

(standard)

(known)

IP address not static → as abhi koi aur hai, baad mein kuch hoga aap.

↓

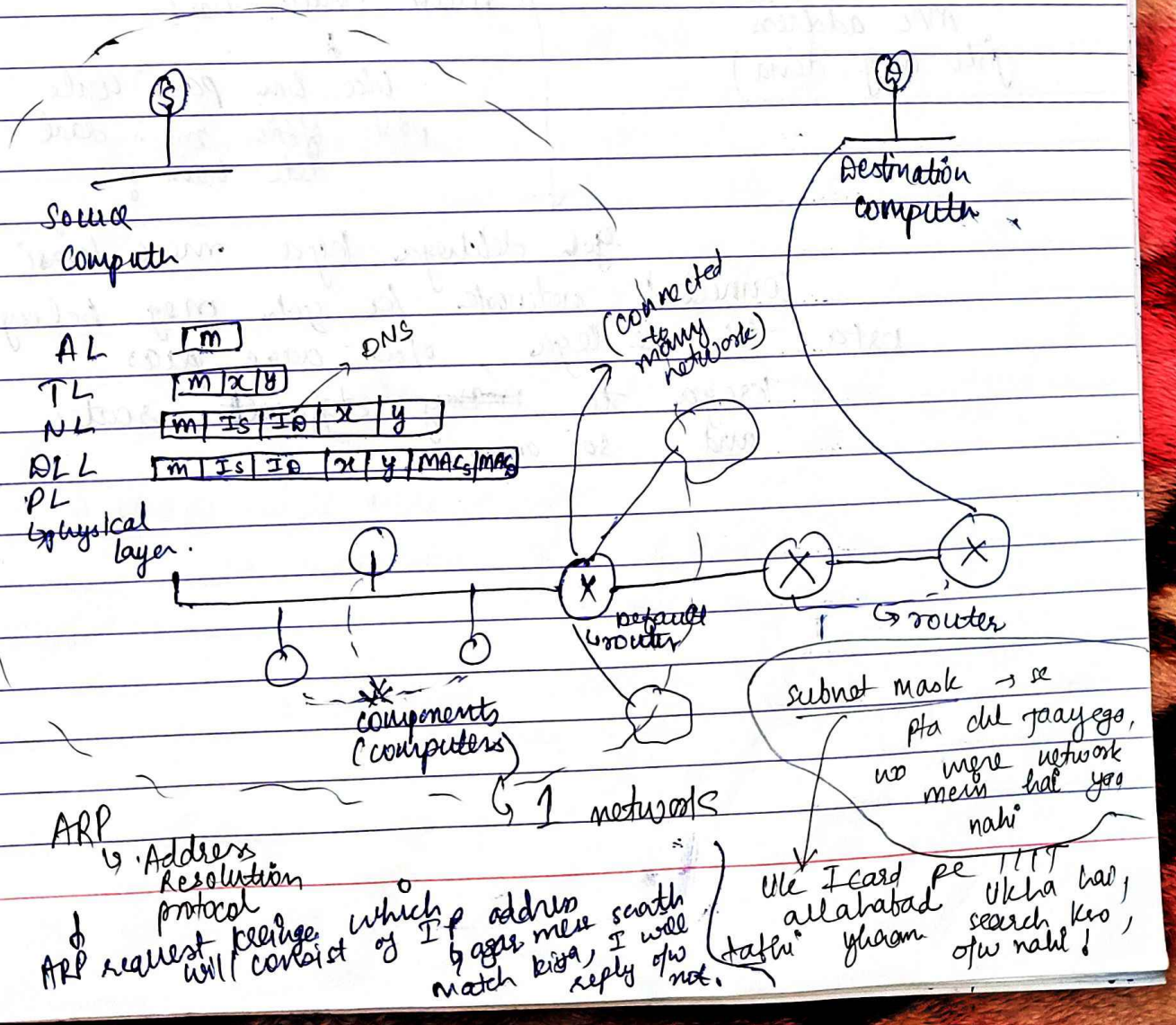
can adjust to make routing or message passing fast.

m	IA	ID	x	y	MAC address of source	MAC address of destination

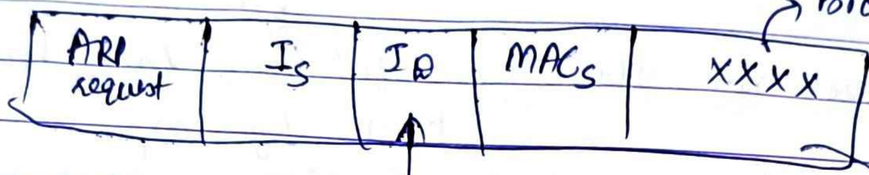
(Data link)

Physical layer → mostly consist of things through which msg is passed.

↳ like amplifier etc.



WOMK



→ Broadcast kiya koi no. ; as MAC address toh pta nahi hai !!

Jiska iske saath match kiya, wo reply kardega !

need MAC address of default (router), agar mere network mein nahi hai !

like hum pass wale post office mein daal dete hain !

← (agar mere network mein hai, need exact device ka MAC address jisko msg dena)

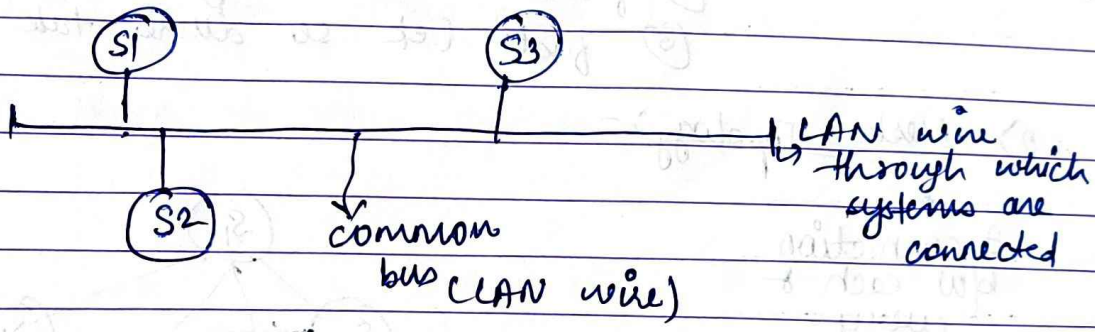
Yeh detect karega kya mere kissi connected network ko yeh msg belong krta toh de dega. o/w aage paas krega to ~~many~~ default router and so on....

10 Jan, 2023
Wednesday

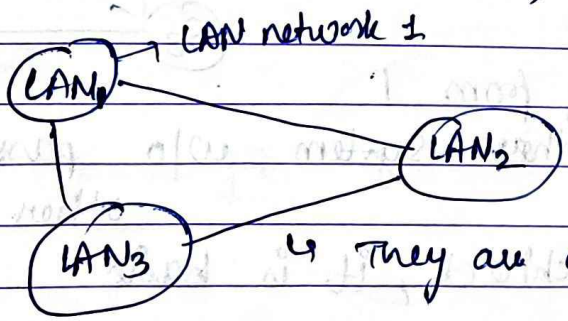
Lec-2 :-

① Types of Networks :-

1) PAN (Personal area network)
2) LAN (Local area network)



3) MAN (Metropolitan area network)



↳ They are connected, called MAN.

4) WAN (wide area network)
↳ connection b/w different states or countries.

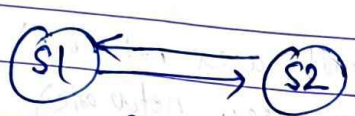
India ——→ Africa
↳ wire through water (fibre optics)

WJmke
= 3v
=mm.

① Network Topologies :- → need to implement all these in lab :)

how a system connects with other " ?

1) point to point connection :-
↳ (through wire)

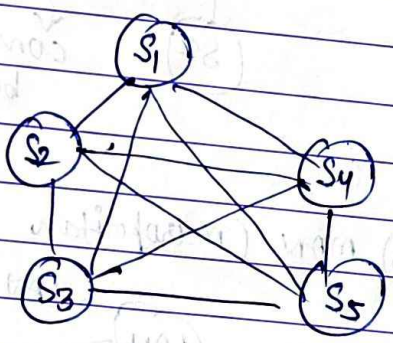


adv :- ① simple, just connects wire
② fault detection easy
③ fast (ek se dusre tak jaana hs)

2) Mesh Topology :-

↓

1 connection b/w each & every system.



advantages :-

① can send msg from 1 to any other system w/o passing via other system.

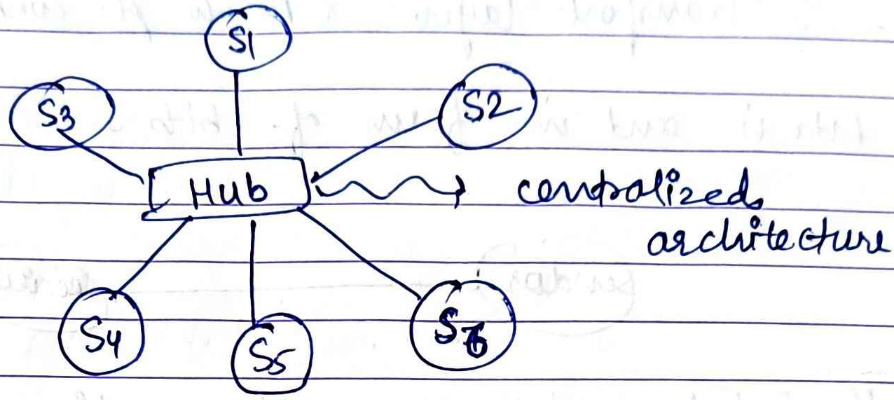
② system to architect, it is basic

Disadv :- ① too many connections, difficult to manage

② let s3 to baaki saare, iske the msg bhejdein, then difficult to handle ofcourse.

3) Star topology :-

WOMK ॐ mo.



adv:-

① each system has only 1 wire, easy to manage!

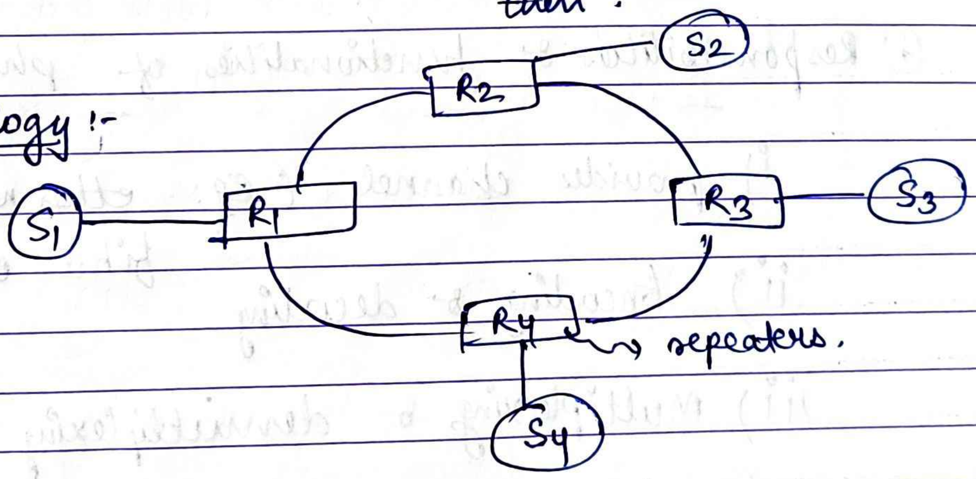
② sbka msg to other system will pass via Hub

disadv:-

① If Hub is busy, other needs to wait

② If Hub fails, whole architecture will fail then.

4> Ring Topology:-



Q why to have so many OSI layers in system??

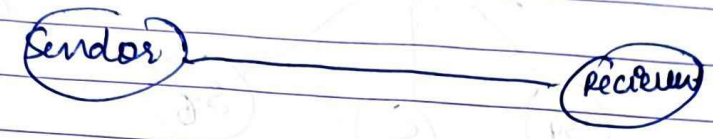
Application layer

↳ where application or actual data is formed.

Sender will send msg to application layer, then it sends to presentation layers.

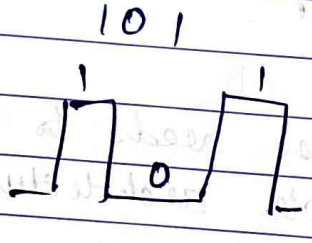
Transport layer (Pt-to-pt connection)

① Data is send in form of bits.



Physical layer takes care of medium through which sendor sends msg to receiver.

bit is decoded in clocks :-



(different-2 encoding-decoding mechanisms are there)

② Responsibilities & functionalities of physical layer :-

i) provides channel (Eg: ethernet wiring, fibre optics)

ii) Encoding & decoding

iii) Multiplexing & demultiplexing → means agar same medium se msg aaye bhut systems se / na to kis / na ho jaayein!

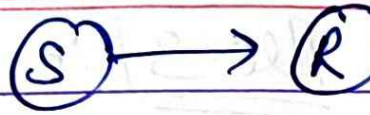
iv) Data rate (bits per second)

v) Bandwidth

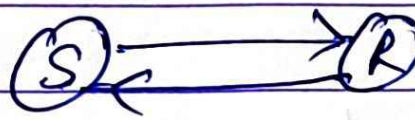
vi) Kaun sa network topology use krega, will be defined in this layer.

vii) Type of wiring: simplex, half duplex, full duplex

WORK

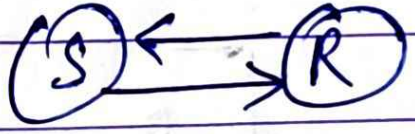
Simplex : 

(only sender can send msg)

half duplex :- 

(both can send msg, but only one can send at a time)

full duplex :-



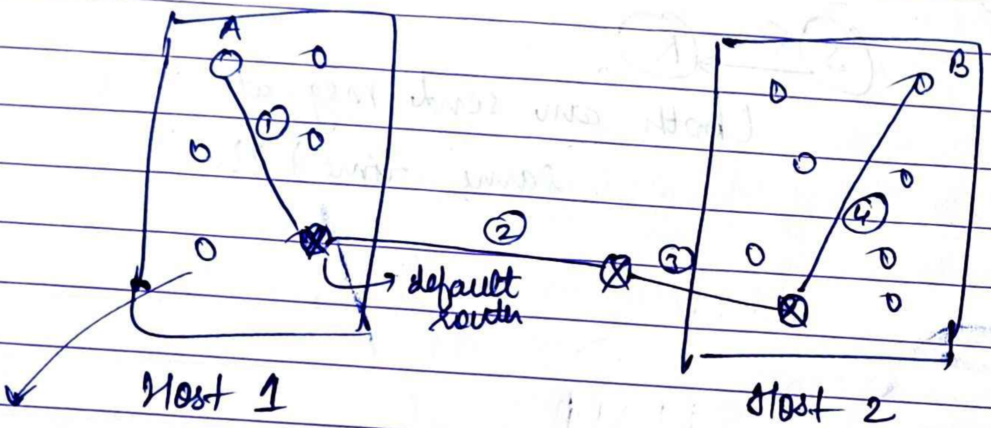
(both can send msg at same time) ??

WOMK ॐ

15 Jan 2024
Monday

Lec-3 :-

Data link layer :- to ensure hop to hop data transmission



many network devices connected

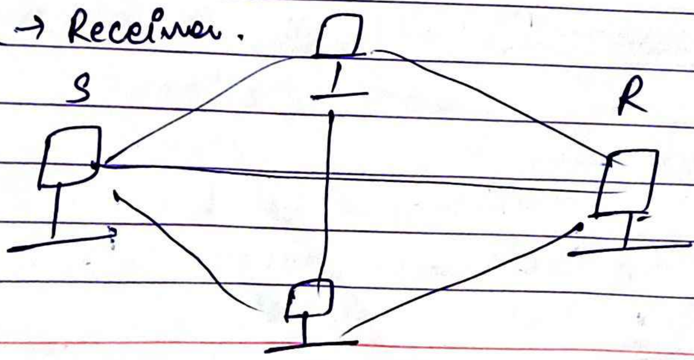
and uske liye ks MAC Adress chahiye.

↳ can communicate with each other directly, (within network) using data link layer

↳ known as hop to hop communication, no router is req. for that

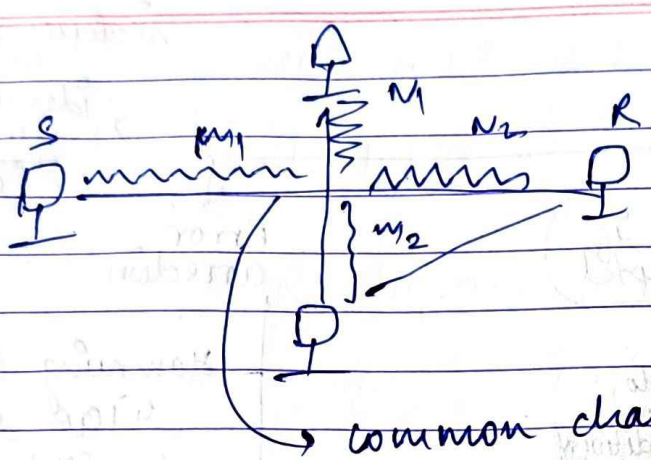
A to B jaane ke liye 4 hop to hop delivery huyi. → uske liye direct connection hota hai

S → Sender
R → Receiver.



(mess topology → not feasible → as so many wires ☹)

Works of DLL.



↳ common channel,
so m_1, m_2 messages can convert into noises N_1, N_2.

So | sol :-
set time, kab kaun can send msg.
↳ but have some problem.
as :- ① kisi ko kam time chahiye, jyada de diya
② jisko ↑ chahiye tha, uska partial msg hi paucha.
↳ also prblm.

so, all need to communicate with each other properly.

2 sol^n :- buffer.
↳ again prblm of buffer overflow.

when speed of sending msg > speed by which R receives | processes the msg. → coherence is lost.
~~jana hoga~~ we want :-

(1) Access control
(2) Flow control.
(3) Error checking mechanism (Error control)
↳ to check whether msg is correctly received or not.

major responsibilities of link Data layer

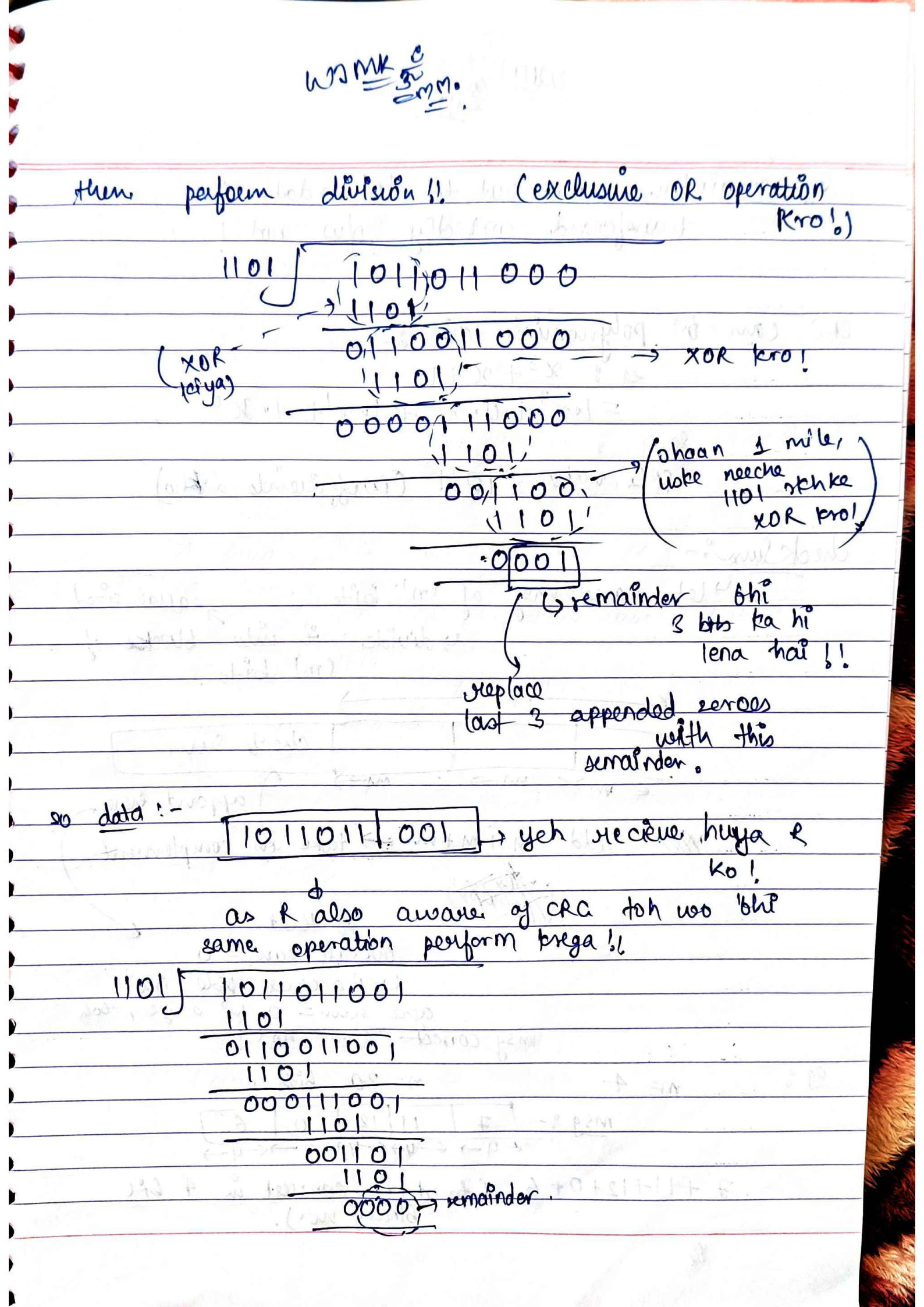
Error handling :-

- Error detection → can detect if data is corrupted
  - Data + Data
    - ↳ prblm need to send additional data
  - Parity ↳ if no. of 1 odds → send extra bit = 1
    - o/w 0.
    - prblm :-
      - 101011 se gar 010111 ho gaye, tab bhi pta nhi chlega error kha!
  - CRC (Cyclic Redundancy check)
    - ↳ S
    - ↓
    - data: 1011011 000
      - must append some additional 0
      - → 3 kiye bcoz CRC mein 4 bits hain, usse ek kam no. of bits → 0 append krdo!
  - checksum

- Error correction
  - ↳ reciever able to identify error & must correct it!
  - Hamming Code
    - ↳ 1GB data sent then additional 0.5 GB should be sent to utilise it for error correction
    - ↳ prblm : need to send additional data

CRC
1101

R


then perform division !! (exclusive OR operation kro !)
1101 | 1011011000
1101
01100011000
(XOR kiya)
→ XOR kro !
1101
0000111000
1101
00100100
(phaan 1 mila, uske neeche 1101 rakhke XOR kro !)
1101
0001
↳ remainder bhi 3 bits ka hi lena hai !!
replace last 3 appended zeroes with this remainder.
so data :-
1011011001
→ yeh receive huya R ko !
as R also aware of CRC toh wo bhi same operation perform krega !!
1101 | 1011011001
1101
01100011001
1101
00011101001
1101
00110101
1101
0000 → remainder.

WITMK e
50 mm.

If remainder comes out to '0' → data is transferred correctly o/w not!

CRC can be polynomial also :-

eg : $x^3 + x + 1$

$= 1 \cdot x^3 + 0 \cdot x^2 + 1 \cdot x^1 + 1 \cdot x^0$

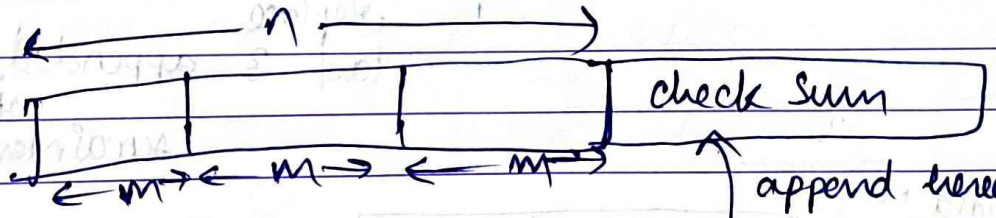
So,

CRC value = 1011 (Coefficients dekho)

Check Sum :-

↳ Let have msg of (n) bits

↳ divide it into blocks of (m) bits, → equal sized



add m ⊕ m + m ⟹ take its complement

so that overall sum = 0

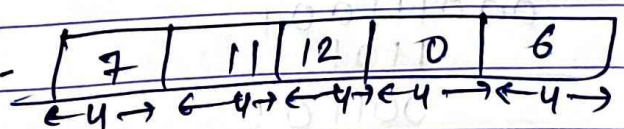
↳ Receiver side bhi agar sum = 0 hi aaye, toh msg correct o/w not!

eg :

m = 4.

n = 20 bits.

msg :-



7 + 11 + 12 + 0 + 6 (to add convert in 4 bit binary no.).

Work is done.

carry 0 1 1 1
1 0 1 1
1 0 0 0 0 (wrap it)
0 0 1 1

7 → 0 1 1 1] → add them, if carry is generated wrap up that
11 → 1 0 1 1]

+
0 0 1 1.

12 → + 1 1 0 0
1 1 1 1

0 → + 0 0 0 0
1 1 1 1

6 → + 0 1 1 0
1 0 0 1
1
0 1 1 0

1's complement to
↳ 1 0 0 1
11
9

append its on eight.
20 bits.

msg :-

| 7 | 11 | 12 | 0 | 6 | 9 |

↳ msg yeh bhejega.
sender

Receiver ke paas jaayega
↳ wo addn karega

1 1 1 1 → aaya.
↳ agar saare 1 aaye

1's complement
↳ 0 0 0 0 → agar saare 0 ↳ only then R will accept it o/w not !!!

WORK

Msg :-

7	11	12	0	6

⇒

7	11	12	0	6	0000

→ append all 0's (4 bit) (as clock sum nhi pta)

⇒

7	11	12	0	6	checksum

S ne bheja

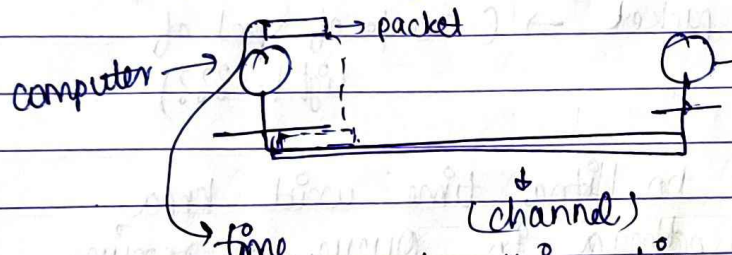
R ne receive kiya, agar error aa gya ⇒ toh sum ka 1's complement ≠ 0 hoga ⇒ toh R receive nahi krega !!

17 Jan 2023
wednesday

Lec-4 :-

① Different types of delays :-

1> Transmission delay (T_t) :- The time taken to put packets from host to the outgoing link.



time taken to place this entire packet on channel → transmission delay.

depends on :-

① Bandwidth (BW) ② Length of packet (L) → (data)

means in 1 sec, how many bits can put on outgoing channel

$$T_t = \frac{L}{BW}$$

→ data → always calculate in power of 2's !!

→ expressed in decimal (in power of 10)

let, L = 1000 bits, BW = 1 Kbps, T_t = ??

$$T_t = \frac{L}{BW} = \frac{1000 \text{ bits}}{1000 \text{ bps}} = 1 \text{ sec}$$

(diff ques)

let, L = 1 Kb, BW = 1 Kbps

$$T_t = \frac{2^{10} \text{ bits}}{1000 \text{ bits per sec}} = \frac{1024}{1000}.$$

Work :

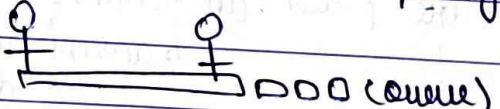
(Tp)

(2) Propagation delay :- It is the taken by a single bit to reach from one end of the link to the other end of link.

d = distance of outlink
v = velocity of packet → (70% of speed of light 3×10^8)

$T_p = \frac{d}{v}$

(3) Queuing delay :- packet ko kitna time wait krna pdhega in Queue at receiver end.
(Tq)



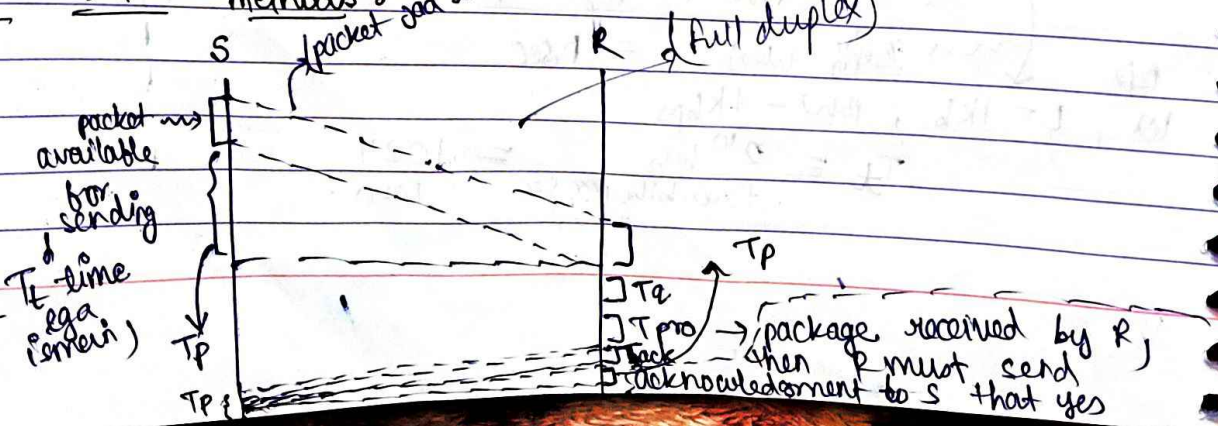
(4) Processing delay :- process hone mein jo delay
(Tpro) hoga → packet receive huya sahi se yaa nhi.

$T_{total} = T_t + T_p + T_q + T_{pro}$

↳ no formula (vary from system to system)

↓ ignore them !!

⑤ Flow Control methods :- (jaa sha hai)



received ✓. → Tack.

acknowledgment → also packet → usmein bhi propagation delay ~~wagera~~ wagera honge!

T_t → vary if packet not same,
but T_p same if u same!!

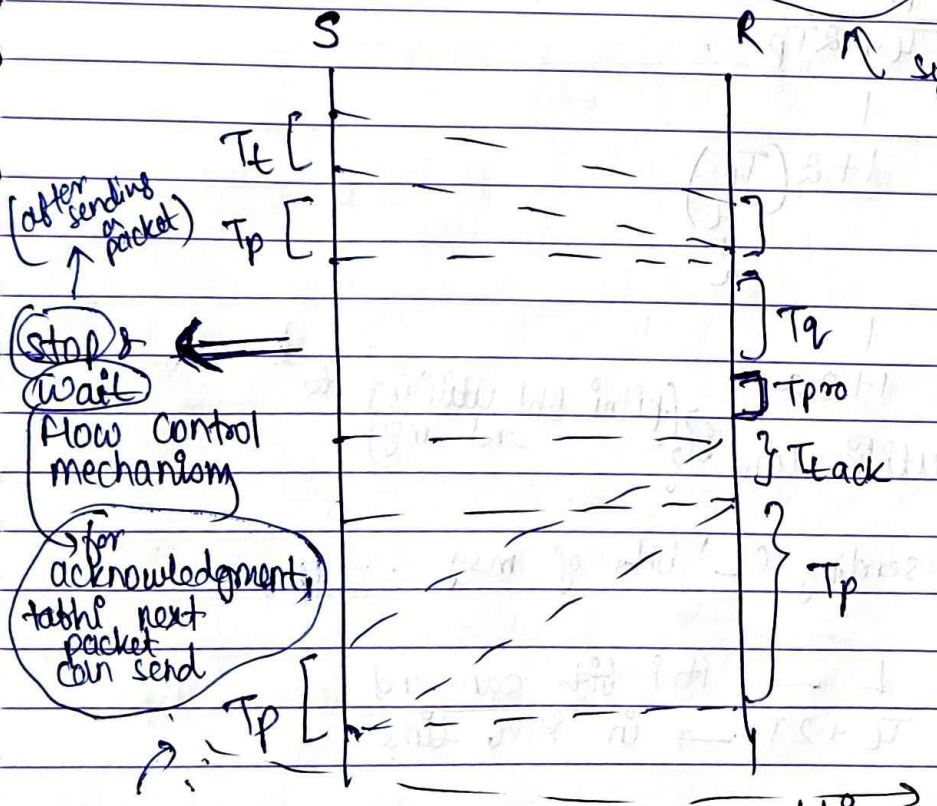
Total time $= T_t + T_p + (T_q + T_{pro}) + (T_{t\,ack}) + T_p$

↑ system dependent

↑ so ignore them!

can be neglected, as acknowledgment packet will be small.

↑ as yaa-toh yes bhejoge, yaa No!



T_q, T_{pro} nahi likha, as usse bhi ignoring hi.

ideally essa hoga, if no noise, but practically noise hoti hai & essa ho skta hai ki packet yaa acknowledgement drop ho gyi ho, na paunchi ho properly!

So,
Total time $= T_t + 2T_p$

Efficiency $= \eta = \dfrac{\text{useful time}}{\text{total time}}$

COMK

we just want 1 msg from S to R.

From user pt. of time,

Useful time = T_t

↑ packet daalo bs outgoing link pe.

So,

$$\eta = \frac{T_t}{T_t + 2T_p}$$

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

$\frac{T_p}{T_t} = a$

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

Throughput / BW utilization ⇒ (kitni BW utilizing to send msg)

Let sending 'L' bits of msg.

So, Throughput = $\frac{L}{T_t + 2T_p}$ → kitni bits can send in kitna time

$$= \frac{\frac{L}{BW} \times BW}{T_t + 2T_p} = \frac{T_t \times BW}{T_t + 2T_p}$$

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

$\frac{T_p}{T_t} = a$

- WOMK ॐ OM.

⊙ let $T_t = 1\,ms$, $T_p = 1\,ms$, then RTT (round trip time) = ?
jaake vaapis aana!

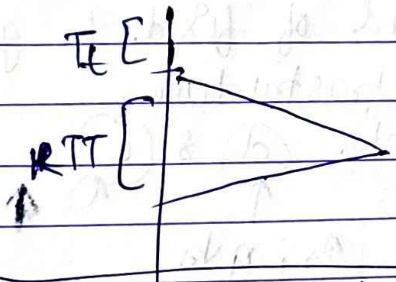
$$RTT = 2 \times T_p = 2\,ms$$

$$\eta = \frac{1}{1+2} = \frac{1}{3} = 33.3\%$$

~~$= \frac{2}{2+1}$~~

If $T_t = 2\,ms$,

$$\eta = \frac{2}{2+2} = 50\%$$ (↑s)



If, $T_t = RTT \Rightarrow \eta = 50\%$
$T_t < RTT \Rightarrow \eta < 50\%$
$T_t > RTT \Rightarrow \eta > 50\%$

We want $\Rightarrow \eta \geq 50\% \Rightarrow \eta \geq 0.5$.

$$\frac{T_t}{T_t + 2T_p} \geq \frac{1}{2}$$

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

$$\Rightarrow T_t \geq 2T_p$$

$$\Rightarrow \frac{L}{BW} \geq 2T_p$$

$$\Rightarrow \boxed{L \geq 2(T_p)(BW)}$$ → cond^n for $\eta \geq 50\%$

WORK

⊙ BW = 4 Mbps , T_p = 1 ms , $\eta \geq 0.5$, L = ?? (8×10^3 bits)

⊙ Factors influencing η :-

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

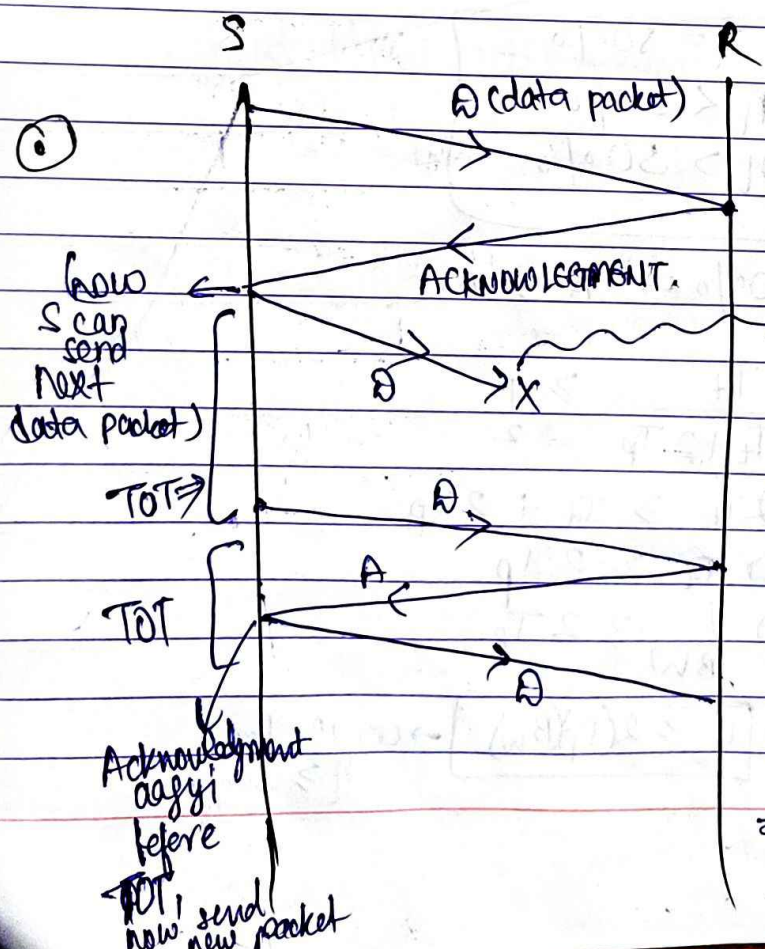
$$= \frac{1}{1+2\left(\frac{d}{v}\right)\left(\frac{BW}{L}\right)}$$

v, BW → kind of fixed for given infrastructure.

so, ~~bd~~ bche (d) & (L)

↑s, η ↓s

↑s, η ↑s



for some reason, this D got lost, S waiting for acknowledgment, but aayegi nahi kabhi S kabhi kuch bhej nahi paayega! ↑ prblm!

∴ R don't know S ne kuch bheja bhi hai!

⇒ 'Ruko bhejta hu S ne kuch bheja hi nahi tha!

wo mil c 5 min. wo mil c 5 min.

solution :- time out timer

↑ means the time mein acknowledgment nahi aayi, toh fir se msg bhejdo!

o/w ↳ new packet immediately bhejdo, jab acknowledgment aa jaaye!! ↖ before TOT.

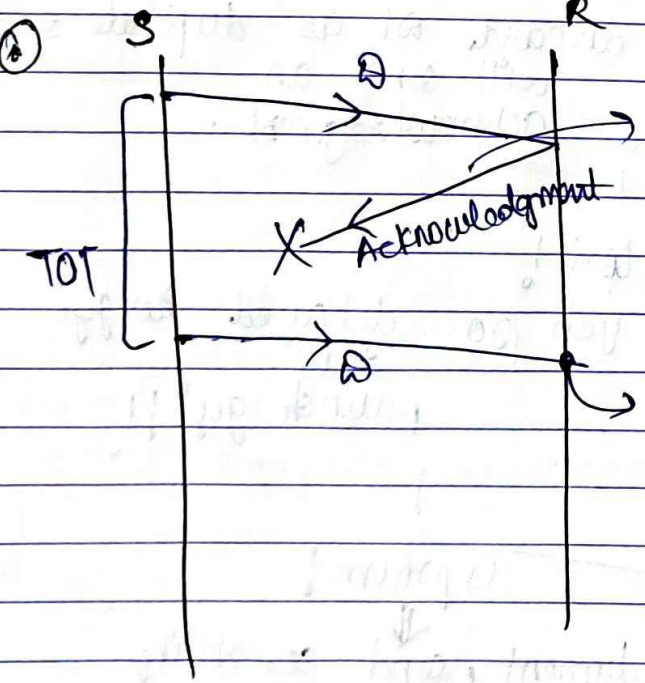
Stop and wait + TOT

||

S & W ARQ

↑

Automatic repeat request.



R ↑ not in position to understand ~~that~~ yeh new packet hai yaa duplicate.

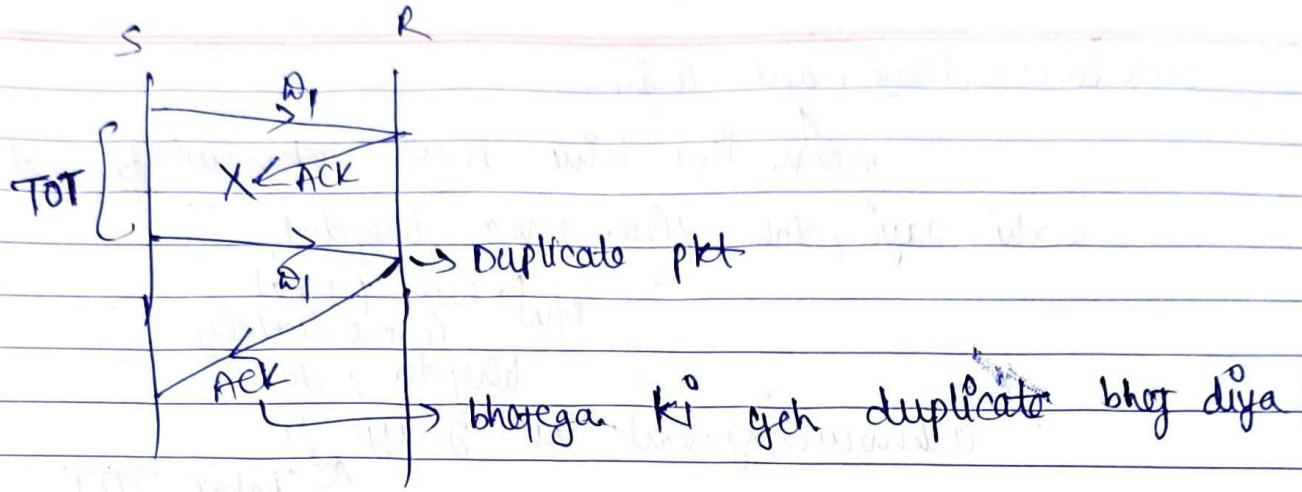
↑

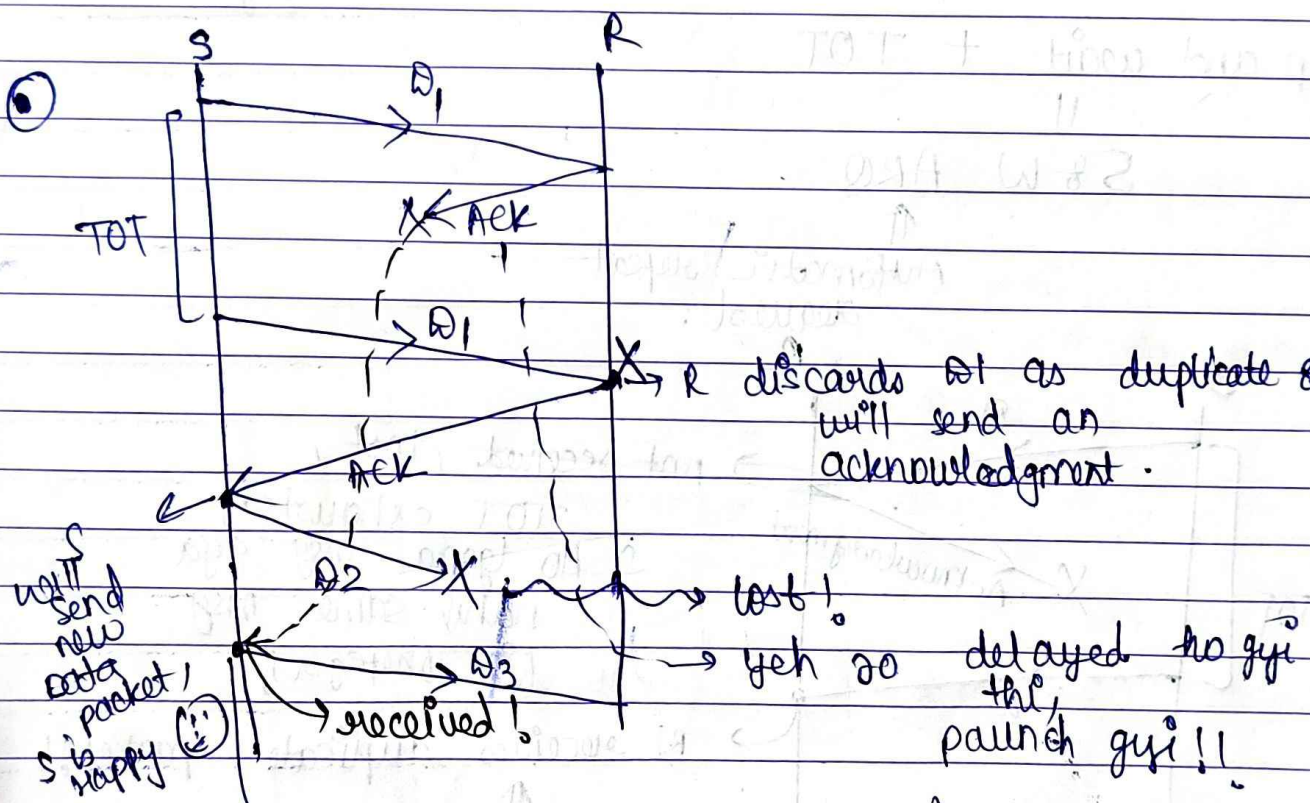
so R must be able to differentiate b/w packet.

↑

so use concept of sequence no.

unique no. held by every outgoing packet.





so in acknowledgment, send something extra telling what next I am expecting. (Acknowledgment number)

sequence no. expected next

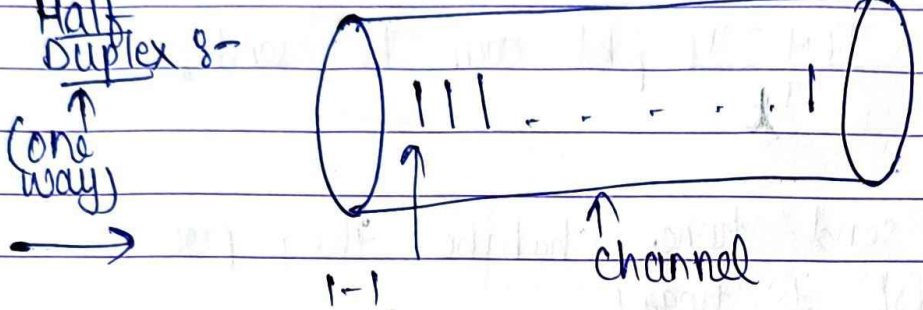
like D1 receive huya, then acknowledgment no. = 2

WORK in MM.

① Capacity of a channel :-

BW = 1 bps → means in 1 sec, can put 1 bit in channel.

Half Duplex :-
(one way)



1-1 krke bits daalte gye in channel !!

Capacity of channel = BW × T_p

(on 1 sec, itne bits bhej skte hain !)

(itna time lgega har bit ko S se R jaane mein)

(itne bits at max can be present at a time in channel)

(full duplex)
⇌
(both way)

capacity of channel = (BW) × (2) × (T_p)

as, $\eta = \frac{1}{1+2\left(\frac{T_p}{T_t}\right)} = \frac{1}{1+2\left(\frac{BW}{L}\right)(T_p)}$

If BW ↑s → η ↓s, capacity ↑s

→ generally we try to ↑ BW, not to ↓.

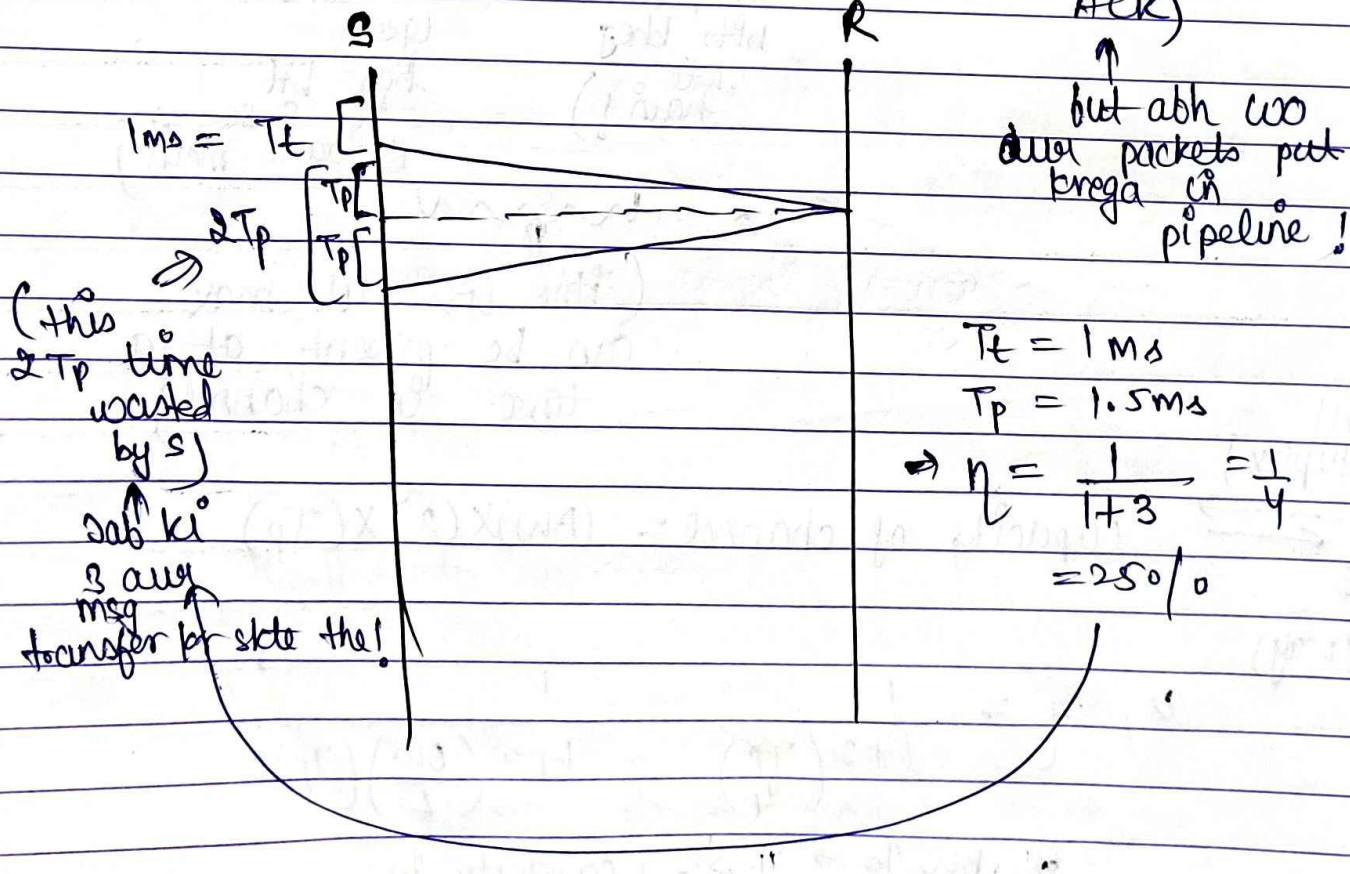
WORK is worship.

In time = T_t sec, 1 pkt can be send.
⇒ " " " 1 sec, $\frac{1}{T_t}$ " " " "
" " " $T_t + 2T_p$ ", $\frac{T_t + 2T_p}{T_t}$ pkt can be send.

So, $1+2a$ pkt send hone chahiye the, par diye 1 hoga!

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

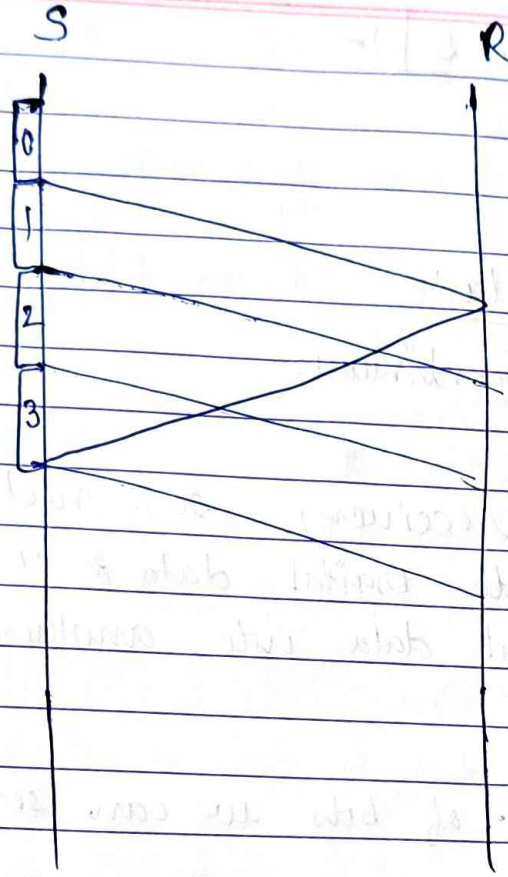
Pipelining Flow Mechanism:- (N pehle toss bcoz S waiting for ACK)



$T_t = 1$ ms
$T_p = 1.5$ ms
⇒ $\eta = \frac{1}{1+3} = \frac{1}{4}$
$= 25\%$

Work ♡♡.

(1st packet ka sequence no. = 0)



3 2 1 0

↳ bhaye : 4 → received no acknowledgment, now wait!

↳ and buffer mein daalo, inko discard mat karo!

| 3 | 2 | 1 | 0 | ← buffer.

let Ack 1 receive huya → toh discard 0, now can send other msg 4.

6 5 | 4 | 3 | 2 | 1 | 0 |

(yet to be send)

known as sliding window Protocol.

↳ all packets in window are send, but not acknowledged, and in left of window wale packets are yet to be send.

17 Jan 2023
wednesday

lec-5 :-

① Analog vs Digital data :-

Analog → continuous
↳ eg. speak
→ we speak & phone is receiver, so need mechanism to convert analog into digital data & " "
" " form of digital data into another form of digital data.

bit rate = 1 sec mein, no. of bits we can send.

S ——— channel ——— R

Signal to Noise Ratio (SNR) :-

$$SNR = \frac{\text{avg signal power}}{\text{avg noise power}}$$

↳ how much power channel is having or can handle!

↳ like bachar se giving heat (???)

$$SNR_{(dB)} = 10 \log_{10}(SNR)$$

↳ decibles

Noiseless Channel :- (impossible to achieve in real life)

Nyquist developed formula for

maximum bitrate = $2 * \text{Bandwidth} * \log_2(L)$

↑ formula works only for noiseless channel.

↑ no. of levels

→ Bits per second (there)

Q. Consider a noiseless channel in which BW = 3000 Hz & there are 4 signal levels. Find maximum bitrate.

A.

maximum bitrate = $2 * (3000) * \log_2(4)$
$= 2 * 3000 * 2$
$= 12000$ bits per second
$= 12$ Kbps

for Noisy channels :-

Shannon developed formula for maximum bitrate
= Bandwidth $* \log_2(1+SNR)$

for noiseless channel ⇒ $SNR = \frac{\text{avg signal power}}{0 \text{ (as no noise)}} = \infty$

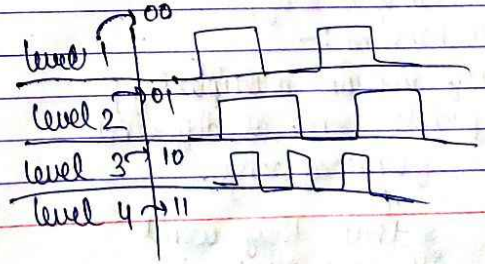
↑ these practically ∞, it is not

Q. consider noisy channel with BW = 3000 Hz with SNR = 3162 (~~3125~~). find max bitrate.

A. max bitrate = $(3000) * \log_2(1 + 3163)$ (~~3126~~)
$= (3000) * \log_2(3163)$ (~~3125~~)
$= 3000 \times 11.6$
$= 34800$ bps
$= 34.8$ Kbps

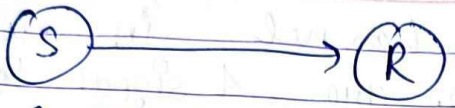
↑ it is dependent on channel speed

→ as data can be send in diff-2 levels.



⇒ $\log_2(4) = 2$
↑ no. of bits required to represent 4 different levels.

WORK :-



Latency : Total time taken ~~from sender~~ for the sender to send the data / for the receiver to receive the data completely.

depends on many things :-

1) propagation delay (t_p)
2) transmission delay (t_t) or (t_d)
3) queueing delay (t_q)
4) processing delay (t_{pd})

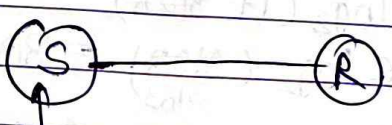
$$\text{Latency} = t_p + t_t + t_q + t_{pd}$$

T_p :- time taken by 1 bit to go from S to R.

$$t_p = \frac{\text{distance b/w S \& R}}{\text{(propagation speed)}}$$

↑ varies from channel to channel.

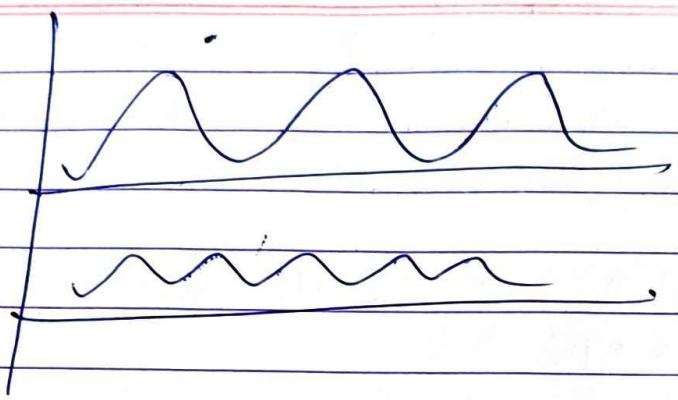
Multiplexing :-



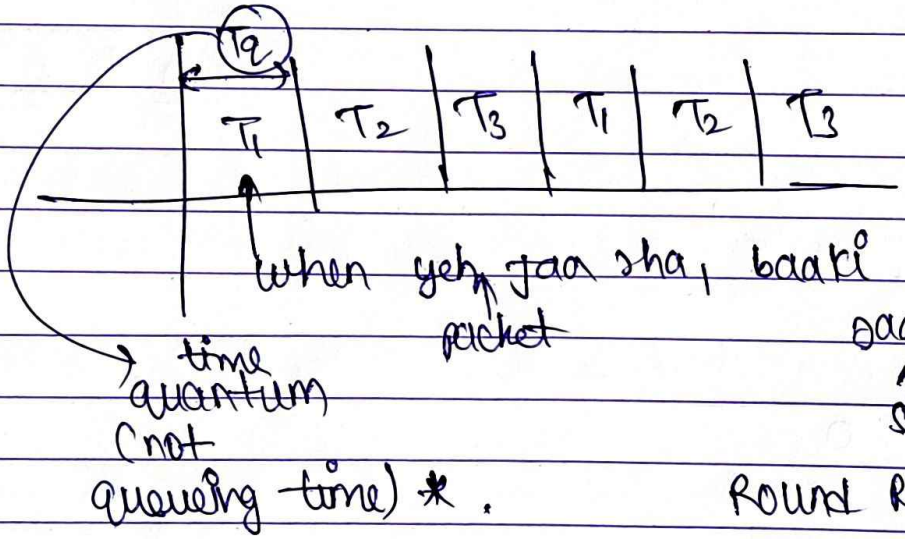
If want to send (simultaneously) multiple packages then can't send them in jumbled way, so need mechanisms :-

(1) FDM (Frequency division multiplexing)
different packets send at different frequency range.
↑ so that they won't interfere with each other.

WDM & DWDM.



(2) Time division multiplexing:-



(3) Wavelength division multiplexing (WDM)

WOMK

24 Jan 2024
wednesday

Lec-6 :-

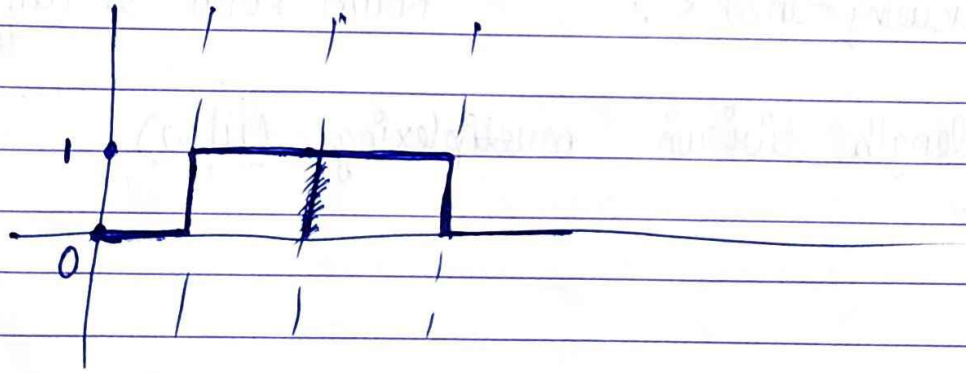
⊙ Data in form of signal, Data, toh conversion toh karni pdhti hai!

Digital to Digital Signal Conversion :-
~~(Encoding)~~ (Line Coding)

→ It is process of converting binary data, sequence of bits to a digital signal.

→ data we represent in 0's & 1's ⇒ known as Binary data.

Eg: 0110 → ko digital signal mein convert krna :-

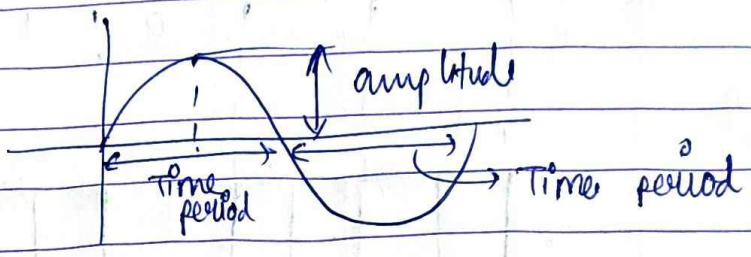


Encoding techniques :- (1) Unipolar → only one used
(2) Polar
(3) Bipolar → +ve, -ve, 0 all are used.

Unipolar :-
Only one voltage level other than '0'.

work is in pdf.

Polar :- Two voltage level other than '0' :-
$+A/2$, $-A/2$.



Bipolar :- Three voltage level :-
+ve, zero, -ve

Why to use Encoding techniques??
Properties of Encoding :-

1. Bandwidth used is reduced.
2. Power is effeciently used.
3. Probability of error is reduced.
4. Error detection and correction capabilities etc...

Unipolar mein signal ko represent karne ke 2 tareeke hote hain :-

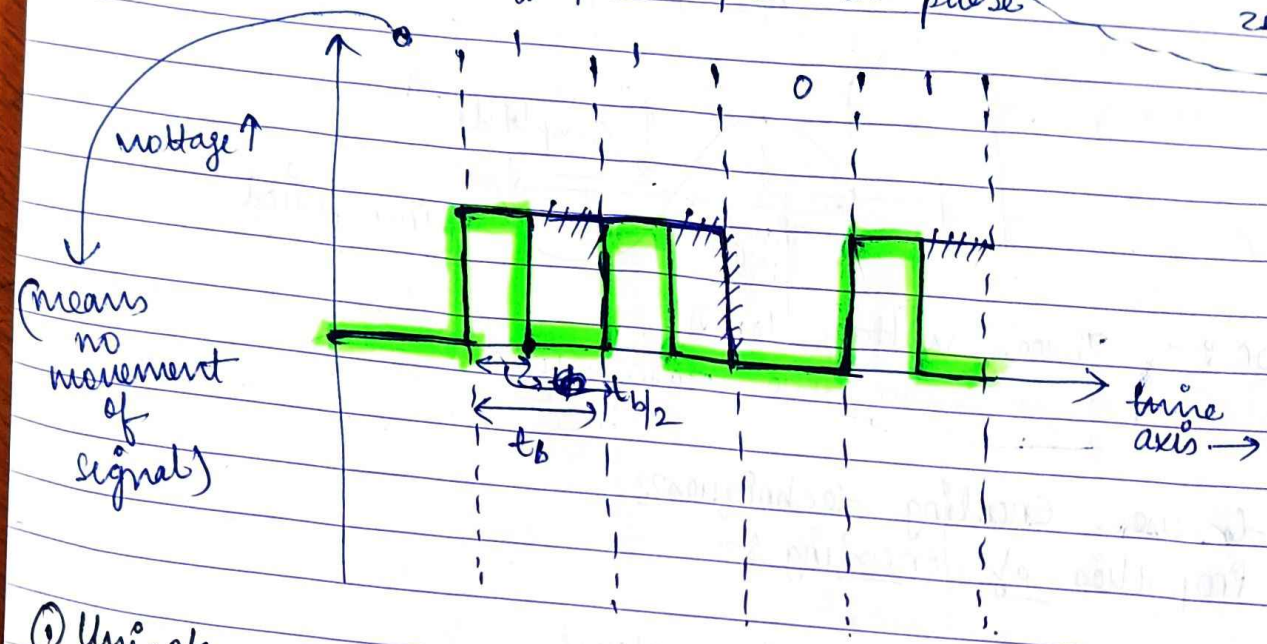
1. RZ (return to zero)
2. NRZ (not return to zero)

NRZ
- NRZ-L
  - 1 → low voltage
  - 0 → high voltage
- NRZ-I
  - 1 → transition happens

WOMK

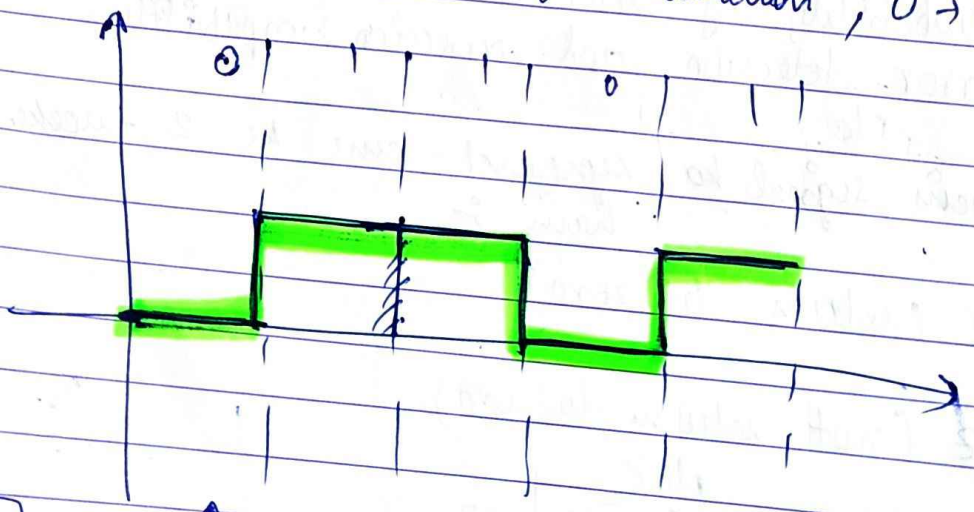
① Unipolar – RZ

↳ 0 → off pulse, 1 – ON pulse for duration $T_b/2$ followed by return to zero

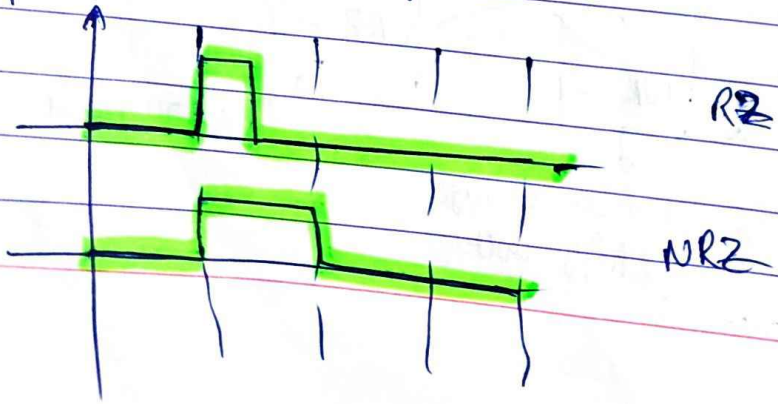


① Unipolar – NRZ

↳ 1 → pulse for full duration, 0 → off pulse.



0100 →

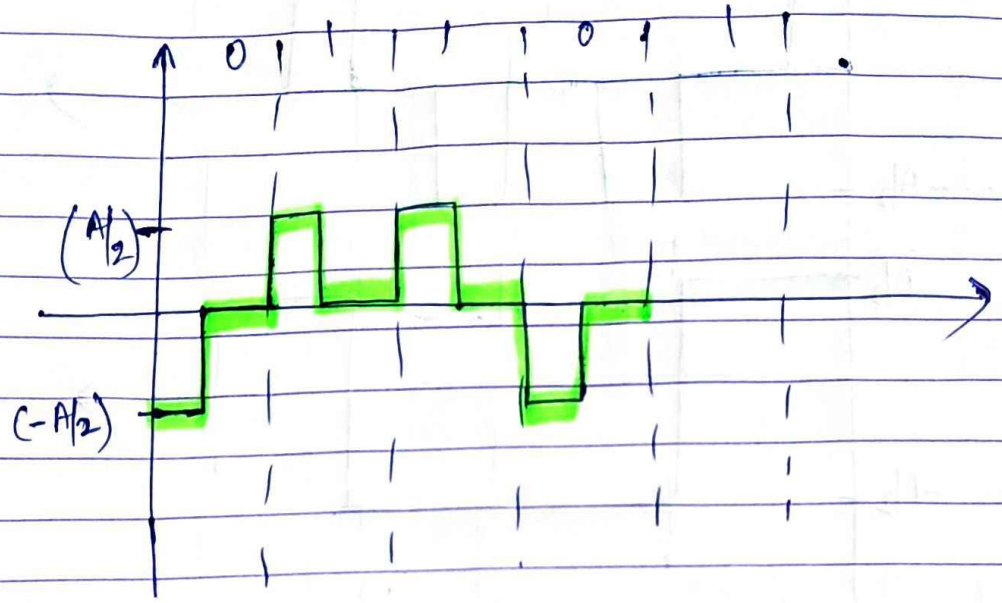


100 MK e
= MM.

④ Polar RZ

0 → $(-\frac{A}{2})$ bit duration $T_b/2$

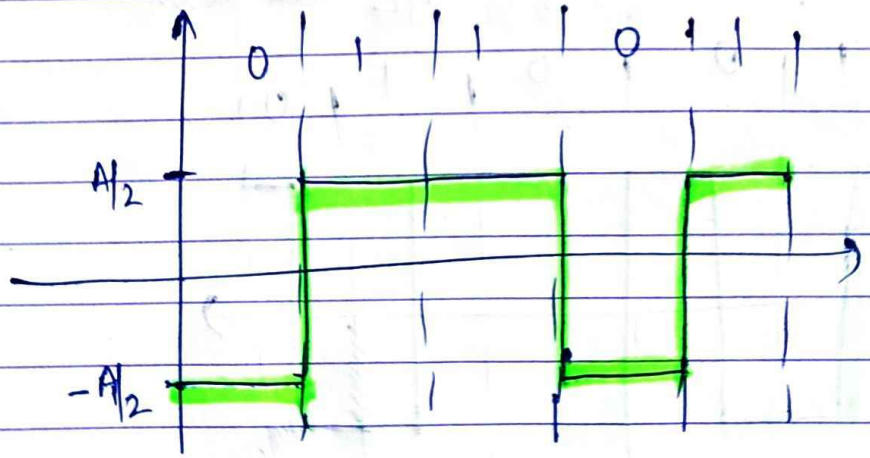
1 → ON pulse for duration $T_b/2 + A/2$ followed by return to zero.

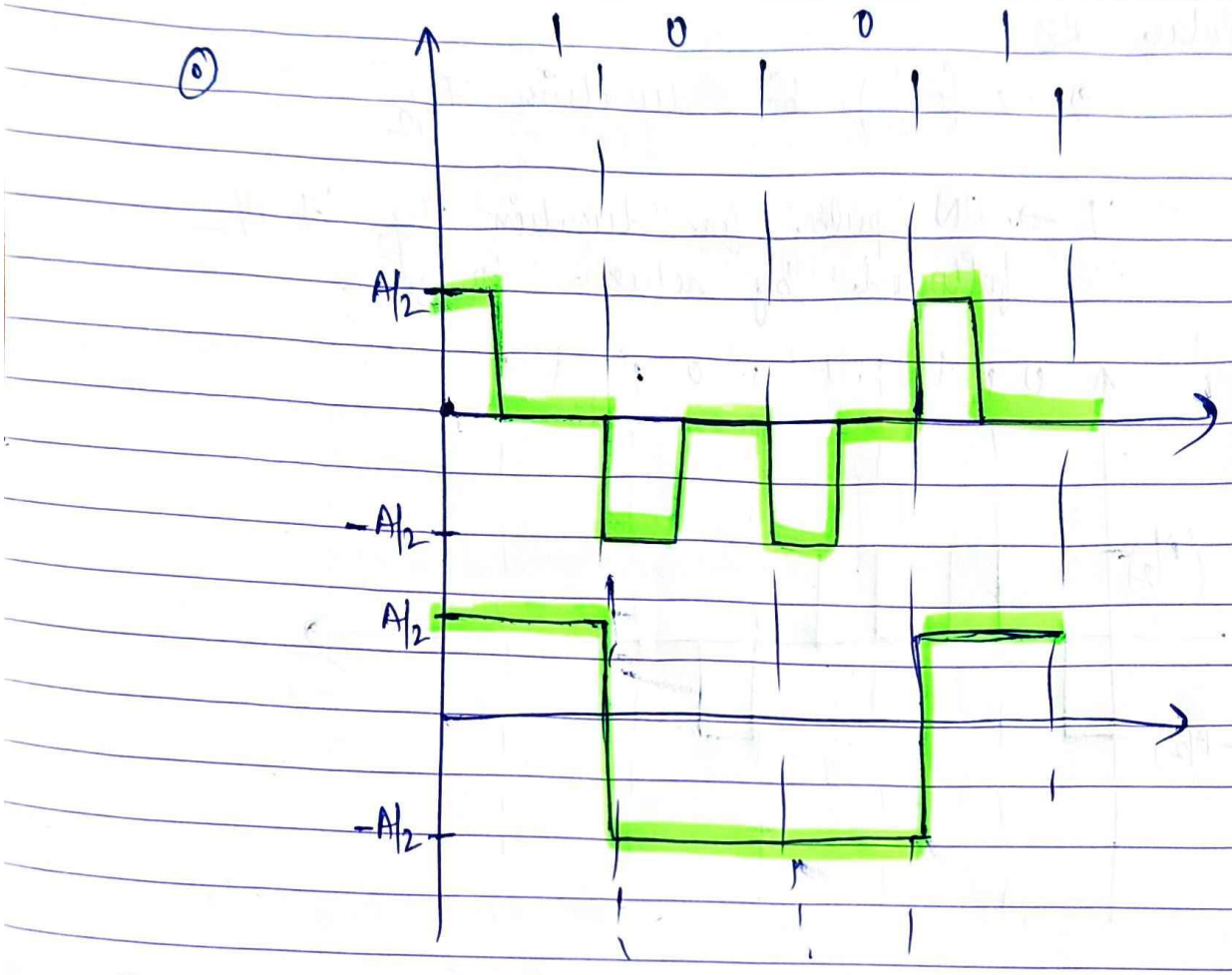


⑤ Polar NRZ

⟹ 1 → pulse for full duration $+A/2$

0 → off pulse $(-A/2)$

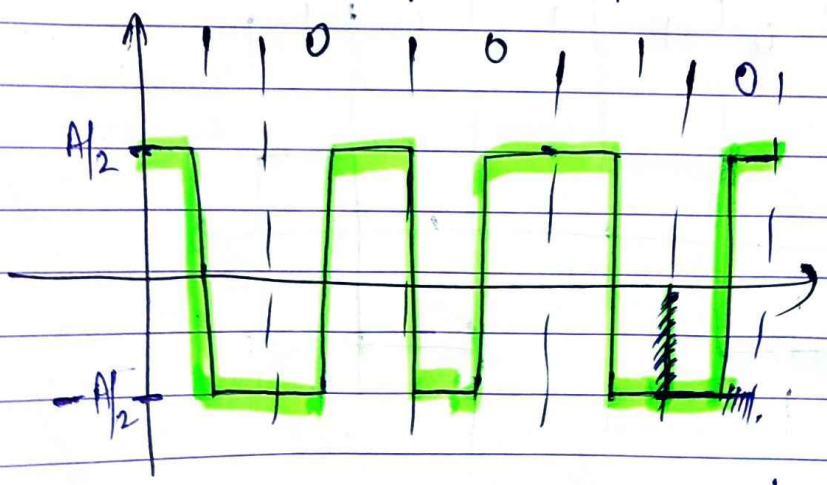


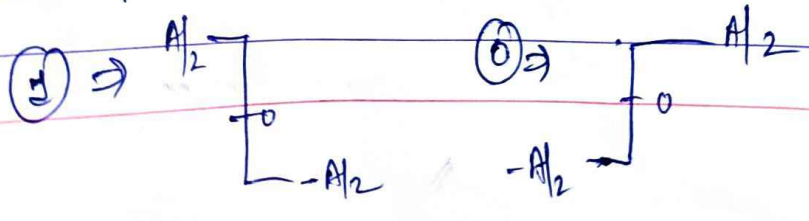


(3) Manchester Encoding :-

0 → -ve to +ve for $t_b/2$ duration

1 → +ve to -ve for $t_b/2$ duration





work is mm.

(4) Differential manchester :- (II)

(I) 0 → -ve to +ve
1 → +ve to -ve

(II) 0 → transition / inverse
1 = no transition.

at starting yeh zero.

then yeh follow kro.

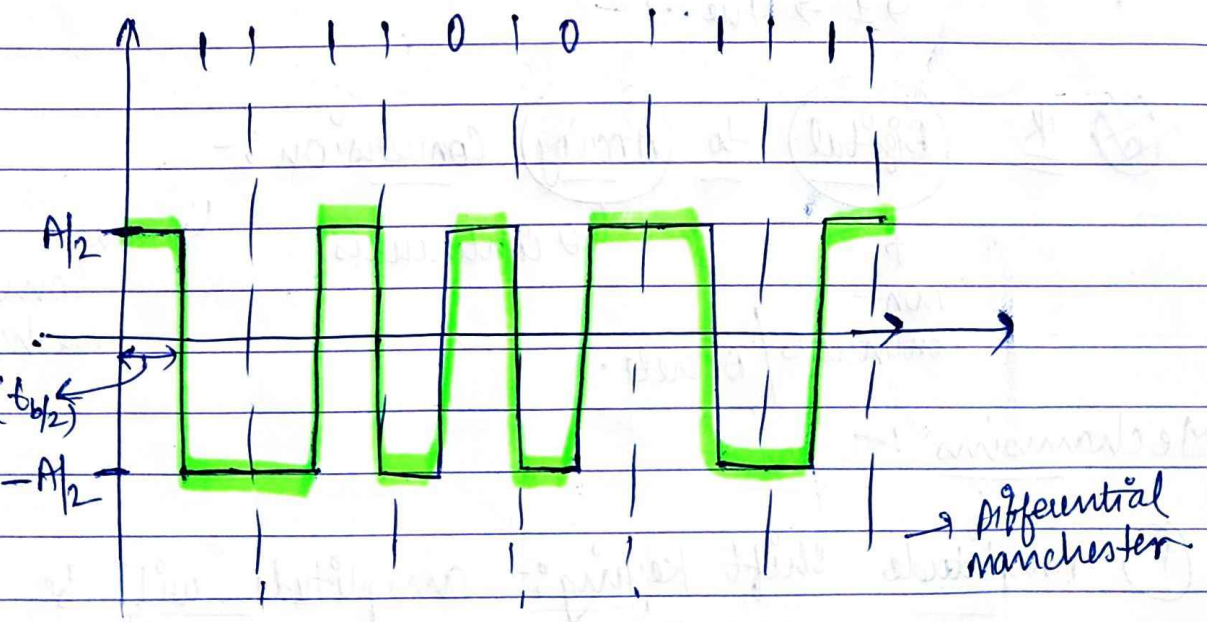
1 | 0 | 0 | | | | 0 |

(A/2)

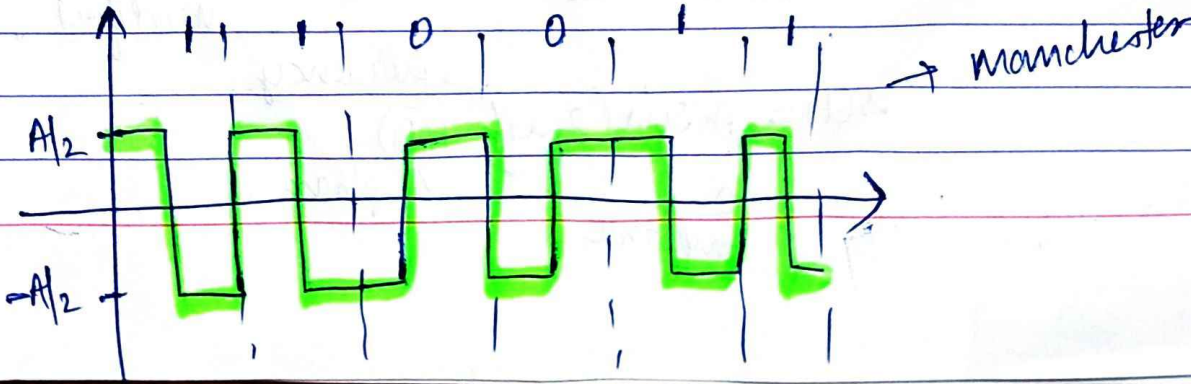
(-A/2)

ismein (I) follow kro

ismein (II) follow kro



→ Differential manchester



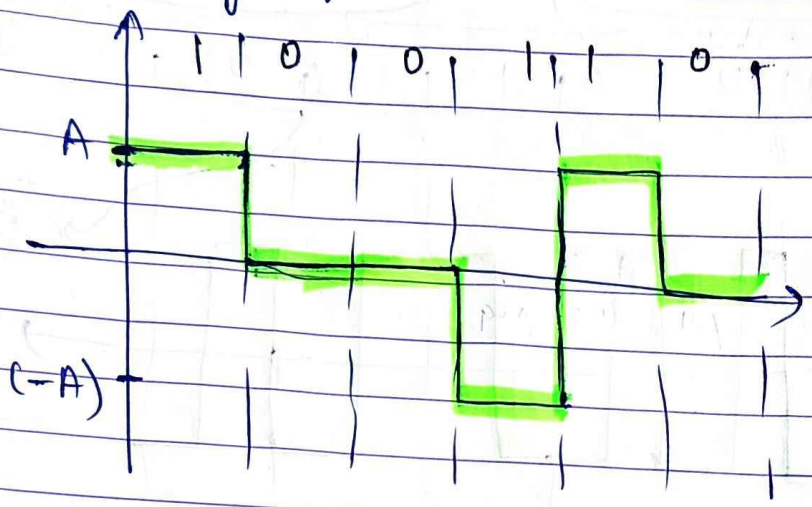
→ manchester

work is from.

(5) Bipolar NRZ

0 → no pulse

successive 1's are represented by pulses with alternating signs → means pehla true, dusra -ve, teesra true.., so on.



Initially → 0 → no pulse
↳ 1 → true.

* Digital to Analog Conversion :-

↳ non-continuous / discrete.

↳ continuous

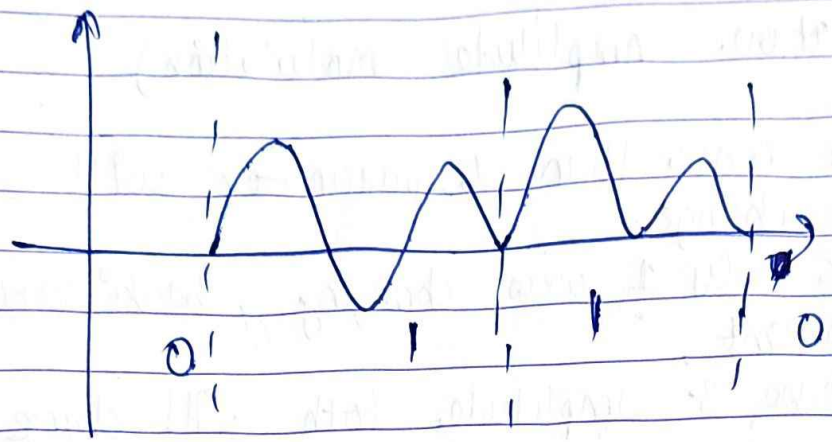
↳ need some mechanism.

Mechanisms :-

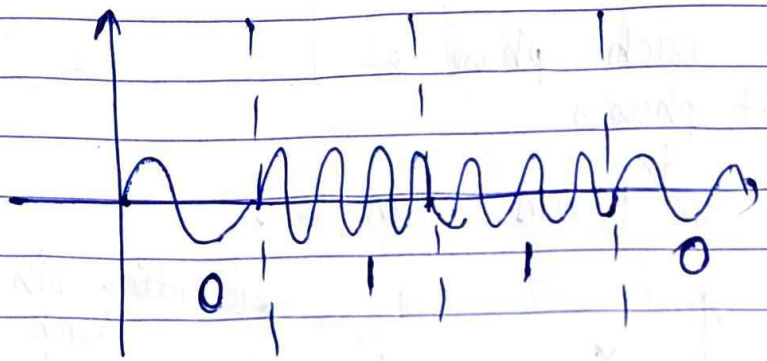
(1) Amplitude shift keying :- amplitude will be modified.

$s(t) = A \sin(2\pi f + \theta)$

A → Amplitude, f → frequency, θ → phase.



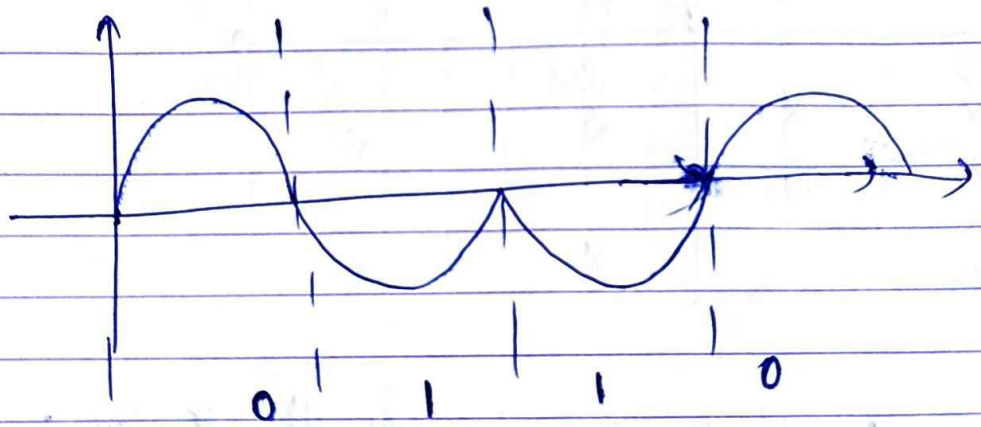
② Frequency shift keying :- set different frequency for 0 & 1.



$s(t) = A\sin(2\omega f + \theta)$

③ Phase shift keying :- (180° shift in phase)

when bit changes



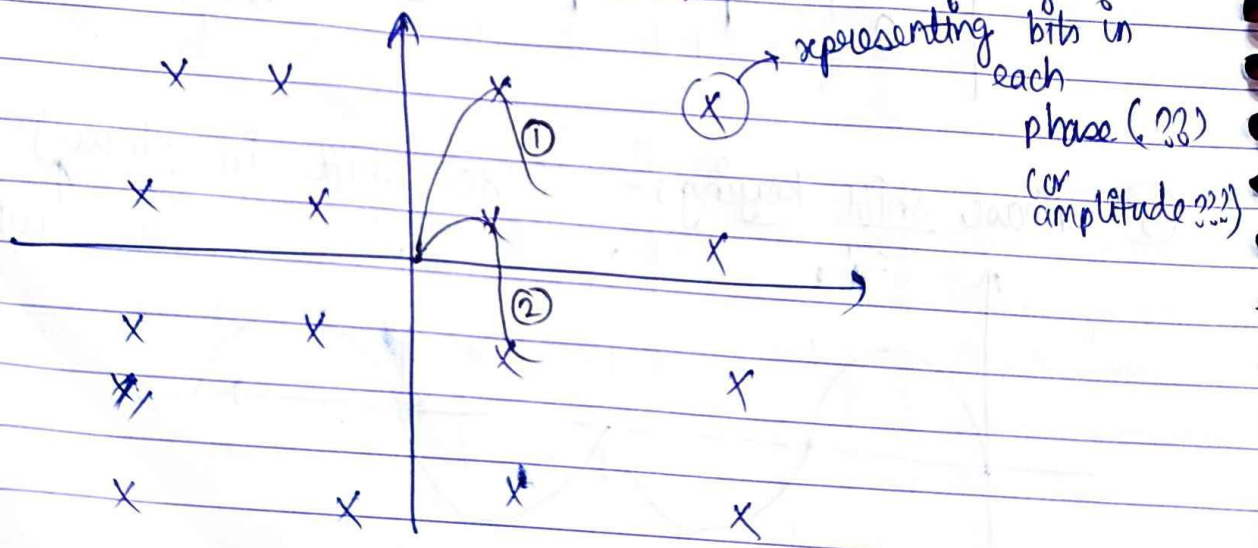
WJMK ಓ ಮ್ಮ.

④ QAM (Quadrature Amplitude modulation)

Here more than 1 parameter will be change,
athi tak only 1 was changing, baaki same constant.
Now, phase & amplitude both will change

4 — QAM (2 bits)
16 — QAM (4 bits)

∴ 4 points in each phase &
4 phases
so 16 QAM example.

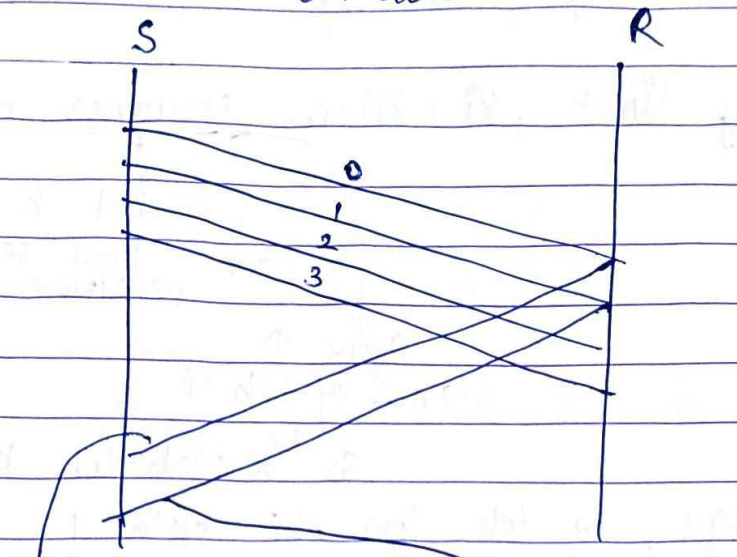


Amplitude can be like ① or ②.

29 Jan 2024
Monday

lec-7 :-

Pipelining :- w/o waiting for acknowledgment, send packets & when " comes, slide the window.



3 2 1 0

(① once in left side, outside window → yet to be transmitted
② window & andar, they are transmitted, but not acknowledged
③ so window & bachan, right mein, they transmitted as well as acknowledged)

acknowledgment came ⇒

4 | 3 2 1 0

these are sequence numbers

5 4 3 2 1 0

pehle in (1+2a)-time sending no. of packet = 1

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

Now, $\eta = \frac{N}{1+2a}$

Now, as in (1+2a)-time, sending no. of packets = N.

What should be size of window?

depends on buffer space's size, sender is having.

Vese toh high hi rkhne ki koshish kreinge!

- Is there any limit, ki kitne sequence no. we can have?

sequence no. → packet k saath dena hota sender ne, receiver ko!

agar ↑ ⇒ no. of bits ↑

so restrict toh krna hoga, oo toh jaa nhi skte!

agar sequence no. <= 9

↑

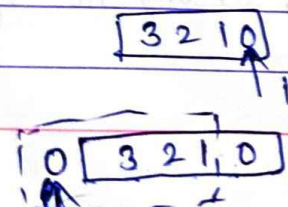
4 bits chahiye hongi

So, $(\log_2 N)$ bits are required to store the sequence numbers.

$\lceil \log_2(1+2a) \rceil$ → min itne bits chahiye to represent sequence no. uniquely!

Let's say sirf → 4 sequence no. hai

0, 1, 2, 3



WIMK:

⊙ All the active packets should have unique sequence number.

⊙ let $T_t = 1$ ms, $T_p = 49.5$ ms, what should be window size?? (W_S)?

→ As want to maximize W_S!

so,

$$W_S = 1 + 2a = 1 + 2\left(\frac{49.5}{1}\right)$$

$$= 1 + 99 = 100$$

unique seq no. required = 100

↑ for that $\lceil \log_2(100) \rceil$ bits chahiye

$= 7$ bits

↑ this is when assuming, $\eta = 100\%$

But say instead of η, no. of bits req. for sequence no is given = 6 (say)

↑ $2^6 = 64$ ← sequence no. can have

~~so, $\eta = 64$~~

so, in $(1+2a)$ times, packets can send = 64

But actually, 100 bhej skte the!

so,

$$\eta = \frac{64}{100} = 64\%$$

so,

$$W_S = \min(1+2a, 2^N)$$

↑ N = ~~total~~ bits req. for sequence no. representation

WJMK :)

① SLIDING WINDOW PROTOCOL :→

- GO-BACK-N
- Selective Repeat

Go-back-N (GB-N) :→

(1) Sender Window size is N > 1

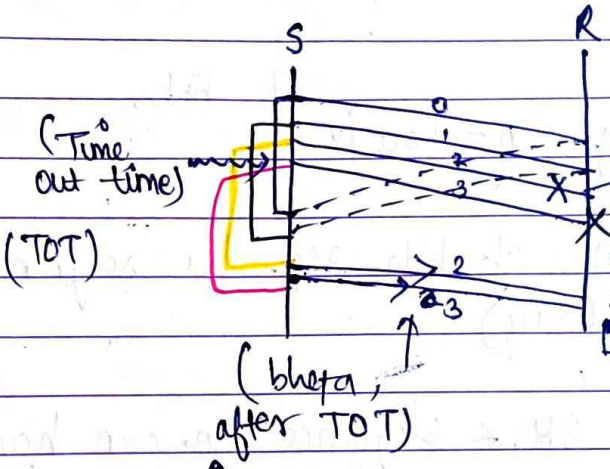
↑ means ek se jyada packet bhej raha hai bt acknowledgement.

(2) Receiver window size is 1

↑ R can't buffer more than 1

GB-4 :-

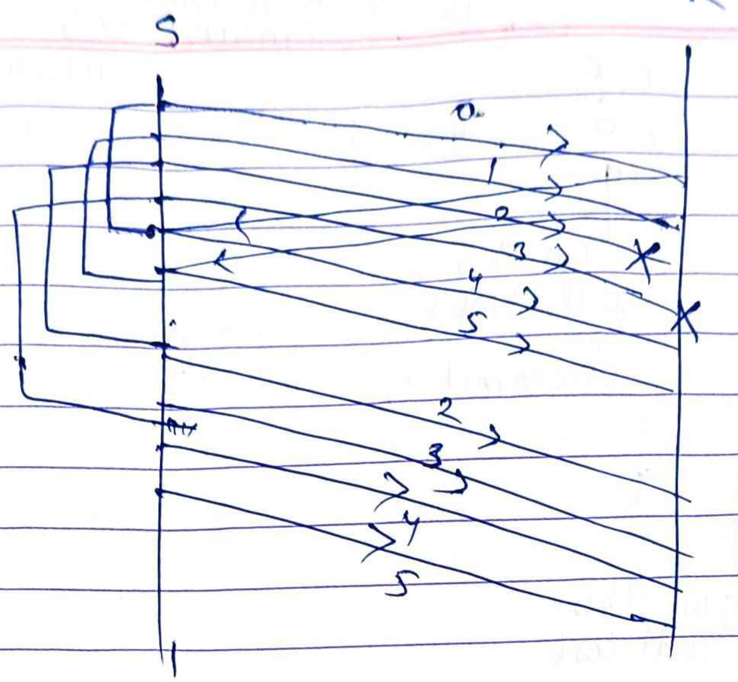
Sender window size = 4.

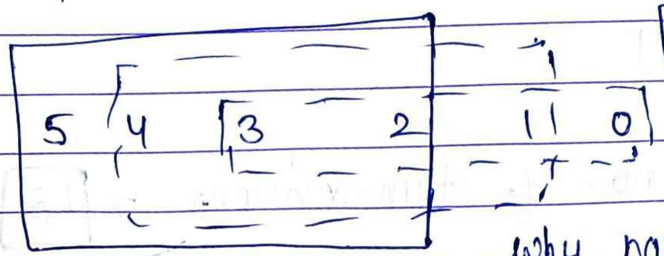


In GB-N, out of order packet is not accepted!

↑ means jo expect nahi kiya, agar wo mila ← it will discard

WJMK ?!

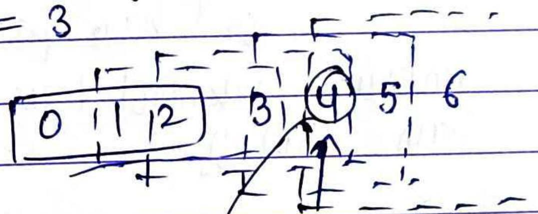




why name, go back N ??

Q. GB 3 :- Every 5th packet transmitted is lost, and we have 10 packets to send.
Then how many transmissions are required ??

A. $W_S = 3$



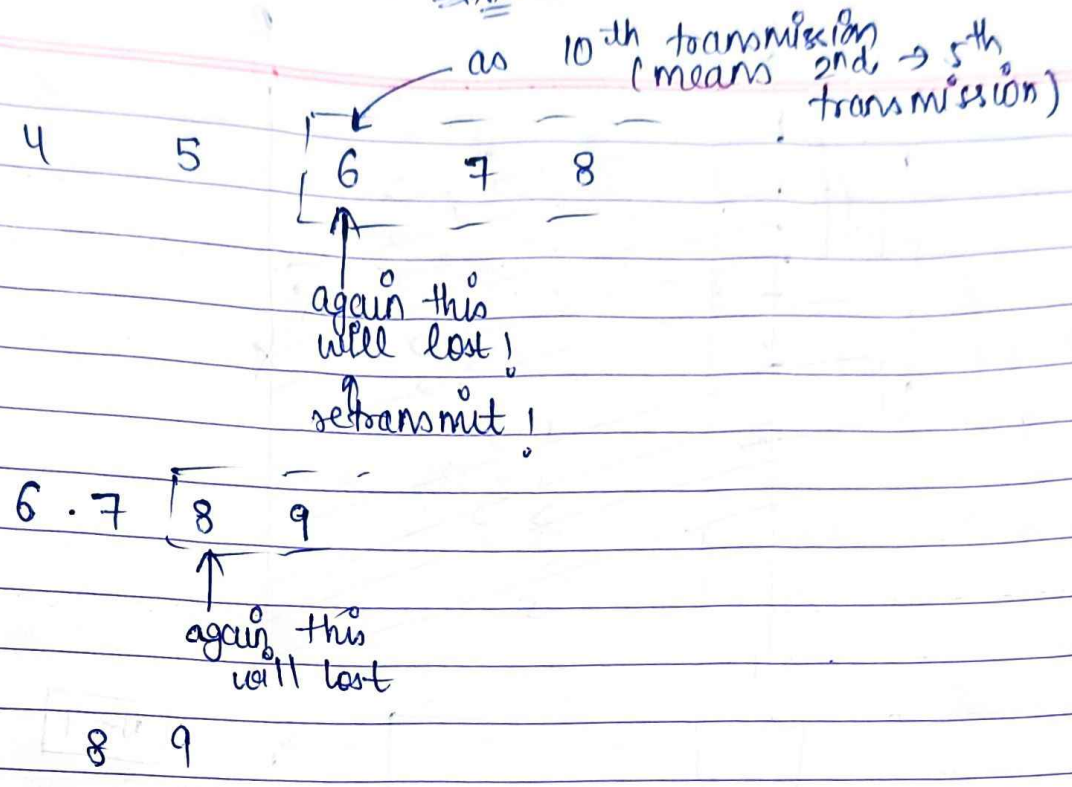
successfully snd ghaan tak & acknowledgement bhi milti rahi !

→ but yeh lost huya, acknowledgement nahi mili! ← so window slide nahi hogi.

and after some ~~time~~, TOT will exhaust ←

so will retransmit (4), (5) & (6)

WSWK = 5 ms.



So, total no. of transmissions = 18

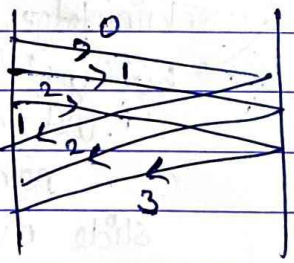
→ So far, we have Independent acknowledgements !! in medium

ant of traffic ↑ will be high !!

as ↑ have packet ki unique acknowledgement bhej rahe hain Am !!

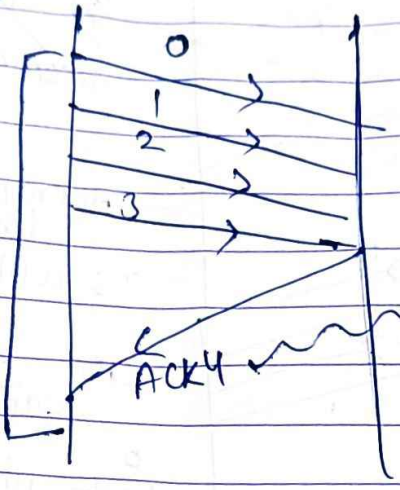
Acknowledgement :-

Independent :-



Work in progress.

Cumulative :-



⇒ for 4 packet sending only 1 acknowledgment ↑ traffic kam!

This cumulative acknowledgement is support in Go-back-N protocol.

So, now,
R can send 1 acknowledgement for multiple packets.

what how long to wait ⅔ to acknowledgement group of packets?

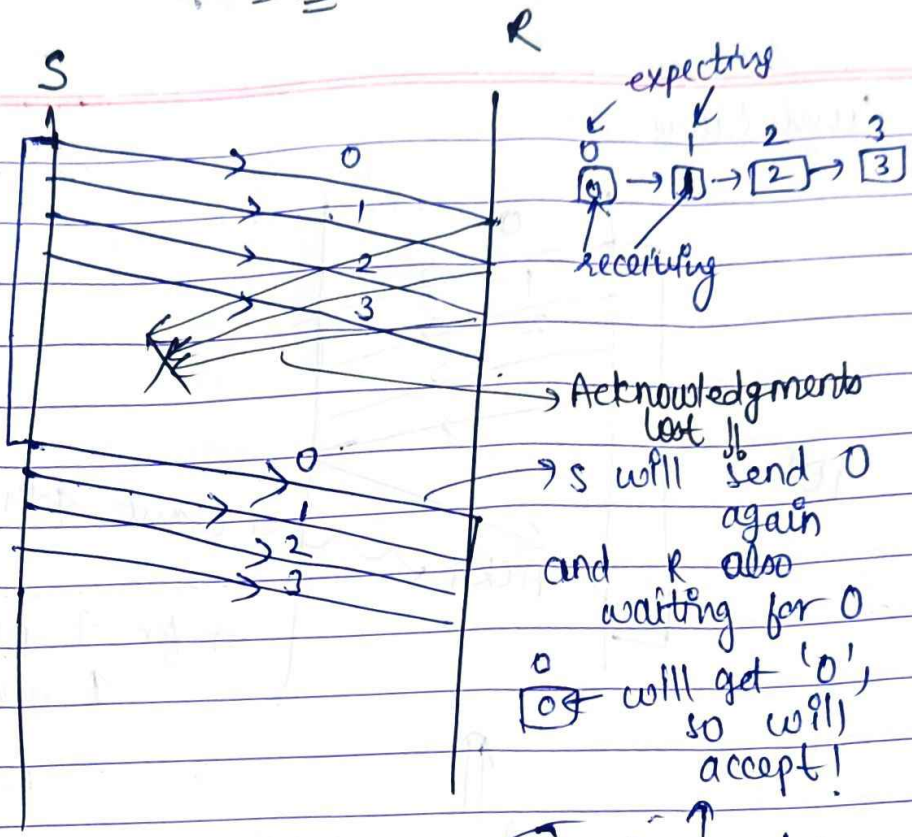
→ If very less ← fir toh independent wala kaam hi hogya.
→ If very ↑ ← toh S wali side TOT hoga ← If it will exhaust or expire ← toh wo aur bhejne lg jayega!

So ek TOT chahiye R ki side that should not be very small, but also < TOT of S.
So, $(TOT)_S$ > Acknowledgement Timer.

WSMK e 3rd

GB-4 :-

3 2 1 0



Yeh sms kr ki purana packet nahi hai ← but wo toh duplicate hi tha!!

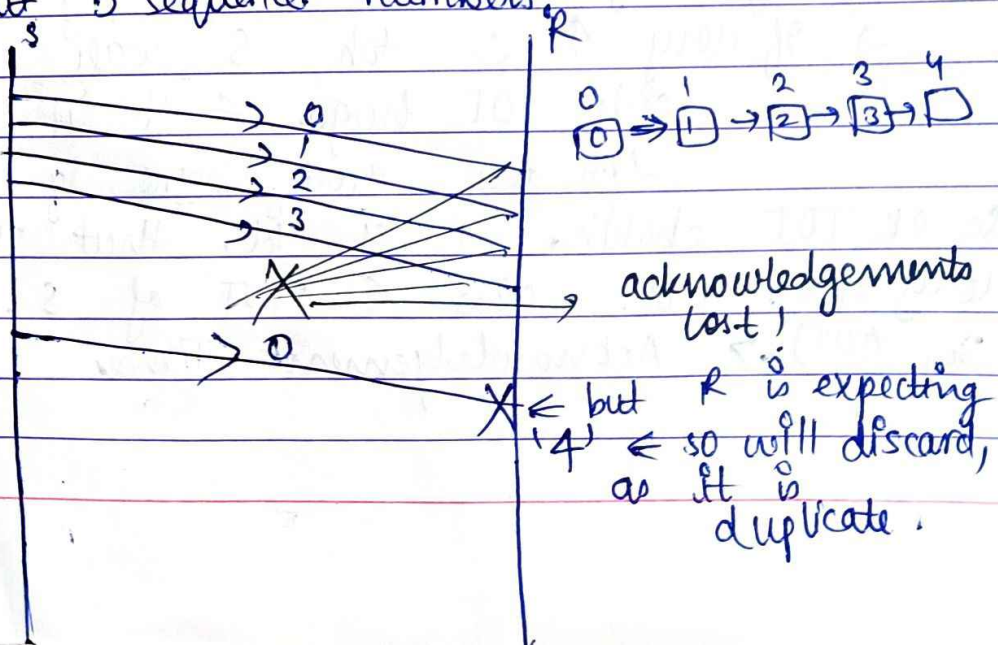
So, R ~~to~~ is unable to identify ~~that~~ ki wo duplicate packet hai!

4 seq no & window size also 4.

Let's say :

ws = 4

but 5 sequence numbers

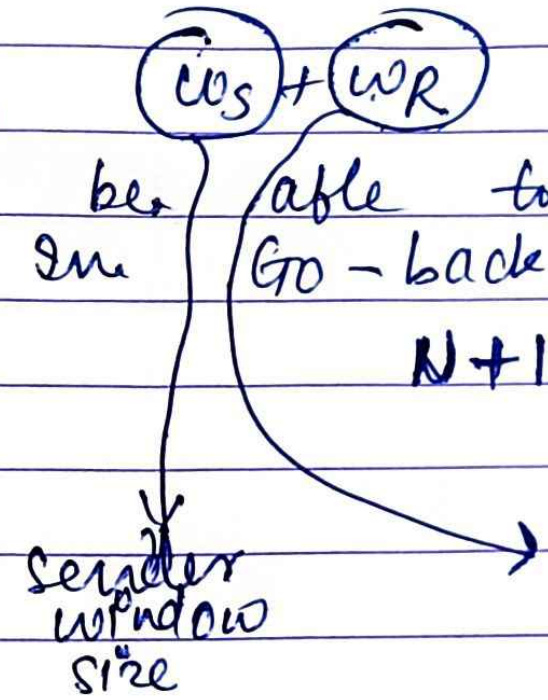


WORK IS DONE.

So, If Sender WS = 4
and Receiver WS = 1
then, 5 sequence no. chahibe for R to be able to identify any duplicate!

so, $(WS) + (WR)$ sequence no. chahibe for R to be able to identify any duplicate.

so on GO-back-N,
N+1 sequence no. chahibe!



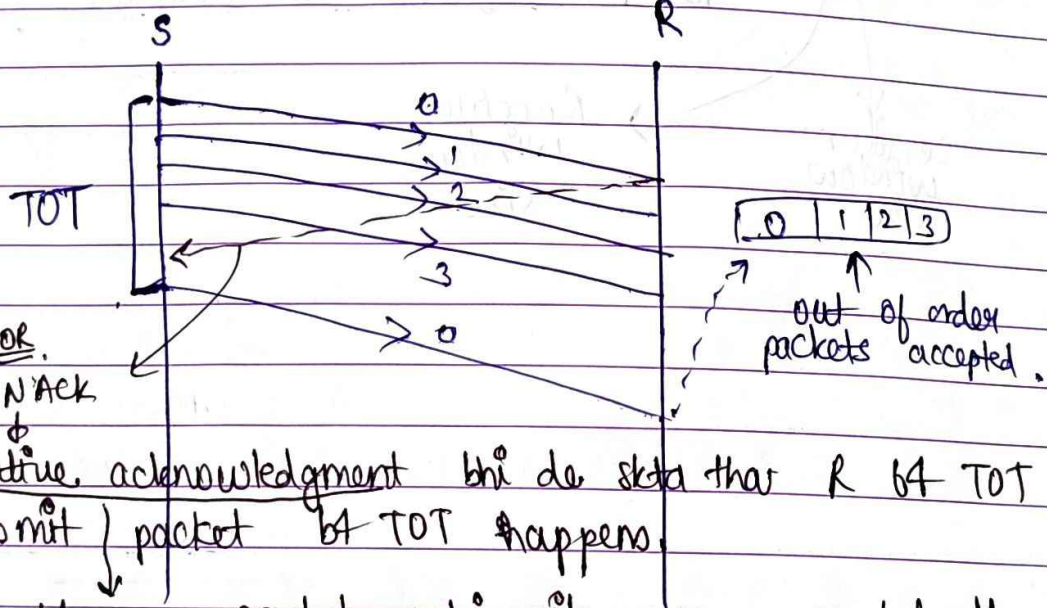
WOMK

5 Feb 2023
Monday

lec-8

Selective Repeate :- (SR protocol)

- $W_S > 1$ (can send multiple packets bt receiving acknowledgment)
- $W_R = W_S$



negative acknowledgment bhi de skta that R bt TOT to retransmit packet bt TOT happens.

btaayega packet nahi mila yaa corrupted, tha yaa duplicate packet.

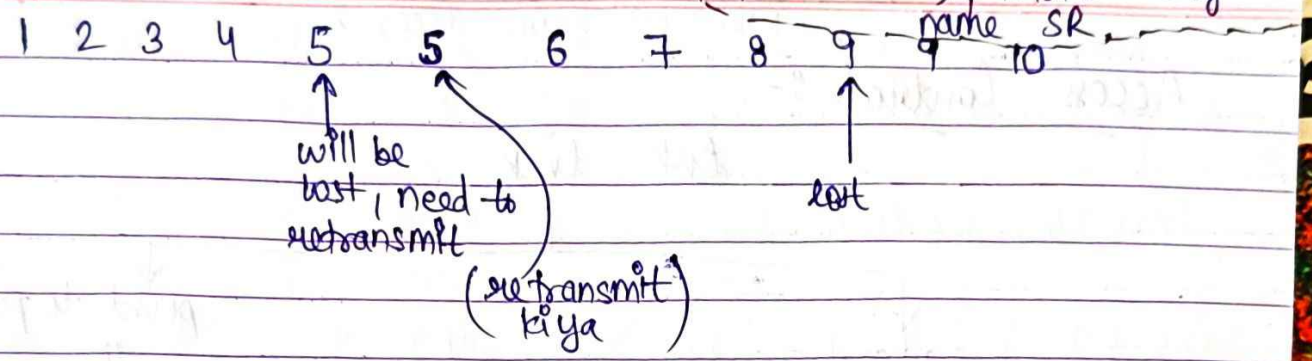
nahi-toh TOT se baad toh S bhejega hi pehle $W_R = 1$ → so if expecting for '0' & na mila, toh uske baad wale like '1', unko discard kr deta hai!

But now as $W_R > 1$ → so R can accept out of order packet.

Q. $W_S = 3$, Total 10 packets, every 5th packet is lost. How many transmissions are required according to SR protocol.

WORK is same.

⊙ In SR → jo packet lost, sirf wo hi selectively retransmit hoga (not set of packet, like in Go-back-N), that's why name SR.



so, Total '12' transmissions.

⊙ SR is somehow similar to sliding window Protocol → as wo hi retransmit kr rahe, jo lost.

⊙ In SR, Acknowledgement is Independent, means har packet ki alag se " bhejo, as out of order packet bhi accept kr raha hai toh cummulative acknowledgement se toh dikkat ho jayegi! pta hi nahi chlega konsa accept kiya, konsa gya hi nahi.

⊙ SR supports concept of Negative acknowledgement as well.

Comparison: (→ how much buffer seq. to store packets (seq both side))

	Stop & wait	GBN	SR
Efficiency	$\frac{1}{1+2a}$	$\frac{N}{1+2a}$	$\frac{N}{1+2a}$
Buffer req.	S→1 + 1 ←R	N+1	N+N
Seq. no. (wst, wR)	2	N+1	2N
retransmission	1	N	1
Band Width (sending N packets, agar ek bhi lost, pura (N) phir se)	low (as transmitting only 1 packet, waiting for only 1 ACK)	high	Moderate

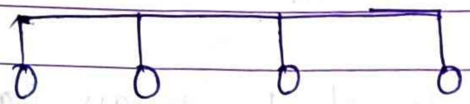
WJMK [illegible]

→ who will have access?

Access Control :-

link

- Broadcast link
  - ↓ link shared by different -2 computers



need to access control mechanism o/w collision of msg can happen

↓

(M-1) Round Robin Method.

→ give turns to transmit msgs.

→ so divide time slice & sbko time quantum do.

So give time slot to every one.

↑ usmein S transmit kr ske msg, wo propagate krke destination tak pahunch ske!

So, $T_{slot} = T_t + T_p$

In $T_t + T_p$ time, doing T_t useful work. so $\eta = \frac{T_t}{T_t + T_p}$

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

where, $a = T_p / T_t$.

- point-to-point

Direct connection

accessing link very easy. (eg. full duplex).

WJMK ☺

prblm :- ① koi msg bhejna hi nahi chahta, so some of Tslot may get waste.

(M-2) Polling :- jo want to access medium, must raise request.

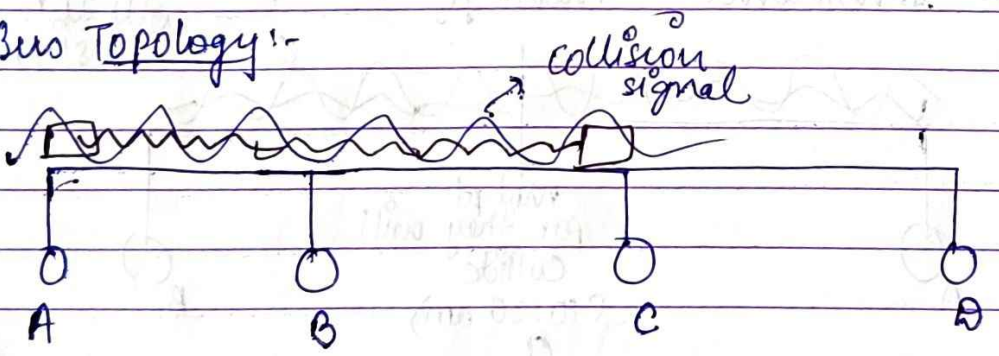
in Tpoll duration → all who want to transmit msg will raise request, then can send msgs.

| Tpoll | Tt + Tp | Tt + Tp | . . . |

(M-3) CSMA / CP (Carrier Sense Multiple Access / Collission Detection) :-

↑ very popularly used, even in Ethernet.

Bus Topology :-



If sender wants to send msg, first it must sense carrier / medium / channel → agar free toh bhejdo, nahi toh ruko.

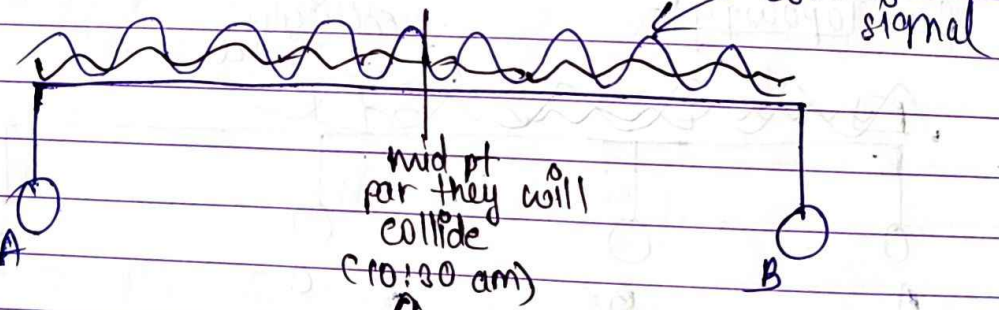
A ne sense kiya channel & found that it is free & place kiya apna data, let's say same time par C ne bhi dekha tha channel → free tha → usne bhi apna packet bheja...

packets will move & will collide → some collision signal will generate ⇒ A & C dekhenge

WIMC Imp.

→ unhe lgega mera chla gya, yeh kisi aur ka hoga, when retransmit nahi krunga.
→ F no concept of ACK (neither +ve nor -ve) in CSMA/CP.

⊙ when A, C will agree that our packet is corrupted ??
↳ when jab wo transmit kar hi raha tha, tabhi collision signal mile usko !!
↳ as tabhi use lgega ki mera msg bhi corrupt huya hoga
--- as esse toh collision signal aate hi rhenge time to time.
↳ so yeh constraint must !!



Say 10 am pe A, B dono ne msg bheja.
T_p = 1 hour

then collision signal, 30 min baad A, B tak paunchega!
↓
means at 11 am
tabhi A, B still must be transmitting msg, only then can detect ki haan mera msg corrupt huya.

So, $T_t > 1$ hour
$\Rightarrow T_t > T_p$

WJMK

Worst Case ⟹

A → 10 am pe msg bheja

① 10:59:59 pe collision ho gya!!

↑

B ke paas toh collision signal jaldi paunch jaayega, but A tak paunchne mein 1 hour lega → 12 noon.

So,

$T_t > 2T_p$

↑

Then can detect any collision, chahe kaise bhi situation ho!

What should be packet length?

$T_t > 2T_p$

$\frac{L}{B} > 2T_p$

$L > 2(T_p)(B)$

So,

$L_{min} = 2(T_p)(B)$

↑

in CSMA/CD or Ethernet to detect collision

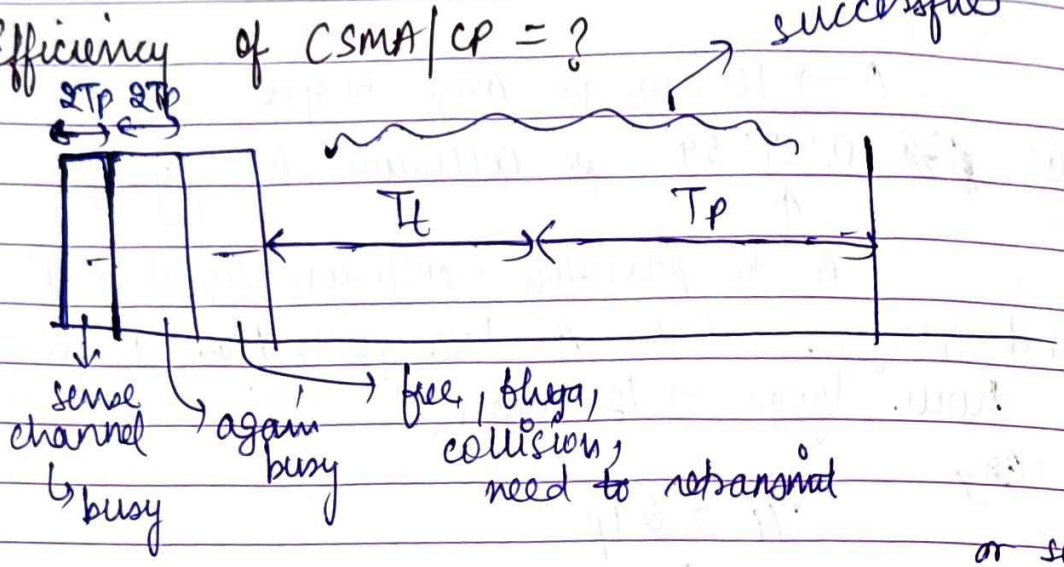
② what if $(2)(T_p)(B)$

↑

Itna bdha data nahi hai to send?

then need to do padding, need to add extra bits.

Efficiency of CSMA/CP = ?



① B4 successful transmission, there is set of failure transmissions.

2Tp → time consumed by 1 failure attempt
at total 'c' failure attempts.

Tt + Tp ← successful attempt.

$$\eta = \frac{Tt}{(c)(2)(Tp) + Tt + Tp}$$

Chahiche sirf Itna time tha to snd 1 pkt.
Bija Itna !!

(1) There are 'n' stations connected in a channel.
(2) Every station wants to snd packet with probability 'p'.
(3) probability of success is when 1 station only transmit the data.

$P_{success} = ({}^{n}C_{1})(p)(1-p)^{n-1}$

koi ek bheje data

WORK & HOME.

① max $P_{success}$ when $p = \frac{1}{n}$.

$$P_{max} = (P_{success})_{max} = ({}^{n}C_1)\left(\frac{1}{n}\right)\left(1-\frac{1}{n}\right)^{n-1}$$

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

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

If $n \to \infty$ (very large no. of stations in channel)

$\Rightarrow$ ~~P_{succ}~~ $\frac{1}{n} \to 0$

then, $P_{\substack{max \\ n\to\infty}} = \lim_{n\to\infty}\left(1-\frac{1}{n}\right)^{n-1} = \frac{1}{e}$

No. of times a host should try b4 success $= \frac{1}{p}$

$= e$.

So, $c = e$.

$\Rightarrow$

$$\eta = \frac{T_t}{(e)(2)(T_p) + T_t + T_p}$$

$$= \frac{1}{1+(6.44)(a)}, \quad a = T_p/T_t$$

$$= \frac{1}{1+6.44\left(\frac{d}{V}\right)\left(\frac{B}{L}\right)}$$

If $d \uparrow_s \Rightarrow \eta \downarrow_s$

$L \uparrow_s \Rightarrow \eta \uparrow_s$

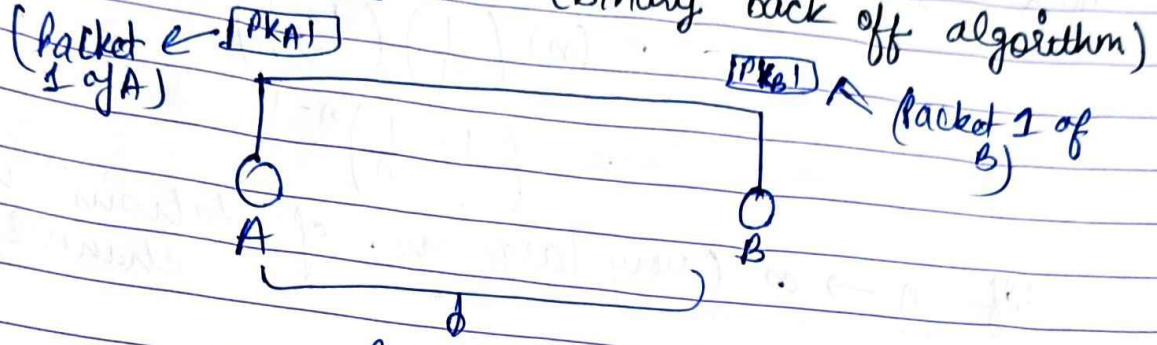
↳ so $d \uparrow, L \downarrow \Rightarrow$ so classical LAN / Ethernet k liye suitable !!

7 Feb, 2023
Wednesday

WMK 3

[Lec-9] :-

Back off algorithm :- (Binary back off algorithm)



Both interested in sending msg → dono dekhenge free → will send → collision will happen, collision signal paunchega dono ke pass

↑ pta chalega collision ho gya

so both will wait for some time

n = how many concurrently packet has been involved in ~~transmission~~ collision, means how many times transmission failed

here n = 1

so, $(0, 2^n - 1) = (0, 2^0) = (0, 1)$

so can wait for time which is multiple of 0 or 1.

$T_A = m * T_{slot}$

$T_B = m * T_{slot}$

m → can chose 0 or 1.

WIMK & Som.

A	B
0	0 → so again retransmit Msg at same time, thus collision!!
0 ←	1 ← $T_B = T_{slot}$ → A wins!
$T_A = 0$	0 → B wins
waiting time of A = 0	1 → collision.

so T_A will capture the channel.

so A will be able to transmit its msg.

Probability that A will win = P(A) = 1/4

P(B) = 1/4

P(collision) = P(C) = 2/4 = 1/2

Let assume → A successfully transmitted the msg.

A	B
0	(1) → so B dekhega Tslot ka baad → busy milega usko!

so B fails 2 times.

A wants to transmit 2nd packet.

← so A ka 1st attempt fail, B ka 2nd.

WORK @ IIT-DM.

so, A → $(0, 2^1 - 1) = (0, 1)$

B → $(0, 2^2 - 1) = (0, 3)$

A	B	
0	0	→ ~~A wins~~ Collision
0	1	→ A wins
0	2	→ A wins
0	3	→ A wins

so A will transmit 2nd packet also.

A	B	
1	0	→ B wins
1	1	→ collision
1	2	→ A wins
1	3	→ A wins

So, P(A) → very high (5/8)
P(B) → very low (1/8)
P(C) = 2/8

→ So higher chance that A will win again
↳ then A = (0, 1) } → again A ke
3rd attempt B = (0, 7) } jeetne ki prob. ↑.

Go with back off algo ⇒ collision chances ↓↓ →
but high prob. ki ek bhejta rahega,
dusra wait karta rahega

↑
Capture Effect
↑

jisne ek baar channel ko capture kr liya, ↑ higher probability ki aage bhi wohi channel ko capture kre!

↑

but collision prob. ↑↑↑
↑ yeh chahiye, but capture effect ☺

Aloha

↓ Pure
↑
allow any device to transmit msg at any time
Agar collision, toh wait for some time & then retransmit.

↓ slotted
↑
slot ↑ ke starting mein only can send

time

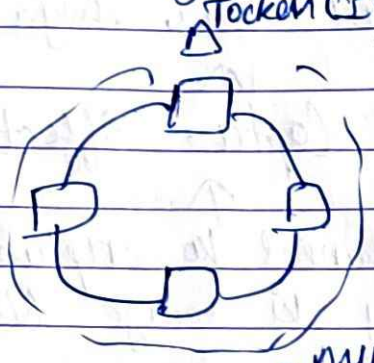
⑥ next Access Control Protocol :- TOCKEN PASSING :-

special packet passed or circulated among host in channel in ring.

→ we use Ring Topology.

WORK FROM HOME.

and jo host holds the tocket → that host can transmit msg in the channel.



much

Ring latency = how time single bit to Circulate complete ring once.

depends on length of ring & velocity at which tocken / bit is revolving

bit latency

$$\text{Ring latency} = \frac{d}{v} + N * b$$

N stations

- every host will hold (bit), process it & will release that time → bit latency

Tocken for constant Time ll TRT

b → how much time a bit takes to pass unit distance.

(N * b) → is in bits time → to make unit uniform

but $\frac{d}{v}$ ——

→ divide this by BW

WBMKE

so finally ⇒

$$\text{Ring latency} = \frac{d}{v} + \frac{N * b}{BW}$$

$$\text{Cycle time} = \frac{d}{v} + N * \underbrace{THT}_{\text{Token holding time}}$$

Useful time = time when u r transmitting some data packet.

$$= T_t * N$$

↑ transmission time of host

↳ and host can send msg only when Token to us pass.

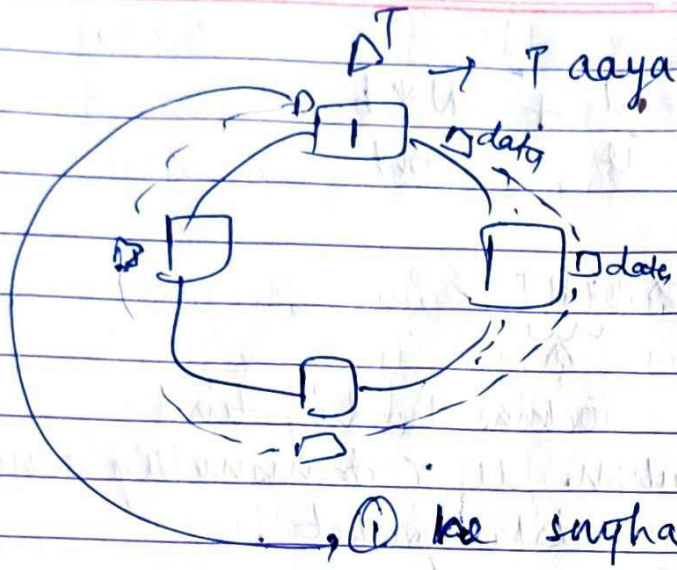
$$\eta = \frac{N * T_t}{\text{Total cycle time}} \quad (\text{useful time})$$

$$= \frac{N * T_t}{\frac{d}{v} + N * THT}$$

- how we can pass the token ??
  - ↳ strategies :-
    1. delayed Token reinsertion
    2. Early Token reinsertion.

① ⇒ will delay the reinsertion of Token in Ring

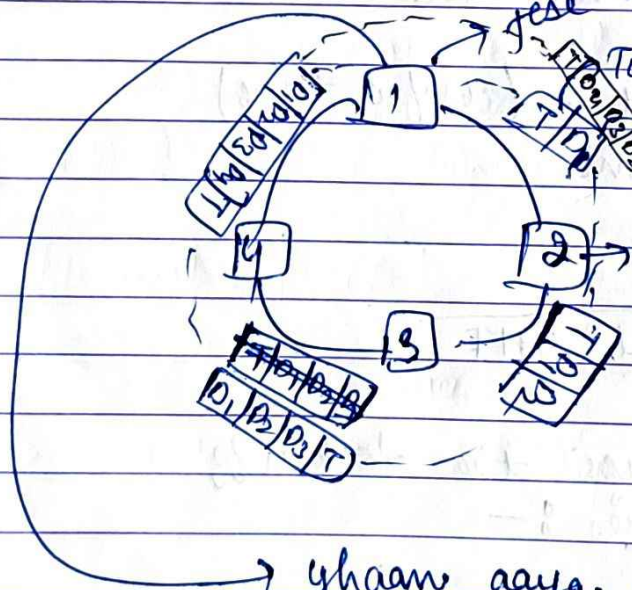
WJMK ☺



T aaya 1 ne liya → kuchh time rkha → data bheja → token choda!

① ke sath data vaapis aa gya → means jisko milna tha mil gya → will release the token after deleting data from channel.

② Early token generation :-



Jese hi data bheja, token bhi immediately release kedega!

2 ne apna data daala & Token release kiya.

→ yhaan aaya → 1 ne dekha D_1 aaya → will remove its D_1 data from channel.

$D_2 | D_3 | D_4 | T$ → jaayega 2 ke paas! 4 will remove D_2.

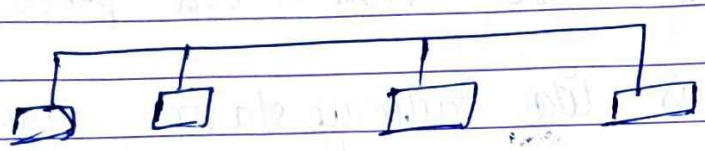
D_4 will released by 4 and sof. T bchega!

WOMK & SOM.

so, its responsibility of sender only to release its data, others are not allowed to do this!

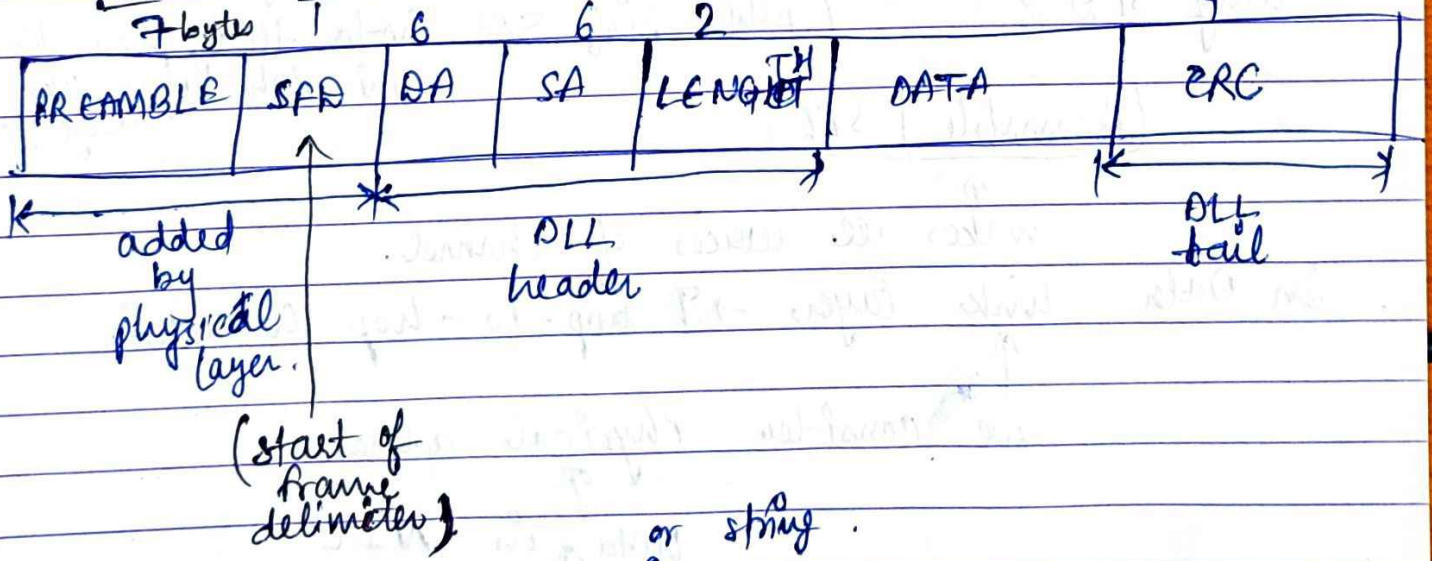
⊙ ETHERNET / LAN TECHNOLOGY / IEEE 802.3 :-

Topology :- Bus



new device → wire to → connect krn with channel!

- Access control :- CSMA/CD
  ↳ Ismein bhi no acknowledgement.
- NO acknowledgement
- How ETHERNET FRAME looks like :-



Preamble :- contains series of :- 1 0 1 0 1 0 . . . 1 0 or string.
yeh honge 56 bits (7 bytes)

WORK FROM HOME

SFD :- 10101011

↑
Similar to preamble, bs ends with '1'.

- channel mein hmesha data hota, agar devices har vaar usse new data samjhte rhein and active rhein → toh problem.

Preamble → is like railway station sound announcement of new train wakes up me & all passengers then may be relevant (accept) or irrelevant (then ignore).

Why SFD ?? (pehle sirf SFD hota tha, preamble nahi, toh kyun leke aaye ??)

Preamble	SFD

↑ wakes all devices of channel.

In Data link layer → J hop-to-hop connection

↑ we consider Physical address

↑ hota ↑ in NIC stored

DA → hard coded 6 byte address

destination address,

Similarly SA (source address) hota.

WORK ~~IS~~ IN.

→ agar ek hi host ko msg bhejna, toh UNICAST address do!

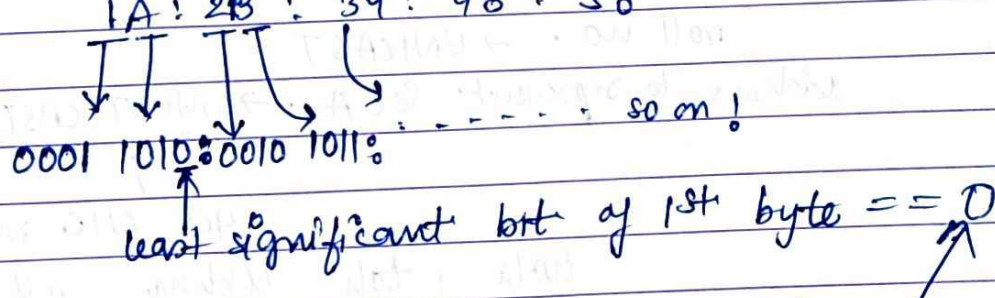
Types of MAC (physical) address :-

① Unicast :- Single destination for single packet.

↑ agar packet unicast.

↑ then least significant bit of first byte is '0'.

→ generally 6 byte address written in hexadecimal.



↑ then it is unicast address.

↑ means unique address for particular host.

Generally in NIC → we use UNICAST ADDRESS only.

↑ means address for that particular computer only.

② Multicast :- When want to send msg to more than 1 host in channel.

↳ yaa toh esse kre ek-2 kike bhejdo packets ... har vaar same pkt., but UNICAST address diff ; OR generate MULTICAST address,

WORK ON.

In multicast address → least significant bit of 1st byte is 1.

eg : A3 : B4 : C5 : 67 : 89 : 10

1010 0011 : 10110100 :

So multicast address!

may ↑ so ↑ points to multiple hosts.

roll no. → UNICAST

address to represent SecA → MULTICAST

↑ yeh NIC mein nahi hota, toh likhna padhega in NIC.

(3) Broadcasting :- When msg, saare hosts ko bhejna ho, jo bhi channel mein hain! (of DA (destination address))

All bits are 1 in MAC address.

FF : FF : FF : FF

DA, SA

↳ MAC address → written in NIC.

Length :- length of data.

CRC → used for Error detection only.

WORK IN PROGRESS.

(limitation of Ethernet)

- Real time application mein Ethernet must not be used.

as CSMA/CD → pehle dhut collision, then jaa kr msg successfully transmit

hola !

Then there comes many models, like :- client server model etc.

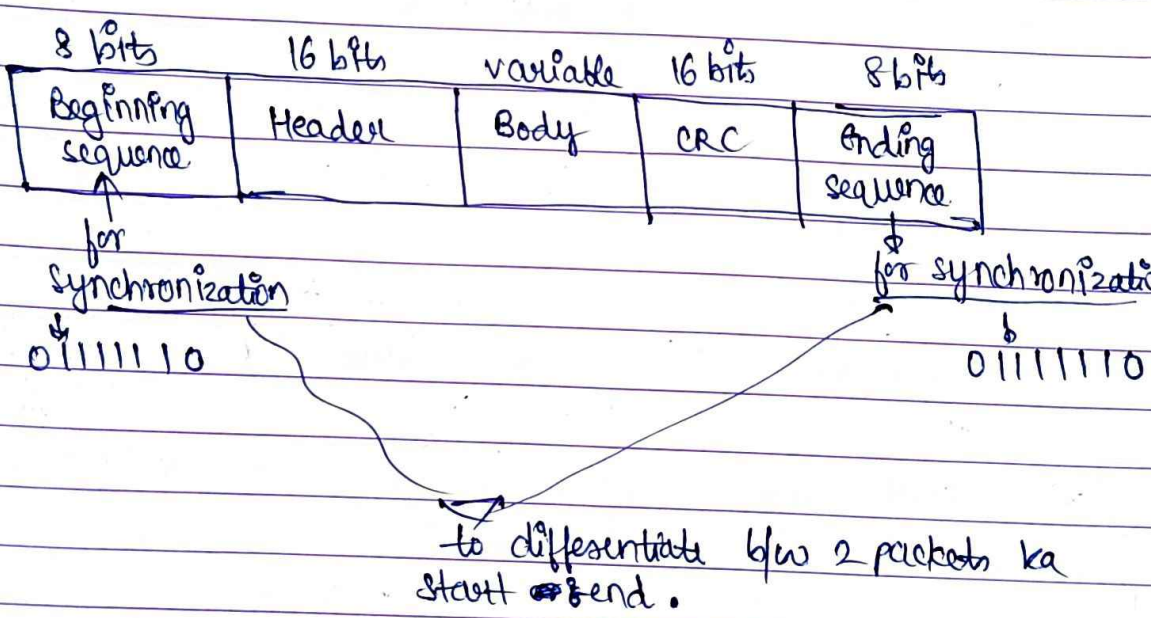
WAMK

9 Feb, 2023
Friday

lec-10 :-

- High Level - data link control (HDLC) :- → it is physical or wireless connection
  - supports both → 1-1 (Unicasting), 1-many (multicasting)
  - → (Data link layer) (DLL)
  - → data viewed as bits by R.
  - → Bit oriented protocol

HDLC frame format :-



① Header consists of :-
  (i) Address (8 bits) → to identify ki unicast or Multicast
  (ii) control field (8 bits) ~~(constant)~~

Types of HDLC :→
  ① I-frame (information) (1st bit of control field = 0)
  ② S-frame (supervisory) (1st 2 bits ——— = 10)
  ③ U-frame (Un-numbered) (——— = 11)

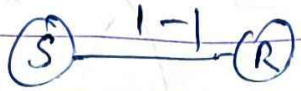
(don't go in much depth)

WORK @ 3 PM.

MTU - 1500B

→ (DLL)

① PPP (Point to Point protocol) :- Byte oriented protocol.
→ unicast protocol (1-1) ↳ R sees data byte wise, R extracts " "



PPP frame format :-

1 Bytes	1 Byte	1 Byte	1 or 2	variable	2 or 4	1
flag	Address	Control field	Protocol	Payload	FCS	flag

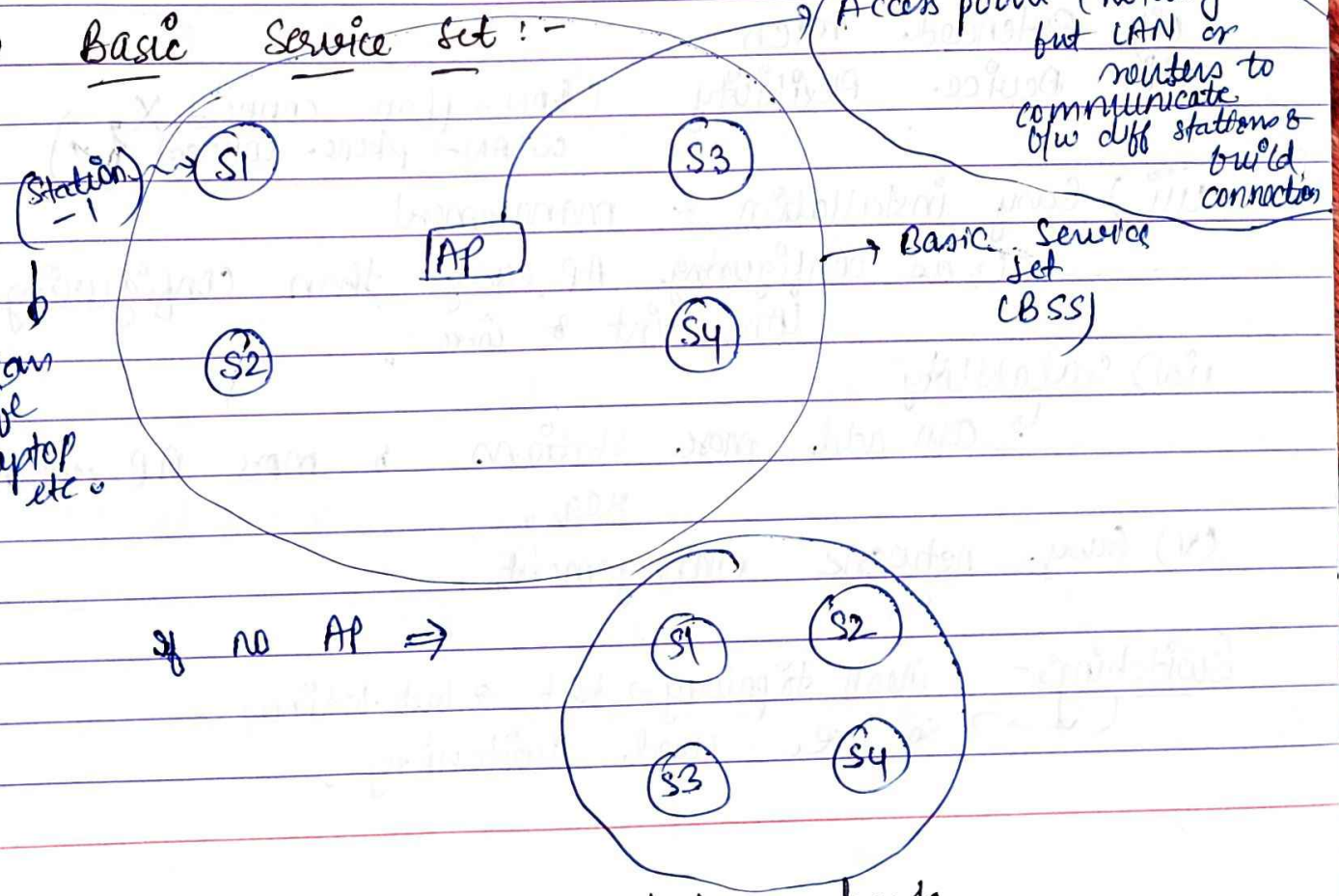
It is constant here, as PPP has no types.

Frame check sequence (CRC only, its name changed!)

WLAN (wireless - LAN) :- (eg. mobile wifi)
↳ connection through radio waves??

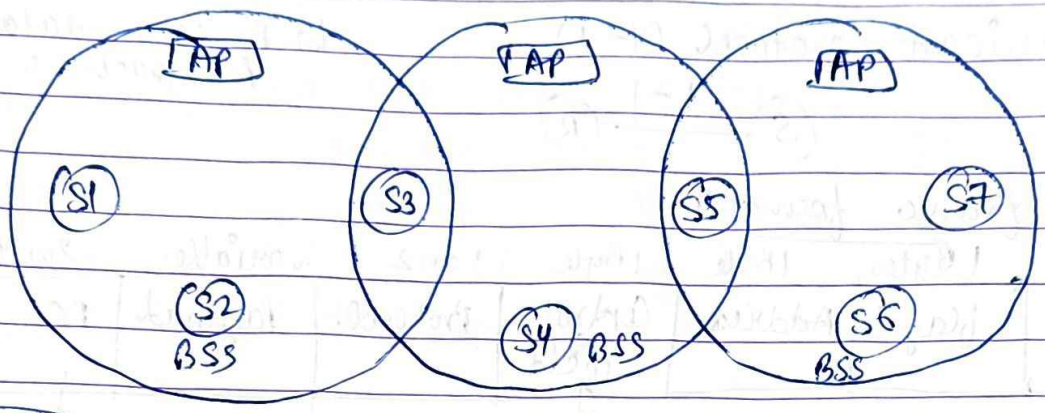
↓
IEEE 80211

• Basic Service Set :-



WORK ☺

⑥ Extended Service Set (ESS) :-



diff BSS connected via ESS, S1 can interact with S7

ESS.

↓

uses MAC address → 48 bits.

Advantages :-

(i) Extended reach

(ii) Device Flexibility (LAN → phone connect X, WLAN → phone connect ✓)

(iii) Easy installation & management
↳ as configuring AP easy than configuring LAN point & wire.

(iv) scalability
↳ can add more stations & more AP (whenever req.

(v) Easy network management.

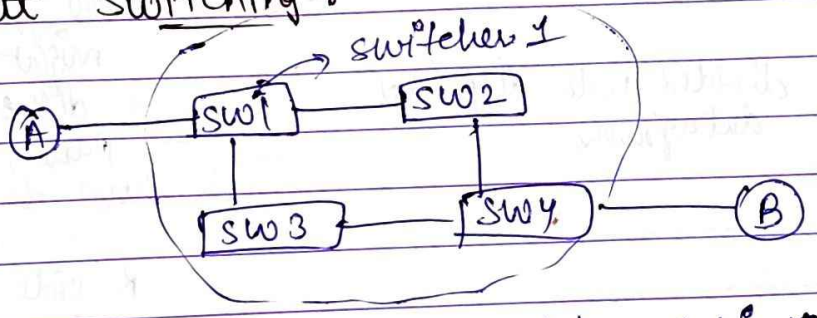
Switching :- Mesh topology → best → but tedious
↳ → so we used switching.

Switching Types :-

1. Circuit switching
2. message switching
3. Packet switching
   - Datagram
   - virtual circuit switching

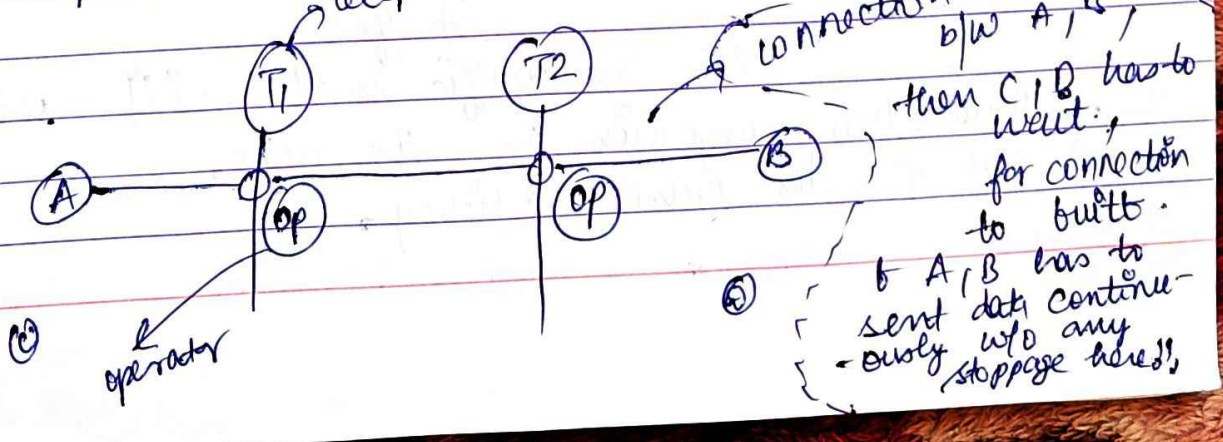
(i) 3 phases of switching :-
   (i) Connection establishment
   (ii) Data transfer
   (iii) Connection termination

Circuit Switching :-



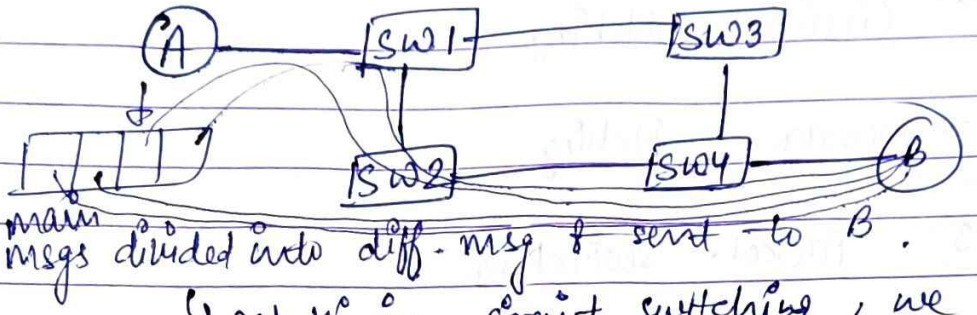
↳ all this dedicated only for connection b/w A & B.

eg :- telephone



WOMKE
3 000.

Message Switching :-

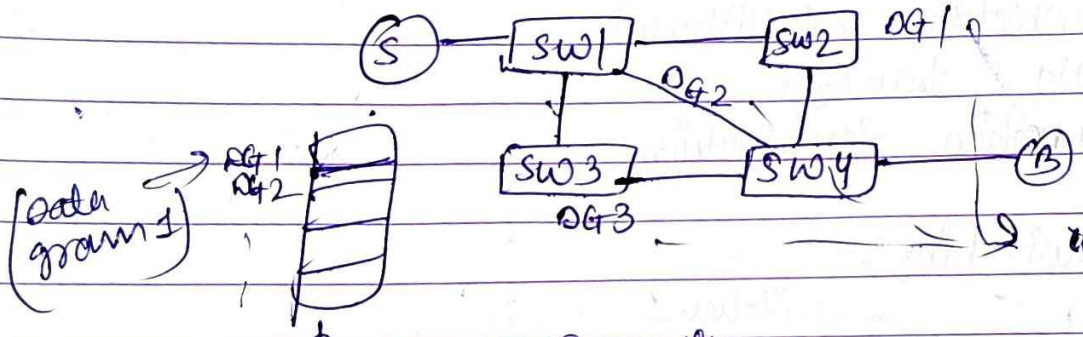


main msgs divided into diff. msg & sent to B.

↳ jab ki in circuit switching, we were sending msg as whole.

Packet Switching :-

⇒ Datagram :-



data divided into different datagrams

different data grams might chose different path, then how to merge data at R side?

↑ use sequence no. for that

↓

S can decide DG path acc. to traffic

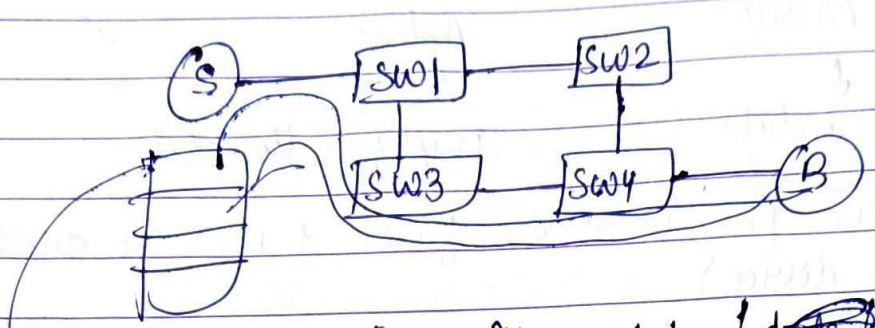
→ so here traffic in n/w will reduce...

→ Thus less congestion in the n/w.

→ Out of order packet delivery.

WORK:
.com.

2) Virtual Circuit Approach :- (combo of packet & circuit switching)

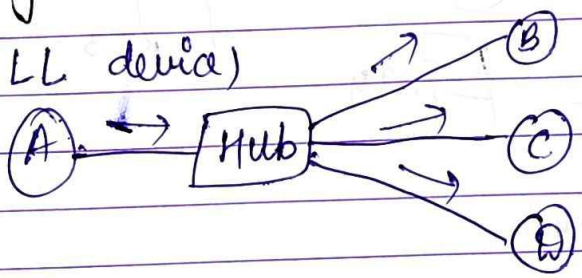


data divided into diff packets / ~~data~~ msgs.
→ sequence no. not required.
→ 1st packet path lega, baaki packets bhi wo hi path chose kreinge!

→ connection oriented
→ only single fixed route.

• Networking devices :-

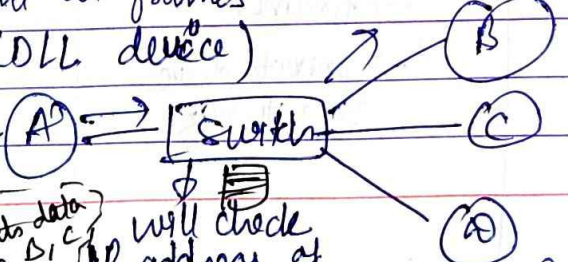
(1) Hub :- (DLL device)
(Physical layer device)



→ Multi-port devices.
→ Hub broadcasts the packets / frames.

A ne packet bheja tha C ko, A → Hub ko bheja, Hub → broadcast krega to B, C, D, C will accept & others will drop the packet.

(2) Switch :- (DLL device)
→ data sent as frames



→ unit-cast, multi-cast
→ Altering & forwarding
→ switch has buffers also to store data.

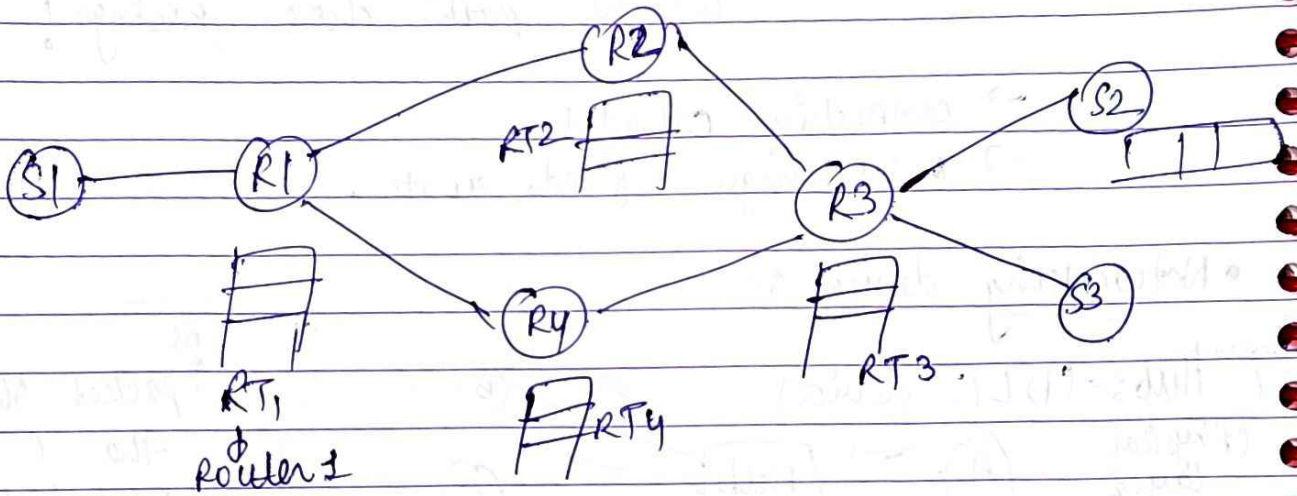
can't do broadcasting but multi-casting
yes: A wants data to go to B, C to switch bhejega
will check IP address of final destination & usi ko bhejega!

WOMK ॐ
=mm.

- Hub → data sent as bits
  (on basis of data forwarding)
  - Passive → (sends data as it is)
  - Active → amplifies the data

(3) (6) Routers :- (NL device) → using this plt is send from 1 BSS to another
↳ Network layer

* does routing using a Dynamic Routing Table.

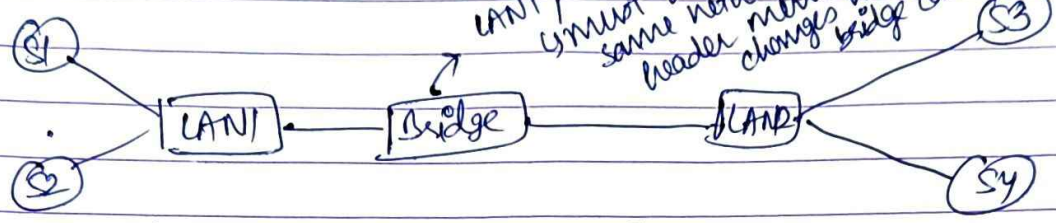


→ data sent as packets.

Hub	Switch	Routers
→ do Broadcasting	→ do unicasting, multicasting	→ do Routing
→ data sent as Bits	→ frames	→ packets
→ connects 2 devices	→ connects devices to network	→ connects 2 network

WORK :- 3rd PM.

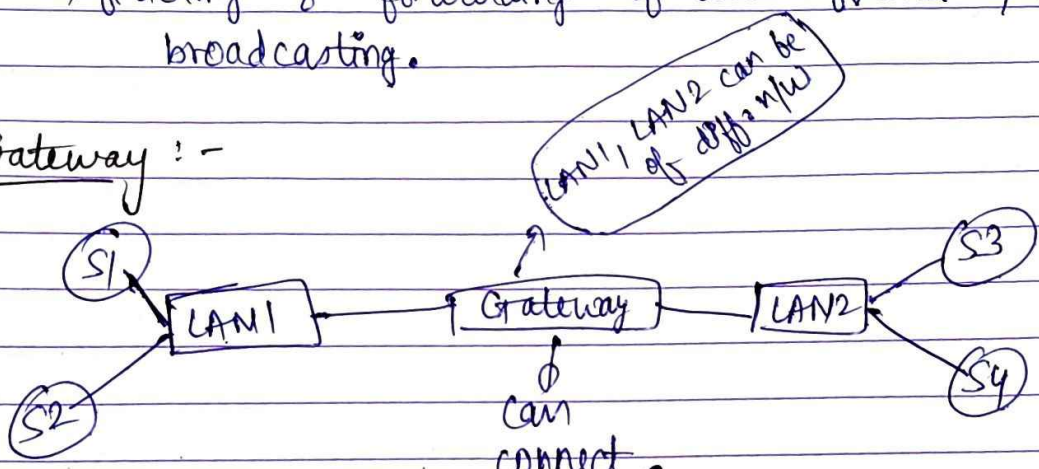
(4) Bridge :- connects two or more LAN networks.



[S1 → bridge → LAN2 → S4]
(for S1 to send msg to S4)

→ unicast.
→ filtering & forwarding of data frames, not broadcasting.

(5) Gateway :-



→ gateway can bridge different network types (using diff protocols)

→ Repeater receives router bits, repeats signal (bits) that router sends.
↳ gives good signals in cases where strength of signal reduces as distance increases.

WJMK ॐ ♡♡. WJMK ॐ ♡♡.

14 Feb 2024
Wednesday

Lec-11 :-

IP Addressing :- → chahiye to access computer on a network.

2 protocols :- IPV4, IPV6

IPV4 → 32 bits hoti hai.
divided into 4 parts :- (of 8 bits each)

IP addressing
(1) classless (2) classful.

Classful :- 2 representations :-
(i) Binary (ii) hexadecimal

172 . 31 . 2 . 3

10101100 . 00011111 . 00000010 . 00000011 (Binary Representation)

1st address → 0 . 0 . 0 . 0 (min)
last address → 255 . 255 . 255 . 255 (max).

IP address is divided into 5 classes :-
Class A 0 (fixed) 7 bits left (so 0 (min) → 127 (max))
B
C
D
E

range
(0.0.0.0 – 127.255.255.255)

WORK IN PROGRESS.

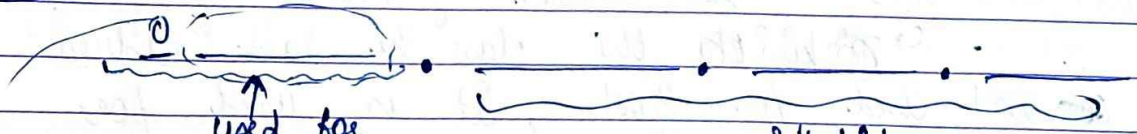
Class B → (128.0.0.0 — 191.255.255.255)
↳ 10 . ——— . ———
(fixed.) (6 bits left)

Class C → (192.0.0.0 — 223.255.255.255)
↳ 110

Class D → used for multitasking (2 ab multiple computers ko connect krna ho???)
↳ 1110
→ not used for IP addressing mostly.

Class E
↳ 1111

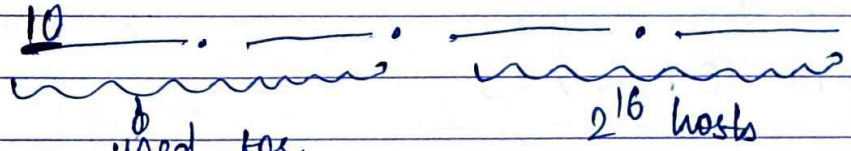
① Class A.



used for assigning network ID (used to identify network) (proxy address).
→ 27 different networks can be assigned.

24 bits
↑
used to assign host / machine
→ 2^{24} different hosts.

② Class B.



used for assigning Network Id
→ 2^{14} different networks.

2^{16} hosts

WOMK ☺ 30 =OM=

Class C

$\Rightarrow 2^{21}$ different networks

	Network ID	Host ID
Class A	2^7	$2^{24}-2$
B	2^{14}	$2^{16}-2$
C	2^{21}	2^8 ~~-2~~

as

so 2 subtract kiya

① 127.255.255 → last address of class A

↳ kisi bhi class ka last address is not used for host, it is used for broadcasting.

② 1st address of any class is just to identify network.

10.1.2.3 ∈ class A.

Subnet mask :- used to identify device kis network ko ∈ hota!

255.0.0.0

Yisko saath AND karo apna IP address ka.

255.0.0.0
AND 10.1.2.3

10.0.0.0

10 lies (0-127) → so belongs to class B.

WORK IN SEM.

⊙ ~~126~~ 254 IP address / network in class C.

(22)

172.2.3.6

↳ AND kro with :-

255.255.0.0. → subnet mask for class B

↳ get ⇒ 172.2.0.0

↳ class-B ✓.

Similar class C ke liye AND with

255.255.255.0

↑ subnet mask for class C

Limited broadcast address (LBA) ⇒ 255.255.255.255

↳ used to broadcast msg to network

(can't go outside the network)

① Private IP

↳ as only host to identify, not network.

↳ so 2^{32} host

• Public IP

② Subnetting :-

~~Class C → 126 IP addresses hain~~

Net ID → 192.2.3.0 → class C ka hai !!

~~with this network~~ 254 IP address can assign, but say it's 40 machine hi.

214 IP addresses waste ho rhe hain !!

WOMK ☺ ☹ MM.

214

so mechanism chahiye ki yeh jo waste na ho, dusri organization use kr ske !!

192 . 2 . 3 . ---

for 40 → max 6 bits are required.

so 6 chi (2) bits ko also identify network mein hi collaborate kr lein toh sahi??

then $2^6 = 64$ different hosts.

so 26 IP addresses / network.

(so 2 bits borrowed from host to network portion)

0 0
0 1
1 0
1 1 → so 4 different networks??

192.2.3.0

192.2.3.00 ---- | 192.2.3.01 ---- | 192.2.3.11 ---- | 192.2.3.10

range → (192.2.3.0 to 192.2.3.63) excluding these 2 → other can be used to assign IP address to a host in a network.

range → (192.2.3.64 to 192.2.3.127)

range → (192.2.3.128 to 192.2.3.191)

range → (192.2.3.192 to 192.2.3.255)

WORK :)

→ class C.

⊙ 195.31.4.0 → divide this network into 2 subnets.

(Fixed length subnetting)

↓ 195.31.4.0 ------

↳ range

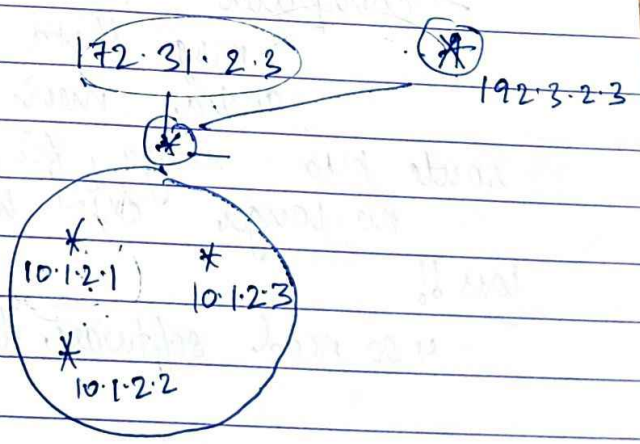
↳ (195.31.4.0 – 195.31.4.127)

↓ 195.31.4.1 ------

↳ range

↳ (195.31.4.128 – 195.31.4.255)

↳ can divide them further as well.



SID DID

10.1.2.1

P

10.1.2.1

WJMK ☺

19 Feb 2024
Monday

Lec-12 :-

① MAC address → for all systems → unique.

Why IP address required?
↳ agar MAC hai
↳ unique ID of system.
↓
is 6 byte address
↳ numbers given on basis of company, country, time when it is built
↳ all MAC address are unique, but no particular pattern is being followed.

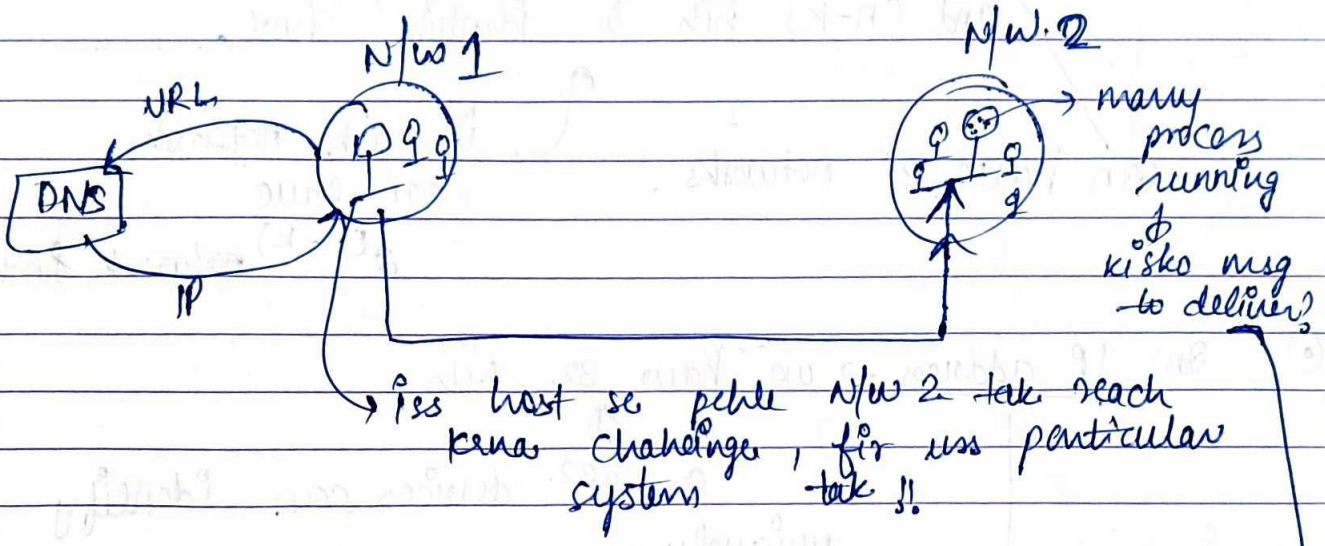
→ computer made in India, aap gye UK, msg bheja usko kisi ne, usne sochega India mein hai → wo India mein route krta rhega, fir it will realise ki device no longer exist here → so mapping efficiency less !!
↳ so need software based/generated address → IP address !

www.google.com
↳ gives IP address.

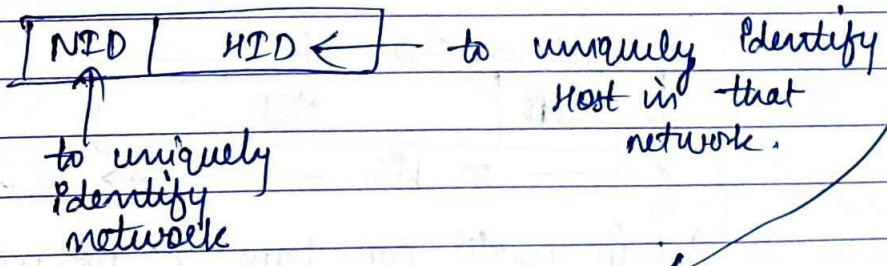
We are not good at remembering IP address, but can remember URL of that particular site.

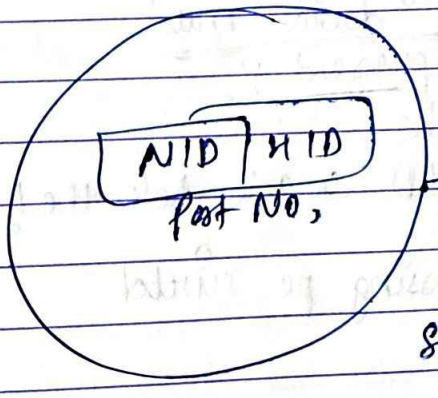
DNS → Domain Net Service.

↳ isko URL do particular site ka, will return IP address.



① IP address is divided into 2 parts :-
① Network ID (NID)
② Host ID (HID)





→ all together called socket ID.

So, IP address + Port No. = Socket ID. !!

WIMK

Let IP address is of (n) bits

then can have 2^n unique IP addresses.

let k bits to identify Network,
and (n-k) bits to identify host.

can have 2^k networks.

in each network, can have $2^{(n-k)}$ hosts.

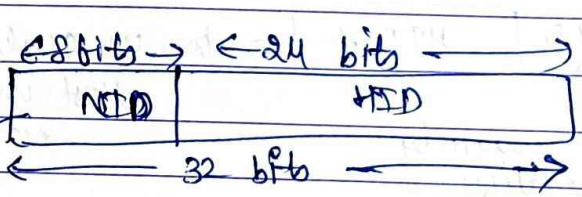
① In IP address → we have 32 bits

so 2^{32} devices can identify uniquely.

(software based address)

NID → Important

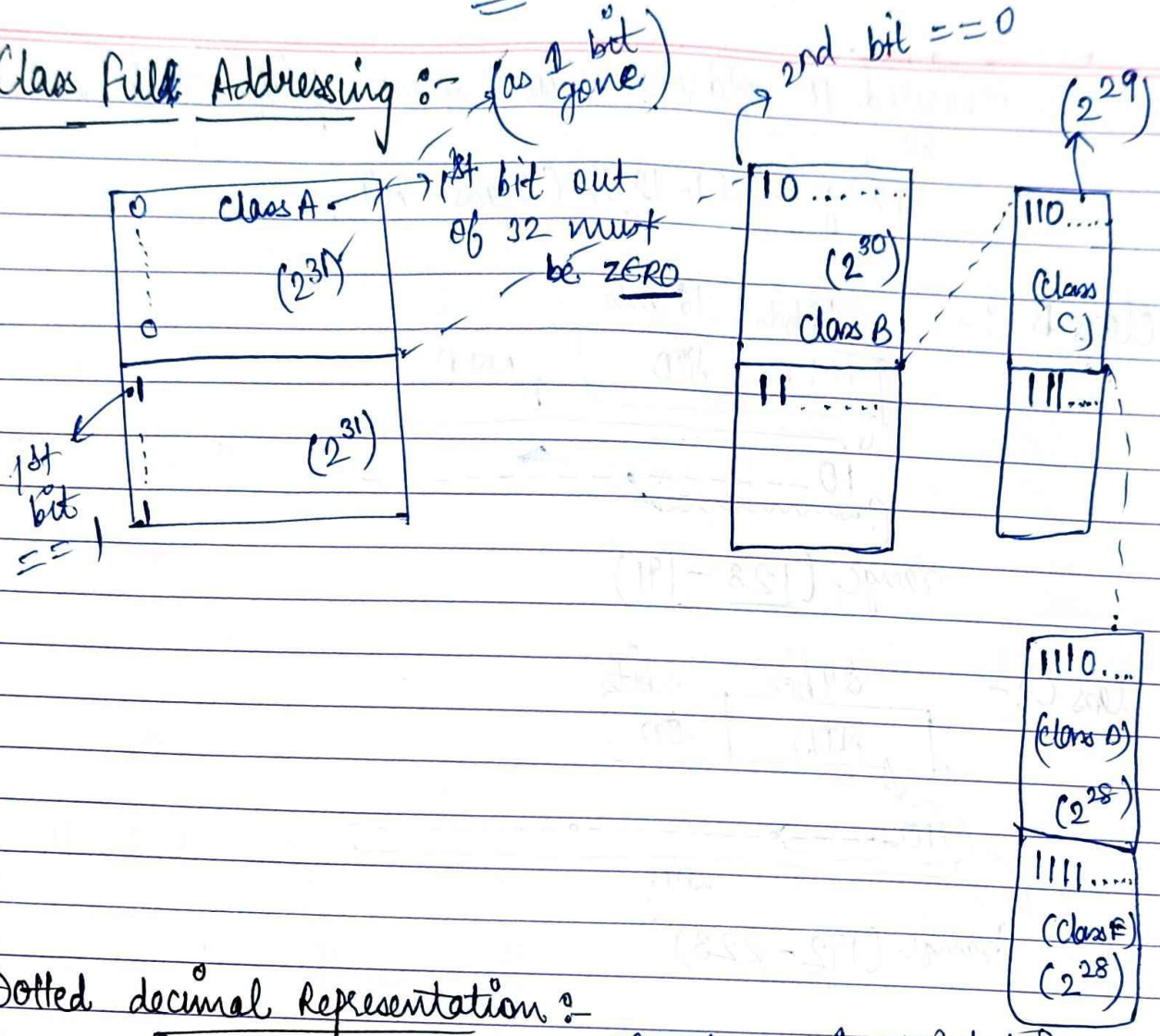
∪ o/w IP address == MAC address.



∴ in world can have 2^8 networks,
and in each network → 2^{24} devices must present !!

Earlier, the host (2^{24}) nahi hote the
↳ most of Host ID waste hote the!
↓
so class-full addressing pe switch kiya gaya

Class Full Addressing :- (as 1 bit gone)



Dotted decimal Representation :-

IP address is divided into 4 parts, each of 8 bits, & we'll write their decimal value in each part.

Class A :-

0.....

2^7 networks can create

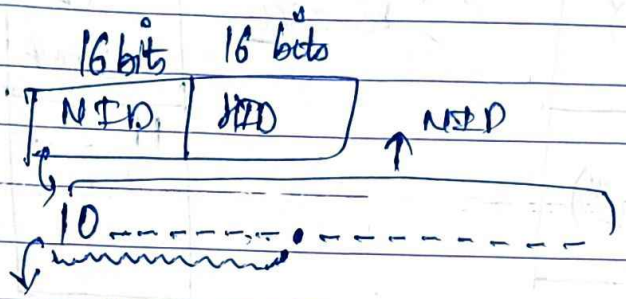
range [0 - 127] → so 128 networks can have!

Out of this → 2 IP addresses are reserved → 1st & last
(same 0) (01111111)
So 126 IP addresses are available

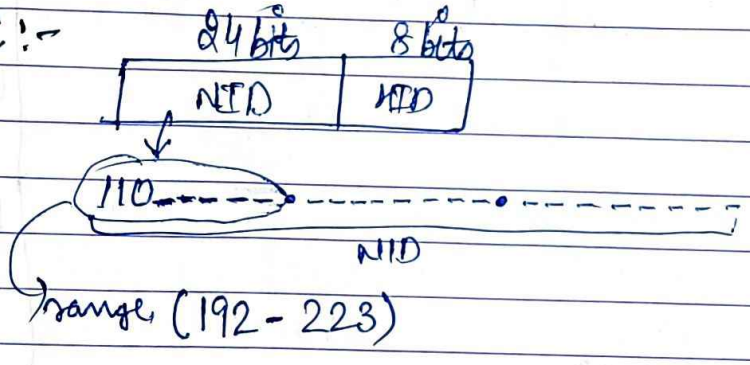
WSMk 8
IV

These 2 reserved IP addresses have some specific tasks.
so
range → (1-126) (Class-A).

Class B :-



Class C :-



Class D, E
↳ used for special purpose (like defence)
↳ not generally divided into NID, HID.

Class D :- 1110 ---- . ---------- . ---------- . ----------
↳ find range

Class E :- 1111 ---- . ---------- . ---------- . ----------

Nowadays, going for classless Addressing.
↳ as Jaroori nahi Network ID jiss class ke acc. chahiye, host bhi utne hi chahiye hain!
↳ so wastage ho sakti hai, yaa kam nahi sakte hain!!

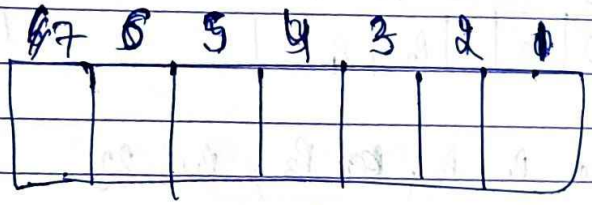
WORK

21 Feb 2024
Wednesday

lec-13 :-

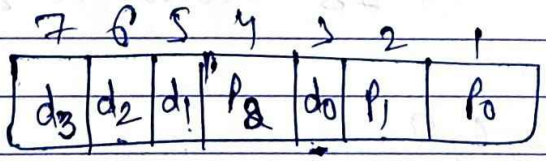
① Hamming Code :-

↳ used for error correction & detection.
↳ If error more than 1 bit then can detect only, can't correct it !!
↳ can correct only if error is in 1 bit.

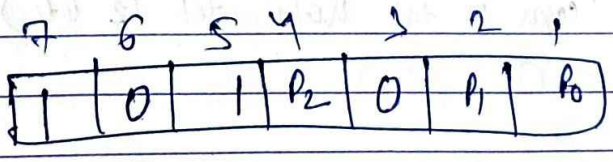


4-bit data (d_0, d_1, d_2, d_3)
3-bit parity → say : P_0, P_1, P_2

these bits will be placed at $2^0, 2^1, 2^2$ respectively!



let our data is :- 1010 ($d_3 d_2 d_1 d_0$)



For P_0 → see alternate data (skipping parity) (& taking alternate data bits)

$P_0 \rightarrow d_0 + d_2$

Perform XOR operation !!

$P_1 \rightarrow d_0 + d_1$

$P_2 \rightarrow d_1 + d_2 + d_3$

WJMK = 3 MM. =

$P_0 = 0 \oplus 0 = 0$

$P_1 = 0 \oplus 1 = 1$

$P_2 = 1 \oplus 0 \oplus 1 = 0$

So,

1	0	1	0	0	1	0

let Data is :→ 1001101
↳ 7 bits

$P_1 \to 2^0$, $P_2 \to 2^1$, $P_3 \to 2^2$, $P_4 \to 2^3$

11	10	9	8	7	6	5	4	3	2	1
1	0	0	P_4	1	1	0	P_3	1	P_2	P_1

To calculate P_1, P_2, P_3, P_4 ??

$P_1 \to 1, 3, 5, 7, 9, 11$ — walon ko XOR kro
↳ (take 1, skip 1)

dekho kitne 1's
↓
3 → odd
so, $P_1 = 1$

$P_2 \to 2, 3, 6, 7, 10, 11$
↳ (take 2, skip 2)
→ 4 1's → even, so $P_2 = 0$

$P_3 \to 4, 5, 6, 7$
↓
(take 4, skip 4)
(agar 12 tak hota, toh 12 lete)

$P_3 = 0$

$P_4 \to$ ~~4, 5, 6, 7~~, 8, 9, 10, 11
↳ (take 8, skip 8)

$P_4 = 1$

WOMK C
3rd MM.

So Data to be sent =

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

Let error occurred here

⇓

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

12 11 10 9 8 7 6 5 4 3 2 1

Receiver should be able to understand that error occurred!

↳ R will also perform XOR operation.

$P_1 \rightarrow$ 1, 3, 5, 7, 9, 11

↳ 5 zeroes → odd ⇒ $P_1 = 1$

↳ abki '0' hona chahiye tha!

→ pehle yeh tha nahi → inse 1 aaya.

→ yeh 1 tha

↳ ZERO aana chahiye tha, but jab 9th position ko = 1 kediya, wo '1' ho gya!

even parity ke value ⇒

$P_1 \rightarrow$ 1, 3, 5, 7, 9, 11

$P_1 \oplus 1 \oplus 0 \oplus 1 \oplus 0 \oplus 1$

↳ isko 1 krna padhega, to make even no. of 1's.

$P_2 \rightarrow$ 2, 3, 6, 7, 10, 11

$P_2 = 0$ (9th position hai nahi, pehle '0' nikaala tha)

WORK

$P_3 = 0$, $P_4 = 1$

If any one of P_i's $\neq 0$, then ∄ error

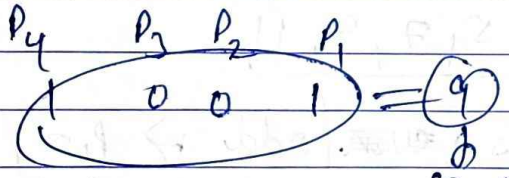
here, $P_1, P_4 \neq 0$

so error!

what is common??

9 & 11,

and



so at 9th bit, ∄ error !!

⊙ complexity, efficiency of Hamming code?

for 4 bit data → redundant 4 bits adding

almost 50% redundant data

⇓

Disadvantage !

CSMA/CD → not good for WLAN!

→ why?

WORK ☺

Properties of CSMA/CD se pta chlega!

↳ Data length ↑

Why good for wired connections?