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.

↓

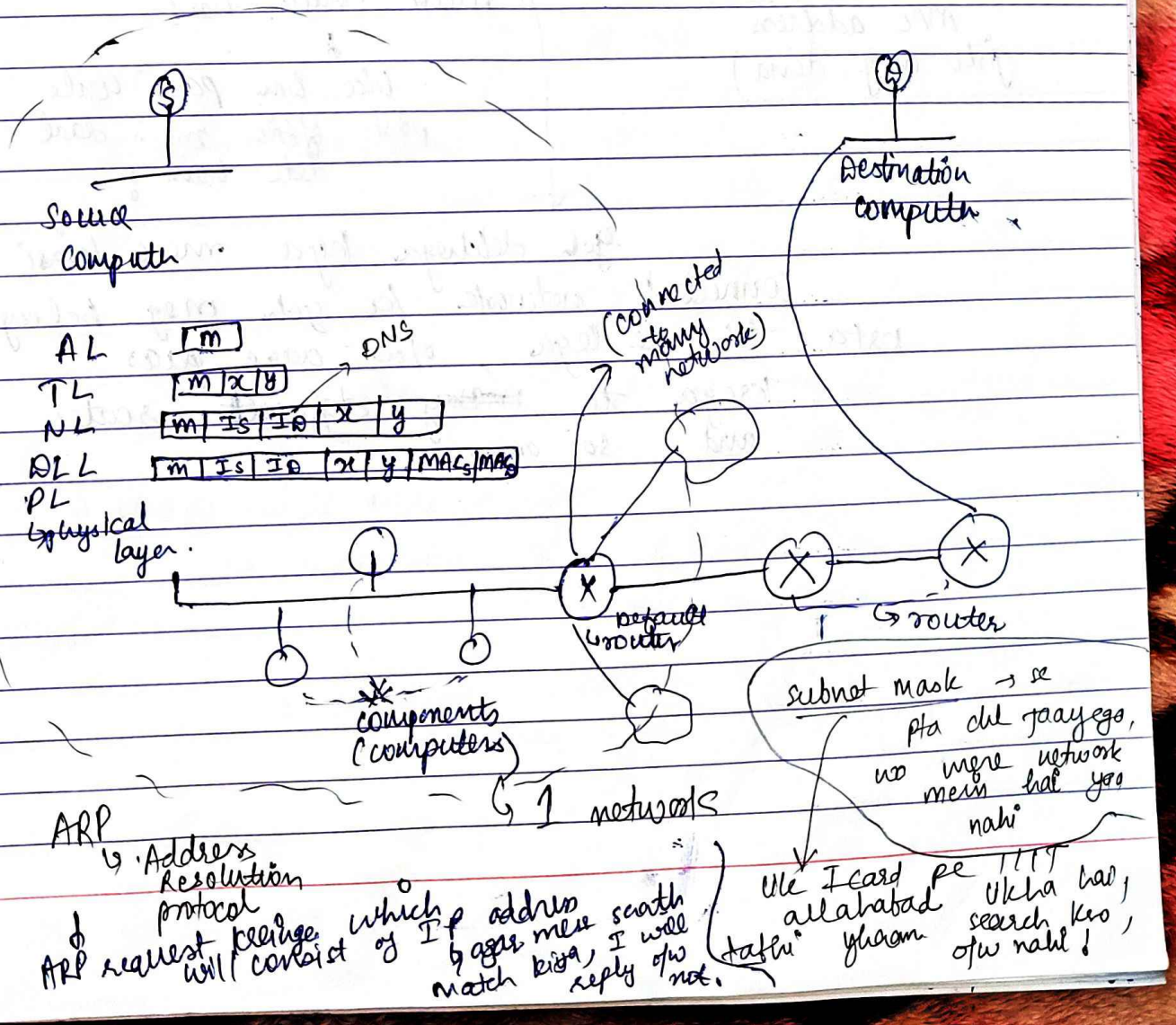
can adjust to make routing or message passing fast.

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
[illegible]

ARP request	I_S	I_D	MAC_S	XXXX

→ 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)

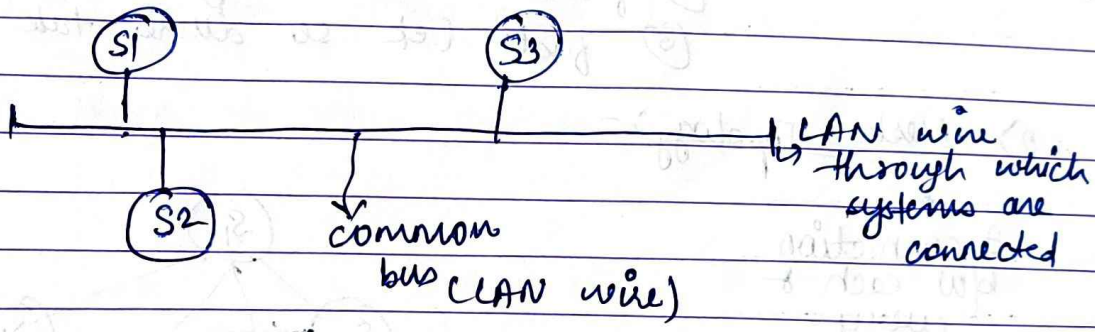
→ Yeh detect karega kya mere kissi connected network ko yeh msg belong krta toh de dega. o/w aage paas krega to ~~many~~ default router and so on....

10 Jan, 2023
Wednesday

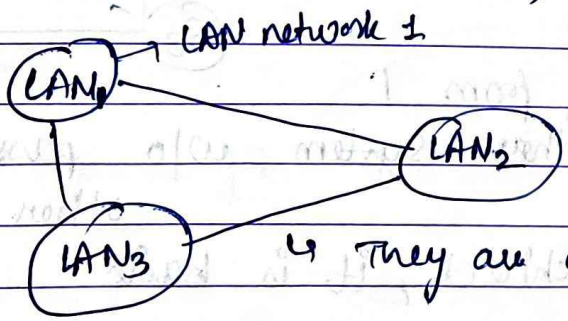
Lec-2 :-

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.

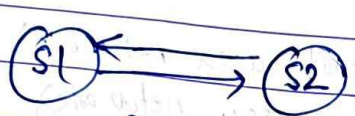
India ——→ Africa
↳ wire through water (fibre optics)

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)

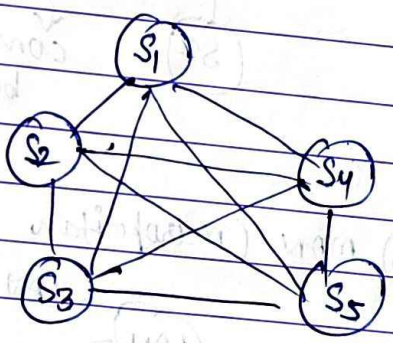


adv :- ① simple, just connects wire
② fault detection easy
③ fast (ek se dusre tak jaana hs)

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.

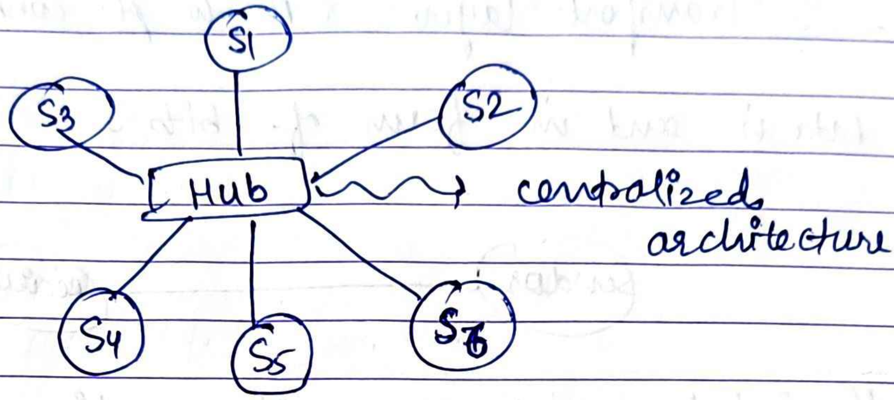
② system to architect, it is basic

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
ॐ MD.



adv:-

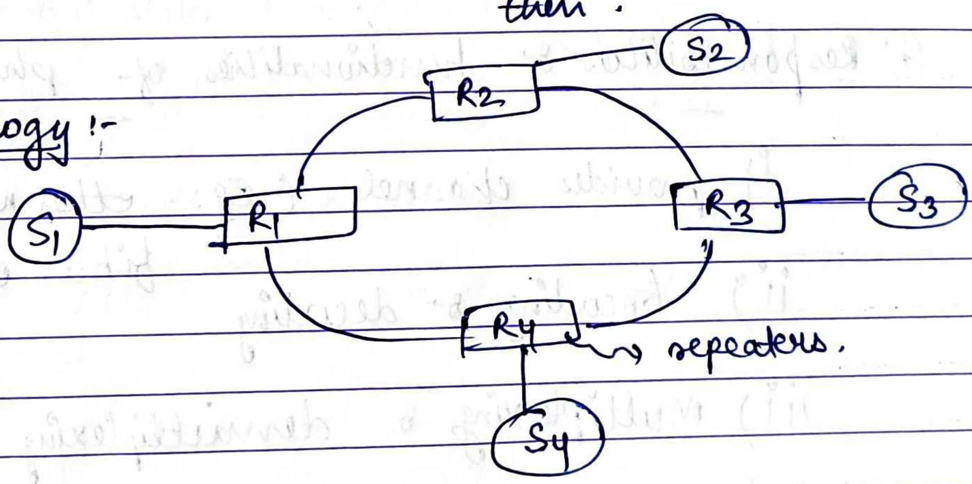
① each system has only 1 wire, easy to manage!

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:-



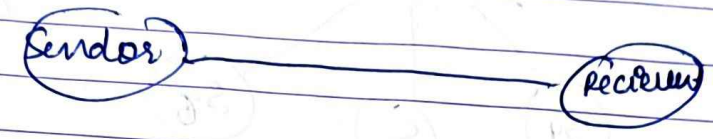
Q why to have so many OSI layers in system ??

Application layer
↳ where application or actual data is formed.

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

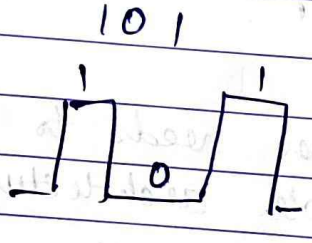
Transport layer (Pt-to-pt connection)

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!

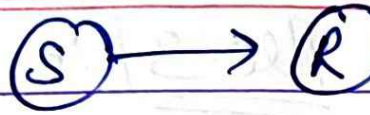
iv) Data rate (bits per second)

v) Bandwidth

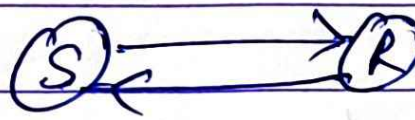
vi) Kaun sa network topology use krega, will be defined in this layer.

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

WORK

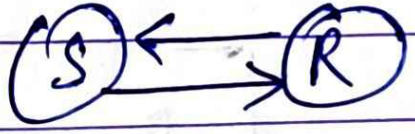
Simplex : 

(only sender can send msg)

half duplex :- 

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

full duplex :-



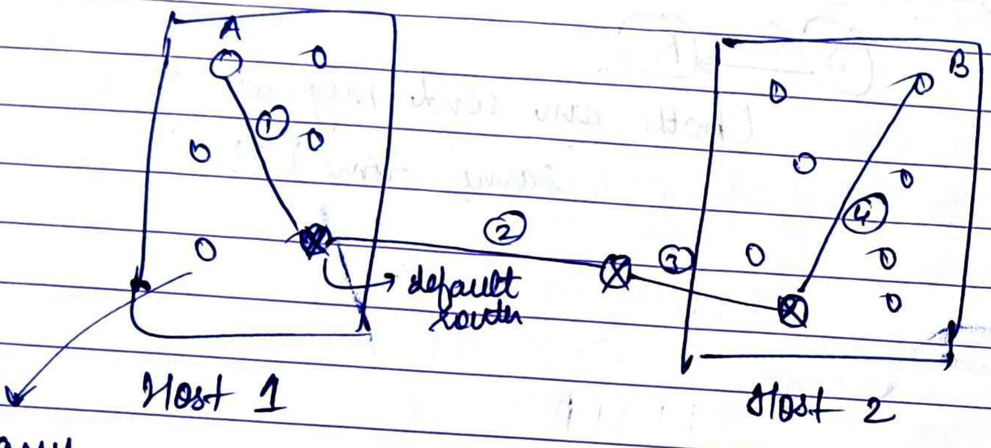
(both can send msg at same time) ??

WOMK ॐ ॐ।

15 Jan 2024
Monday

[Lec-3] :-

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



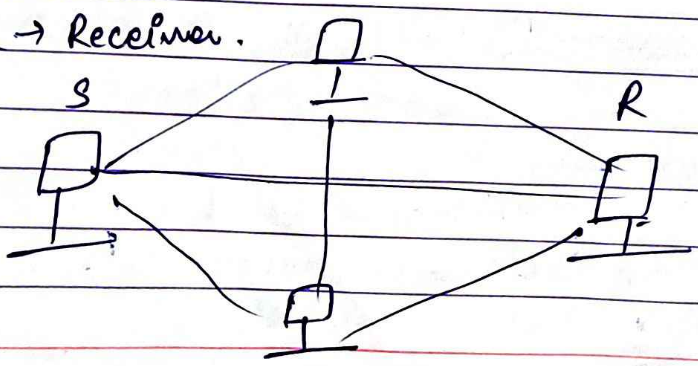
↳ can communicate with each other directly (within network) using data link layer

and uske liye hi MAC Adress chahiye.

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

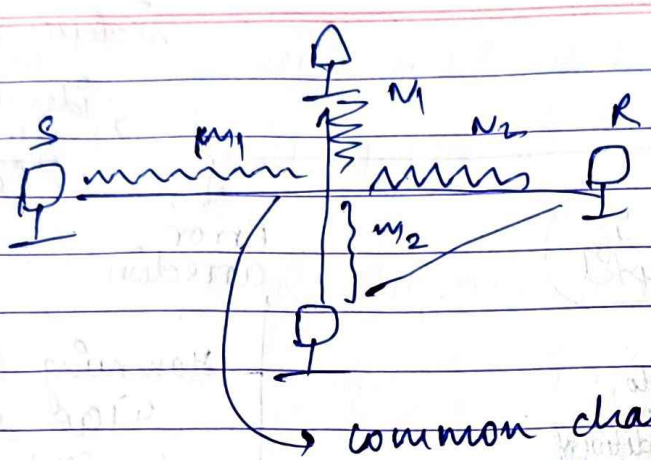
A to B jaane ke liye 4 hop to hop delivery huyi.
uske liye direct connection hota hai

S → Sender
R → Receiver.



(mesh 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

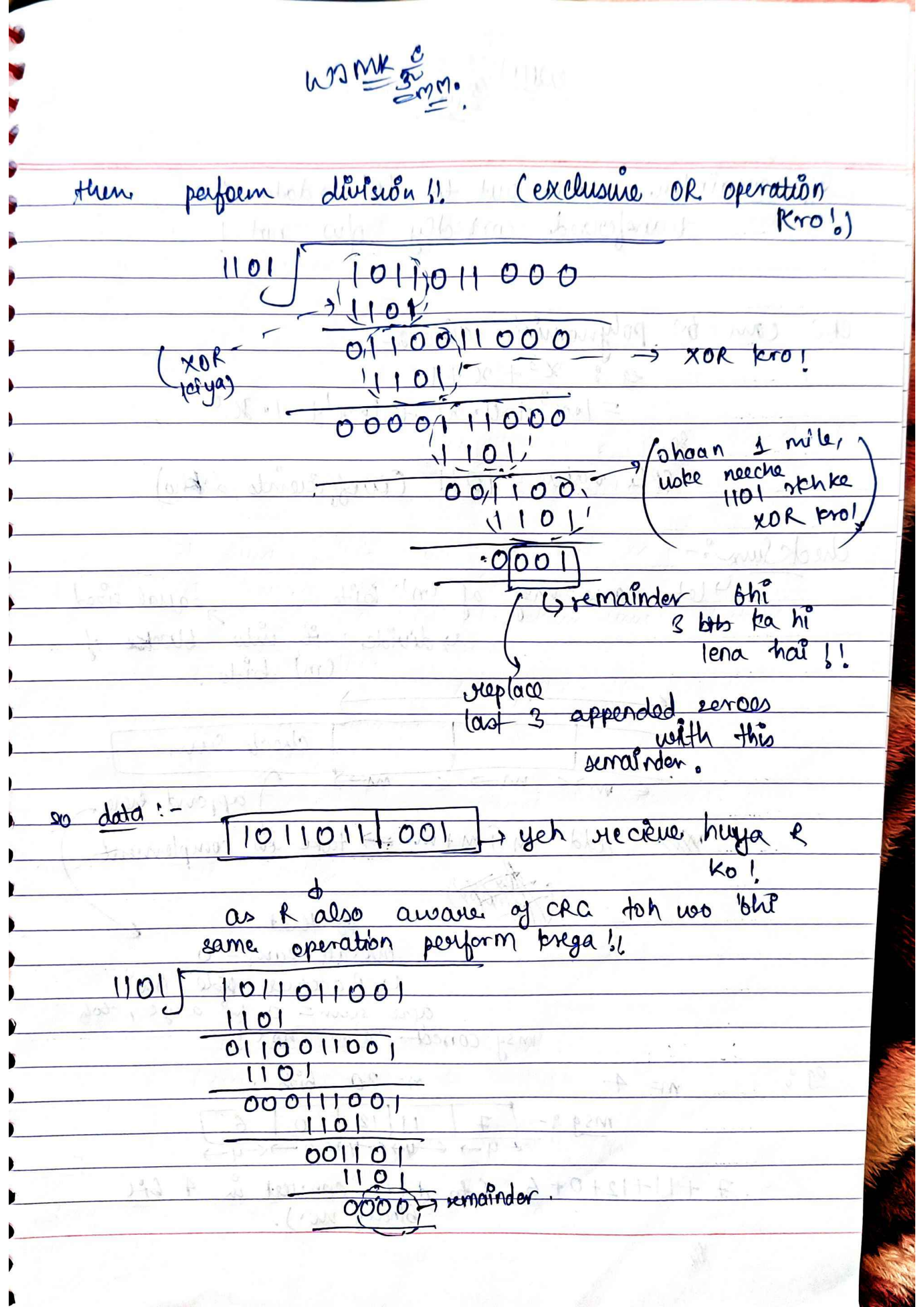
Error handling :-

- 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 : $x^3 + x + 1$

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

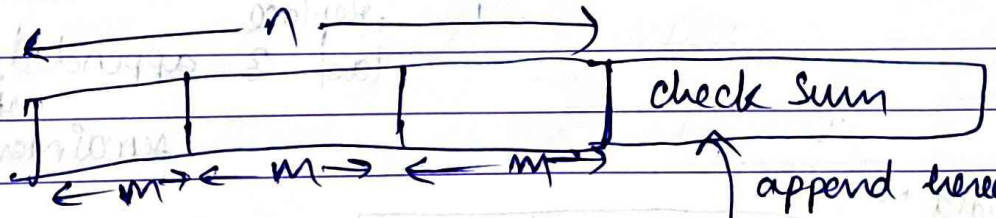
So,

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

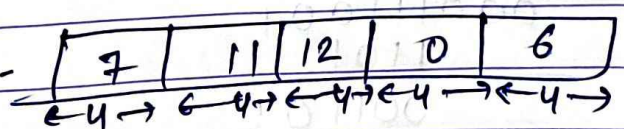
↳ Receiver side bhi agar sum = 0 hi aaye, toh msg correct o/w not!

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

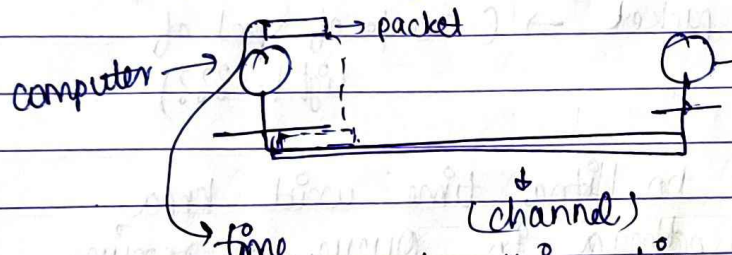
R ne receive kiya, agar error aa gya ⇒ toh sum ka 1's complement ≠ 0 hoga ⇒ toh R receive nahi krega !!

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 :

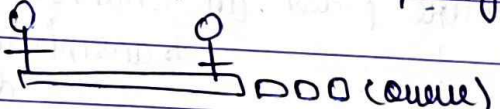
(Tp)

(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)



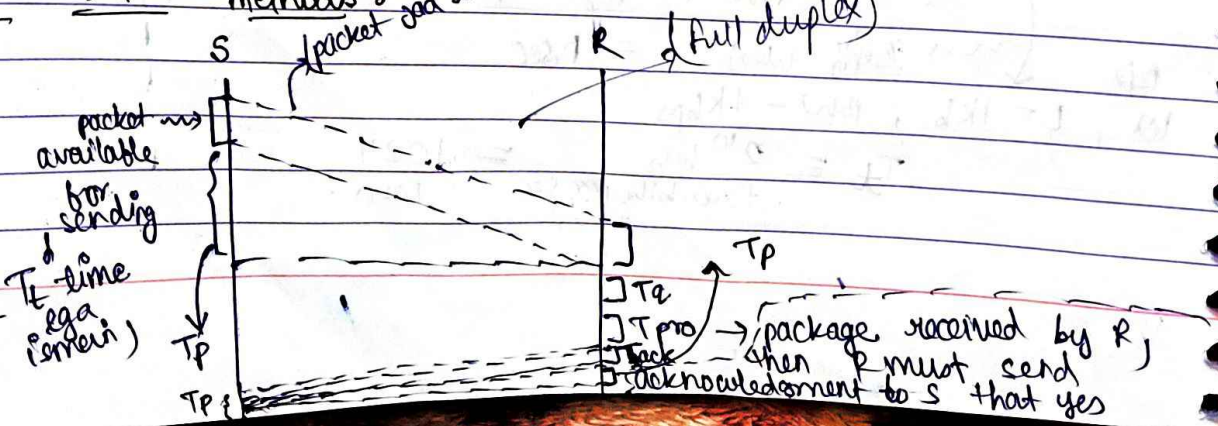
(4) Processing delay :- process hone mein jo delay
(Tpro) hoga → packet receive huya sahi se yaa nhi.

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

↳ 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!!

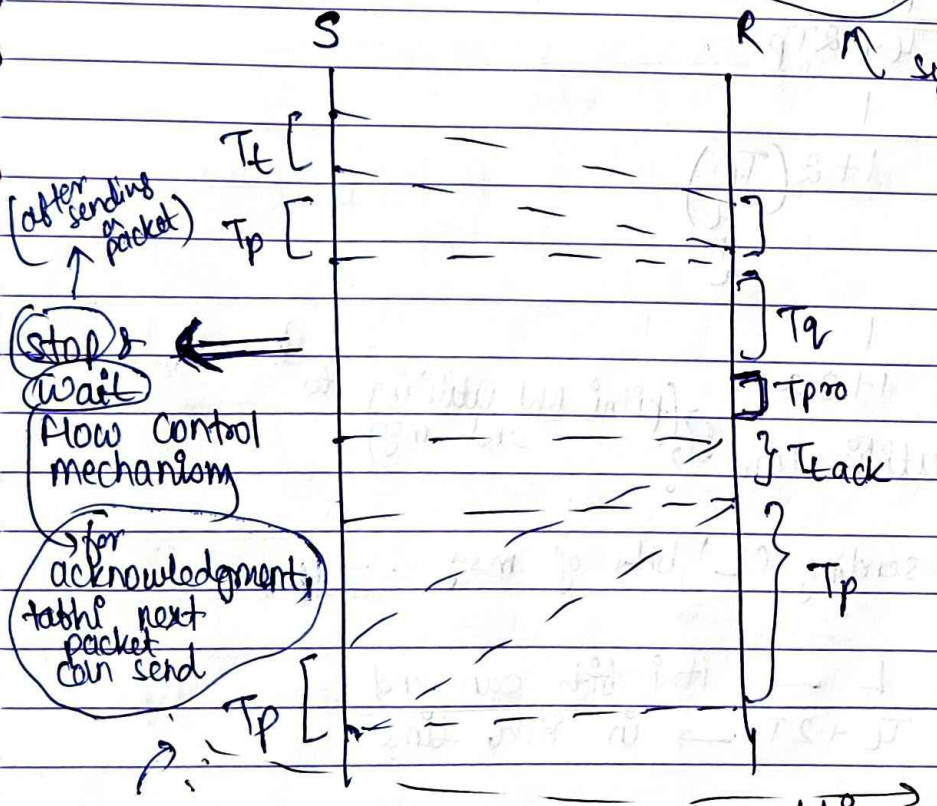
Total time $= T_t + T_p + (T_q + T_{pro}) + (T_{t\,ack}) + T_p$

↑ 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

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

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

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

- WDMK ॐ OM.

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

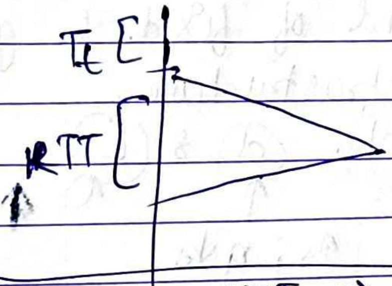
$$RTT = 2 \times T_p = 2\,ms$$

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

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 :-

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

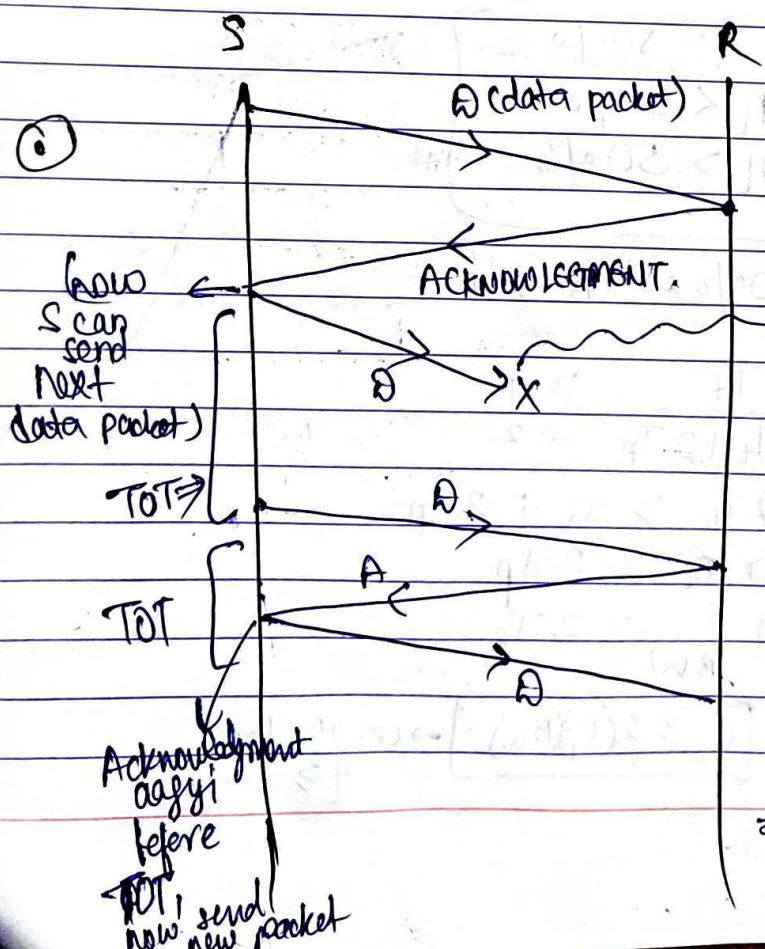
$$= \frac{1}{1+2\left(\frac{d}{v}\right)\left(\frac{BW}{L}\right)}$$

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.

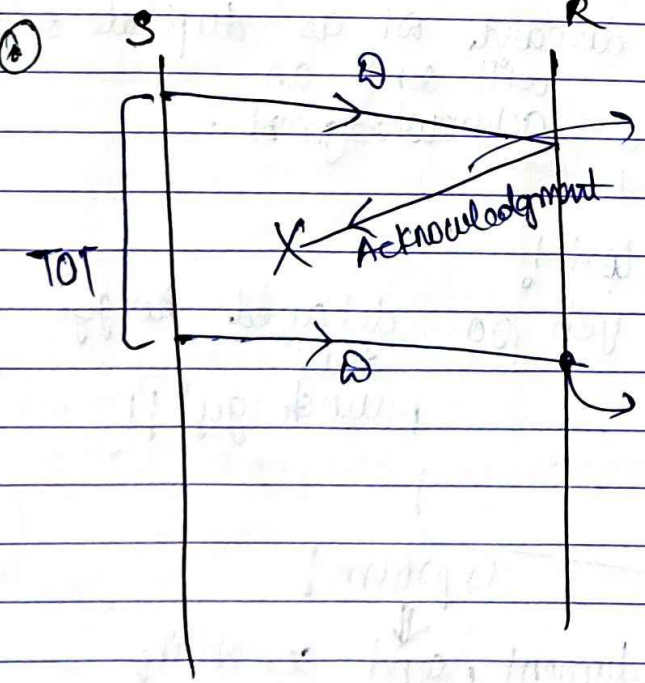
Stop and wait + TOT

||

S & W ARQ

↑

Automatic repeat request.



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

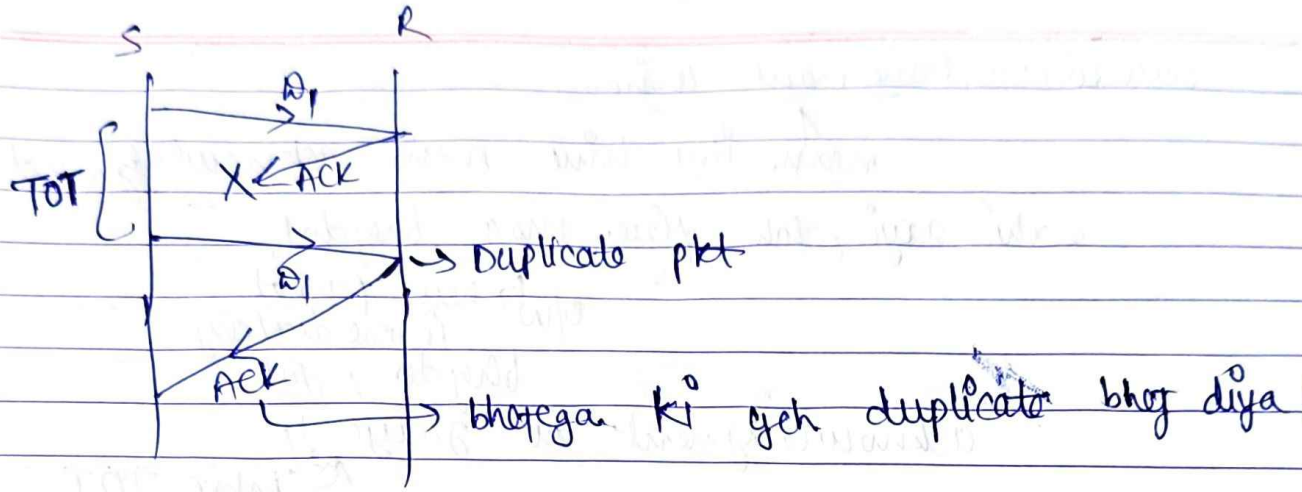
↑

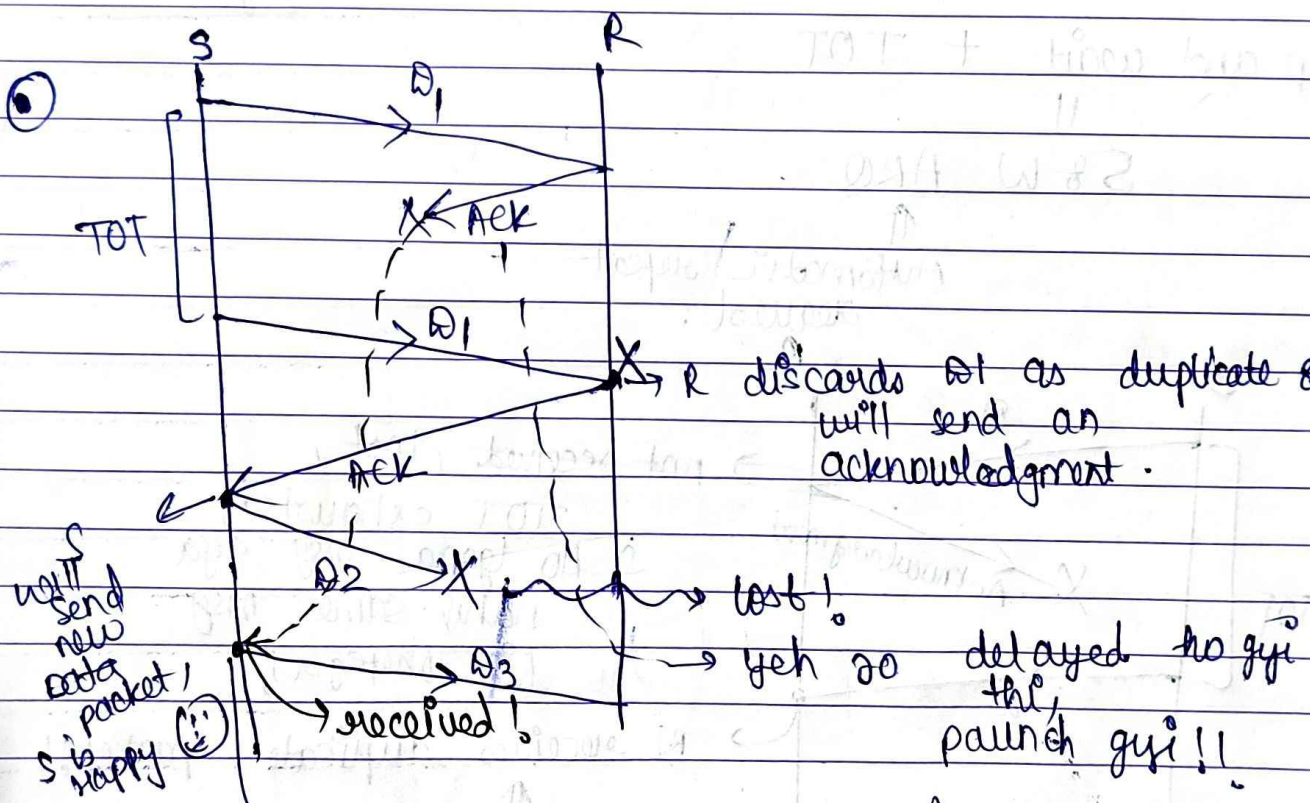
so R must be able to differentiate b/w packet.

↑

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

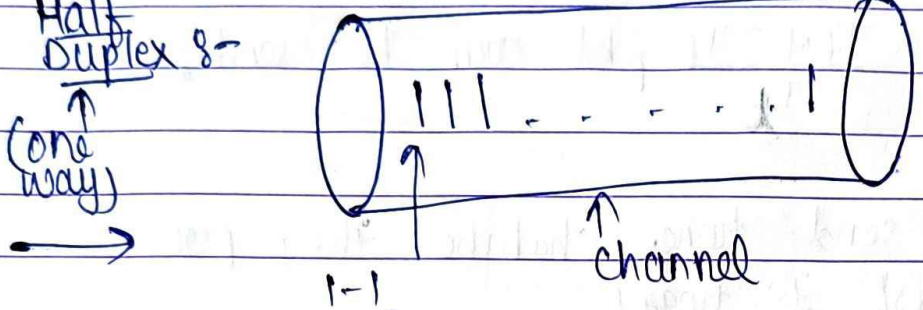
like D1 receive huya, then acknowledgment no. = 2

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 ↓.

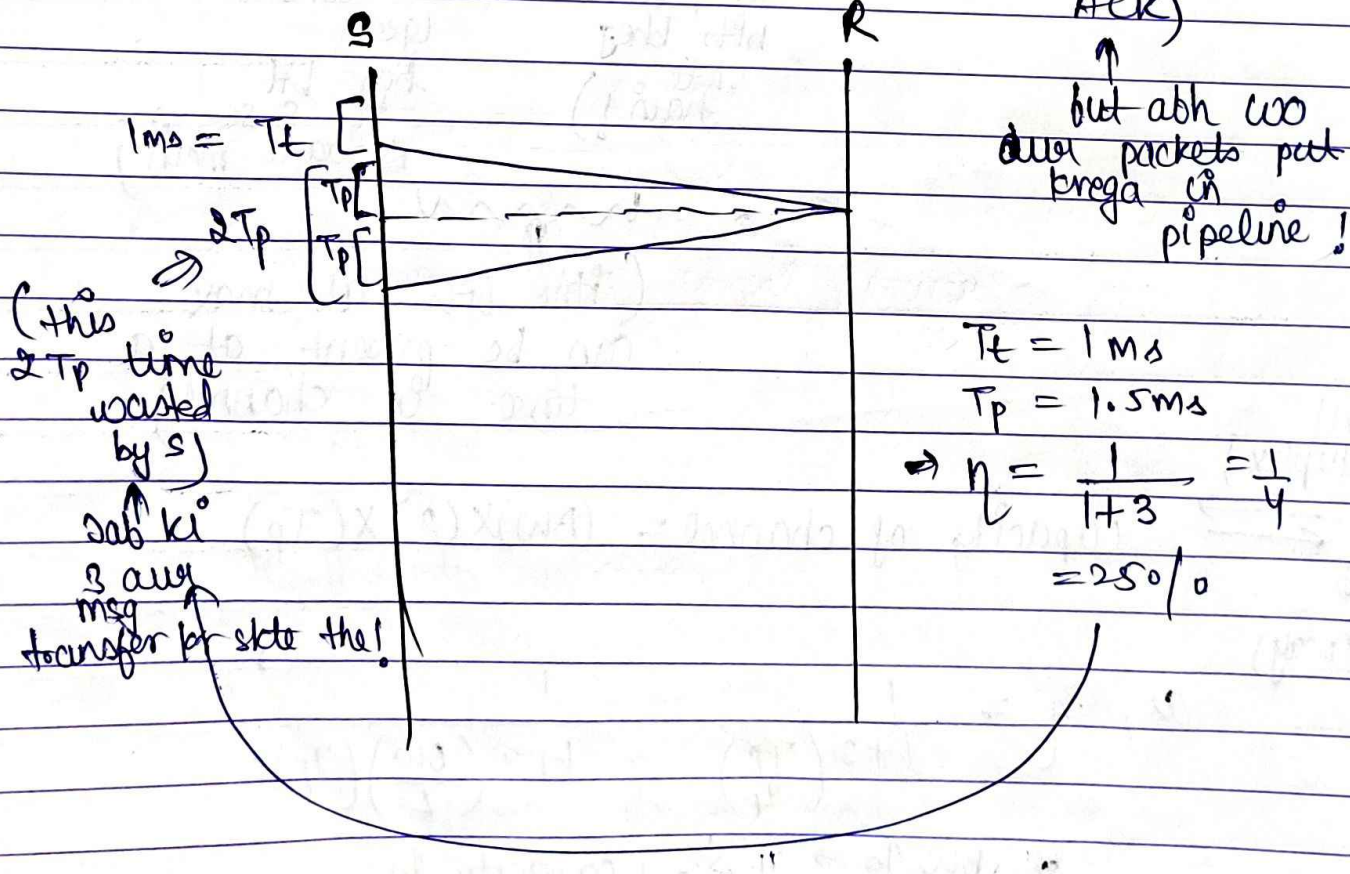
WORK is worship.

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!

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

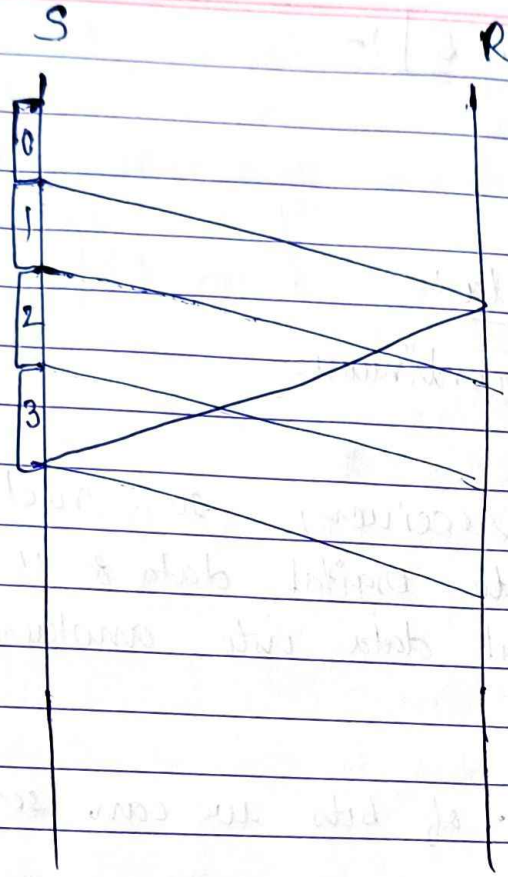
Pipelining Flow Mechanism:- (N pehle toss bcoz S waiting for ACK)



$T_t = 1$ 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 ⇒ $SNR = \frac{\text{avg signal power}}{0 \text{ (as no noise)}} = \infty$

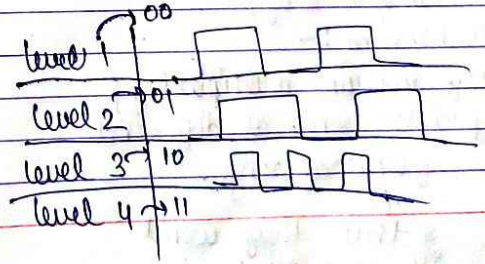
↑ these practically ∞, it is not

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

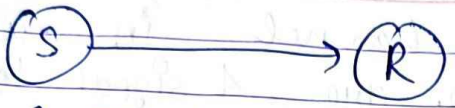
↑ it is dependent on channel speed

→ 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})

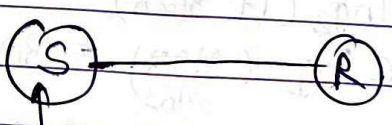
$$\text{Latency} = t_p + t_t + t_q + t_{pd}$$

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.

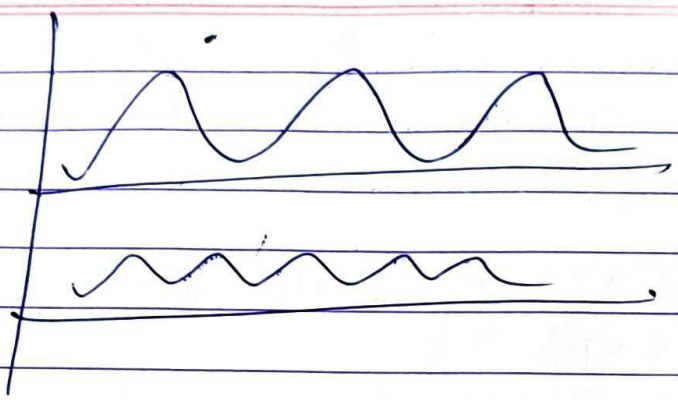
Multiplexing :-



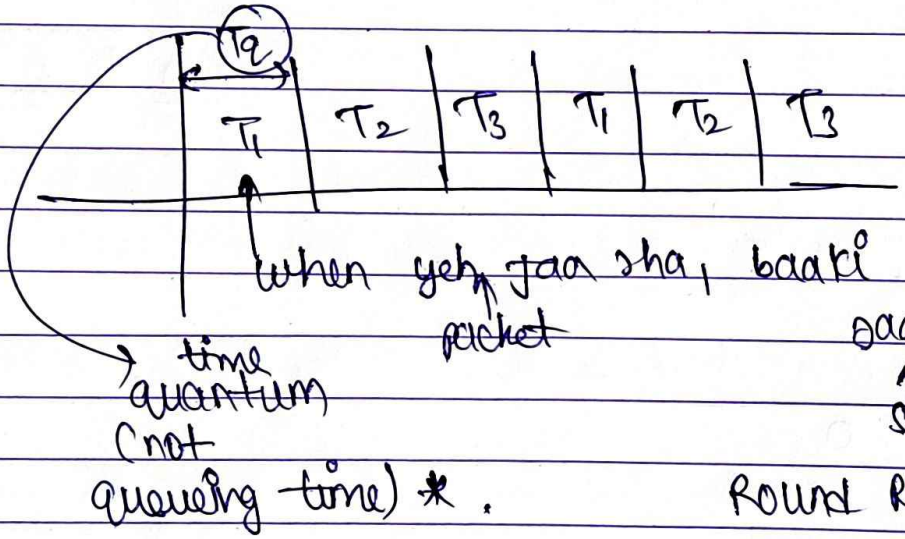
If want to send (simultaneously) multiple packages then can't send them in jumbled way, so need mechanisms :-

(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 :-

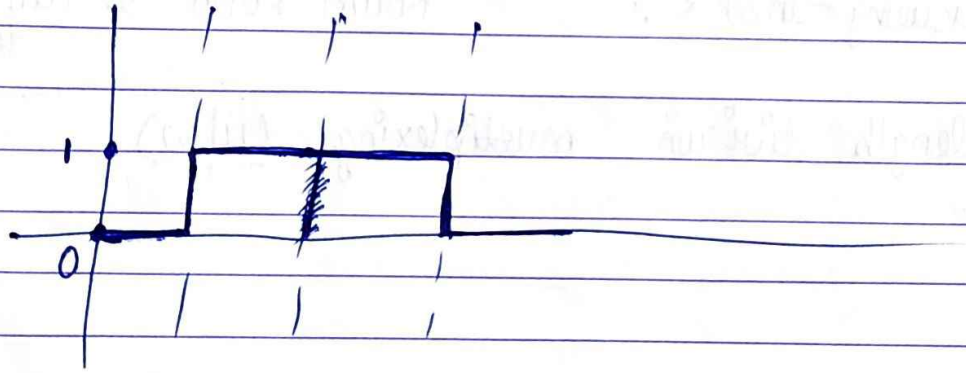
⊙ Data in form of signal, Data, toh conversion toh karni pdhti hai!

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 :-

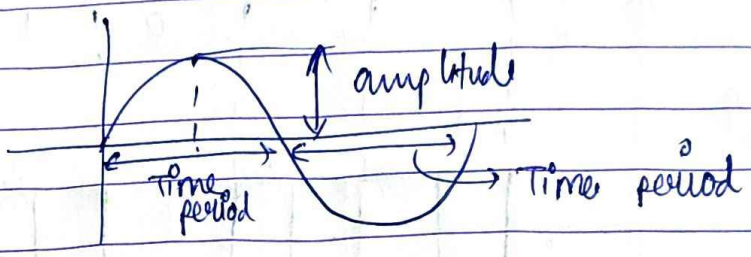


Encoding techniques :- (1) Unipolar → only +ve used
(2) Polar
(3) Bipolar → +ve, -ve, 0 all are used.

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 :-

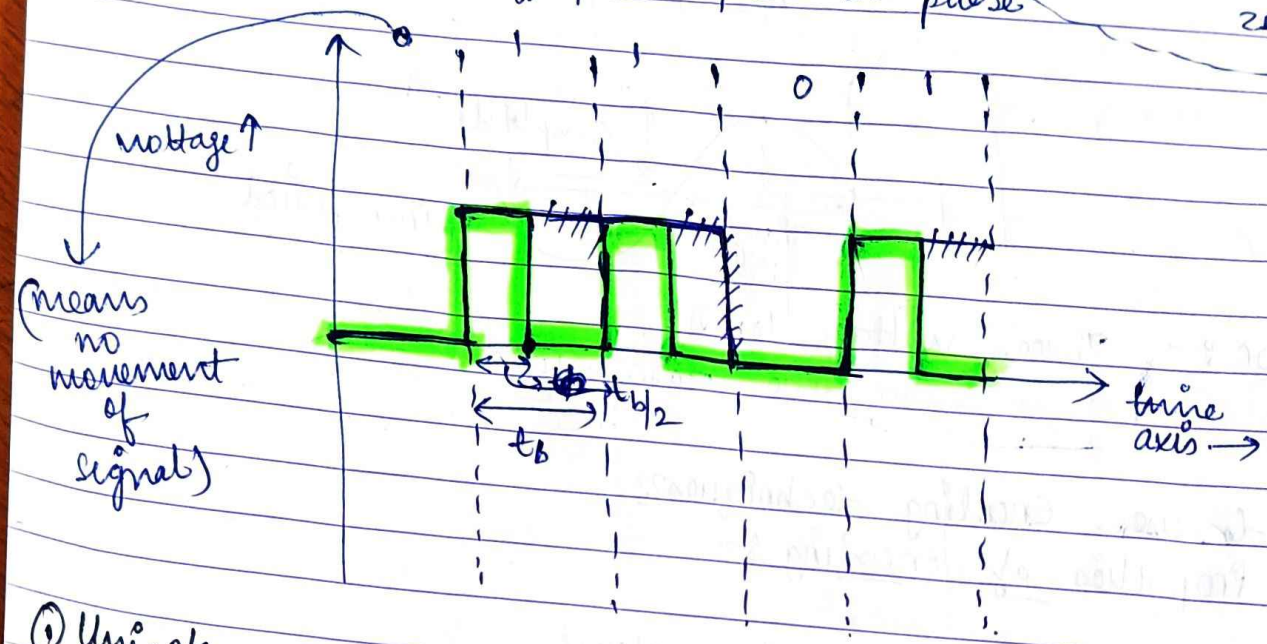
1. RZ (return to zero)
2. NRZ (not return to zero)

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

WOMK

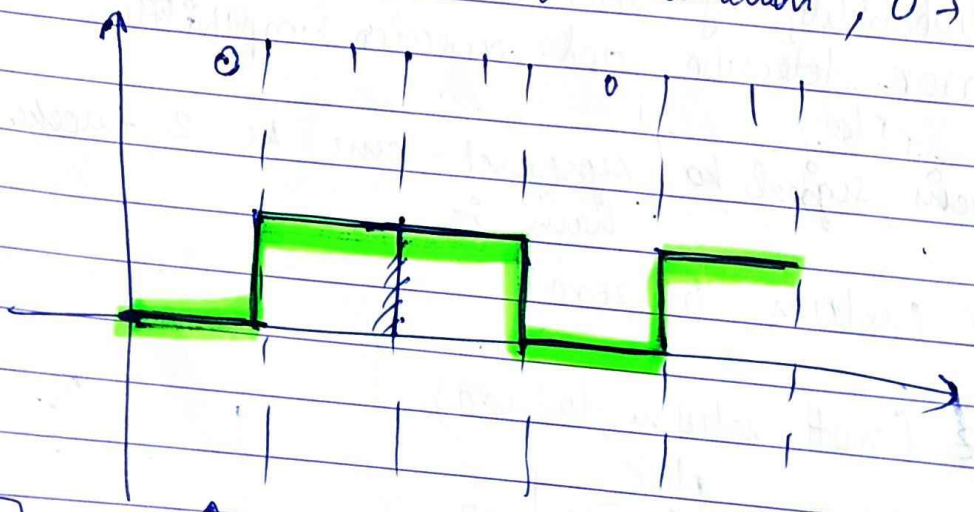
① Unipolar – RZ

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

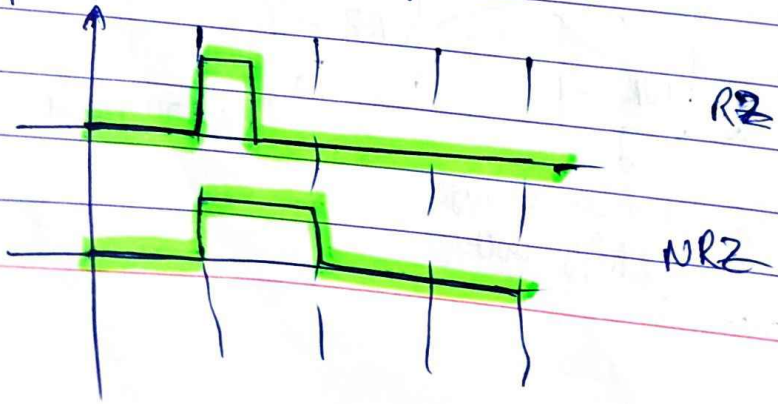


① Unipolar – NRZ

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



0100 →

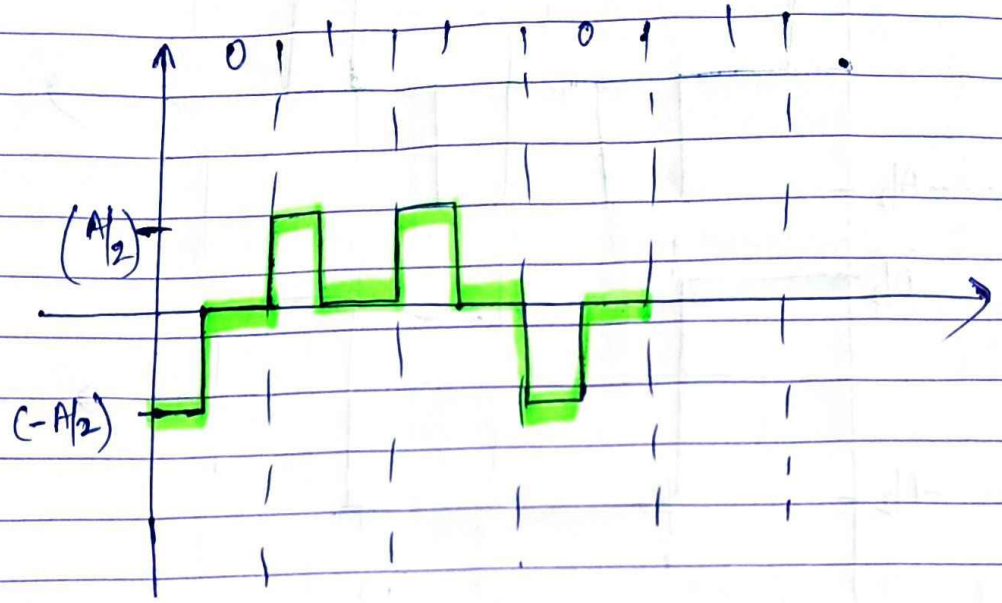


100 MK e
= MM.

④ Polar RZ

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

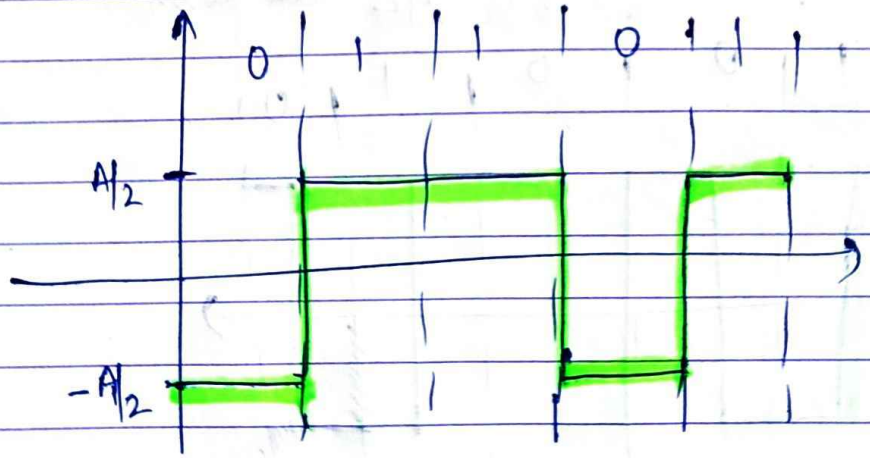
1 → ON pulse for duration $T_b/2 + A/2$ followed by return to zero.

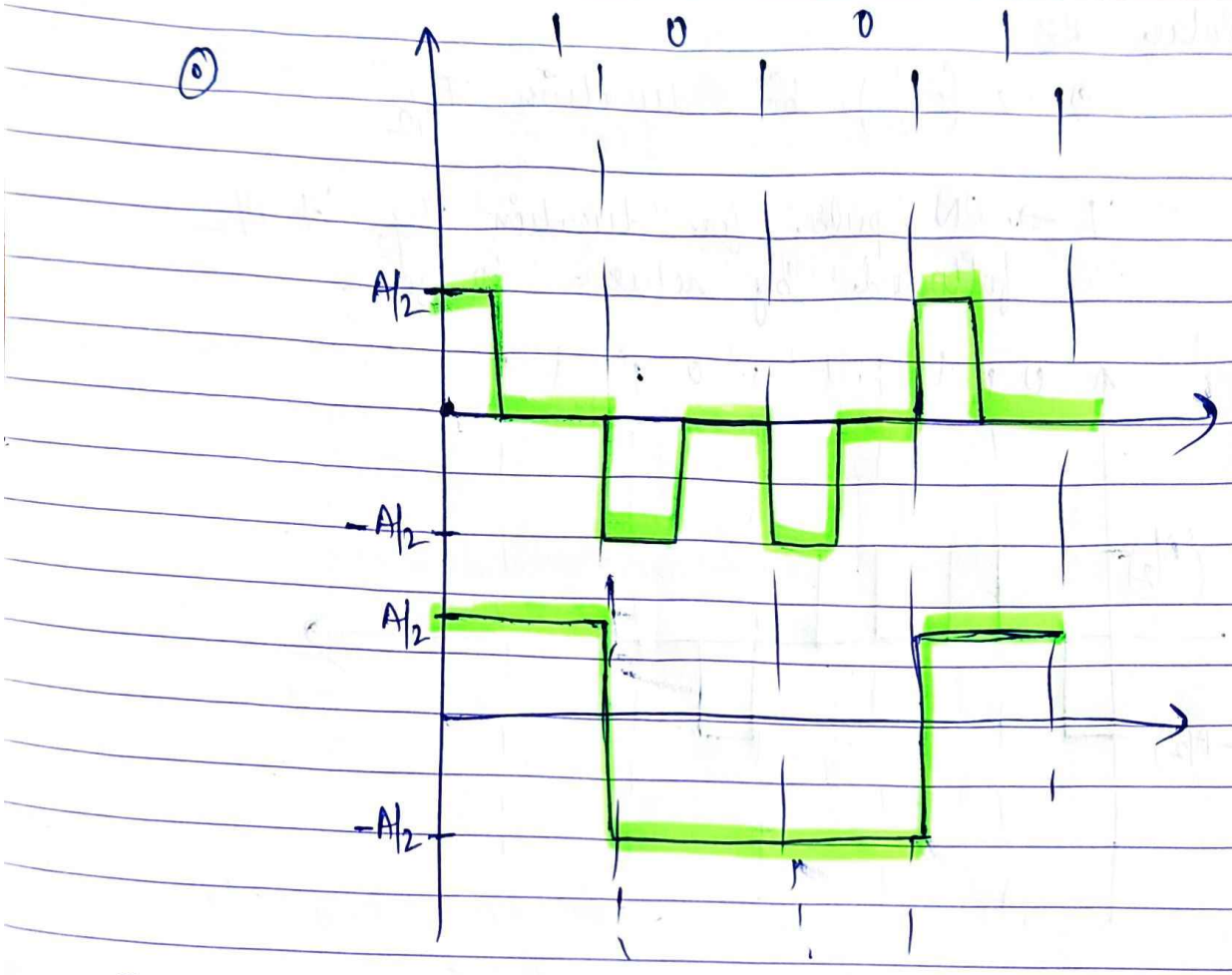


⑤ Polar NRZ

⟹ 1 → pulse for full duration $+A/2$

0 → off pulse $(-A/2)$

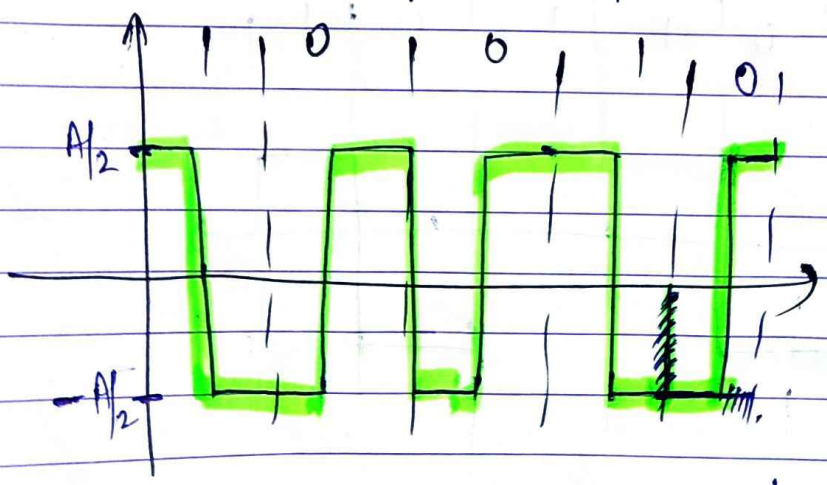


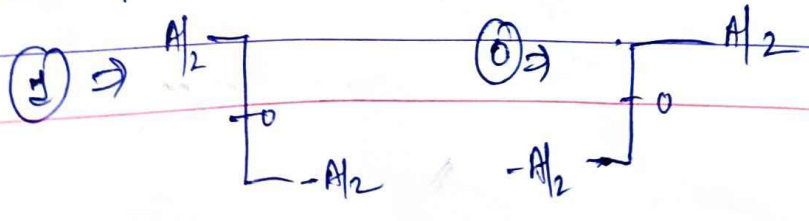


(3) Manchester Encoding :-

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.

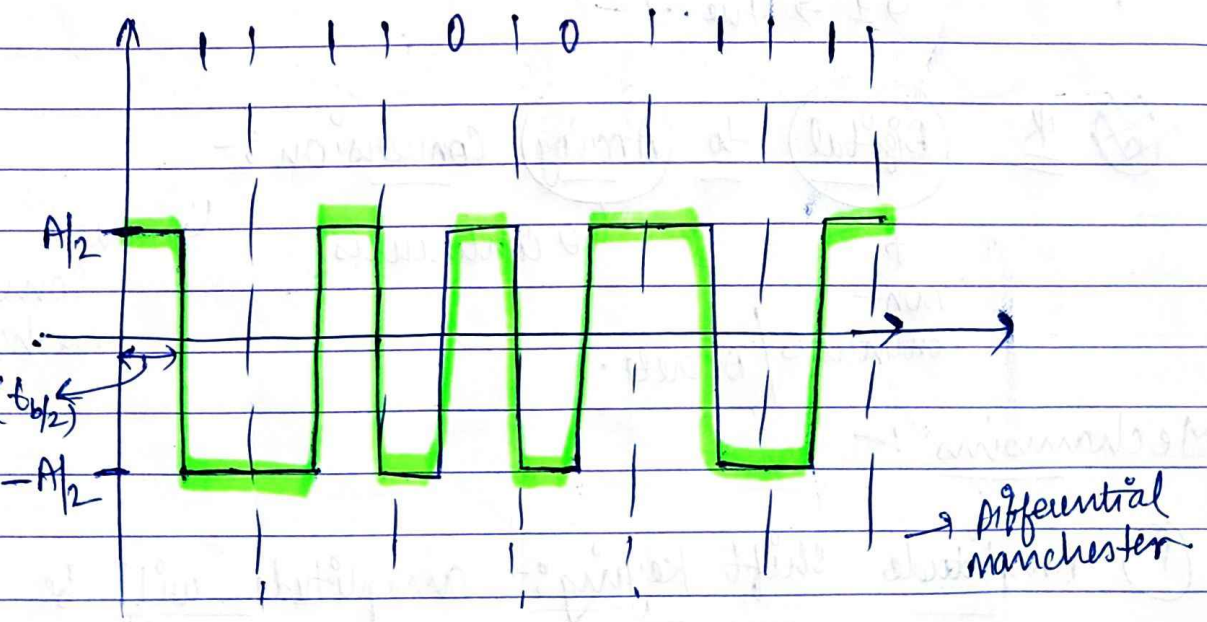
1 | 0 | 0 | | | | 0 |

(A/2)

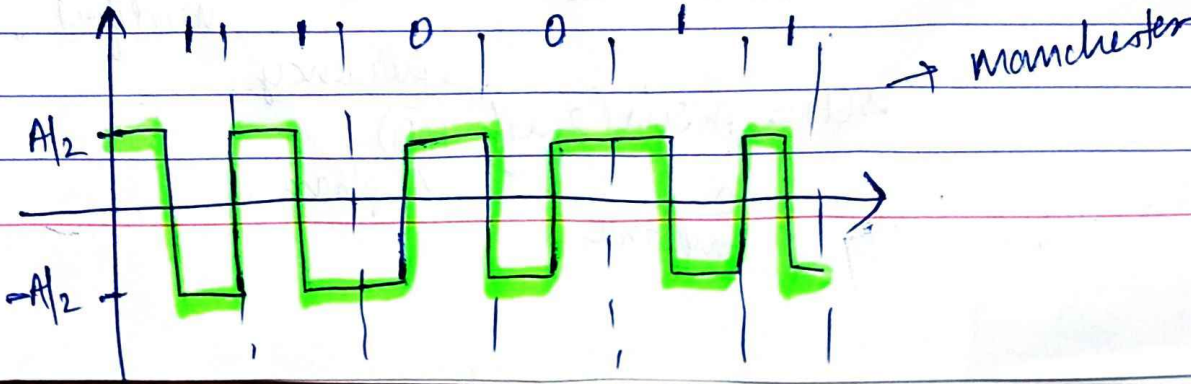
(-A/2)

ismein (I) follow kro

ismein (II) follow kro



→ Differential manchester



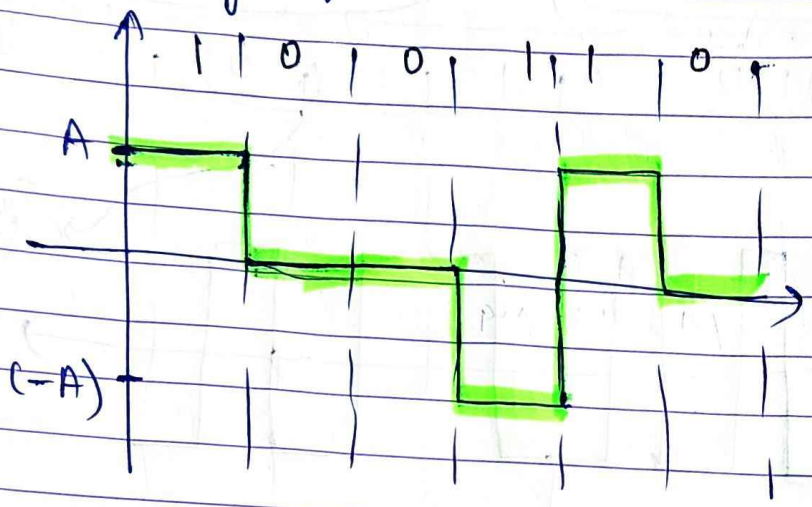
→ manchester

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

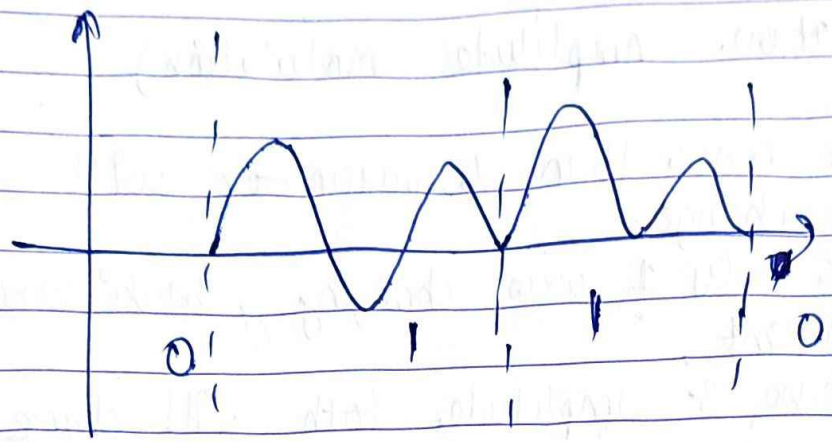
↳ need some mechanism.

Mechanisms :-

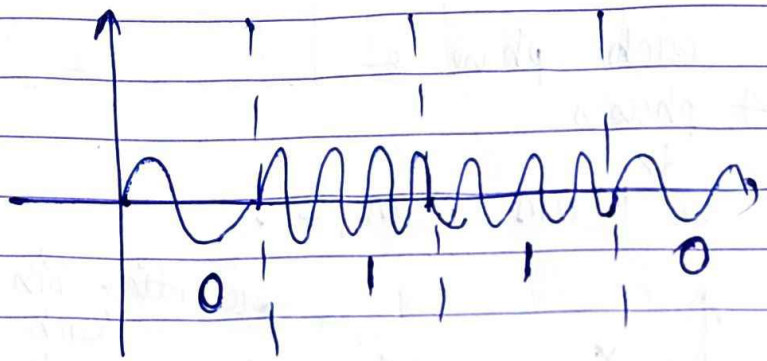
(1) Amplitude shift keying :- amplitude will be modified.

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

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



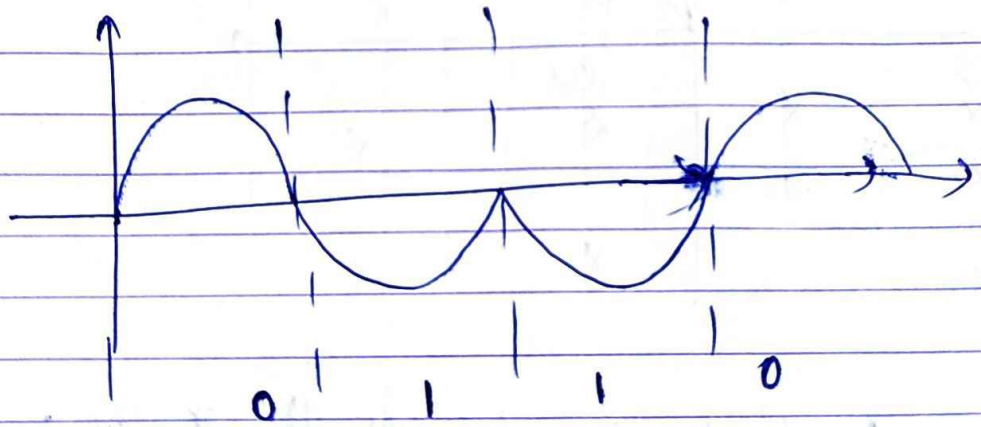
② Frequency shift keying :- set different frequency for 0 & 1.



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

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

when bit changes



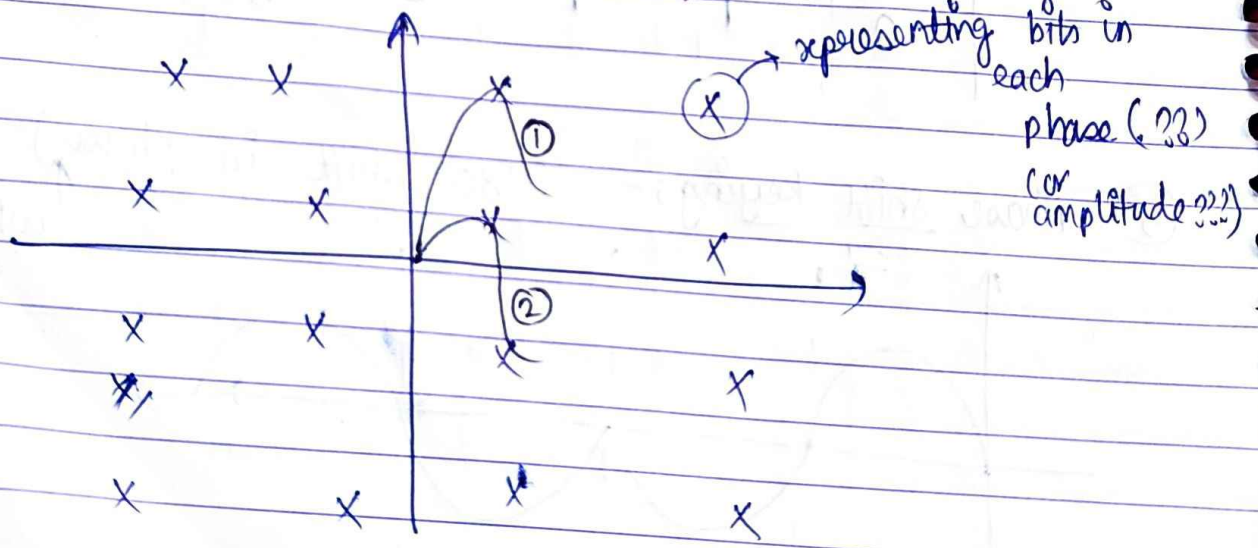
WJMK ಓ ಮ್ಮ.

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.

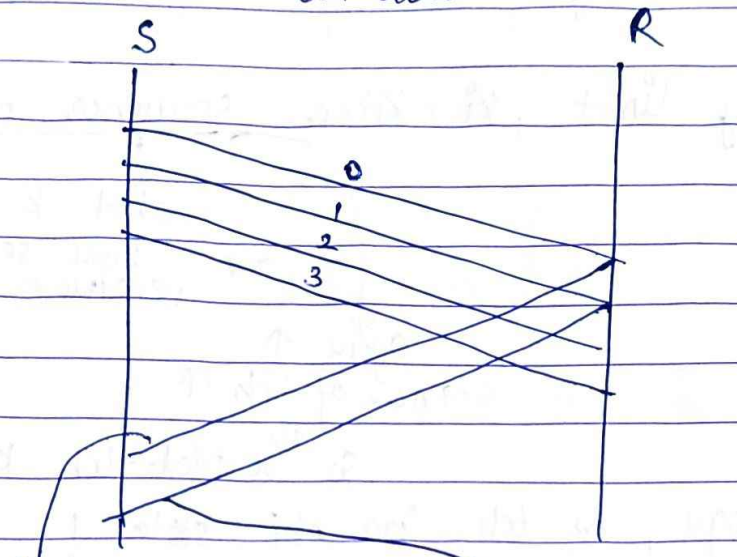


Amplitude can be like ① or ②.

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

↑

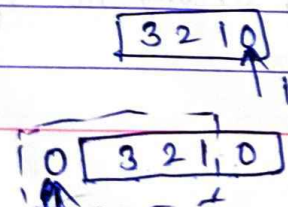
4 bits chahiye hongi

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

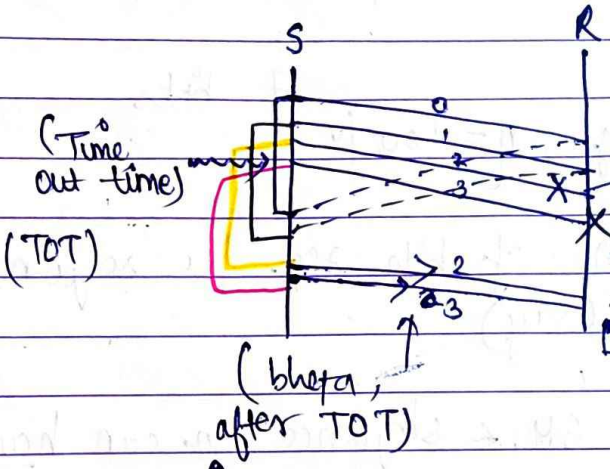
↑ means ek se jyada packet bhej raha hai bt acknowledgement.

(2) Receiver window size is 1

↑ R can't buffer more than 1

GB-4 :-

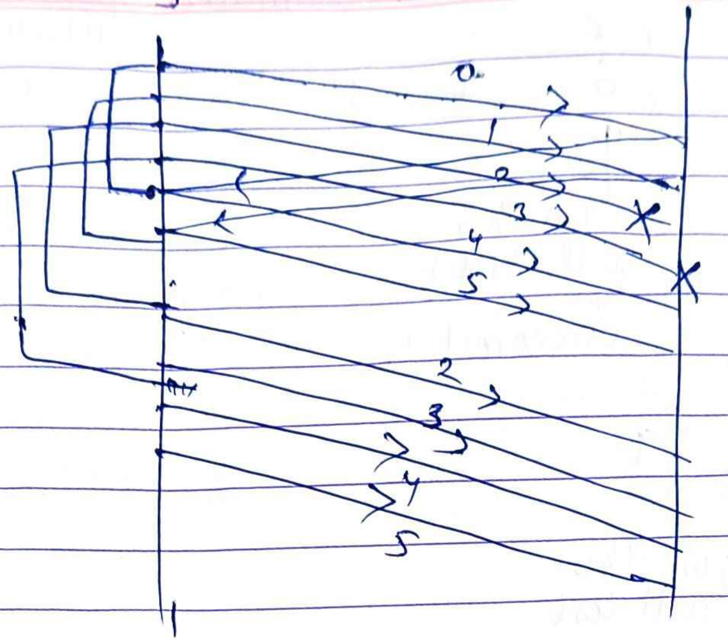
Sender window size = 4.

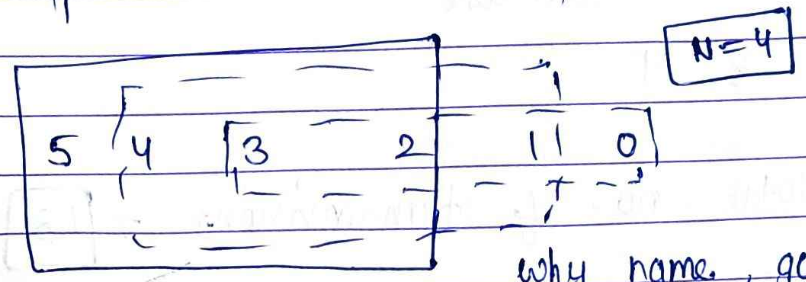


In GB-N, out of order packet is not accepted!

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

WMK 8:10.

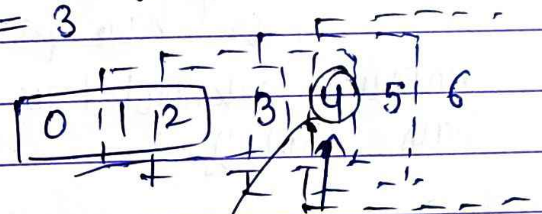




why name, go back N ??

Q. GB3 :- Every 5th packet transmitted is lost, and we have 10 packets to send. Then how many transmissions are required ??

A. $W_s = 3$

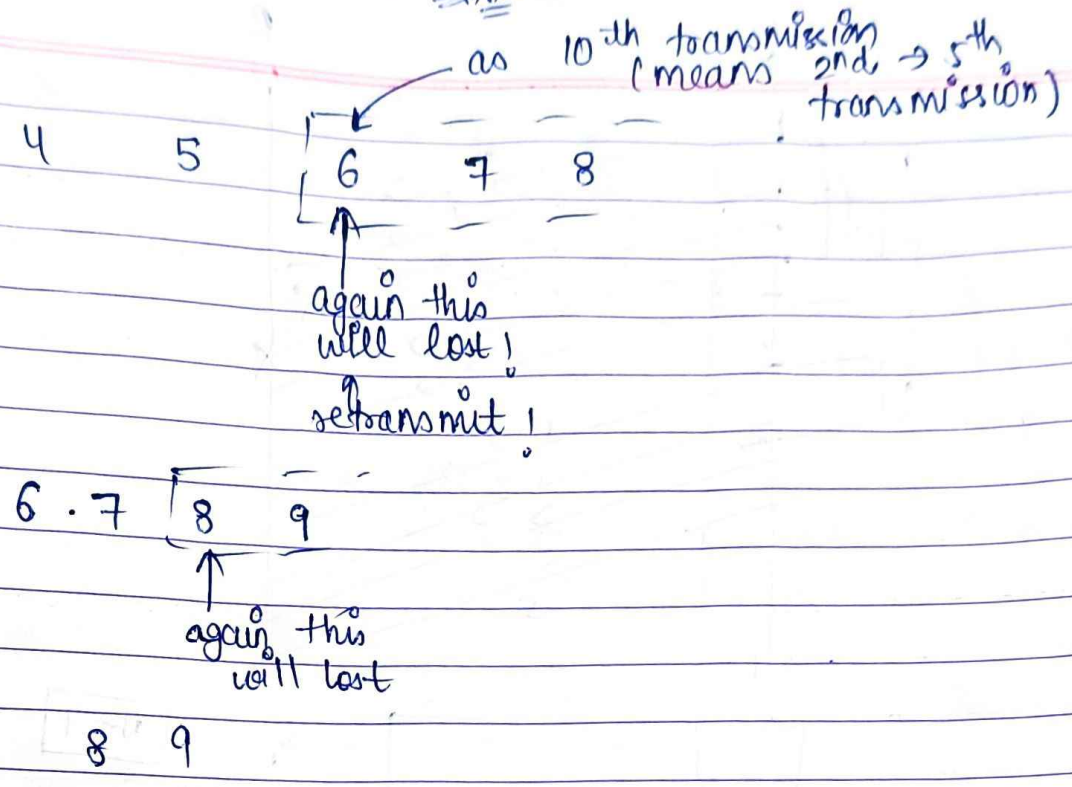


successfully snd yhaan tak & acknowledgement bhi milti rahi !

→ 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

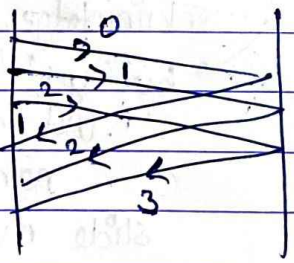
→ So far, we have Independent acknowledgements !! in medium

ant of traffic ↑ will be high !!

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

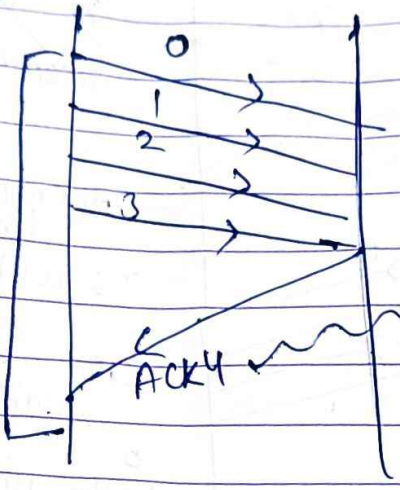
Acknowledgement :-

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?

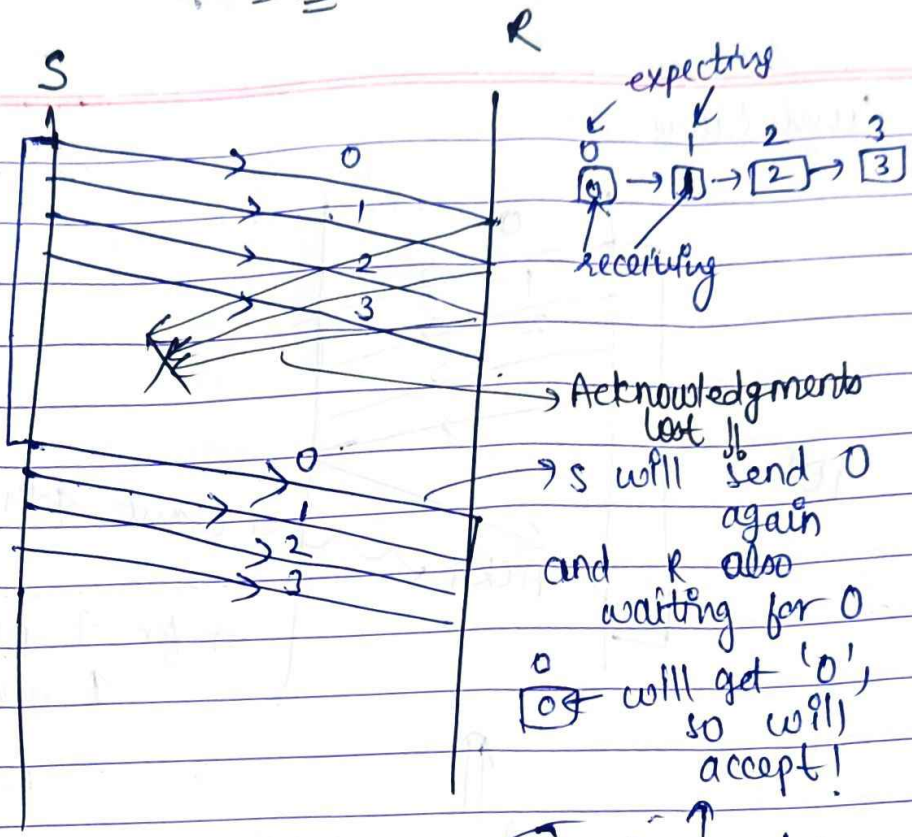
→ If very less ← fir toh independent wala kaam hi hogya.
→ If very ↑ ← toh S wali side TOT hoga ← If it will exhaust or expire ← toh wo aur bhejne lg jayega!

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!!

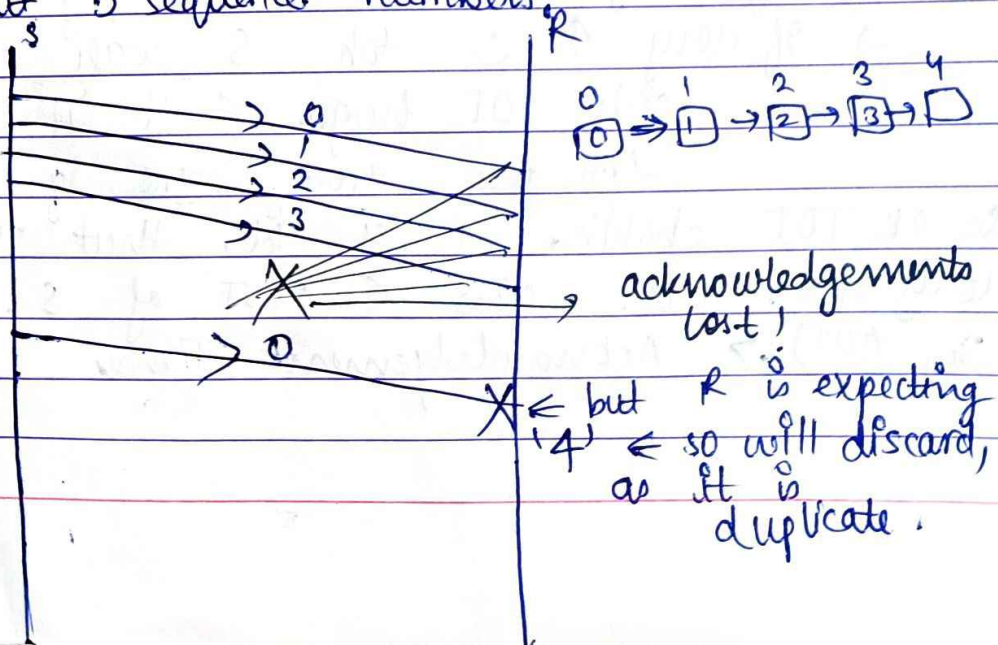
So, R ~~to~~ is unable to identify ~~that~~ ki wo duplicate packet hai!

4 seq no & window size also 4.

Let's say :

ws = 4

but 5 sequence numbers

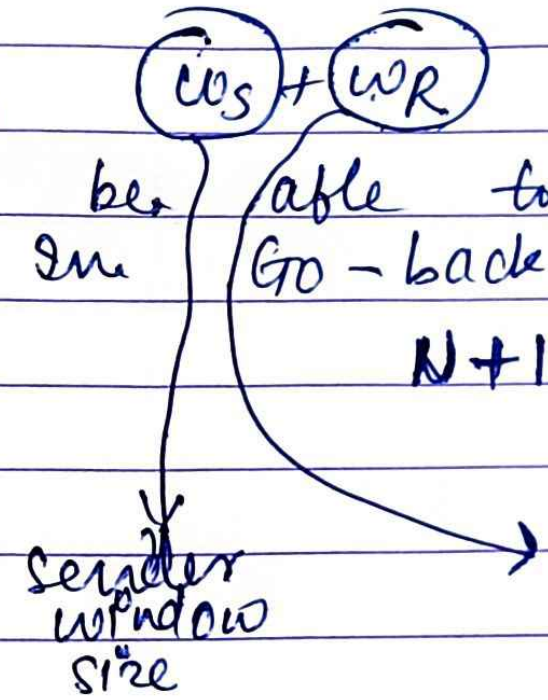


WORK IS DONE.

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!



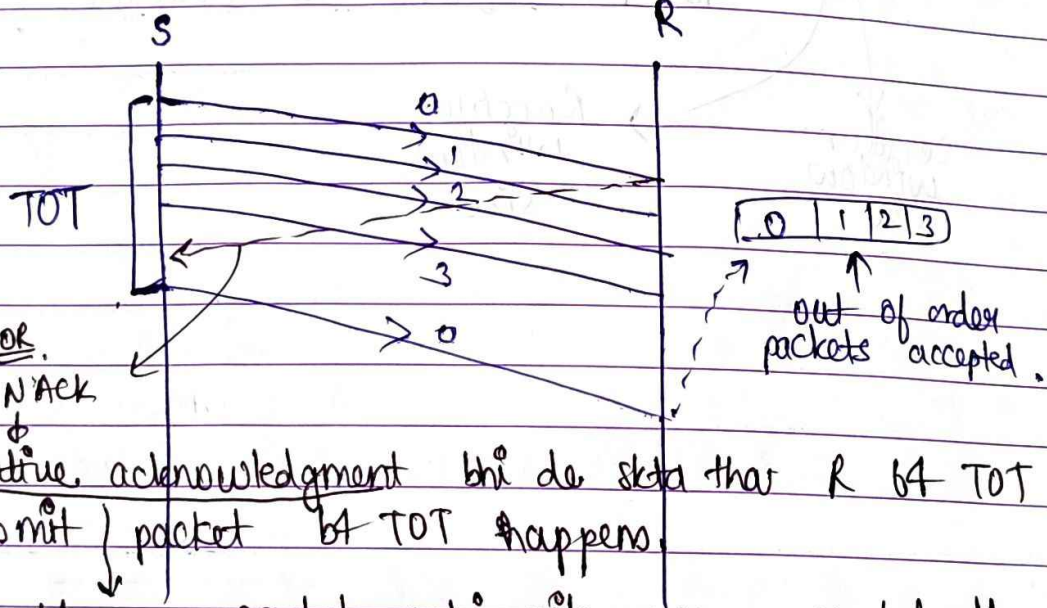
WOMK

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.

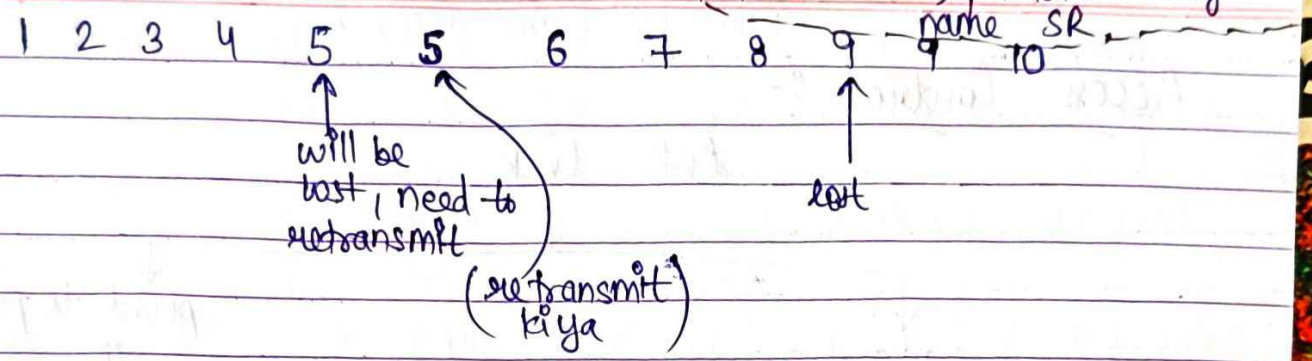
nahi-toh TOT se baad toh S bhejega hi pehle $W_R = 1$ → so if expecting for '0' & na mila, toh uske baad wale like '1', unko discard kr deta hai!

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

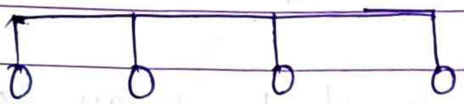
WJMK

→ 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.

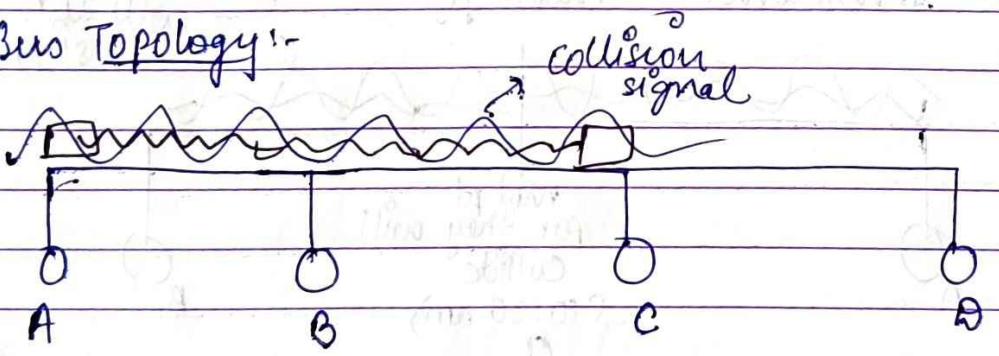
in Tpoll duration → all who want to transmit msg will raise request, then can send msgs.

| 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.

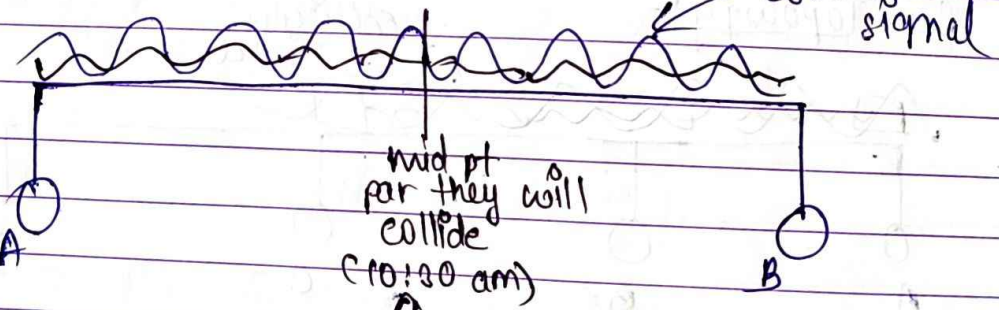
A ne sense kiya channel & found that it is free & place kiya apna data, let's say same time par C ne bhi dekha tha channel → free tha → usne bhi apna packet bheja...

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

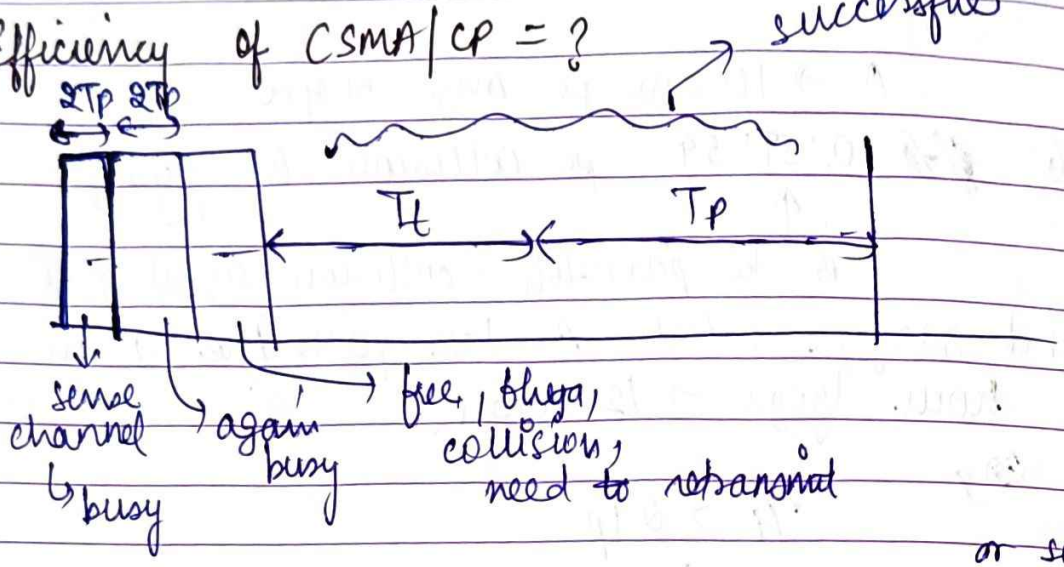
② what if $(2)(T_p)(B)$

↑

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 $d \uparrow_s \Rightarrow \eta \downarrow_s$

$L \uparrow_s \Rightarrow \eta \uparrow_s$

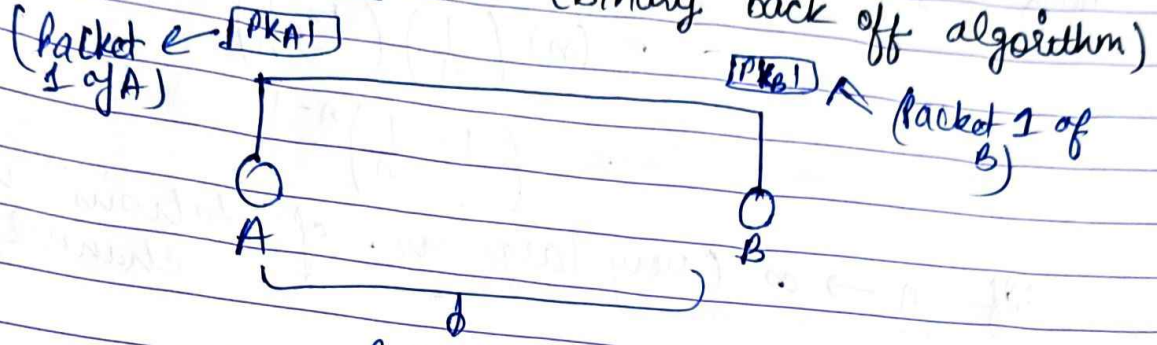
↳ so $d \uparrow, L \downarrow \Rightarrow$ so classical LAN / Ethernet k liye suitable !!

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

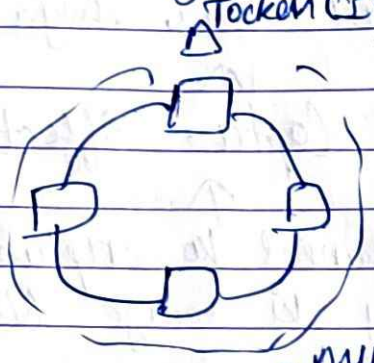
⑥ next Access Control Protocol :- TOCKEN PASSING :-

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.

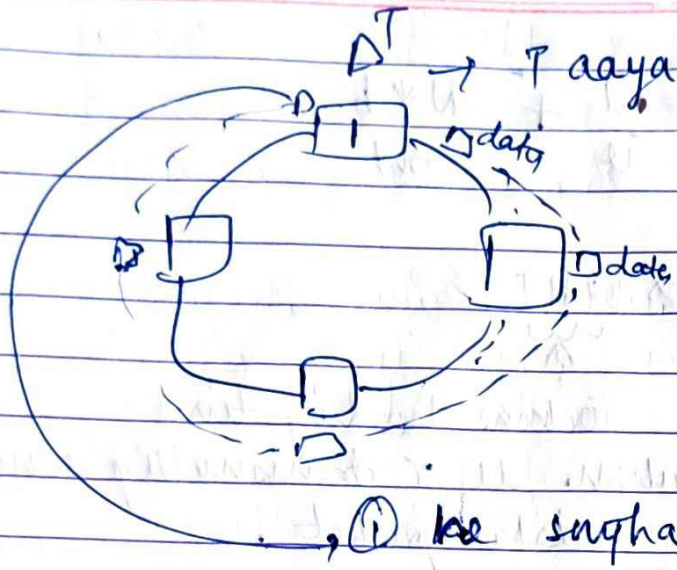
$$\eta = \frac{N * T_t}{\text{Total cycle time}} \quad (\text{useful time})$$

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

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

① ⇒ will delay the reinsertion of Token in Ring

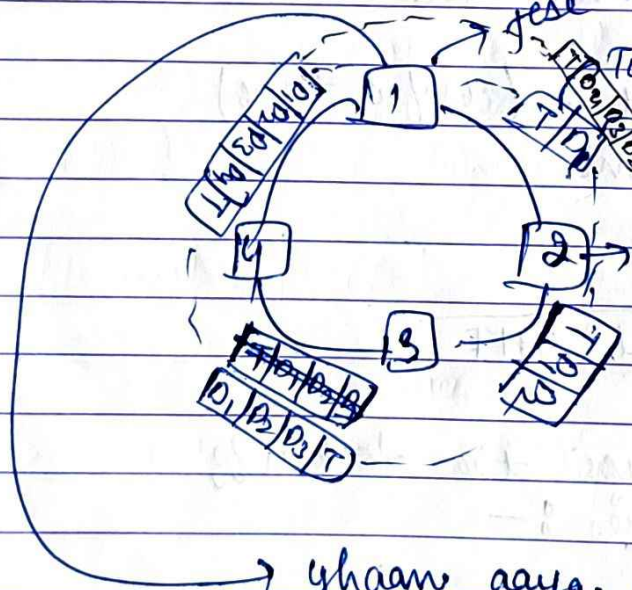
WJMK ☺



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.

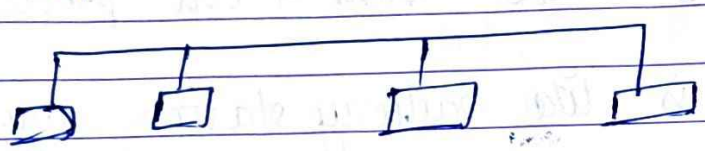
D_4 will released by 4 and sof. T bchega!

WOMK & SOM.

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

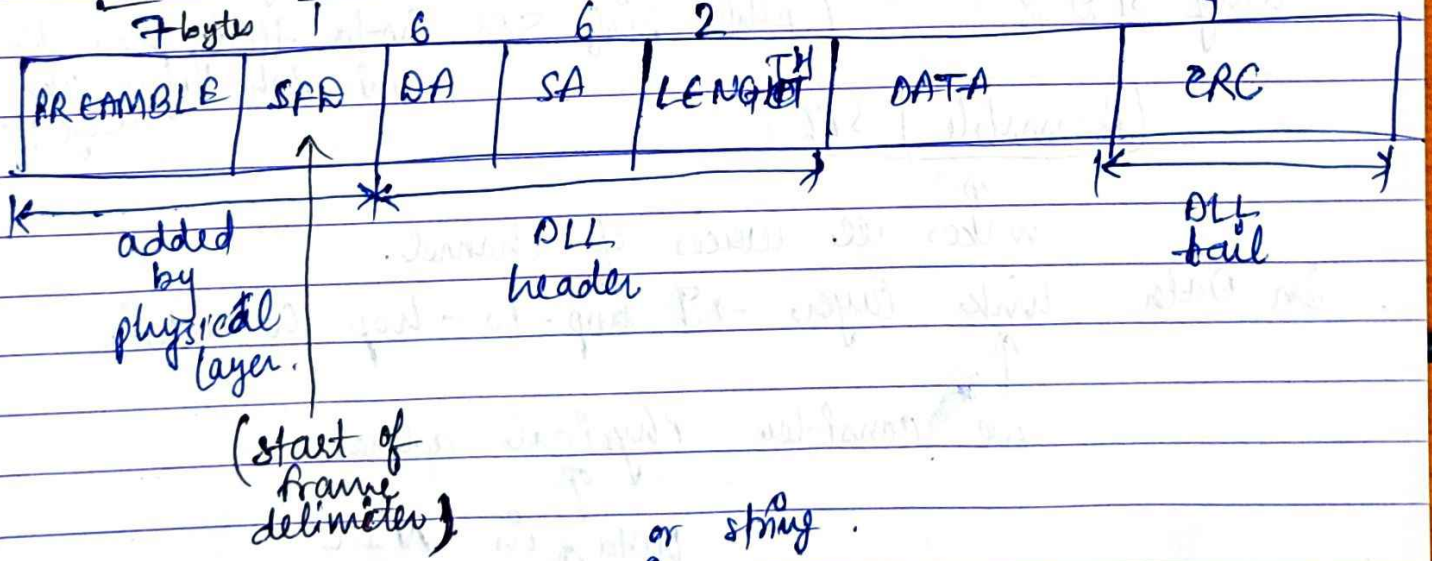
⊙ ETHERNET / LAN TECHNOLOGY / IEEE 802.3 :-

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!

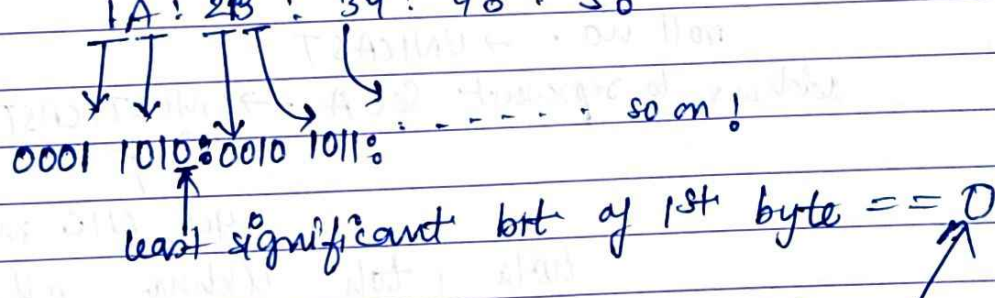
Types of MAC (physical) address :-

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.

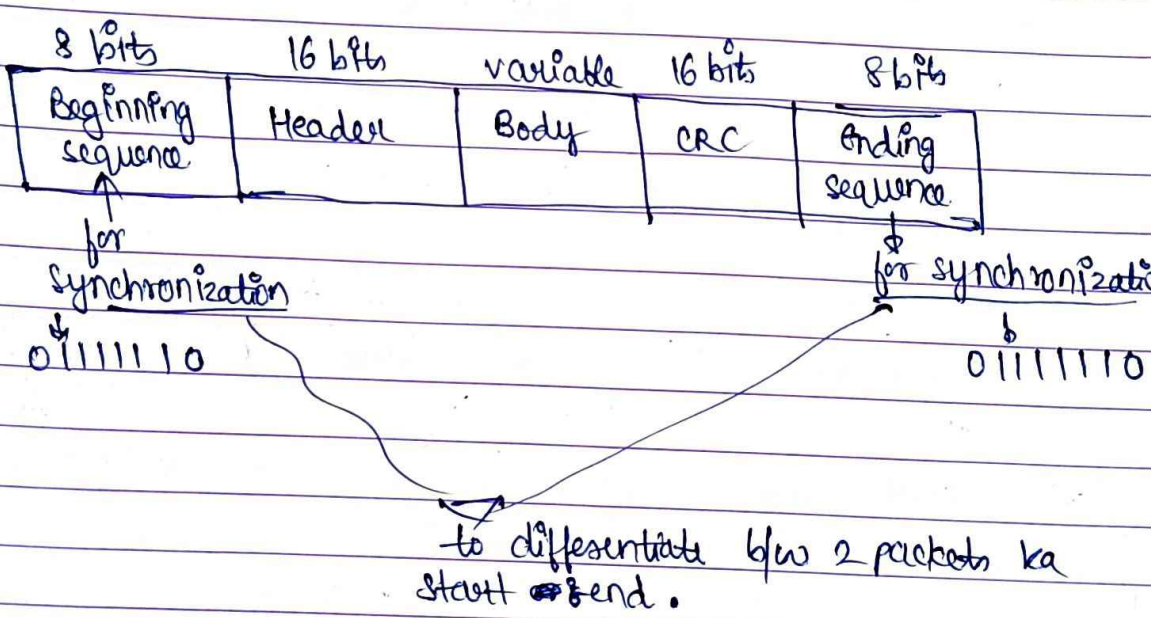
WAMK

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)

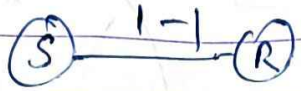
(don't go in much depth)

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

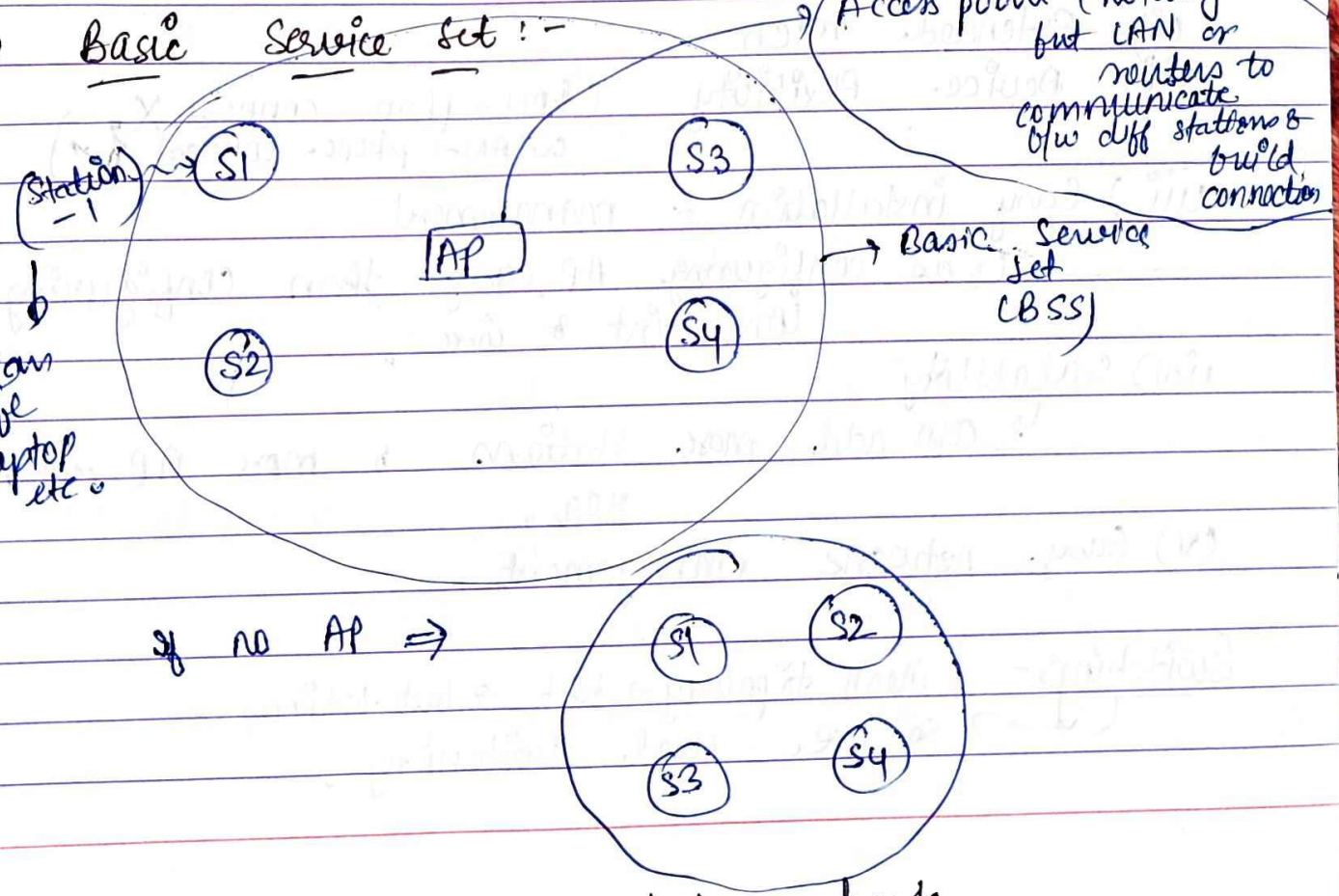
It is constant here, as PPP has no types.

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

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

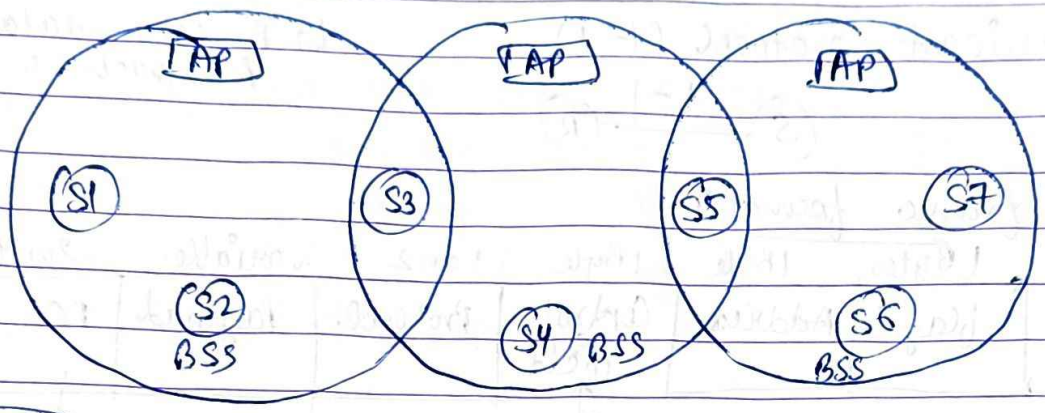
↓
IEEE 80211

• 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.

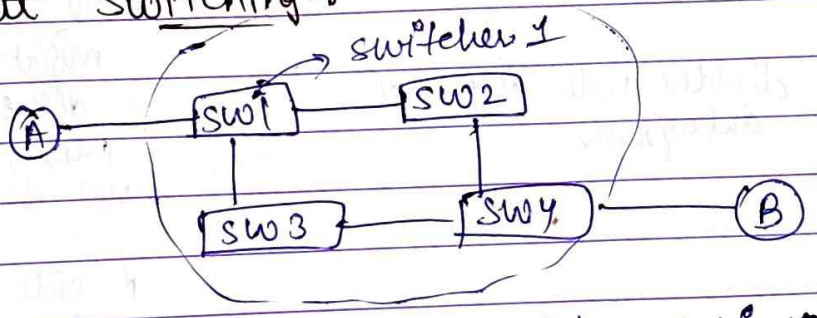
Switching :- Mesh topology → best → but tedious
↳ → so we used switching.

Switching Types :-

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

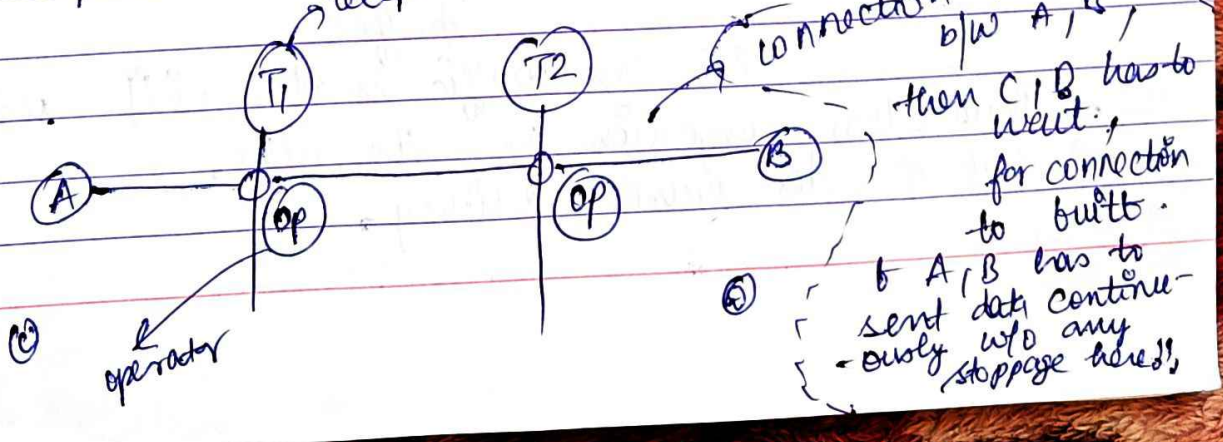
(i) 3 phases of switching :-
   (i) Connection establishment
   (ii) Data transfer
   (iii) Connection termination

Circuit Switching :-



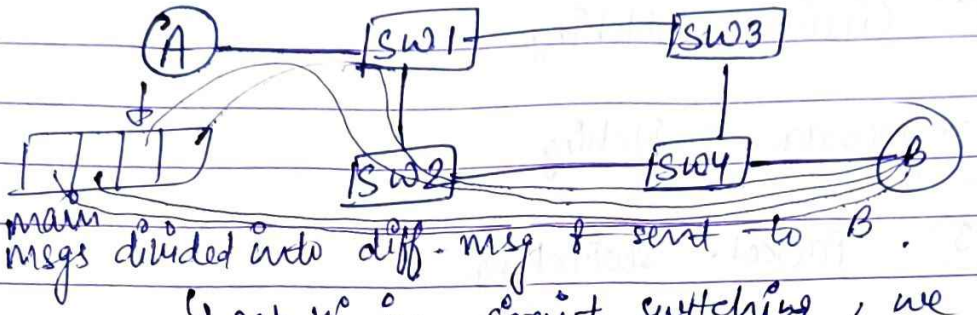
↳ all this dedicated only for connection b/w A & B.

eg :- telephone



WOMKE
3 000.

Message Switching :-

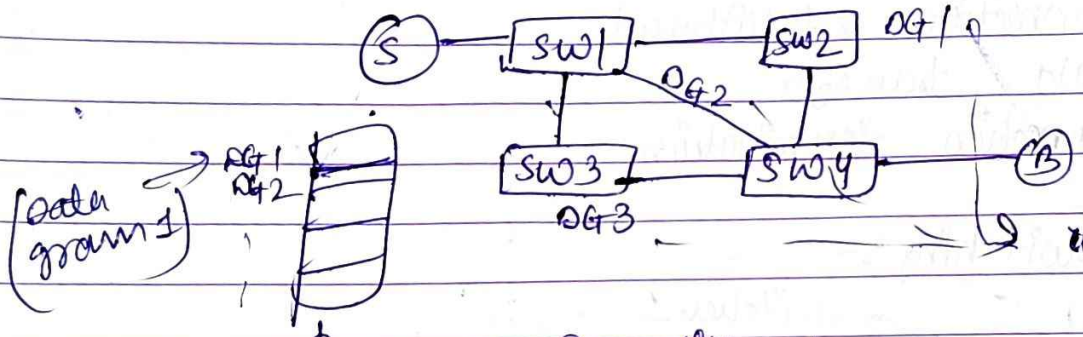


main msgs divided into diff. msg & sent to B.

↳ 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

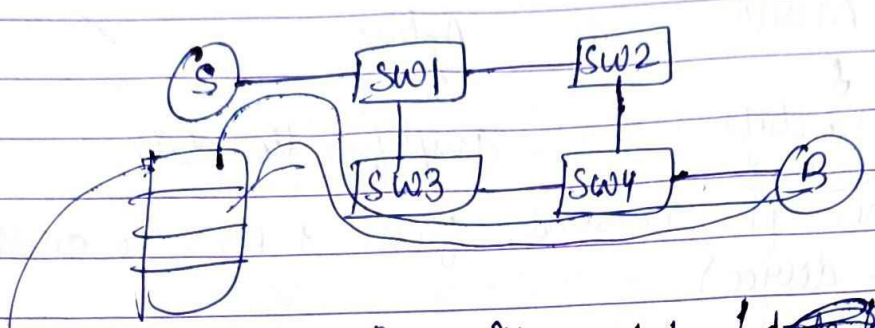
→ so here traffic in n/w will reduce...

→ Thus less congestion in the n/w.

→ Out of order packet delivery.

WORK:
.com.

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

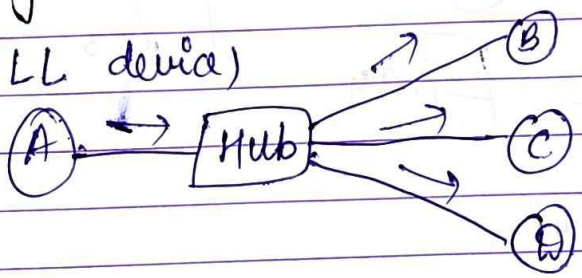


data divided into diff packets / ~~data~~ msgs.
→ sequence no. not required.
→ 1st packet path lega, baaki packets bhi wo hi path chose kreinge!

→ connection oriented
→ only single fixed route.

• Networking devices :-

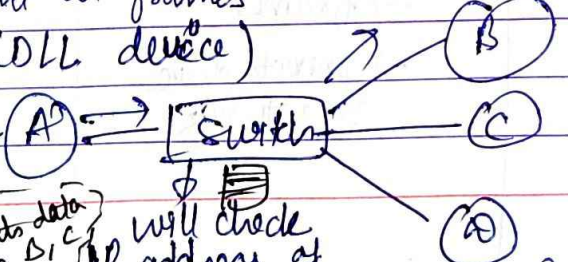
(1) Hub :- (DLL device)
(Physical layer device)



→ 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.

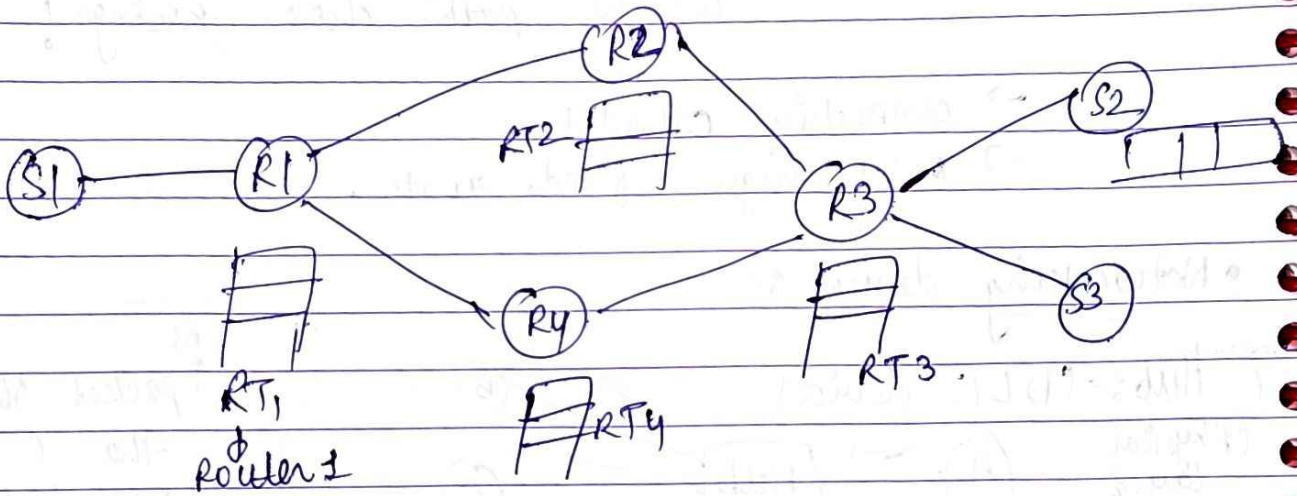
can't do broadcasting but multi-casting
yes: A wants data to go to B, C to switch bhejega
will check IP address of final destination & usi ko bhejega!

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.

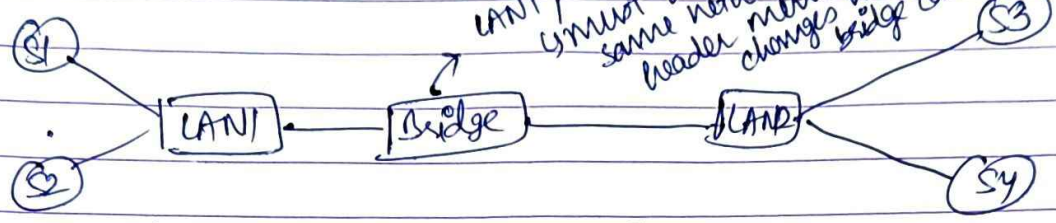


→ data sent as packets.

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.

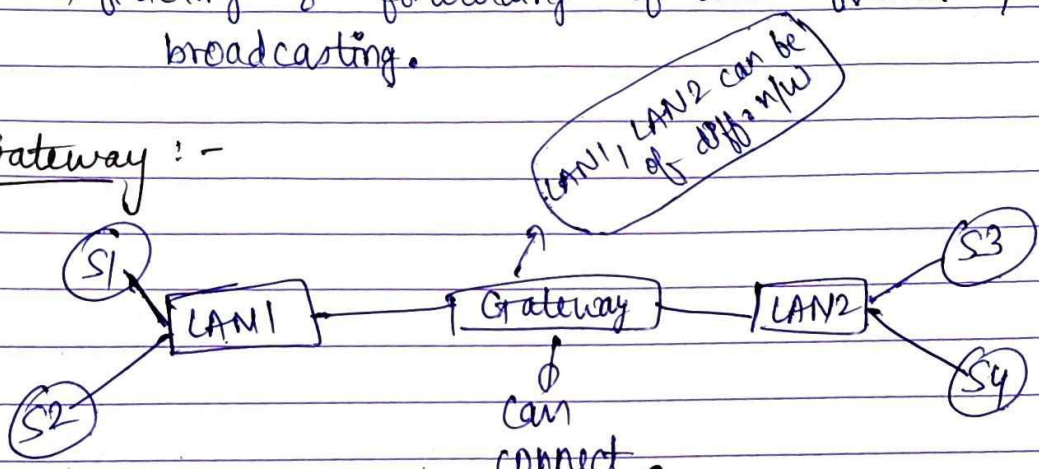
(4) Bridge :- connects two or more LAN networks.



[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

↑ 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 :-

range (0.0.0.0 – 127.255.255.255) ← class A 0 (fixed) 7 bits left (so 0 → 127) min max

B

C

D

E

WORK IN PROGRESS.

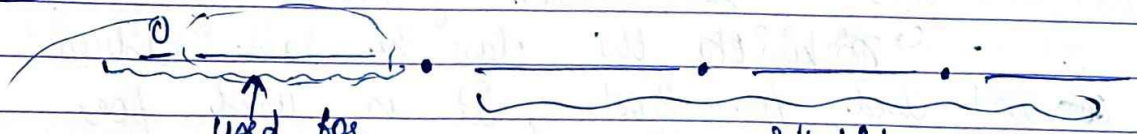
Class B → (128.0.0.0 — 191.255.255.255)
↳ 10 . ——— . ———
(fixed.) (6 bits left)

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

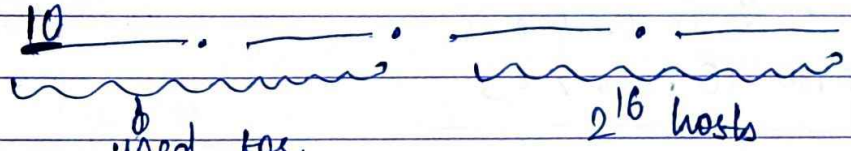
① Class A.



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

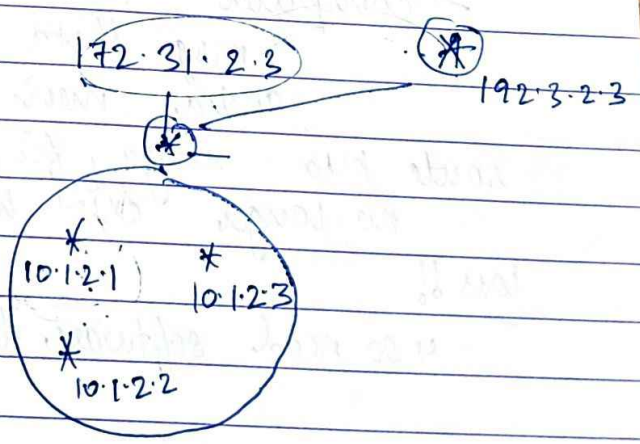
↳ (195.31.4.0 – 195.31.4.127)

↓ 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.

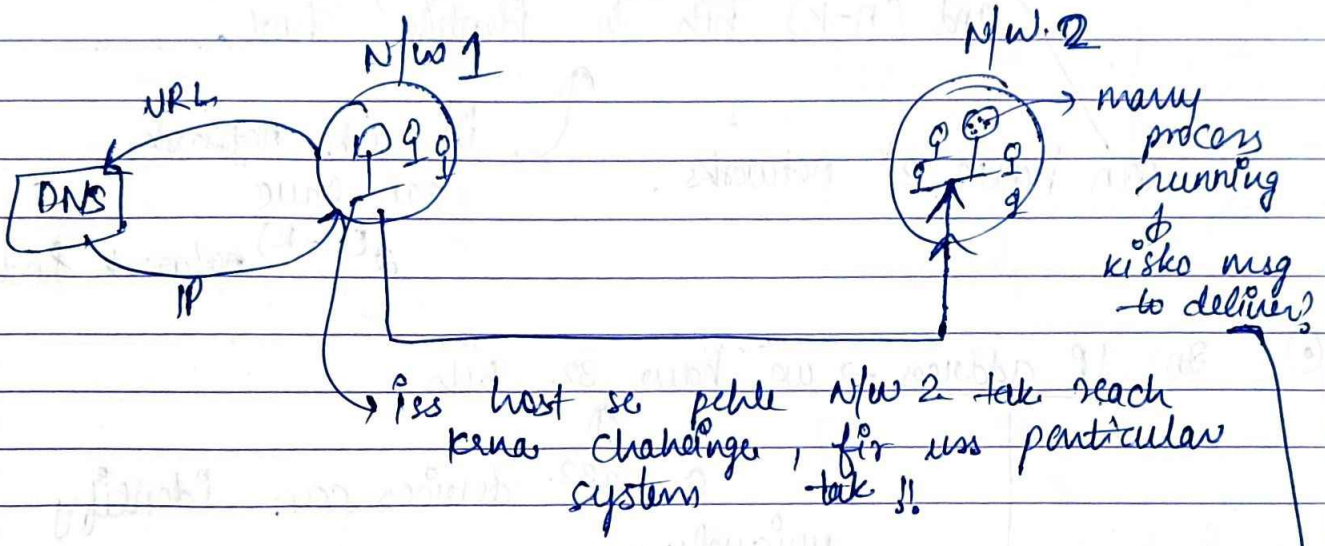
→ computer made in India, aap gye UK, msg bheja usko kisi ne, usne sochega India mein hai → wo India mein route krta rhega, fir it will realise ki device no longer exist here → so mapping efficiency less !!
↳ so need software based/generated address → IP address !

www.google.com
↳ gives IP address.

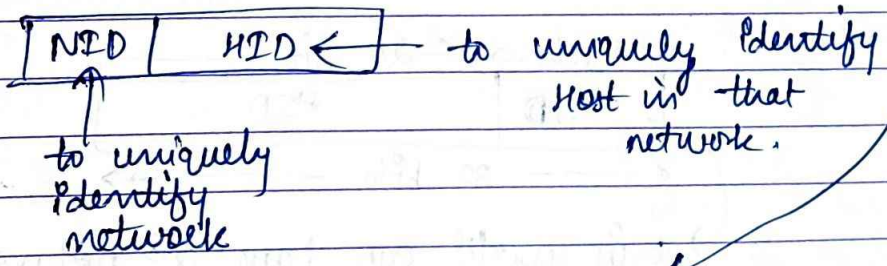
We are not good at remembering IP address, but can remember URL of that particular site.

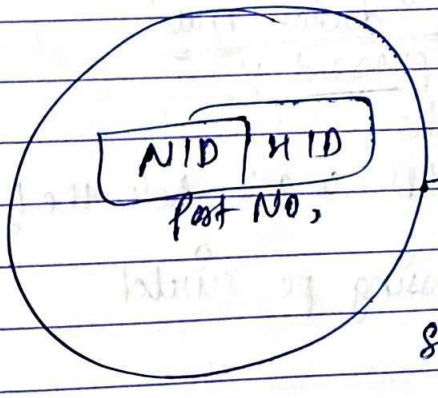
DNS → Domain Net Service.

↳ 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.

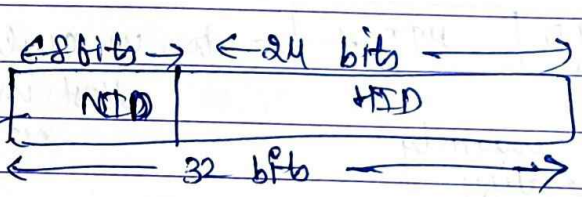
① In IP address → we have 32 bits

so 2^{32} devices can identify uniquely.

(software based address)

NID → Important

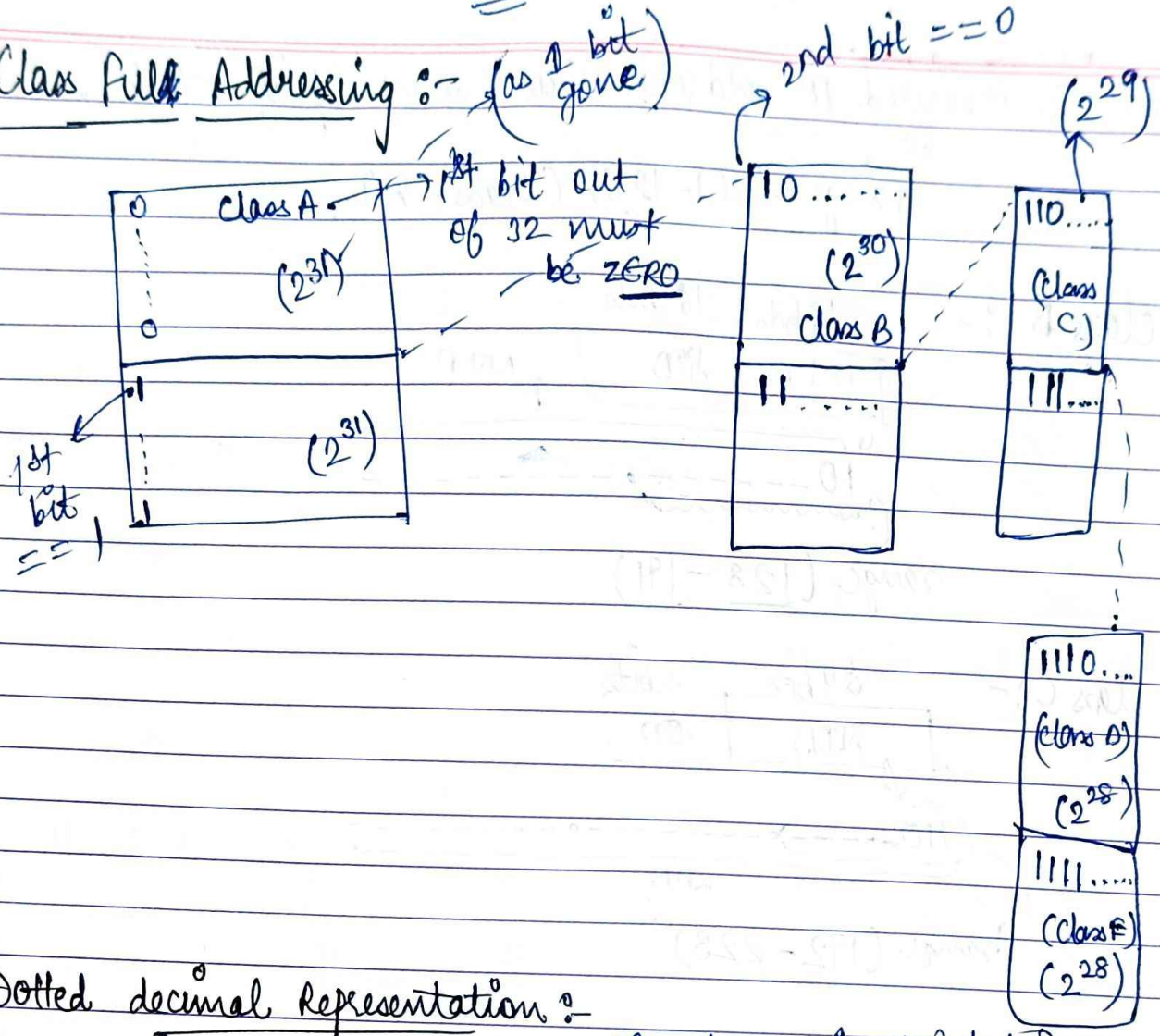
∪ o/w IP address == MAC address.



∴ 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

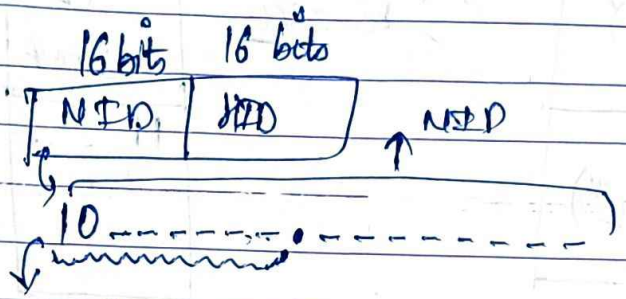
range [0 - 127] → so 128 networks can have!

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

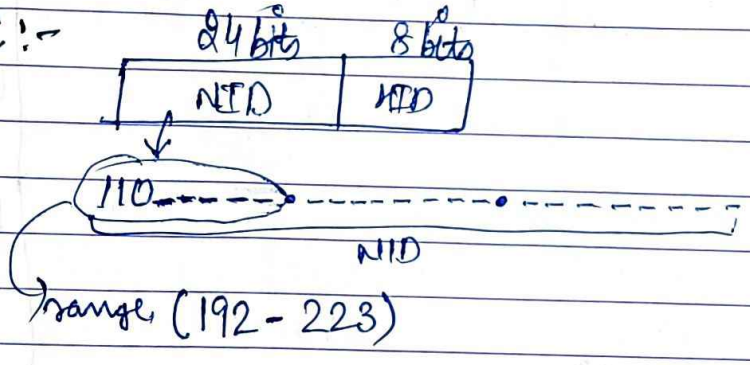
WSMk 8
IV

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!!

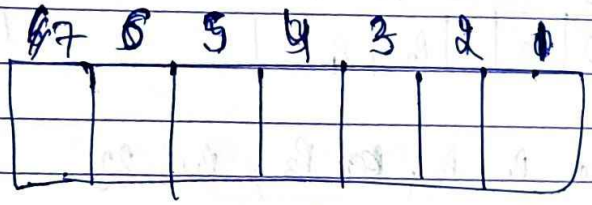
WORK

21 Feb 2024
Wednesday

lec-13 :-

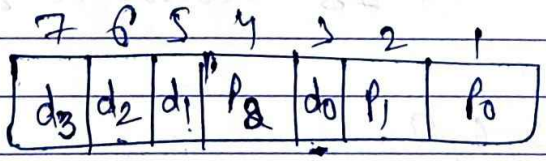
① Hamming Code :-

↳ 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.

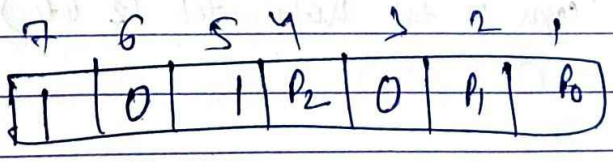


4-bit data (d_0, d_1, d_2, d_3)
3-bit parity → say : P_0, P_1, P_2

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

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

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

To calculate P_1, P_2, P_3, P_4 ??

$P_1 \to 1, 3, 5, 7, 9, 11$ — iwalon 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 occured here

⇓

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

11 10 9 8 7 6 5 4 3 2 1

Receiver should be able to understand that error occured!

↳ R will also perform XOR operation.

$P_1 \to$ 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 kr rahe ⇒

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

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

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

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

$P_2 = 0$ (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

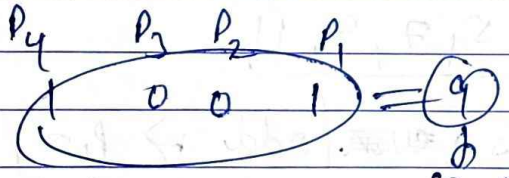
here, $P_1, P_4 \neq 0$

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?

कालतंतु कश्चिच्छित्त्वा भविष्यति,
निरमुक्तेर कालेत्वम् अभविष्यत्॥ ॐ.

WOMK ॐ ॐ.

4 March 2024
Monday

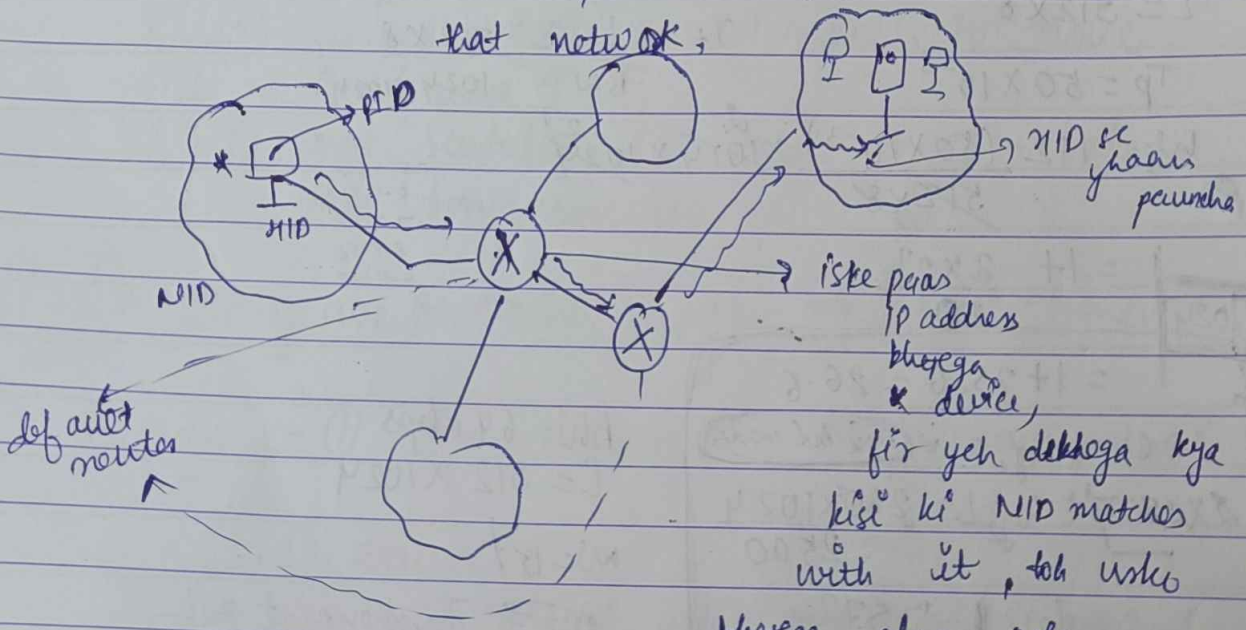
lec-14 :-

NETWORK LAYER :-

IP addressing → helps to route the packet in right direction
→ Not hard-coded
→ as devices moves from here to there frequently, so MAC address not preferable, IP address can change frequently.

NID → to reach particular network
HID → to reach " host in that network

PID → (Process ID), to reach particular process in that network.



IP address helps to perform host to host delivery.

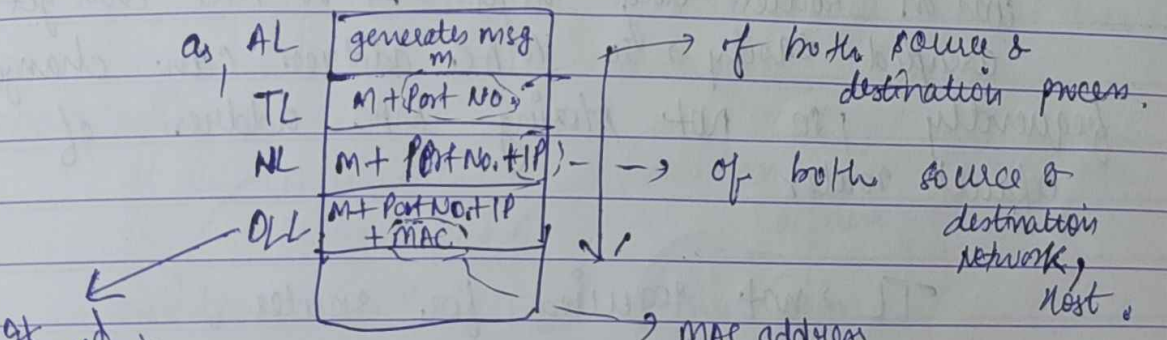
Port No. → to reach particular process in host

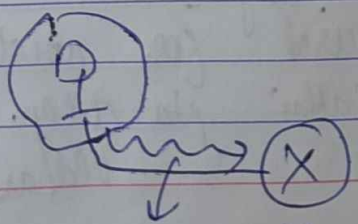
So :→ IP + port No. = Socket Id.

a router can be connected to multiple routers as well, generally ek hi default router hona chahiye, vese no problem agar ek se jyada default router ho, it will send in all directions then !!

WHERE is the MAC ADDRESS ??

for each host, 5 layers of TCP/IP.





yeh chle paaye MAC ki vjaah se.

Hm IP address nahi denge default router ka, bcoz then destination ka IP address will be overwritten and will be lost!

MAC address of default router pta chla, broadcasting karke!
↳ but kyun kare?
↳ as frequently use karenge! toh khin na kahin store krlo na, as MAC won't change, will change only when NIC will get corrupted.

load on router very high → so NIC can get corrupted easily → so MAC address can change frequently, so not storing MAC address of default router

TL → not required for router.
↳ as ismein port no. → jisse pta chlta process.

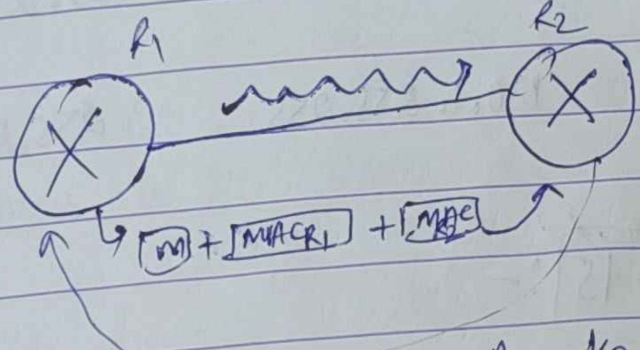
router btaata kis direction mein bhejna packet
jiska baaki sirf host tak msg bhejna, aage host khudka process tak pauncha dega!

NL → required for router.
↳ taaki pta chle router ko, kidhar bhejna data!

WDMK & TDMM:

> does host has MAC??

Every router has Routing Table :-
→ knows IP address of Default Router, but not MAC address!



R2 apna MAC R1 ko bhejega & R1 apna & R2 ka MAC add karke msg aage bhejega!

If Network very large, HID in IP is further divided into subnetwork.

Broadcasting :-

(1) Limited → Broadcast within its own N/w → 255.255.255.255 → all 1's (in IP address)

(2) Directed → Broadcast to all host in a different N/w → NID . 1111....1 (HID) ← (NID chahiye uss network ki)

(NID of destination)

DBA → Directed broadcast address
LBA → Limited " "

WORK

WORK

→ class A

IP address	NID	DBA	LBA
1.2.3.4	1.0.0.0	1.255.255.255	255.255.255.255
10.15.20.60	10.0.0.0	10.255.255.255	255.255.255.255
130.1.2.3	130.1.0.0	130.1.255.255	255.255.255.255

(130.1 → n/w, 2.3 → Host)

class B

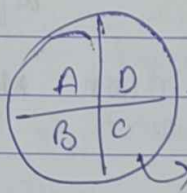
lec-15 :-

6/3/24

Wednesday

SUBNETTING :-

If have big n/w
↳ want to divide in sub n/w
then go to subnetting.



← 1 n/w
↳ divided into 4 networks

Ex IP address ⇒ 200.1.2.0

200 → belongs to class 'C'

for Host = 8 bits

so 2^8 IPs

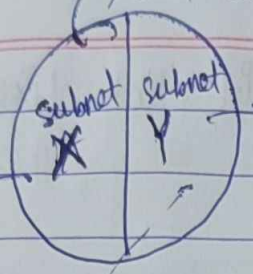
= 256 IPs.

200.1.2.--------

(8th bit) want to divide it into 2 subn/w

WOMk 2
= 30

can have 128 IP's



→ can have 128 IP's

How can do this ?

1st address is :- 200.1.2.00000000
last address is :- 200.1.2.11111111
"
200.1.2.255 :

so,

→ can range from 200.1.2.0 to 200.1.2.127

→ " " " —— 128 —— 255.

If 8th bit of HID is '0' → then subnet x,
(1) —— y.

Subnet x :-

address present in it are ranging from 200.1.2.0 to 200.1.2.127.

for the network as a WHOLE :-
address range from 200.1.2.0 to 200.1.2.255.

200.1.2.0 ↑ This address is N/w Id of this n/w

200.1.2.255 ↑ This is limited broadcast address of this N/w.

so 256-2 = 254 remaining IP's

→ This address is N/w Id of this subnetwork (subnet ID)

→ This is limited broadcast address.

↳ 128-2=126.

work @ 3:00 pm.

↳ here saare 1's hi hain as 8th bit toh fixed hain '0'.

0 1 1 1 1 1 1 1

↳ saare 1.

Prblm !!

(1) 200.1.2.255

↳ LBA of subn/w as well as of n/w as whole.

↳ limited broadcast address!

Then where to broadcast.

(2) 200.1.2.0

↑

N/w Id of entire N/w as well as of subnet x.

↓

So which N/w we are referring!

Again problem ☹

Interpretation is based on from where packet is coming? → If source is outside the N/w, then or host it has no idea of any subnetting so for it 200.1.2.0 is N/w Id of N/w as whole, 200.1.2.255 is LBA of N/w as whole !!

If source is within N/w, then info is regarding subnetworks,

200.1.2.0 → N/w Id of subnet x

200.1.2.255 → LBA of " "

⑥ How Router knows ki packet N/w ~~se~~ k baahar se aaya yaa within N/w se?

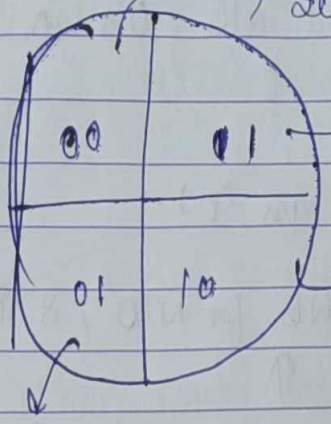
↓

IP address se pta chlega.

WOMk ke sm. (or source)

Q. How router will identify ki host & destination belongs to same N/w or not??

If want to divide into 4 N/w's:-

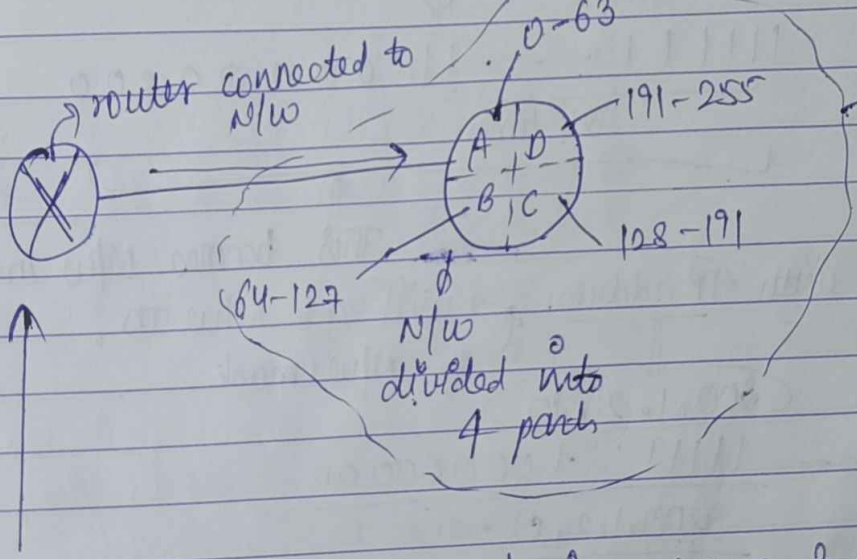


→ 200.1.2.0 to 200.1.2.63

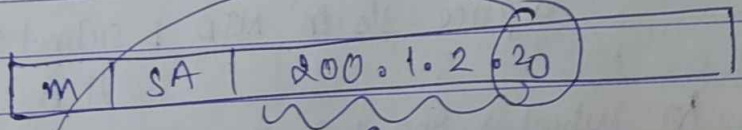
→ 200.1.2.192 to 200.1.2.255

→ 200.1.2.128 to 200.1.2.191

200.1.2.64 to 200.1.2.127



router ke paas koi msg having source & destination address :-



clearly DA ∈ above N/w.

so pass to interface A (as $0 \le 20 \le 63$)

How this all is done??

WSMK e 30 min.

NETWORK MASK :- router ko kaise pta chla packet kis N/w ko pass bhejna h

↑

All 1's in network ID and all 0's in HID.

200.1.2.0

↳ belongs to class 'C'

↑

so 24 bits for NID, 8 bits for HID.

⇑

so put 24 1's and 8 0's

⇓

11111111.11111111.11111111.00000000

24 times

⇑

This becomes N/w mask.

'And' kro with IP address → will get N/w ID of N/w mask.

200.1.2.20

AND 11111111.11111111.11111111.00000000

200.1.2.0

SUBNET MASK :-

↳ place 1's in NID + subnet ID and 0's in HID.

for subnet ⇒ 200.1.2.0

subnet mask ⇒ 11111111.11111111.11111111.11000000

⇒ 255.255.255.192

save for a, b, c, all!

~~for N/w id~~.

as N/w into 4 sub N/w, thus 2 bits of HID are also preserved ⇒ these 2 bits are subnet ID.

'And' bro subnet mask ka with IP address of A → 200.1.2.130

⇓

11001000.00000001.00000010.10000010

will get ⇒

11001000.00000001.00000010.10000000

⇓

200.1.2.128

Now Router having 1 routing table :-

Interface hain :- sabki n/w 10's hain of subnets

A	200.1.2.0
B	200.1.2.64
C	200.1.2.128
D	200.1.2.192

router ko pta chla, I have to go to Interface C.

Here, sbka bits in NID + SID is same = 26,

But agar essa hota :-

Variable Subnetting ⇒ as har subnet mein not same no. of IP's

A 00 | C 11 | 10 | B 01

take like 2 bits chahiye, ↑ will have 26 1's in subnet mask

Is 1's in subnet mask ⇒ like ek bit chahiye

↳ toh essa ho skta hai

WORK OF SUBNETTING.

ki. AND kro & & subnetwork ID se match kre, then consider that one which have longer string of 1's.

Here subnet mask for A, B, C will be different.

A → 25 1's
B, C → 26 1's.

① jinka size is same → unka subnet mask same, o/w different.

200.1.2.0

↑ class 'C'

24 1's in N/w mask
and in subnet mask → 26 1's.

so,
26 - 24 = 2.

Then $2^{(2)}$ = (4) → subnets are there.

So,
No. of subnets = $2^{(1's \text{ in subnet mask} - 1's \text{ in N/w mask})}$

Q. class A, subnet mask has 18 1's.

↳ so $2^{18-8} = 2^{10}$ subnets.

WIMK ⇒ 32.

WIMK ⇒ 32.

8 1's so can't be in class B or C

as 0's for NID

→ 1 gone for LSA, other for NID of subnet

Subnet mask	No. of Hosts	Subnets class A (can have in)	Subnets class B	Subnets class C
255.0.0.0	$2^{24}-2$	1	Not Possible	Not possible
255.128.0.0	$2^{23}-2$	2	"	"
255.192.0.0	$2^{22}-2$	4	"	"
255.255.0.0	$2^{16}-2$	2^8	1	"
255.255.254.0	2^9-2	2^{15}	2^7	"
255.255.255.240	2^4-2	2^{20}	2^{12}	2^4

255.255.255.240 → 11111000

2	240	0
2	120	0
2	60	0
2	30	0
2	15	1
2	7	1
2	3	1
	1	

16/03/24 saturday

Lec-16 :-

① Supernetting is vice-versa of Subnetting.

class C → 2^8 → very less

class B → 2^{16} → very large

so have multiple class C

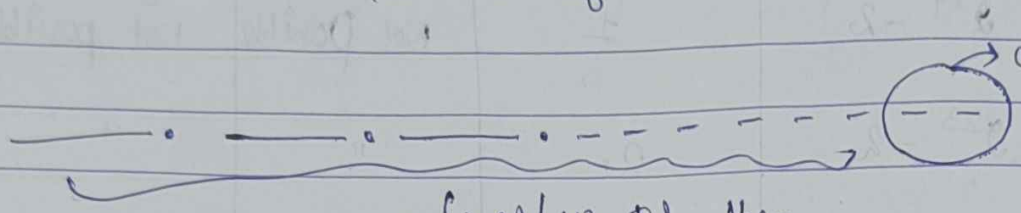
↳ agar continuous tats

jyada fayeda, if not ", then all IP's treated as separate N/W id's.

Classless addressing N/W

COOMK

let have 4 N/W Id. of class C., if contiguous then :-



↳ N/W Id then

∴, { Host Id se kuch bits leke N/W Id ko de rhe hain, in Supernetting.

↓

smaller n/w's ko combine krke bigger supern/w bnaana.

↳ iska ulta hota hai in Subnetting

⊙ Why classless addressing?

↳ bcoz of supernetting!

like class C → 2^8 → too small

class B → 2^{16} → too large

27 bits for N/W Id

5 bits for Host Id

Similarly iska bhi subnet mask etc. hota hai.

WORK

18/3/24
Monday

Lec-17 :-

Classless Addressing :-

CIDR (Class Inter domain routing)

→ not restricted to any fixed no. / size of IP address.

Conditions to be followed :-

1. all IP's should be contiguous.
2. size should be in power of 2 i.e. 2^n.
3. 1st IP address of the block should be evenly divisible by the size of block.

Format :- a.b.c.d / n

n → indicates no. of bits for Network ID. (must know for routing.)

32 - n → no. of bits for host ID.

eg:

200.1.3.14 / 27

↑

so 1st 27 bits for Network ID.

Here we take block of IP's. so better to say "block ID" instead of N/w ID.

→ means Host ID wali saari bits = 0, 1st IP address of block → block ID represent krta.

Eg: 100.1.2.32 to 100.1.2.47

↳ whether it satisfies 3 conditions or not?

1st Contiguous ✓

2nd 16 IP's = power of 2 = 2^4 ✓ → so least 4 significant bits must be zero.

3rd size of block = 16.

100.1.2.32

⇓

100.1.2.{00100000} (in binary)

→ zero hain! so 3rd condn also satisfied ✓

Eg:- 150.10.20.64 to 150.10.20.127

1st ✓

2nd 64 IP's = 2^6 ✓

3rd 150.10.20.01000000 → 6 zeroes.

⇒

so satisfies

Eg: 100.1.2.40/28 → representation se pta chl gya hai, 'classless IP address hai.

↓

tell 1st & last IP address of the block,

→ last 4 bits for Host ID, first 28 for N/w ID

↳ constant won't change!

Block ID

Ans. 100.1.2.00100000

to

100.1.2.00101111

↳ represents directed broadcast ID.

100.1.2.32 to 100.1.2.47

100.1.2.40

⇓

100.1.2.0010 1000

↳ will remain constant

↳ will vary

for 1st IP → all 4 will be 0

and for last IP → all 4 will be 1.

i.e.

100.1.2.00100000 to 100.1.2.00101111

Subnetting :- (in classless)

20.30.40.10/25

20.30.40.00001010

So,

1st IP address is 20.30.40.00000000

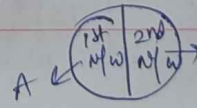
last IP ——— 20.30.40.01111111

→ If want to divide into 2^1 N/w's, then have to pick most significant bit of Host ID.

So, 1st N/w from 20.30.40.00000000 to 20.30.40.00111111

and 2nd N/w from 20.30.40.01000000 to 20.30.40.01111111

↳ Subnet mask for whole N/w as well as sub N/w A.



work in progress.

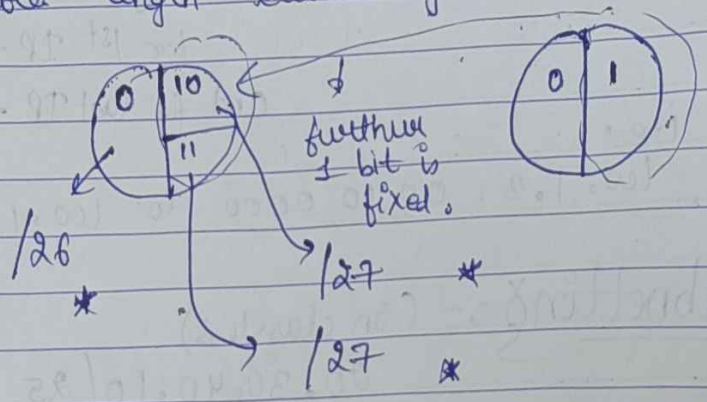
subnet mask for sub N/w A is :- 20.30.40.0/26
while for whole N/w :- 20.30.40.0/25

(Block ID of entire block.)

(Block ID of subnet A)

① If want to divide it into $4 = 2^2$ subnetwork, then 2 most significant bits of host ID are required.

② Even variable length subnetting can also be done:



Why we need subnet mask? Why need subnetting?

Consider
I_A, S_A — I_B
↓ ↓ ↓
host, Subnet mask of A — host

↳ iska help se A can get its block ID or subnet ID.

knows address of B

I_A AND S_A = subnet ID of A wrt A
↳ (operation)
$= S_i$

WOMK

A does not know, subnet mask of B.

So, I_B AND S_A = Subnet ID of B wrt A

$= S_2$

If $S_1 == S_2$, then A and B belongs to same N/w.

N/w belongs to diff N/w.

then A have to send packet to default router

↳ fir uski responsibility ki kaise 'B' tak pauchana hai.

SuperNetting :- (Inverse of Subnetting)

↳ combining smaller n/w.

whether 2 N/ws can be combined or not, depends on rules :

(1) Blocks should be contiguous. (CEK block ke baad agla apne aap toh pkka hi contiguous hoga!)

(2) size of each block should be same and in power of 2.

(3) The first block ID should be divisible by size of block.

Eg: 200.1.0.0 / 24
200.1.1.0 / 24
200.1.2.0 / 24
200.1.3.0 / 24

→ block ID's of 4 diff blocks.

Can they be aggregated or combined? If Yes! what will be the resultant block ID.

- Contiguous ✓
- same size = 2^8 = power of 2.
- size of new block = no. of blocks × size of each block

$= 4 \times 2^8$

$= 2^{10}$.

200.1.00.0000000.00000000 /22

↳ all are zeroes, thus 3rd condition also satisfied !!

20 March 2024 → (Header length)

Wednesday

Lec-18 :-

IPv4 :- (Internet protocol) → bcoz version has 4 bits (version no. = = 4)

(Data grams)

Total = 32 bits = 4 bytes

Header length

Version (4 bits)	HL (4 bits)	Type of service (8 bits)	Total length (16 bits)
Identification no. (16 bits)		DF / MF	Fragment offset (13 bits)
TTL (8 bits)		Protocol (8 bits)	Header Checksum (16 bits)
Source IP			
Destination IP			
OPTIONS (0-40 bytes)			
Data			

4B, 4B, 4B, 4B, 4B, (0-40) B

Time to leave

(mandatory) (optional) → (Data length)

COOMK
5

minimum size = 4 + 4 + 4 + 4 + 4 (→ as yeh mandatory hain)
= 20 bytes

so,
IP header size range is (20B – 60B)

(HL) → represents size of IP header
as destination should know from where header is starting and its size.
→ as 4 bits → so max = 15
but agar header length = 20 (as min toh itni hogi)
↑
how to represent ☹
↑
max header length = 60.
↑
so go for scaling!!
↑
1111 → represents 60
(15) ↑ take ceiling value ← ÷ by 4

if header length size = 58
then, $\frac{58}{4} = 14.5$
↑
ceiling = (15)
so pad ~~pure~~ 2 additional bytes.
($60 = 60$)
(so always take higher multiple of 4)

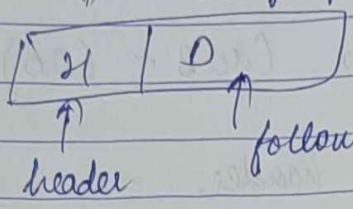
Type of Service (will discuss later)

Total length :- total length of data ~~graph~~ gram

WORK

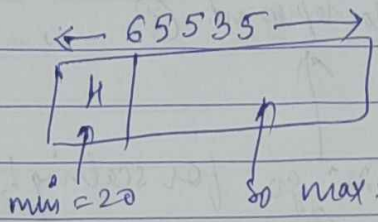
⇒ Total length ko represent karne ke liye, we've 16 bits

⇓ consist of 2 parts :-



highest no. that we can represent using 16 bits = $2^{16} - 1 = 65535$

↑ max. size of ~~Data graph (or~~ Data gram ~~222~~



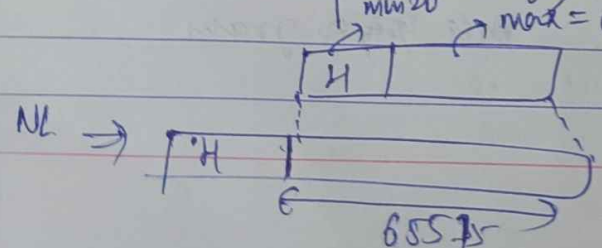
packets are coming from application layer where some msg is generated, then we come to TL (segmentation happen), then to NL, then to DLL, then to PL.

same packet (msg) ke diff name in diff layers.

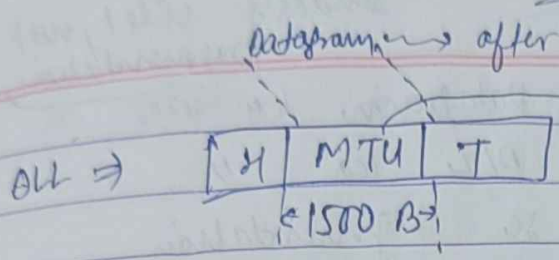
AL → msg
TL → segment
NL → Datagram
DLL → Frame
~~PL~~

In TL → there is something called header followed by data (info)

↑ also has min size = 20 bytes.



WOMKE



AL → create msg independently, not thinking what can be max size of segment in TL or max size of datagram in NL etc..

NL knows ki ~~65515~~ max size of segment that TL can send me = 65515,

any data coming from AL to TL, can't exceed 65495 B.

NL want to put its datagram in DLL,
↑
datagram ko frame kehta and size of " can't exceed 1500 B.

so, need to divide datagram of NL into multiple datagrams, so that each part ka size does not exceeds 1500 B, so fragmentation needs to be done.

TL → segmentation hoti hai ∴ (Whose-ever the bottleneck, it creates segments accordingly)
↑
(diving data of AL into multiple segments, such that each " size does not exceed 65495 B).

so, 2 vaar divide ka hua hain 😊,
ek vaar TL pe, ek vaar NL pe.

segmentation must be performed at sender's side, not fragmentation

Isse accha toh dekho Datagram ka size chalta ~~chalta~~ yaa Frame of DLL ka "
" ⇒ jo min → uss hisaab se segmentation karo at sender's side. (so bottleneck dekha)

↓

fragmentation ki toh zaroorat hi nahi fir.

Then where this fragmentation required ??
(is)

required at intermediate routers.

↳ kyuki yeh to maine bs apne network ~~ko~~ ko dekh kar bol diya.

router
↳ NL, DLL, PL (bs yeh 3rd layer hoti hai).
↳ TL nahi hai (toh segmentation nahi kr skte)

connected to multiple n/ws.

may be ek n/w jismein DLL frame size > 1500 B,
dusre n/w mein ——— = 1500 B.

↳ then has to divide datagram further → thus fragmentation required.

so Fragmentation is performed at routers side

AL → par ek msg thg
↳ but segmentation, fragmentation hoti rahi... bhut parts bn gye....
ab sender ko bhejna, kaise bhejein?
kaise pta chle they are segments of same msg or different msg?

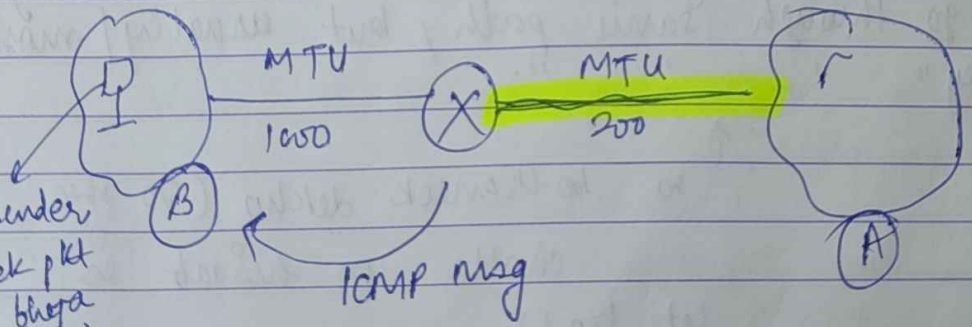
WORK IS DONE.

As sender ko toh nhi pta, aap tod rahe ho!
to
Identification number hona chahiye, har msg ka.

when ÷ing into fragments/ segments m/s this identification number does not change,

So each datagram has unique Identification number
↳ represent kiya jaata by 16 bits,
So max no. that can be represented is $2^{16}-1$.

DF (Do not fragment)
↳ DF=1 → means router is not supposed to fragment that datagram.



↳ with frame size = 900 (< 1000)
↳ so fine
from sender's pt of view, as uske N/w ka MTU size = 1000.
So sender ne DF=1 set kiya, ki pehle fragment mat karna!

WOMK

But iss pkt ko pass krna pdhega through yellow to pass to Destination N/w

but MTU = 200 (< 900)
but router can't fragment it, as DF = 1.

so, router won't fragment, but send ICMP msg to network B.

(Internet control msg protocol)

jisse router btaayega ki yeh problem ho gyi, sender ko btaayega.

Sender wants atomicity
↳ ki yaa toh single pkt ki tarah jaaye yaa fir jaise main kahun vese hi todna, o/w mat bhejo.

packets of same source going to same destination may not go through same path, but usually/mostly they " " " ".

↑ so bottleneck dekho (jo sbse chotta, uss hisaab se set karo!)

→ Now Sndr will set msg size = 200.
agar router ke saath koi ek N/w hoga with MTU < 200, then sndr ko utni set karni pdhegi size.

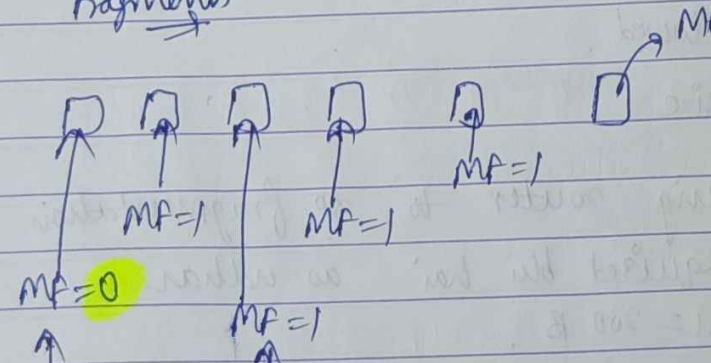
chlo ab paunchgya msg!

↳ Now sender realizes ki agar itna size rkhein - toh msg paunch jaayegd.

Thus,
wo sender kitnidn aage se, segmentation ki esse krega agar usne DF=1 rkha toh.

⊙ MF (More Fragments)
↳ means this is not last fragment of this identification no., there are more fragments following this fragment with same identification no. ⇔ MF=1

Fragments

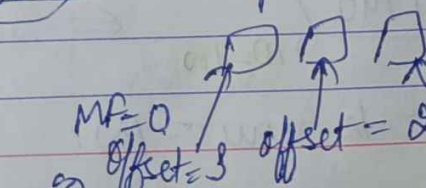


means there are more bytes of same msg following me.

this is last byte, no other byte is following me.

Fragment Offset :- → Indicates relative position of particular datagram

eg:-



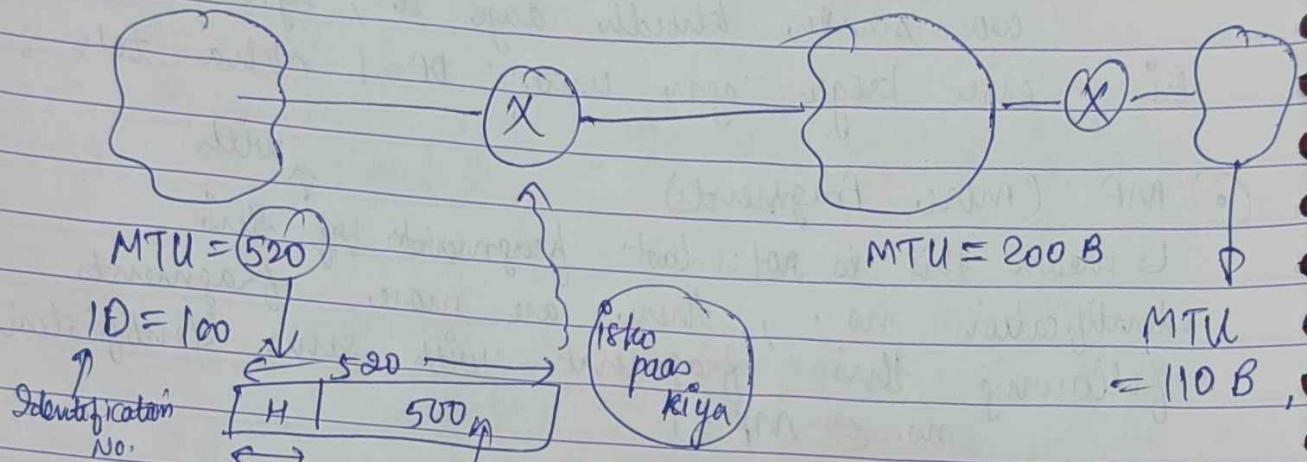
3rd fragment & last fragment, no other is

2, 1st fragment

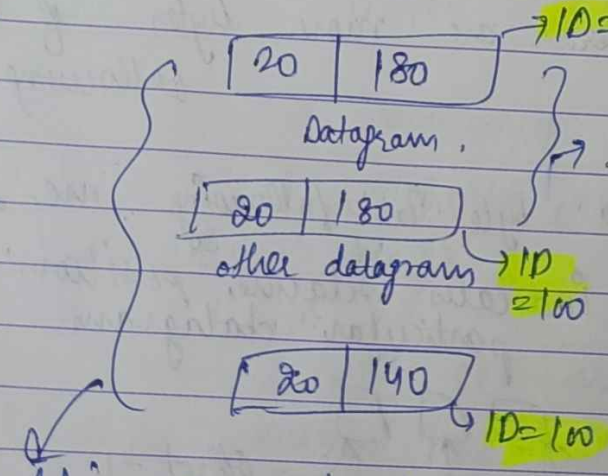
following me.

so offset can't be greater than 3, <=3 is acceptable.

FRAGMENTATION :-

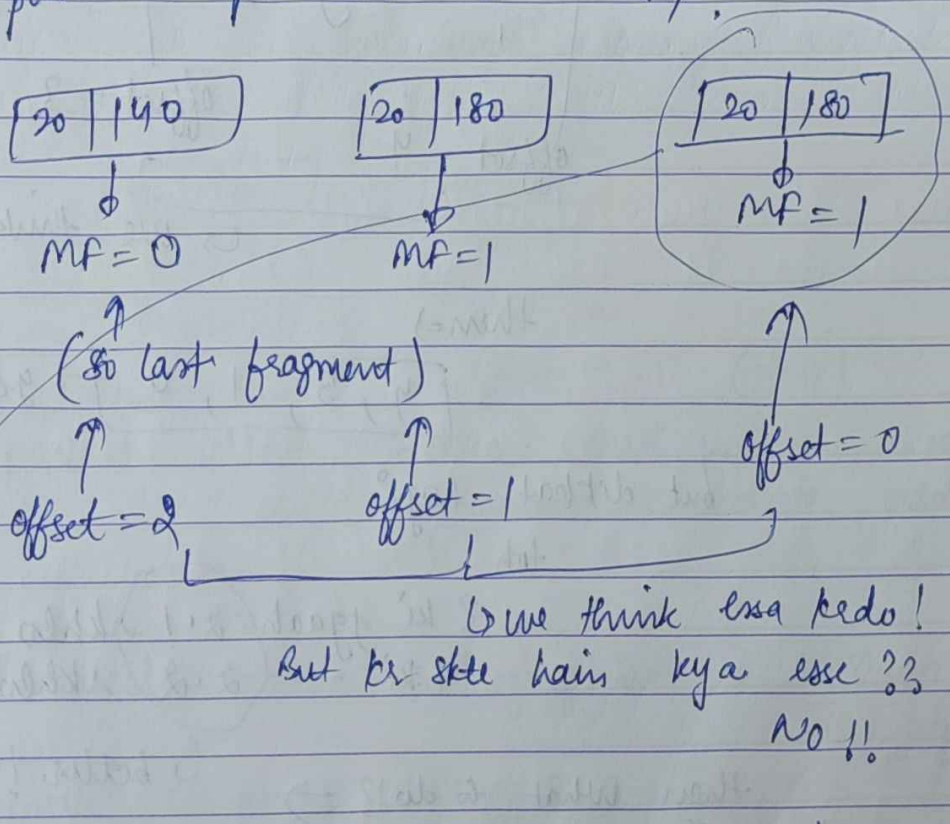


DF = 0 → sender is allowing router to do fragmentation & fragmentation required hui hai as udhar MTU = 200 B.



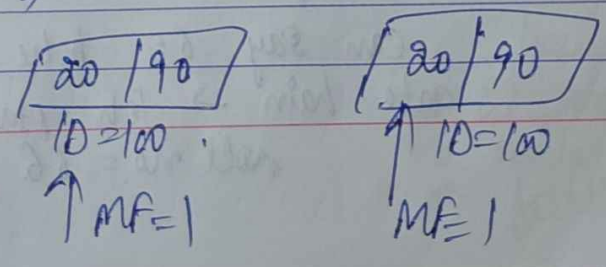
same approach is followed by other routers for fragmentation, if needed.

Now jab R receive krega, it must be able to place them in correct order. Uske liye we require something called "Fragment offset". (as essa koi bhi datagram & fragment kaafi bhi R ke paas, kissi bhi path se pahunch skta hai).



↳ we think essa kedo!
But kr skte hain kya esse ??
No !!

maanlo yeh gya uss router ke paas jo connected to N/w with MTU = 110.
so ⇒ further fragmentation hogi ↓

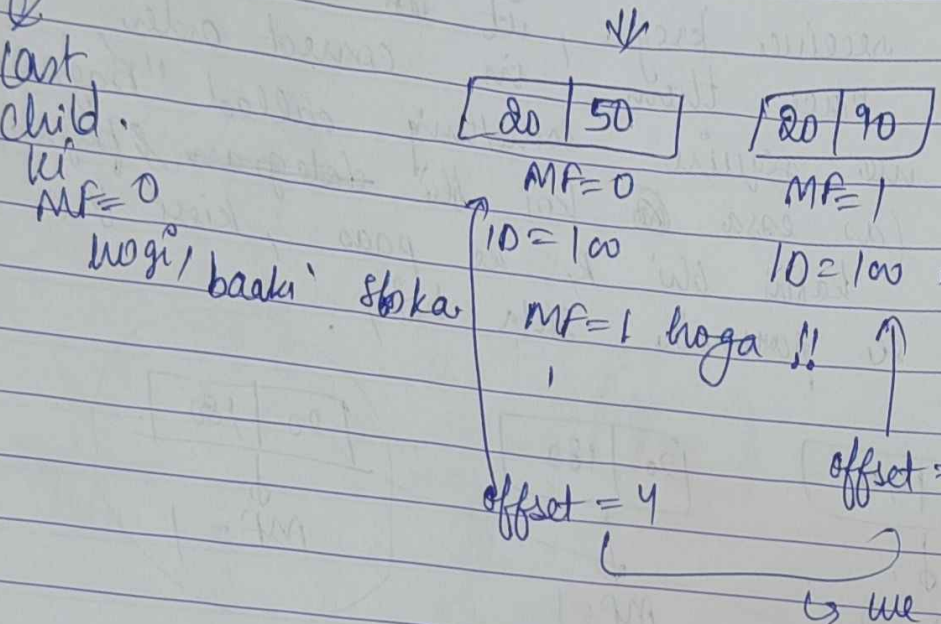


If parent has MF = 1, then all child will definitely has MF = 1

WOMPC

But agar parent has MF=0, then children can have MF=0 or MF=1.

If [20|140] jaata MTU = 110 ke paas



then ⇒

[4, 3, 1, 0] → yeh huye offsets !

but dikkat hogi

toh

3 ki jgaah 2,1 rkhlo
4 ki — 2,2 rkhlo.

↳ better !! (but not best)

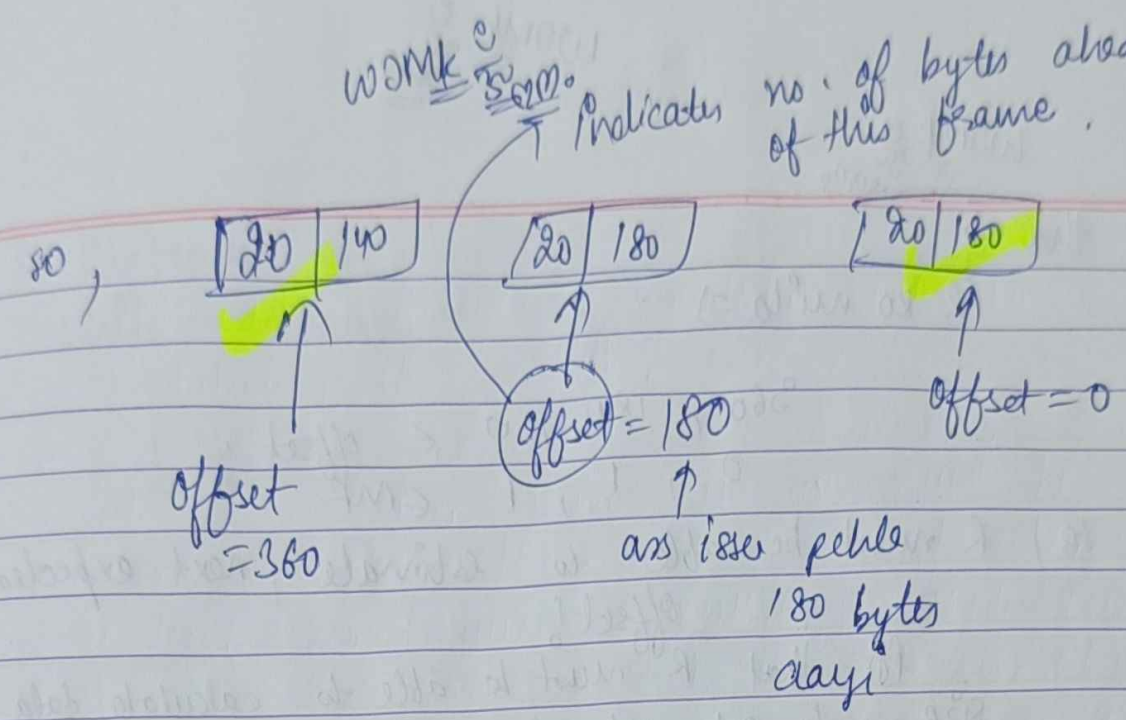
then what to do?? ⇒

but in offset Ukho → how many bytes are preceding it !

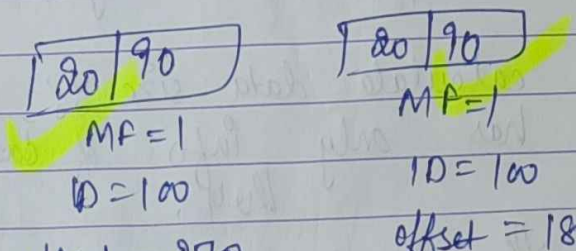
like roll no = 66

↑

Can say 65 bche isse pehle aate hain → toh pta chl jaayega roll no = 66



Let's say [20|180] with offset = 180 wala paas kiya through MTU = 110



so parent offset dekho and usmein size of child fragment ka data, add kro.

Now R will receive 4 fragments (Yellow tick wale)

with offsets ⇒ 360, 270, 180, 0
MF ⇒ 0 ; 1 , 1 , 1

↳ R inko sort krega on basis of offset.

but R ko yeh kaise pta chlega ki saare fragments mil gye hain uss datagram ke ?? (uske baad hi sort karega)
maanlo 270 wala na mila - - -
Usko pta hi nahi ki further ∄ ho gya

WORK ☺

WORK ☺

tha !

R ko nikala ⇒

360 , 180 , 0 ← offset.
0 , 1 , 1 ← MF

so, R must be able to estimate, next expected offset!

for that R must be able to calculate data size → to get next offset value !!

270 ← 180 ← 0

↳ expected, nahi aaya, wait !

How R can calculate data size ???

as, it has only info of datagram of itself.

↓↓

Total length − Header length.

① Total length → 16 bits
Fragment offset → 13 bits
→ how can represent no. having 16 bits with 13 bits ☹

20/3/24
wednesday

Lec-19 :-

problem !!

we'll use scaling factor.

Scaling factor = $\frac{2^{16}}{2^{13}} = 2^3 = 8$.

WORK

So instead of writing no. of bytes preceding, write according to scale factore.

so instead of 180, write largest smaller multiple of 8.

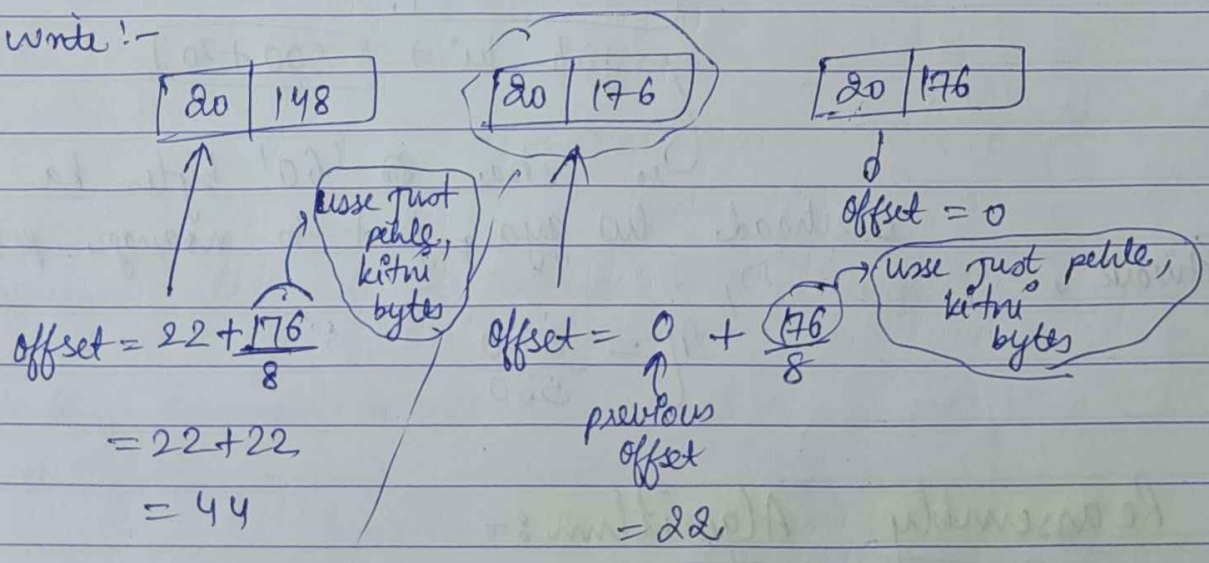
= 176

Now ÷ by 8 ⇒

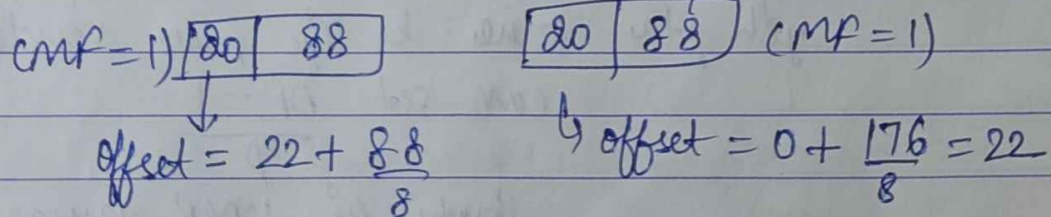
$\frac{176}{8} = 22$

so offset value = 22 (≠ 180)

So write :-



of this one is further fragmented into 2 parts :- (as MTU = 110)



WORK:

Then ⇒ [20 | 148]

↳ offset = $\frac{33+88}{8} = 44$

So, 4 fragments received by R. with offsets ⇒
0, 22, 33, 44.

1st fragment size = 176 + 20 → Header size
2nd ——— = 88 + 20
3rd ——— = 88 + 20
4th ——— = 148 + 20
↳ data size

⇓

[500 + 80].

jab ki ⇒ [500 + 20]

↳ so extra '60' bytes ka overhead ho gya, just to manage prblms in network.

So,

$\eta = \frac{520}{580}$

Reassembly Algorithm :-

MTU of entire channel = min (MTU of each N/W DLL)

↑ yeh pta krne ke liye, sender can set DF = 1.

↑ kyuki fir ICMP aayega & wo sender, segmentation krta rhega, jab tak segment size <= MTU na ho jaye!

WORK ☺

Q. Why sender can set DF = 1 ?? reason ?

- Sender send some data, segmentation & fragmentation huyi & Destination tak pauncha.

If MF = 1
↳ No doubt, this datagram is fragmented.

MF = 0
↳ can't say with surity ki fragmented or not.

Case 1: If MF = 0 and fragment offset = 0
↳ No fragmentation done.
(This is 1st & last frame)

Case 2:- MF = 0, fragment offset ≠ 0
↳ fragmentation done & it is last frame.

fragment offset = 0 → means 1st frame.

~~MF = 0, fragment offset~~

R → firstly check whether datagram is fragmented or not.

↑ check krega MF & fragment offset dekh kar.

↑ no need to reassembling

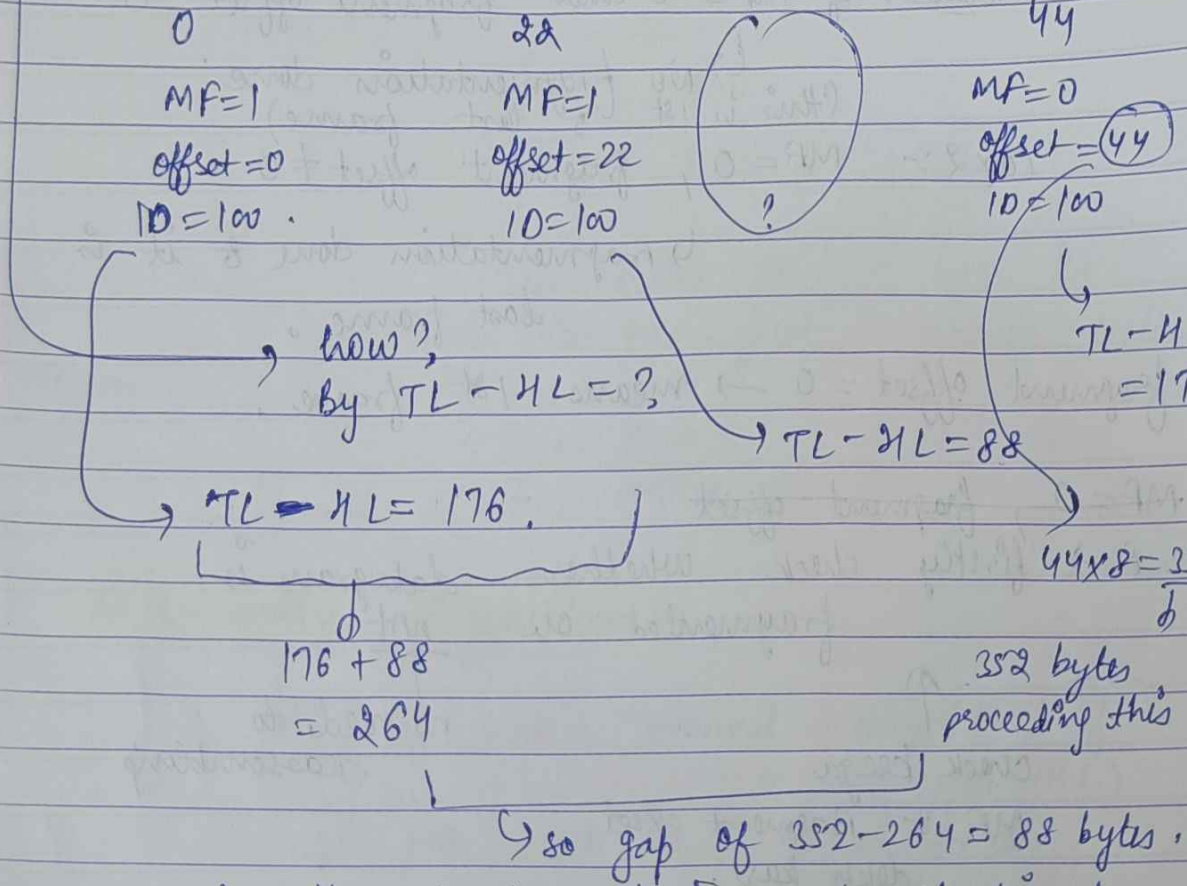
- How R will reassemble agar fragmentation huyi?

work :)

Let's say pehle R ko mila fragment ≠
with offset = 22
ID = 100
MF = 1.

So R will wait !!

Now (44) came, MF = 0, offset = 44, ID = 100.
then comes (0), MF = 1, offset = 0, ID = 100
~~still~~ As R knows some packet is missing.
R stores in order :-

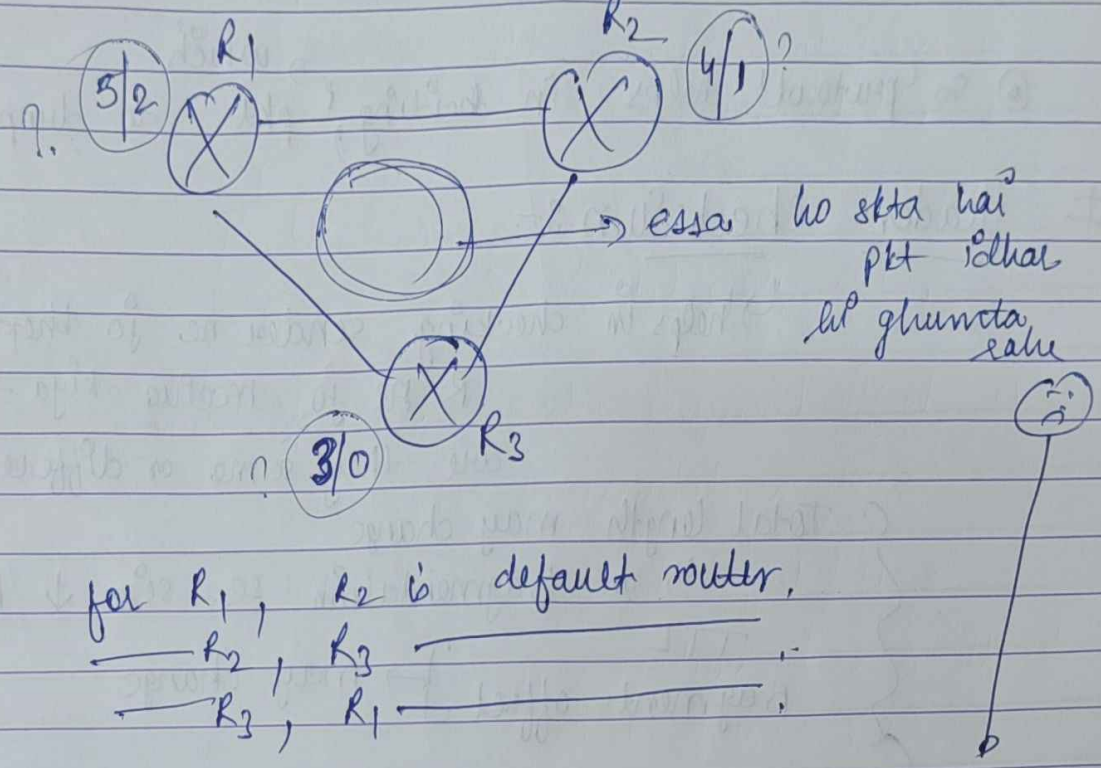


So R will wait for certain amt of time!
If utne mein nahi' aaya → then R will come to know that fragment is blocked, then R won't ~~send~~ ask sender to send remaining packet, as it not

WORK

aware of fragments.

Thus, R_3 will drop all the received fragments as well.



for R_1, R_2 is default router.

— R_2, R_3 ——— .

— R_3, R_1 ——— .

So TTL bhaata, kitne hop-to-hop delivery pkt kr skta hai 64 reaching destination o/w router will drop the packet.

Protocol :-

agar s/w limited, yaa congestion in n/w, then kuchh pkt drop krne honge...

par kaunse?

costly pkt can't be dropped.

lower priority ka pkt can be dropped.

→ actually a no. given to pkt jo bhaata protocol type of pkt.

WOMK :)

⊙ UDP (User Datagram Protocol) preferred over TCP ??
ICMP → less priority
even

◉ so 'protocol' helps in deciding, which pkt to drop.

Header checkSum :-

↳ helps in checking sender ne jo bheja & R ne jo receive kiya → are they same or different !!

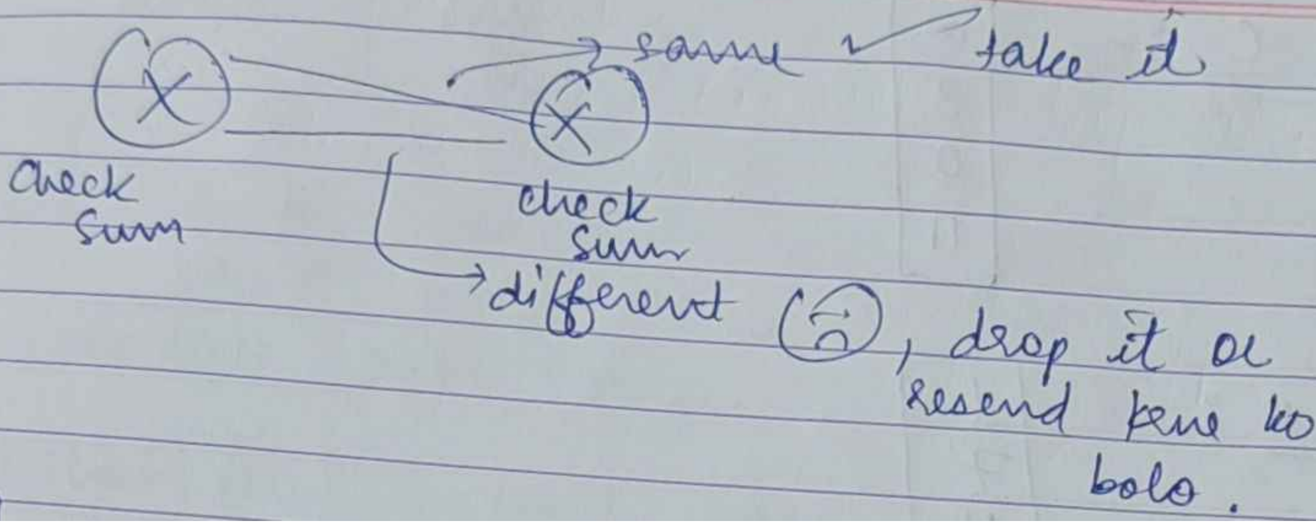
Total length may change
↳ as fragmentation se size ↓ hoga.
TTL
Fragment offset } → may change

↳ so some fields are bound to change,
so, Header Checksum may change!
But from 1 default router to another ... these values won't change.

Generally, data very large → uspe checksum lgana mushkil baar-baar
↳ so yeh R side krenge
baar-2 sirf Header checksum krenge, sirf header ko dekhenge, data ko nahi, jab ki protection usko deni hai.

↳ TL ??? mein where end to end jaata.

WOMK



same
take it
check sum
check sum
different
, drop it or resend kene ko bolo.

Reassembly Algorithm

In IPV4, the reassembly algo involves the destination host assembling the fragmented packets back into the original datagram

MF = 1 ⇒ it is fragmented

MF = 0 ⇒ can't say fragmented or not
because if not fragmented first and last is same } confusion
but for fragmented also last gets 0

MF = 0 fragment offset = 0 ⇒ first fragment

MF = 0 → fragment offset = 0 ⇒ No fragmented
→ fragment offset ≠ 0 ⇒ Fragmented

No fragmented ⇒ No need to go reassembly algo

0 22 33 44

missing

(176) (88) (88) (176)

0 22 44 × 8 = 352

MF = 1 MF = 1 MF = 0

offset = 0 offset = 22 offset = 44

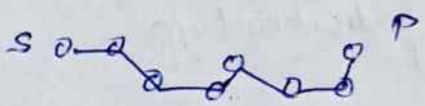
ID = 100 ID = 100 ID = 100

176
88
264

352
264
88

errors not detected in IPV4, header checksum does not contain data

options
- → Record Route (sometimes we need to record the route which is followed by the data)
- → source routing (by which path source should move)
- → padding

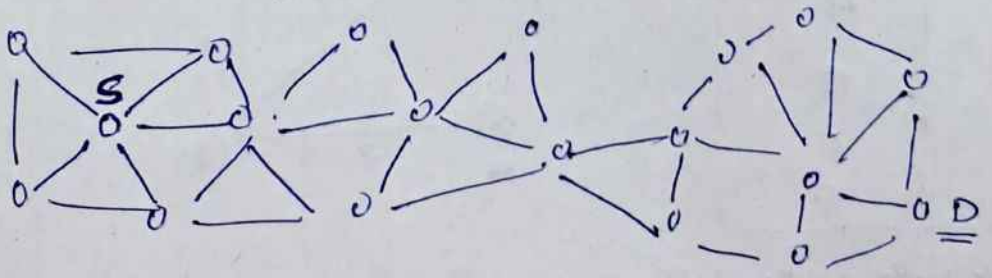


Routing

Flooding (spread the information to everyone) again they will spread to their friends. Ultimately information will reach to destination.

advantage	disadvantage
→ No routing table (no need to mention which direction) to be passed	
→ shortest path is guaranteed	
→ Reliability (If one route gets down then also data will reach destination through other nodes ☺)	

Thus [data must reach as soon as possible (defence)]



Routing (passing data through only one possible paths)

i) no duplicate pkts
ii) low traffic
] advantage

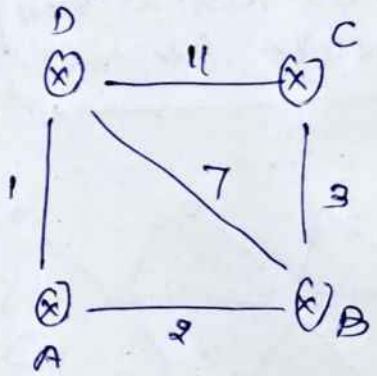
Routing table
Reliability less
] disadvantage

Routing

- Static (particular path mentioned)
  If we add new nodes path should be updated
- Dynamic (If one of the node is down they will take other nodes at that instant)
  - Distance vector routing (DVR)
    Dijkstras algo
  - link state routing (LSR)
    Bellmanford Algo

~~Bellmanford~~ ~~Dijkstras~~ ~~DVR~~

DVR for D



Destination	distance	next hop
A	1	A
B	7	B
C	11	C
D	0	D

min possible path with 1 Hop

OSPF

In RIP (<= 0.5.1.002

DVR from A

A	0	A
B	2	B
C	∞	—
D	1	D

DVR for all the nodes will form their DVR

B

A	2	A
B	0	B
C	3	C
D	7	D

DVR for C

A	∞	—
B	3	B
C	0	C
D	11	D

every nodes will receive DVR from their neighbour after knowing all they will try to minimise the distance to reach the destination

$$A \rightsquigarrow A = \min \begin{cases} A \to A \\ A \to B + B \to A & 2+2 = 4 \\ A \to D + D \to A & 1+1 = 2 \end{cases}$$

D

$$\overline{=} 2$$

but current distance to reach A is 0 so there will be no updation

$$A \to B = \min \begin{cases} A \to B = 2 \\ A \to B + B \to B = 2 \\ A \to D + D \to B = 8 \end{cases} \quad (2)$$

$$A \to C = \min \begin{cases} A \to B + B \to C = 5 \\ A \to D + D \to C = 12 \\ A \to C = \infty \end{cases} \quad (5)$$

$$A \to D = \min \begin{cases} A \to D = 1 \\ A \to B + B \to D \ 9 \end{cases} = (1)$$

min possible path with 2 hop

Dest	Dist	NH
A	0	A
B	2	B
C	5	B via
D	1	D

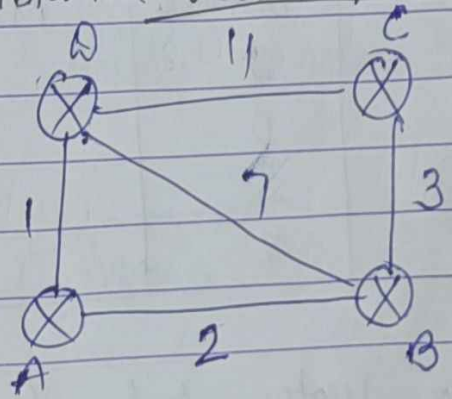
A to C via B

We need to go for (n-1) updation for each nodes

3/4/24
wednesday

lec-20 :-

Distance Vector Routing :- (Algo)



every router will have distance vector :- (for A)

→ Next stop → (host ??)

Destination	distance	NH
A	0	A ~~B~~
B	2	B
C	∞ (don't know)	—
D	1	D

(for B)

Destination	distance	NH

every router will share only distance vector with their neighbour.

like A will share → | 0 | 2 | ∞ | 1 | with B.

B from C :-

∞
3
0
11

B from D :-

1
7
11
0

B ka khudka table :-

Destination	Distance	Next hop
A	2	A
B	0	B
C	3	C
D	7	D

A → can receive distance vector only from B and D (only from neighbours).

any router will accept dusre ki help only if resultant is low cost path.

Distance of B from A = 2

So, B will add 2 in distance vector of A

0+2	=	2
2+2		4
∞+2		∞
1+2		3

→ but yeh toh better (B' se) so update kro in B' ka table.

So ⇒

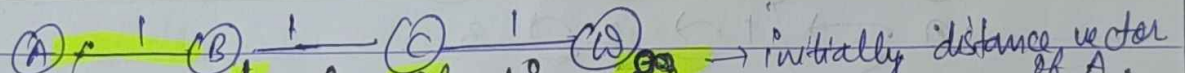
B ka table update ⇒ hoga

Destination	Distance	NH
A	2	A
B	0	B
C	3	C
D	3	A

Similar dekho kya aur improve ho skta hai B ka table,
C, D → se no improvement.
→ ab B ka updated table agye share hoga C, D, A ke paas, fir wo apna table update krke aage share krenge.

⑤ what are unused edges?
like BD = 7 is unused edge here.

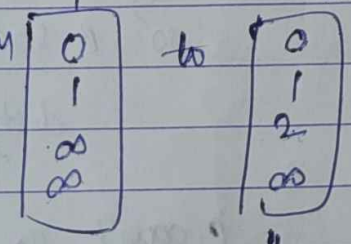
⑥ Count to Infinity problem:- Good news spread fast (connection nahi tha ab bna diya)
Bad news " "



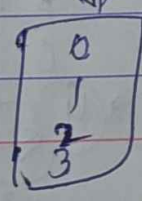
→ initially distance vector of A.

Dynamic Routing algo
↳ periodically share info and routing table. (if new node/edge is added or removed).

agar yeh link udd jaaye (goes down)
then A to B distance is '∞'.
↳ agar link hota :- updated A ka distance vector

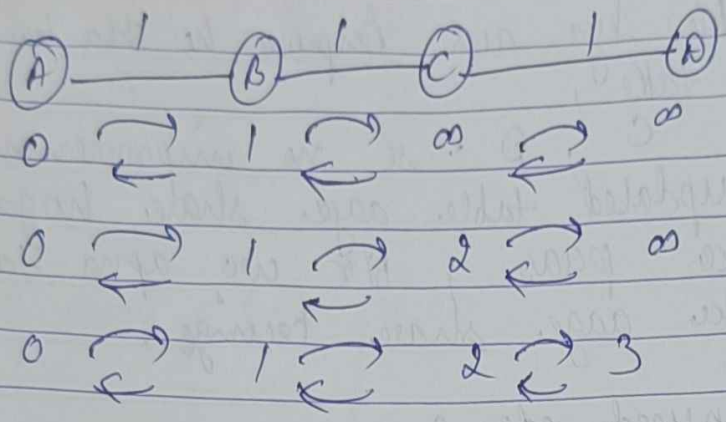


(jab B ka " " nikla)



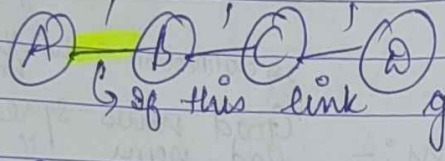
(tab C ka distance vector nikla)

Work: 3:00 PM.

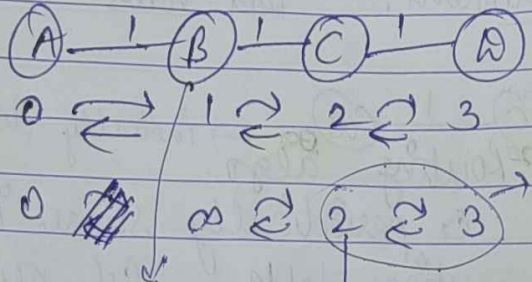


If distance is already less, then can't update!

Now:-



↳ If this link goes down.



→ abhi inko nahi pta link tut gya, they will share table all again!

unhappy, not connected to A.

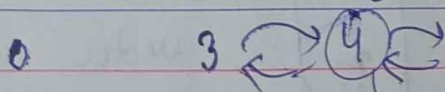
But C saying, I can take you to A by distance = 2

↳ so B sochega = 2+1 = 3

distance mein 'A' tak paunch jaayunga

C can't go to A directly, & kehta ∞+1 mein paunch jayega

C kehta 3+1



2 nahi uthi, 4 kyu as

Previous value se compare nahi kiya, sirf neighbours se jo info value mili, unmein se min dekhta hain bss!

WOMK :- DVR → Distance vector routing.

0 5 ⇄ 4 ⇄ 5

0 5 ⇄ 6 ⇄ 5

⋮

so values are increasing gradually !!
↳ so something going wrong

Say there '20' value is very high like ∞.

↳ toh jab ↑ ho-ho ke udhar paunchenge, count to ∞ prblm (:0) aagyi !

→ infinite loop prblm is also there !

prblm is that :-

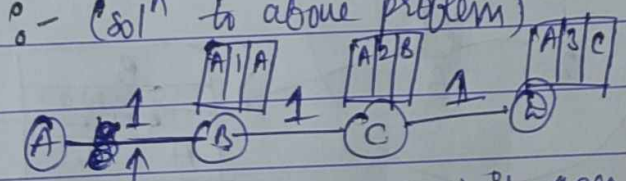
C bta rha hai B ko main 2 mein A tak paunch jaayunga, but yeh nahi btaya B ke through hi paunch paayunga, tab toh B usse baat sunta. hi na !!

↳ so NH must also be shared !

↳ But this DVR is used in early time when bandwidth was very less. so distance of packet jyada high nahi ke. skte the, toh sirf distance vector share kste the.

Split Horizon :- (sol^n to above problem)

don't help the node from which it is taking help

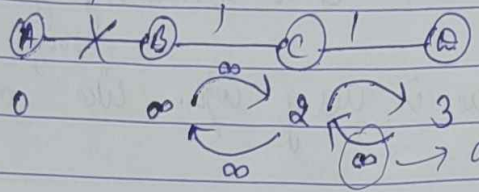


WORK :

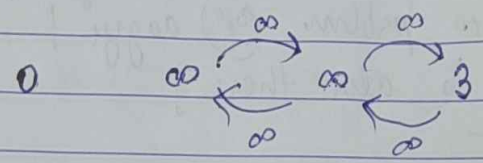
No, C, D → believes that they have path to reach (A) → via (B) only ☹
so can't help B.

So, for B, C khega unless distance to A is 'oo'.

for B, D



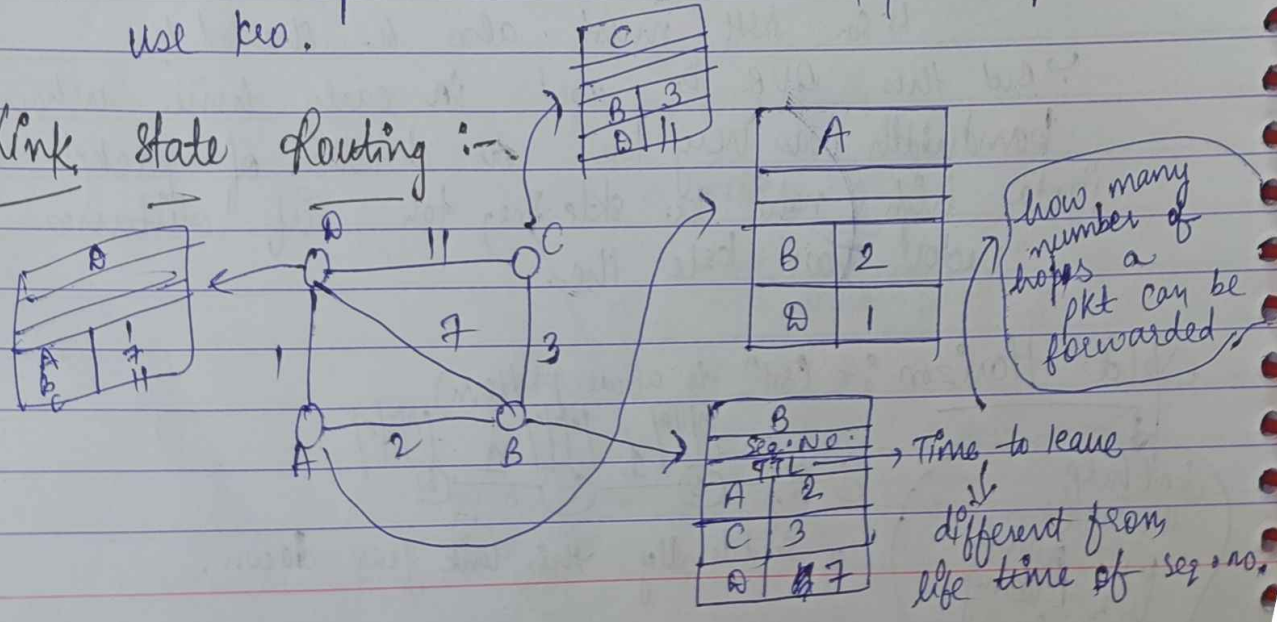
→ as D can't help C as D is going to A via C only.



0 ∞ ∞ ∞

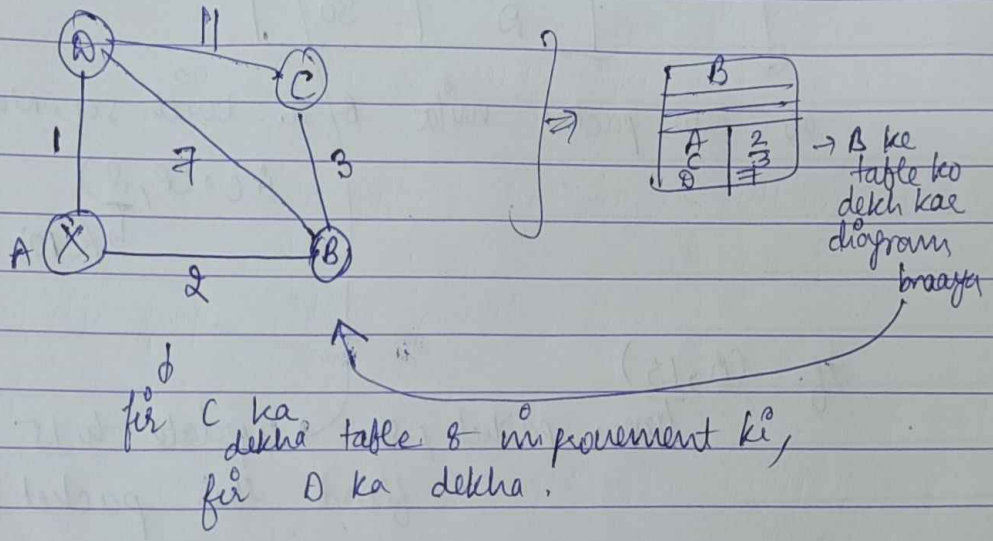
If explicitly mentioned DVR with split horizon, only then use split horizon method, o/w simple DVR use kro.

Link State Routing :-



WOMK ☺ SO ☺M☺

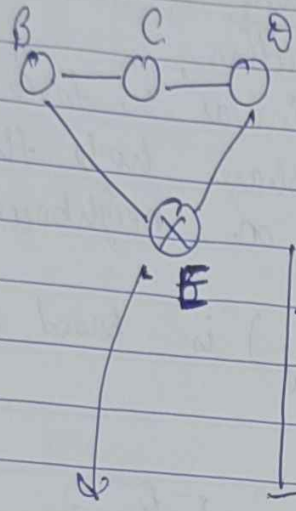
Now, routers will do flooding of these link state tables, to all other nodes / routers.
While in DVR mein bhi similar se table bnde the but sirf neighbours mein share hote the wo, so DVR is based on neighbour / local info.
While a LSR (Link state routing) is based on global info.



→ Visually ~~drawn~~ drawn the entire network using tables.
then, minimal distance path to be found.
Apply single source shortest path algorithm (Like Dijkstra algo).
→ Entire concept is based on Broadcasting | flooding | heavy info flow.

Want to limit this, so use sequence number,
↳ to distinguish b/w old and new table

WOMK:



Router	Seq. No.
B	10
C	20
D	30

If new packet mila B se with seq. No. = 8
i.e. (B, 8)
↳ (<10) (so old one)
↳ so drop this packet.

If (B, 15)
↳ new packet, so ↳ update to 15 & flood this packet.

(B, 11) → drop ~~(X)~~ kro.
(B, 15) → drop kro.
So controlling unnecessary broadcasting.

15 → 1 0 0 0 1 1 1 1
maanlo yeh bit corrupted ho gyi
↓
31

(B, 16) → drop ho jaayega ☹
Jab ka new packet tha!

Unfortunately agar
yeh '1' ho jaayega → bss fir toh saare reject ho jaayenge!

WORK IS WORSHIP.

① To address this problem we'll add info of lifetime along with every sequence no.

↓

- Kitne time ke liye NO value valid,
  ↳ seq. NO.

↓

uske baad drake kam seq. NO. wala milega, wo le leinge hm !!

8 April 2024
Monday

Lec-21 :-

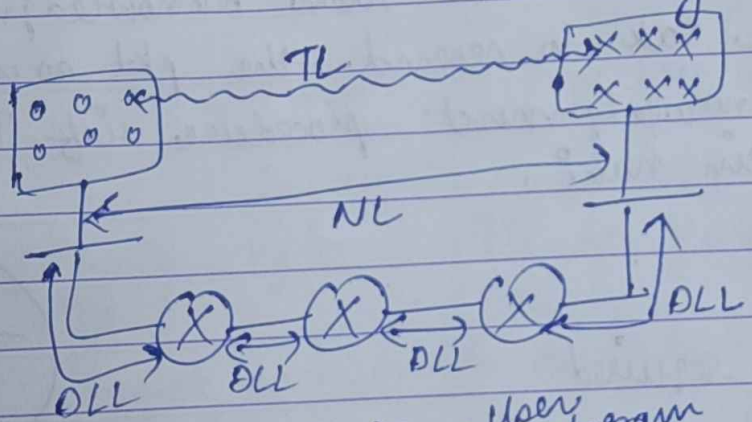
DLL → for hop to hop data delivery

NL → for host to host data delivery

TRANSPORT LAYER :-

↓

for process-process data delivery



Buffer reserved
↳ jab tak Ack na aaye, unko buffer mein rkho, discard mat kro. (served side)

→ Receiver side → 3 pkt aaye, but process ek karega, toh baaki 2 ko buffer mein rkhega

Design of protocols for TL :-

→ User datagram protocol

Connectionless (UDP)

→ No Bandwidth, buffer, connection is reserved.

connection-oriented

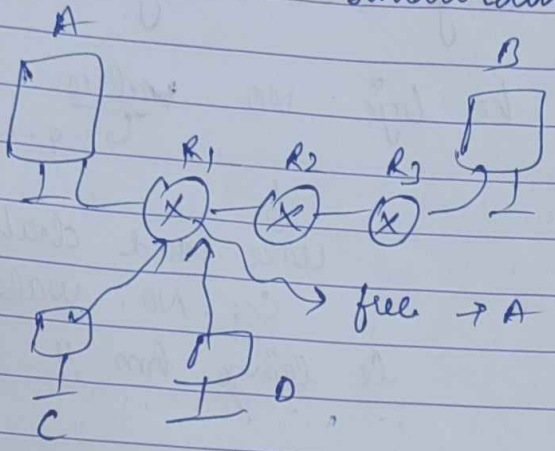
→ Bandwidth, buffer, connection is reserved.

→ path fixed. Isse jaayega to usually subsequent packets bhi usi same path se jaate hain.

TCP
(Transmission control protocol)

WORK

What should be size of Buffer?
Bandwidth ?



free → A ne bheja, but R_2 may be congested
↳ so can't forward packet.

If R_1 not sending many packets → means free → so select it to send packets.

Connection oriented
↳ agar koi pkt due to any reason na jaa paaye Receiver tak then Acknowledgment jaati hai sender tak to resend the pkt as wo nahi jaa paaya due to which reason, wo bhi bhaata
↳ so acknowledgement procedure sirf TCP mein hai, UDP mein nahi.

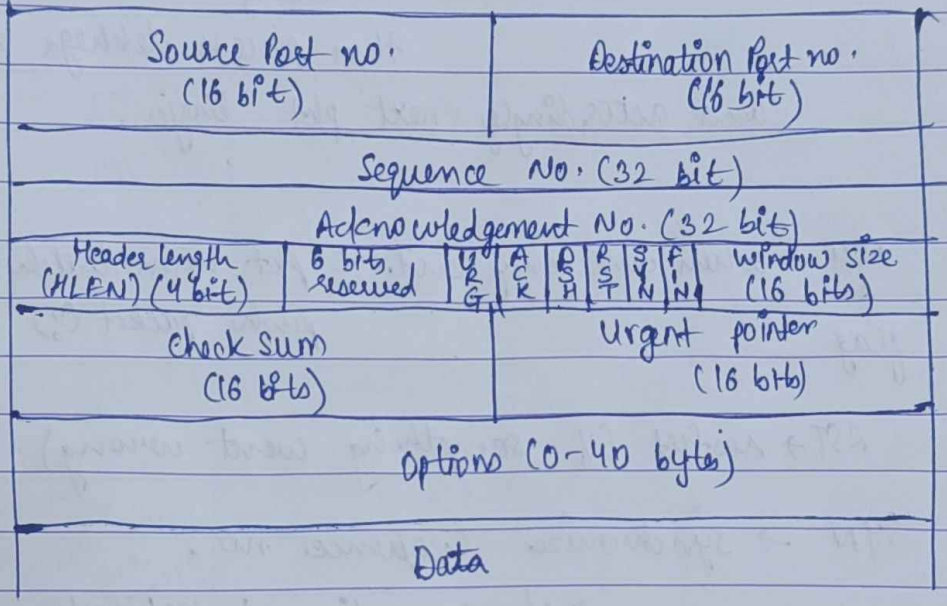
DLL → MAC req.
NL → IP req.
TL → IP + Port No. required
Socket No. (or socket address)

NL → DOP / POP → counting every pkt / datagram
↓ Datagram oriented protocol
↳ packet oriented protocol

WSMK

TL → Byte oriented protocol
(every outgoing byte is counted).

TCP :-



agar application / process ne thoda time hi chahiye hai → toh port no. usko thode time tak do, so that that port no. can be used by other processes as well.

every outgoing byte will be given a 16 bit no.

Ack no. → tells next byte expected.
being

Header length → only 4 bits.
while, 20 - 60 bytes size hai of TCP.
so scaling factor use kro → multiple of 4 → toh ÷ kro by 4 → o/w padding of additional bits kro!

WJMK :)

WJMK :)

Urgent pointer → to del msg if don't want to send,

↳ ACK
If flag=1
↳ then treat that pkt as ack.,
then process dekhega ack no,
and accordingly next pkt bhejo.

PSH → when emergency, send 1 pkt immediately → push packet (?)
↑ flag

RST → restart (If something went wrong)

SYN → synchronize sequence no.
↳ o/w congestion in network.

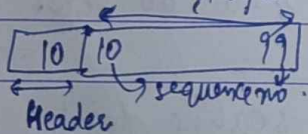
FIN → if =1 → means my ~~comm~~ communication is done / nothing to send now, finished
So can free the resources reserved for this communication purpose.

15 April 2024
Monday

lec-22 :-

TCP :- In TCP, every byte is counted.

Sequence No. :-
↳ unique no. given to every byte



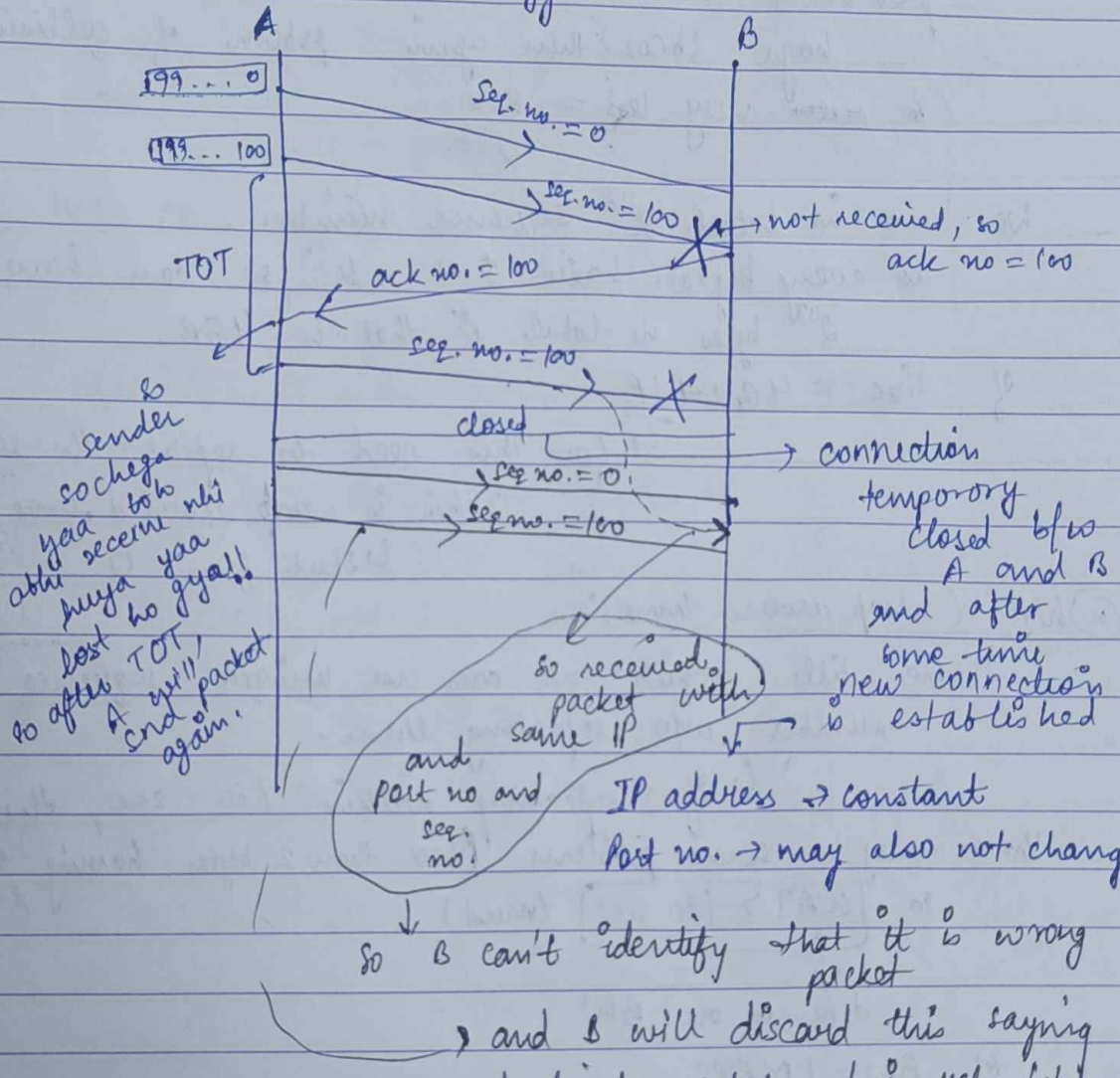
↳ represents sequence no - of 1st byte present in data.

WINKS
=MM.

Acknowledgment no. :- tells expected next byte ka sequence no.

↳ If = 100

↳ then sender samjhega 99 tak successfully receive ho gya hai.



Problm :- allowing same kind of sequence no. in every new connection.

In general, pkt remains alive for 180 sec.

Rel:- like ticket in theatre valid kro only for certain duration (like 3 hours), uske baad dusra bnd same jgah pr same room mein baitha skta hai.

WJMK

①

→ once connection is closed, do not allow another new connection within 180 sec → But not a good idea.

② start from Randomly initialized sequence no.

probability ki 0 - 199 mein se no. fise select hoga. (bcoz then again prblm of collision)

& ~~over~~ very less = $\frac{200}{2^{32}}$.

We have in total 2^{32} sequence number.

as every byte have 1 " ", so can have 2^{32} bytes in total ∴, that is 4GB.

If size = 4GB + 1B

↳ for this need to repeat the seq. no.

∴ ↳ this is wrap around ~~time~~

↳ start from 0

① WAT (Wrap around time) :-

Time till which we can use unique sequence number w/o repeating them.

↳ If repeating within 180 sec, then these may be some problem. (bcoz then 2 bytes having same seq. no.)

so, WAT > 180 sec (must)

↓

depends on BW

If BW = 1 MBPS

↳ means in 1 sec, 1 MB = 10^6 bytes are consumed, or 10^6 sequence no. are consumed.

⇒ for 2^{32} " ", time req to consumed = $\frac{2^{32}}{10^6}$

$\simeq 4296$ m.sec.

> 180

→ so safe!

WORK

① If BW = 1 GBPS :-

10^9 seq no. consumption time = 1 sec.

2^{32} ——————— $= \frac{2^{32}}{10^9} = 4$ sec

[< 180 sec.]

So problem !!

If we don't want to ↑ BW

↳ so one soln is to ↑ bits in sequence no.

(BW) X (Lt) → will tell how many seq. no. (unique) are req.

↳ if $> 2^{32}$ then prblm !

Life time (here 180 sec if not given)

So bits req to represent seq = $\lceil \log_2 (BW \times L_t) \rceil$

= N bits (say)

↳ if > 32 (then prblm)

** then [N-32] bits can be taken from options bits in TCP. (0 – 40 bytes)

[WAT > Lt]

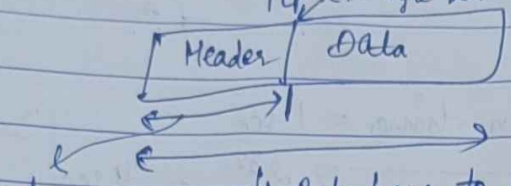
Ack No. :- Next byte ka seq. no. expected.

from header length field of TCP, can know from where 1st byte started (of data) but don't know last byte.

But agar total length pta ! can know

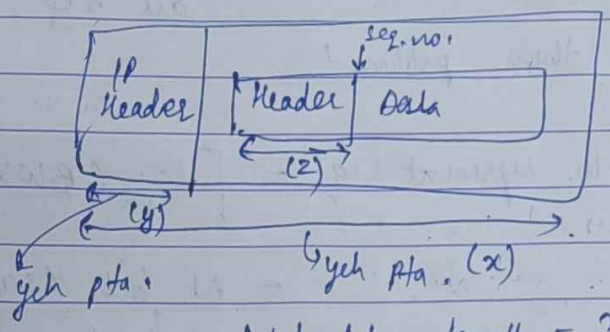
WORK

Sequence no. of last byte :
(TCP ⟵ 1st byte ka seq. no. pta hai)



yeh pta hai ↳ But how to get total length ?
↳ not a field in TCP
but in IPv4, we've 'total length' as field.

To encapsulate it with IPv4 datagram :-



so, total data length = x-y-z

Eg. ① In TCP segment,
Header length = 5
Seq no. = 100
and in IP datagram, Header length = 5
and Total length = 1000
Find last byte seq no,

A. Data length in TCP = 1000 - ~~5 5~~ 5×4 - 5×4
= 1000 - 40 = ~~960~~ 960
so, last byte seq no = 100 + 960 (-1) → kyuki zero se start ho rha hai
~~1060~~
= 1059

17/4/2024
Wednesday

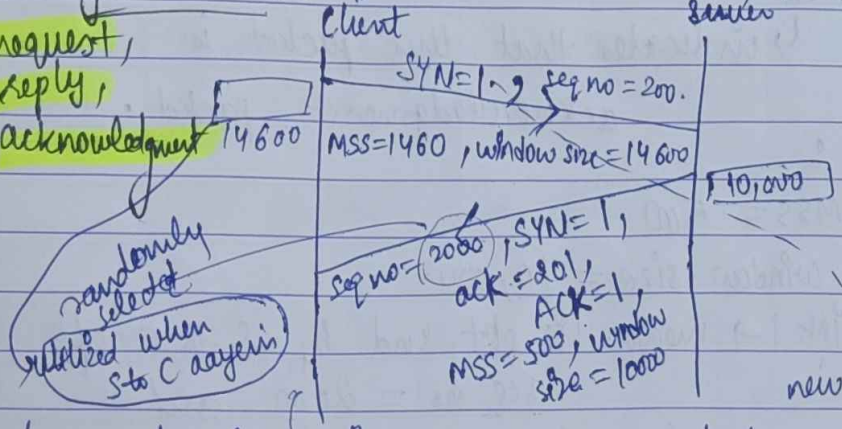
lec-23 :-

TCP :- connection oriented protocol

6 Flags :- ↳ does not means putting or cutting wire, we are conceptually building connection.

3 phases :-
(1) connection establishment
(2) Data Transfer
(3) Connection termination

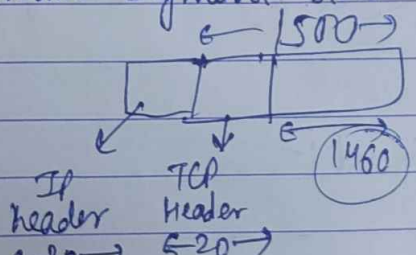
3 Way Handshake :-
↳ request, reply, acknowledgment



(S) → expecting nothing, not prepared, C sending data suddenly!
↳ so I stly build a connection.
→ want to build new connection, want to synchronize and with server, want to communicate, SYN=1, my sequence no. will start from 200. randomly selected!

(connection establishment DONE)

MSS
↳ maximum segment size.



client side :-
MSS = 1460
window size = 14600
↳ means have buffer of size = 14600.

Work:

(i) If overloading client, how many segments, server can send = $\frac{14600}{1460}$

$= (10)$.

So, 10 segments client can ~~send~~ store at ~~waiting~~ sending for any acknowledgement to sender.

ack = (201)

↑ next expected sequence number.

Ack = 1

↳ indicates that this packet is acknowledgment packet.

Server side :

MSS = 500

window size = 10,000.

SYN=1 → means 1st pkt snd by S to C of seq no = 2000 and also giving ack.

and MSS = 500

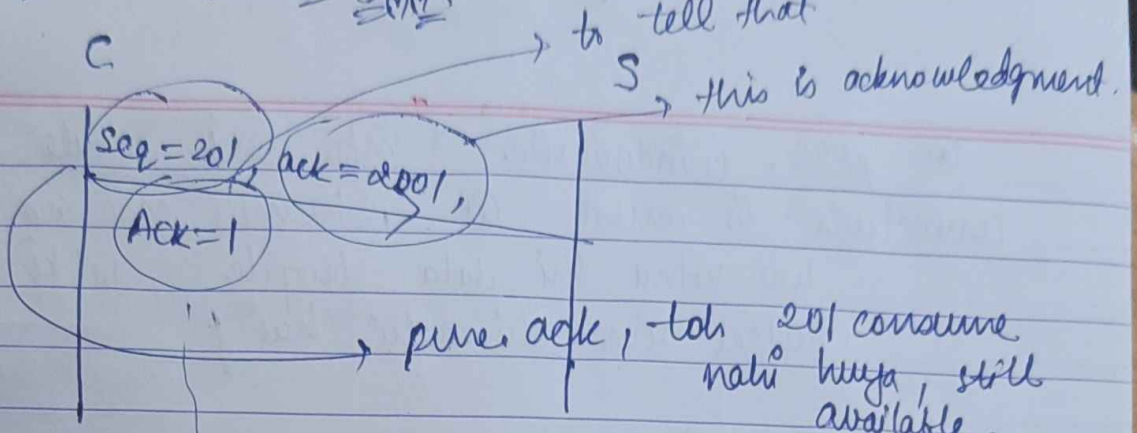
↳ means isse bdha size nhi bhejna, agar bhej diya toh mujhe fragmentation krni pdhegi!

Now server will wait for acknowledgment from client.

Diagram continued :-

WOMK C SV ka.

WOMK C SV ka.



every SYN(=1) flag will consume one sequence number.
each ACK(=1) ——— no ———

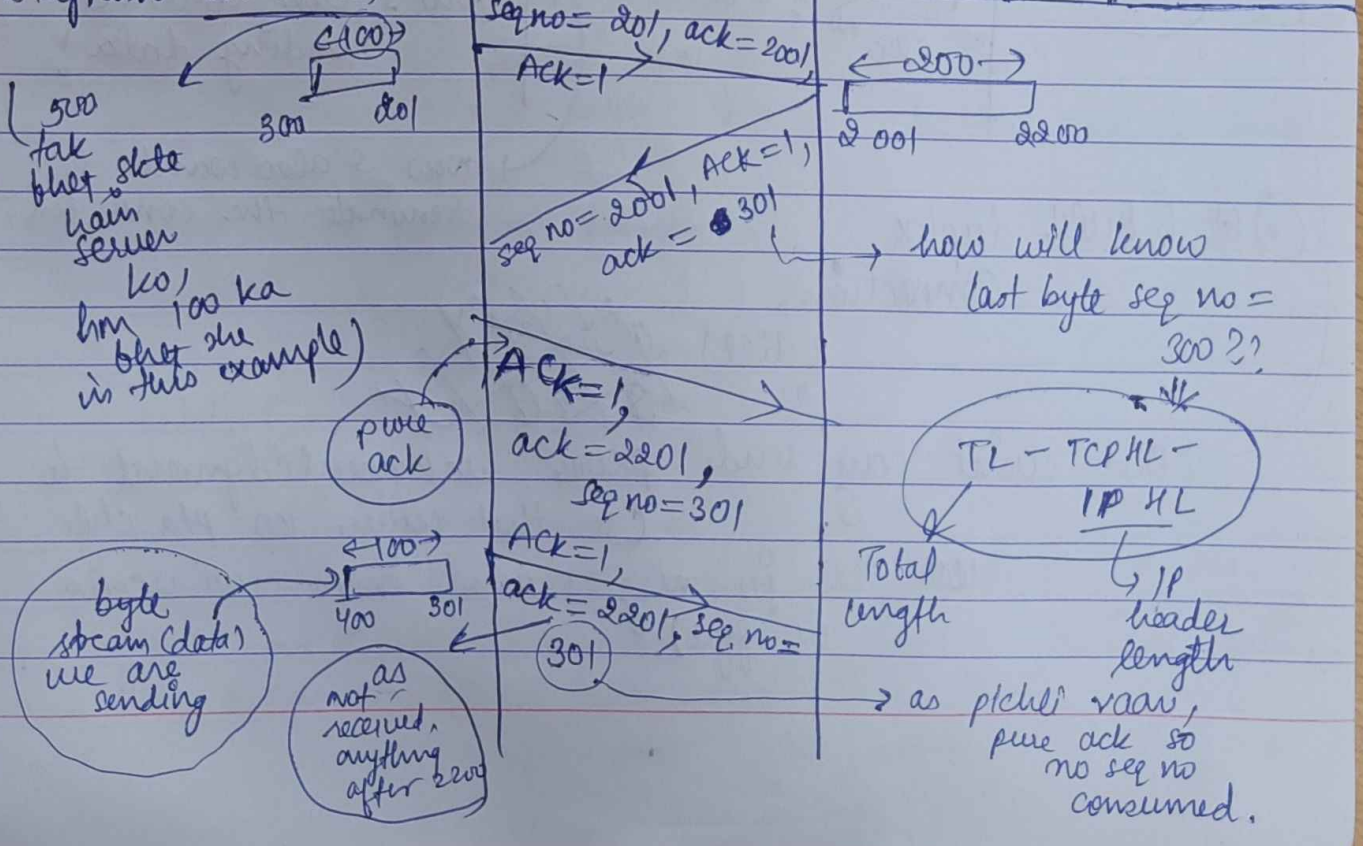
here pure acknowledgment, no data send along with it, so no seq no consumed, o/w one seq no. will be consumed.

each FIN (=1) flag will consume one seq. number.
every byte data ———

FIN → finished (connection)

Piggy backing → sending data along with ack??

Diagram Continued:-



(300 tak bhej sakte hain server ko, 100 ka hm bhej rhe is this example)

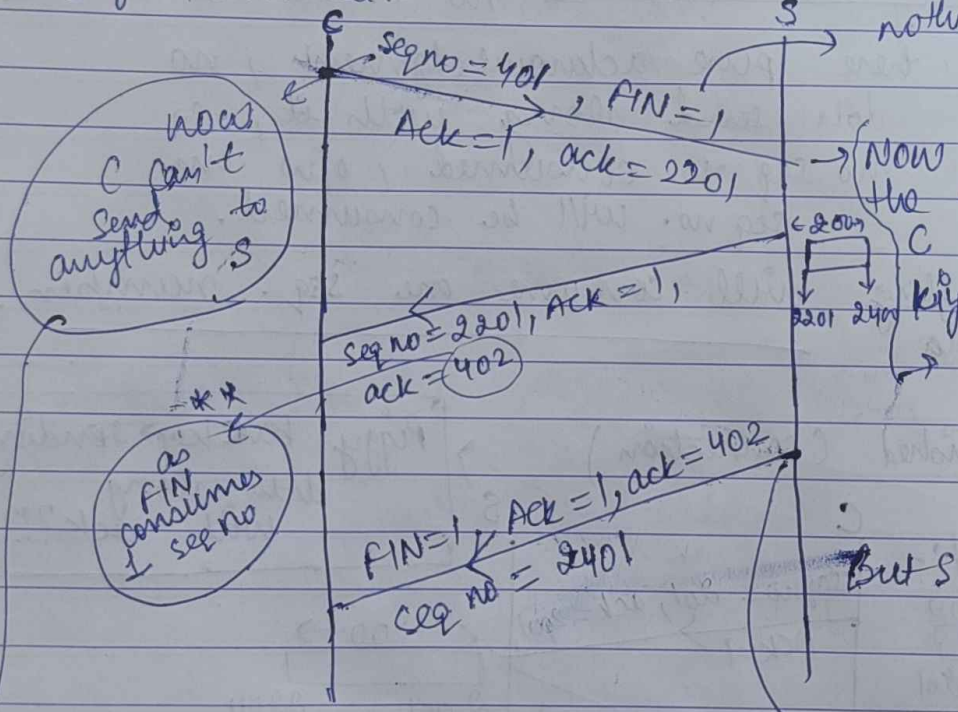
WOMK ☺

⑧ MSS, window size → info deni while establishing connection is must , taaki esse na ho wo kitna bhi data bhej de , jab ki utna buffer size bhi nahi hai !

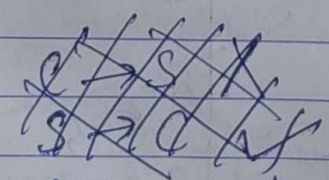
So Data Transfer done.

Now connection Termination

Diagram continued :-



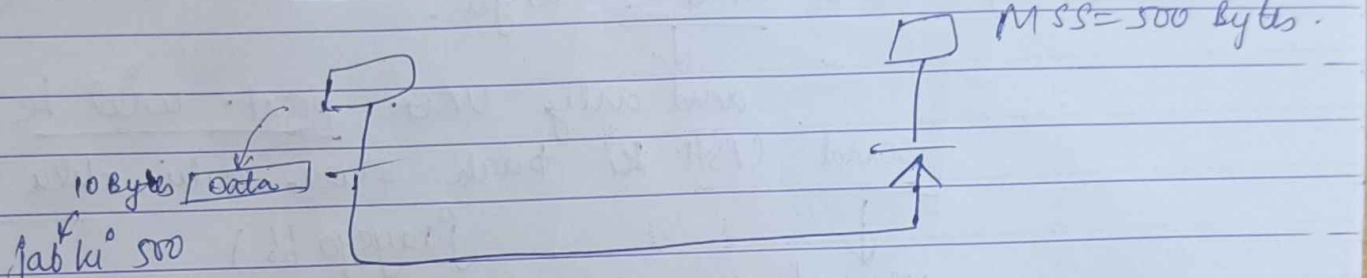
⑨ It is Full duplex Connection.

(still) 

But client can send pure acknowledgment to S. (so that server ko pta chle ske jo msg maine bheja wo receive ho gya).

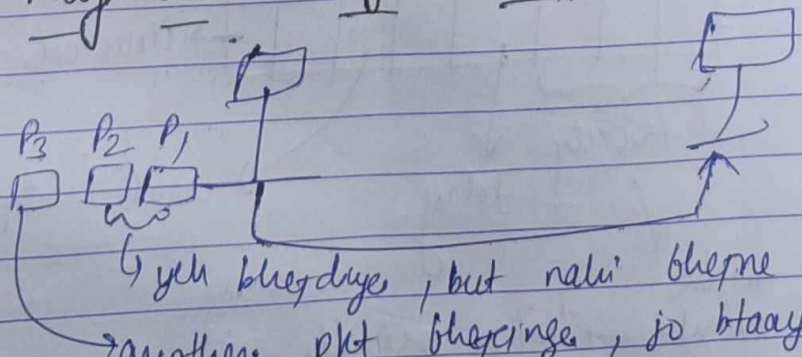
WOMK ☺

PSH flag :- (Push Flag)



Jab ki 500 tak bhej skte,
whether hmein yeh data immediately bhej dena chahiye. or we should wait ??
bcoz agar transfering only 10 B, then req. atleast 20 B TCP Header and 20 B IP header. so 40 B overhead for 10 B.
so don't send immediately, don't push, wait! add more data and then transfer!!
PSH flag used for interactive application.
PSH = 1
↳ means whatever I have, I have to send it immediately irrespective of size!
Sirf jiska PSH = 1 hai wo nahi, jitne bhi uss byte stream mein honge, saare chle jaayenge!

URG Flag and Urgent Pointer :-



↳ yeh bhejdiye, but nahi bhejne ke another pkt bhejenge, jo btaayega ki P1, P2 mat receive krna, but then P3 pehle jaana chahiye P1, P2 se, then P3 ka URG = 1 krdo for that purpose.
↳ does not guarantee ki P1, P2

se pehle jaayega, it depends ki aapne kab realise kiya and URG=1 kiya.

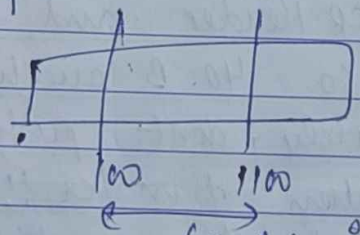
↓

and only URG part will be send CPSH ki baat saara nahi chla jaayega !!)

↓

urgent pointer help krega utna part snd krne mein!

Say :-



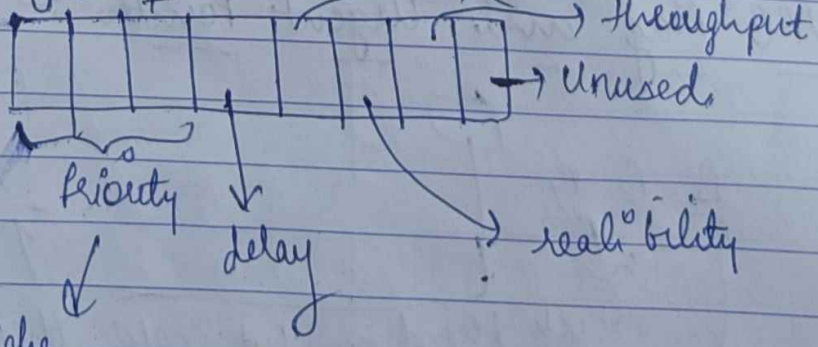
↳ sirf itna part urgent (say)

Data from S to R go through routers

so router should undru ki pkt → urgent

Here "type of service" field of IPv4 will be used.

↳ 8 bit field (cost)



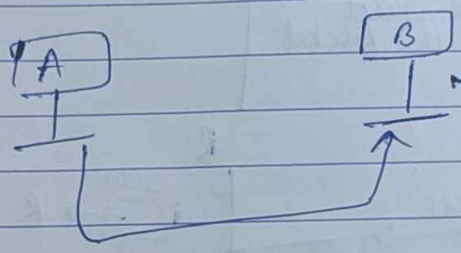
higher number → higher priority

URG = 1 → priority = 7

jiski priority ↑ → wo pehle bhejega router aage !!

reset flag

RST Flag :- means when something going wrong, some result going wrong, then reset the things with this flag!



B says suddenly goes down and wake up, toh pehle waala sab bhool jaayega ki A ne connection establish kiya tha, B sochega yeh pkt kyu bhej rha hai, so B RST=1 bhejega ki haan reset kro connection!

→ can be send by both S and C.

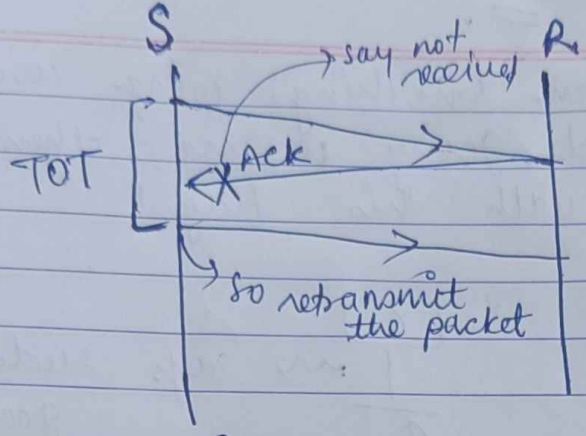
Retransmission in TCP :-

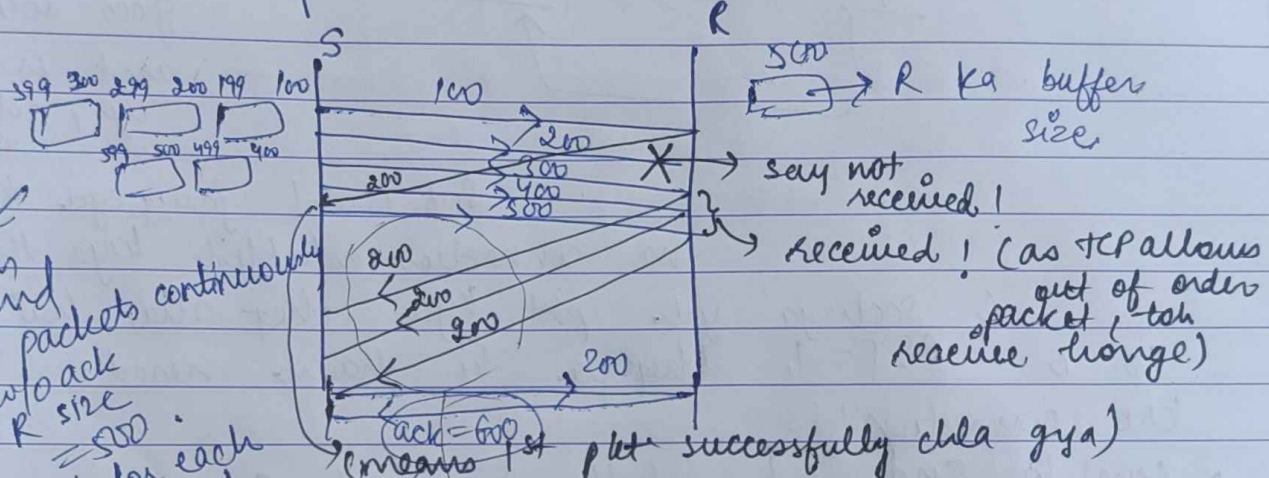
- TCP uses both SR + GBN
  - SR → $W_S = W_R$ → allows R to accept out of order packets. → independent acknowledgement
  - GBN → allows cummulative acknowledgement.

75% → SR

25% → GBN

WINMK = 500.





as Sender receiving 3 duplicate acknowledgments → means pkt with starting seq no = 200 may be lost and pkt with ——— 200 ke baad wale are received, that's why receiving duplicate acknowledgments.

→ So TCP allows to send cumulative acknowledgement.

⊙ Using window size, MSS → dono ne ~~kkkk~~ mil kar ek space set kri!

But in b/w ∃ N/w → what about health of N/w?? kya wo bhna

WORK IS WORSHIP.

jhel skta jitna aap ek-dusre ko bhej skte ho!

How to know if congestion in N/w.

receiving 3 duplicate acknowledgments ⇒

means 1 pkt no received & another 3 pkt are received.

so retransmit it ⇒ after exhaustion of TOT.

if congestion of N/w is not severe