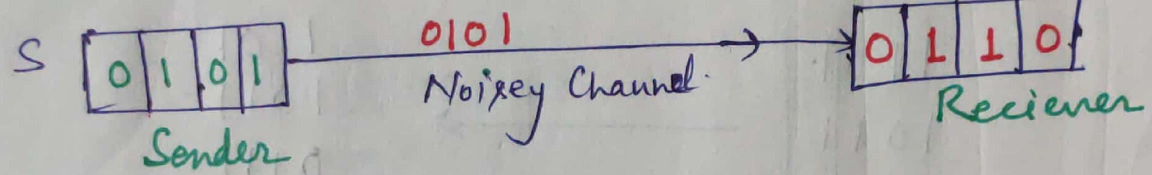
Lecture-14
Computer Network

29.09.20

Error Control: Detection of error (ED)
Correction of Error (EC)

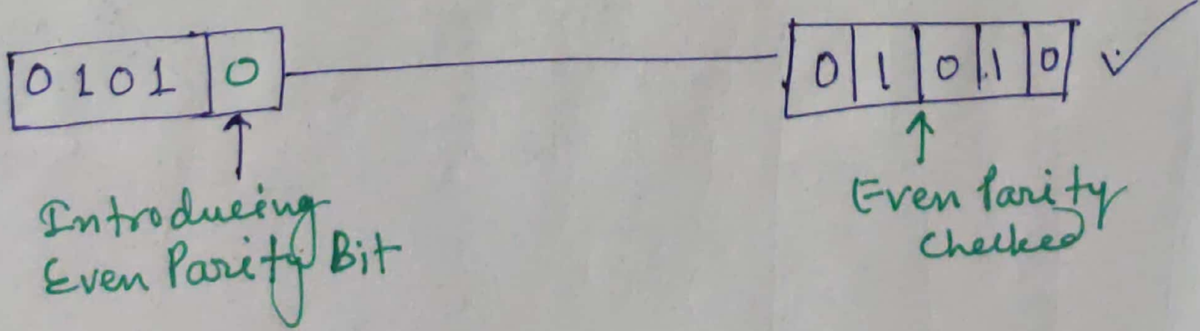
Types of Error → Single Bit Error
→ Burst Error



Error Detection Methods

1) VRC (Vertical Redundency Check)
2) LRC (Longitudenal " ")
3) CRC (Cyclic " ")
4) Check Sum

Parity Bit: An additional bit is appended to the original message to make all one's ~~equal to~~ even/odd in number.



VRC (Even Parity)

101011 | 101101 | 011101 | 1101010 X | 101111 X | 101110 X

LRC

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

$\longrightarrow$

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

Compared

= Matched → No Error

≠ Not Matched → Error

CRC (Cyclic Redundancy Check):

Polynomial = $x^3 + x + 1$

Message(data) = 100110

Divisor = 1011

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

Message bits	Appended Bits
Original Mesg	0's (n−1)

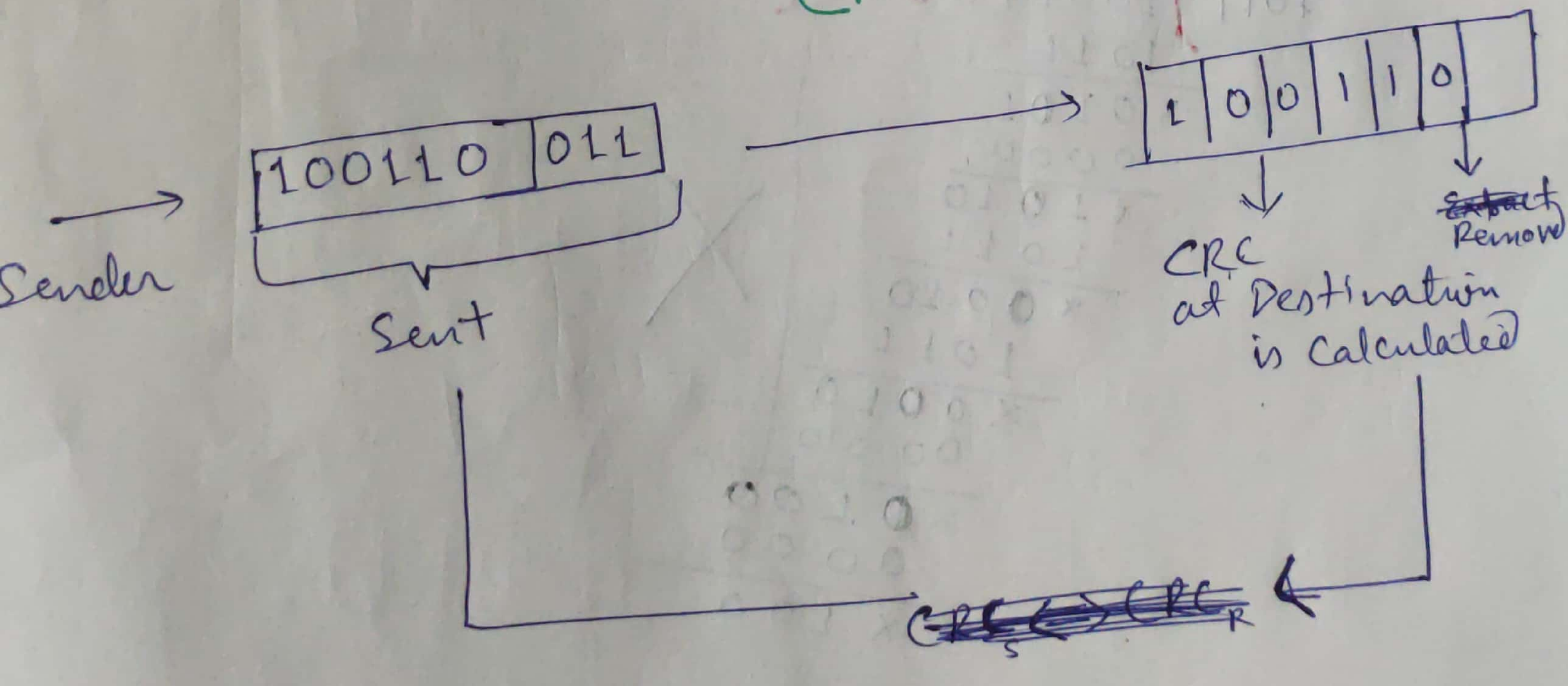
↓

$\boxed{100110000}$

```
                 101100
1011 ) 100110000
       1011
       x0101
        0000
       x1010
        1011
        x0010
         1011
        x0010
         0000
         x0100
          0000
          x100
```

$\boxed{1000110000}$

```
1011 ) 100110000 ( 101001   → Dividend  Q
       1011
       ----
       x0101
        0000
        ----
        x1010
         1011
         ----
         x0010
          00000
          -----
          x0100
           0000
           ----
           x1000
            1011
            ----
            x011   ← Remainder
             CRC
```



(5)

$$
\begin{array}{r}
Q \\
2\overline{)\,17\,}\ (1) \\
16 \\
\hline
\cancel{1}\,1
\end{array}
$$

1011) 100110011 (101001

1011

0101

0000

1010

1011

0010

0000

0101

0000

1011

1011

XXXX

0000

17 + Remi

17+1

$$
\begin{array}{r}
2\overline{)\,18\,}\ (0) \\
18 \\
\hline
0
\end{array}
$$

	Dig.
0000	0
0001	1
0010	2
0011	3
0100	4
0101	5
0110	6
0111	7
1000	8
1001	9
1010	10
1011	11
1100	12
1101	13
1110	14
1111	15
10000	16

$P_1 \Rightarrow 1, 3, 5, 7; 9, 11$

$P_2 \Rightarrow 2, 3, 6, 7; 10, 11$

$P_3 \Rightarrow 4, 5, 6, 7$

$P_4 \Rightarrow 8, 9, 10, 11$

Similarly: $P_3 = 110\underline{0}$

$\boxed{P_3 = 0}$

& $P_4 \Rightarrow 100\underline{1}$

$\boxed{P_4 = 1}$

Data Word

1	0	0	1	1	0	1	

$m = 7$ Recieved $\rightarrow$ 1001111

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

$\boxed{r = 4}$

Parity Bits = 4;

eg: P_1, P_2, P_4, P_8

Code Word format

D_{11}	D_{10}	D_9	P_8	D_7	D_6	D_5	P_4	D_3	P_2	P_1
1	0	0		1	1	0		1		

Calculating the value of P_i

$P_1 \Rightarrow 1, 3, 5, 7, 9, 11 \Rightarrow D_{11}\ D_9\ D_7,\ D_5,\ D_3,\ P_1$

$1, 0, 1, 0, 1\underline{1} \Rightarrow \therefore \boxed{P_1 = 1}$ ($\because$ No. of '1' = odd)

$P_2 \Rightarrow$ ~~P2, D3, D6, D7, D10, D11~~

$P_{11}, P_{10}, P_7, D_6, D_3 \therefore P_2 \Rightarrow 1 0, 1 1 \underline{0}\ P_2 = 0$

$\boxed{P_2 = 1}$ ($\because$ No. of '1's - odd(3))

Now putting the values of P_i's into Code Word format

D_{11}	P_{10}	P_9	P_8	D_7	D_6	D_5	P_4	D_3	P_2	P_1
1	0	0	1	1	1	0	0	1	0	1

But the recieved Code Word is

D_{11}	D_{10}	D_9	P_8	D_7	D_6	D_5	P_4	D_3	P_2	P_1
1	0	0	1	1	1	1	0	1	0	1

Computer Network

Bin.	Dig.
0000	0
0001	1
0010	2
0011	3
0100	4
0101	5
0110	6
0111	7
1000	8
1001	9
1010	10
1011	11
1100	12
1101	13
1110	14
1111	15
10000	16

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

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

$P_3 \Rightarrow 4, 5, 6, 7$

$P_4 \Rightarrow 8, 9, 10, 11$

Similarly: $P_3 = 110\underline{0}$

$\boxed{P_3 = 0}$

& $P_4 \Rightarrow 100\underline{1}$

$\boxed{P_4 = 1}$

Data Word

1	0	0	1	1	0	1

$m = 7$ Recieved $\rightarrow$ 1001111

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

$\boxed{r = 4}$

Parity Bits = 4 ;

eg: P_1, P_2, P_4, P_8

Code Word format

1	0	0		1	1	0		1		
D_{11}	D_{10}	D_9	P_8	D_7	D_6	D_5	P_4	D_3	P_2	P_1

Calculating the value of P_i

$P_1 \Rightarrow 1, 3, 5, 7, 9, 11 \Rightarrow D_{11}\ D_9\ D_7,\ D_5,\ D_3,\ P_1$

$1, 0, 1, 0, 1 1 \Rightarrow \therefore \boxed{P_1 = 1}$ ($\because$ No. of '1' = odd)

$P_2 \Rightarrow$ ~~$P_2, D_3, D_6, D_7, D_{10}, D_{11}$~~ $\Rightarrow$

$P_{11}, P_{10}, P_7, P_6, D_3$ $\therefore P_2 \Rightarrow 1 0 1 1 \underline{0}$ $P_2 = 0$

$\boxed{P_2 = 1}$ ($\because$ No. of '1's - odd(3))

Now putting the values of P_i's into Codeword format

1	0	0	1	1	1	0	0	1	0	1
D_{11}	P_{10}	P_9	P_8	D_7	D_6	D_5	P_4	D_3	P_2	P_1

But the recieved Code Word is

D_{11}	D_{10}	D_9	P_8	D_7	D_6	D_5	P_4	D_3	P_2	P_1
1	0	0	1	1	1	1	0	1	0	1

IT-1 (3rd yr) 16/8/12

Andaleeb Fatima

Anam Mushtaq

Anam Khan(1)

COMPUTER NETWORK

Lecture-19
Computer Network

01·10·20

COMPUTER NETWORK

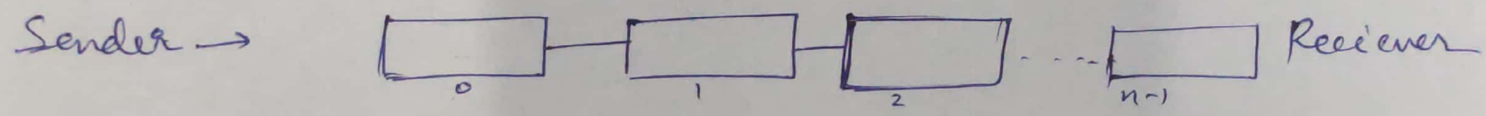
Error Correction Method:

ARQ: Automatic Repeat Request → Uses feedback channel for Retransmission of data packet.

EC : Error Correction

↓

Linear Block Code



↓

Algorithm for Error Correction

↓

$\boxed{\textbf{Hamming Code}}$

Data Word: m $\quad$ | 0 | 1 | 1 | 0 | 1 |

Redundent Bits: r

$$\boxed{2^r \geq m+r+1}$$

Code Word =

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

$m = 7$
$r = 4$ $\left(2^r \geq m+r+1\right)$

2^0 — 1
2^1 — 2
2^2 — 4
2^3 — 8

Q- Message (m): 1 0 0 1 1 0 1
Find Hamming Code for the given message

Sol^n

$m = 7$

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

$2^4 \geq 4 + 7 + 1$ ✓

$\boxed{r = 4}$

M1	M2	M3	P8	M4	M5	M6	P4	M7	P2	P1
1	0	0	1	1	1	0	0	1	0	1
11	10	9	8	7	6	5	4	3	2	1

Calculation of Parity Bits - P_i (Redundant Bits)

2^0 P_1 = 1, 3, 5, 7, 9, 11 [1 0 1 0 1 1]
2^1 P_2 = 2, 3, 6, 7, 10, 11 [1 0 1 1 1 0]
2^2 P_3 = 4, 5, 6, 7 [1 1 0 0]
2^3 P_4 = 8, 9, 10, 11 [1 0 0 1]

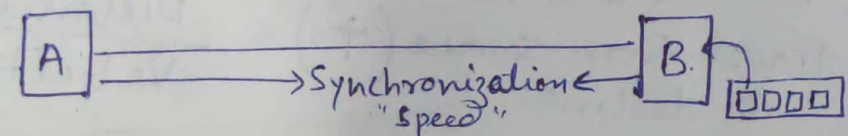
Even Parity

$\boxed{\text{Code Word: } 10011100101}$

2^3 P4	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0
2^2 P3	1	1	1	1	0	0	0	0	1	1	1	1	0	0	0	0
2^1 P2	1	1	0	0	1	1	0	0	1	1	0	0	1	1	0	0
2^0 P1	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0

Lecture-20
Computer Network

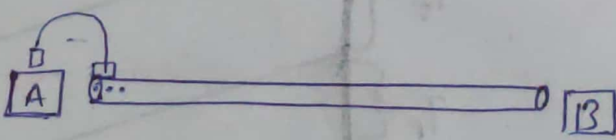
FLOW CONTROL: Preventing a fast running sender over a slow running reciever.



Sender should transmit data at a speed which reciever is able to handle it.

Delays in Network:

(T_t) Transmission Delay:



1-Bit ⟶ 1-Sec $B = 1 b/s$

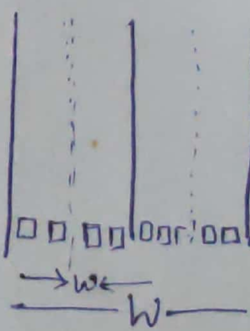
10-Bit ⟶ 10-Sec $= \frac{10}{10} = 1 \ b/s$

$L =$ 100 bits (Length of Packet)

$B =$ 10 bps (Bandwidth)

$$T = \frac{\cancel{100}^{10} \text{ bits}}{\cancel{10} \text{ bits/sec}}$$

$$\boxed{T_t = 10 \text{ sec}} \Rightarrow \boxed{T_t = \frac{L}{B}}$$



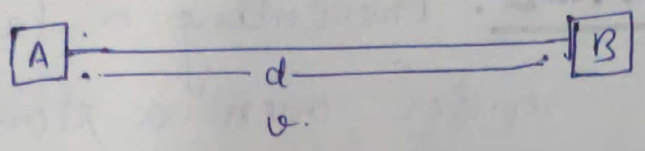
0.21
2.1

2) Propagation Delay (T_p) Round T

$V = 3 \times 10^8$

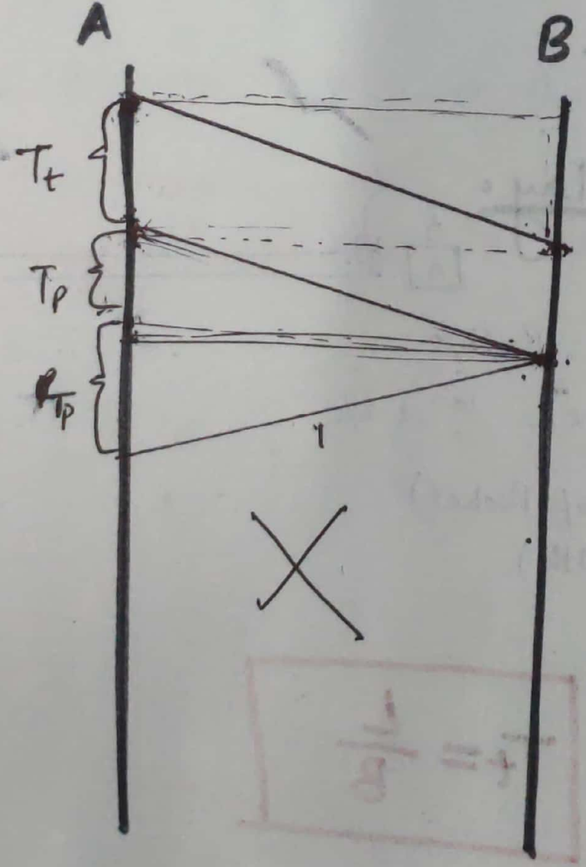
$V_r = 3 \times 10^8 \times 0.7$

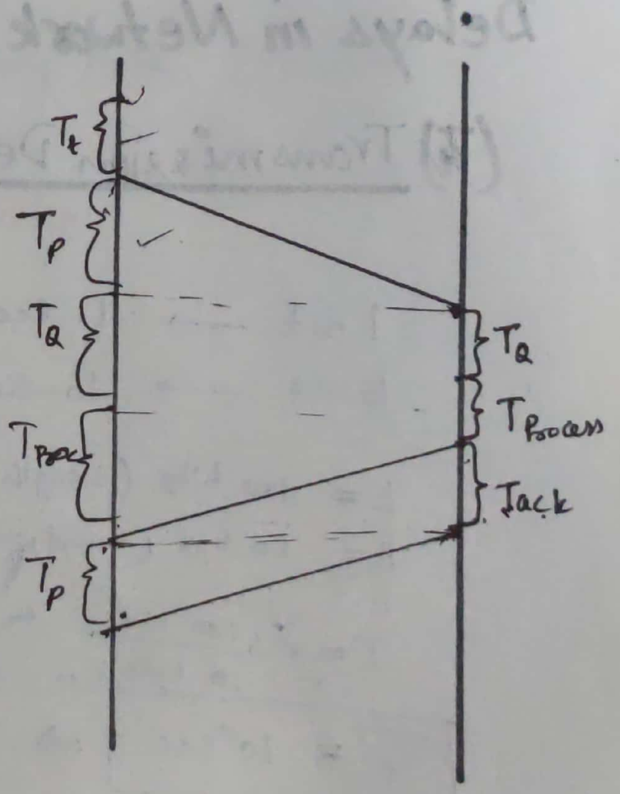
$= 2.1 \times 10^8$



Time taken to travel from source to destin^n. $(t) = \dfrac{\text{Distance}}{\text{Velocity}}$.

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





$$T_{total} = T_t + T_p + \underbrace{T_Q + T_{process}}_{0} + T_p + \underbrace{T_{ack}}_{0}$$

$$= T_t + 2T_p + T_{ack \to 0}$$

$$\boxed{T_{total} = T_t + 2T_p}$$

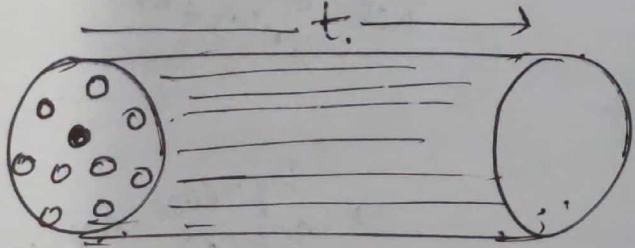
~~100100~~

100111001 01 → 10011100101

1001 1110101 $\boxed{100111\,10101}$

↓ Error

$P_1 =$ 1



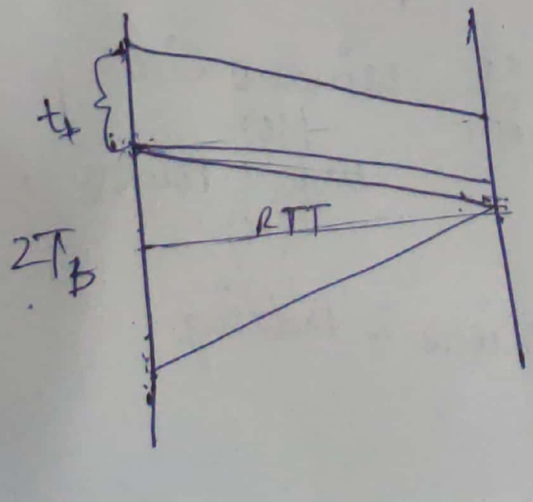
$$t_p = \frac{d}{v}$$

1 — 1 sec

10 — 10 s

L Bits = $\frac{L}{B}$

$$\boxed{T_t = \frac{L}{B}}$$



$B = 100$ bps

$\eta = 0.5\%$

$= \eta \cdot B$

$= 0.5 \times 100$

$= \frac{100}{2}$

$\boxed{= 50 \text{ bps}}$

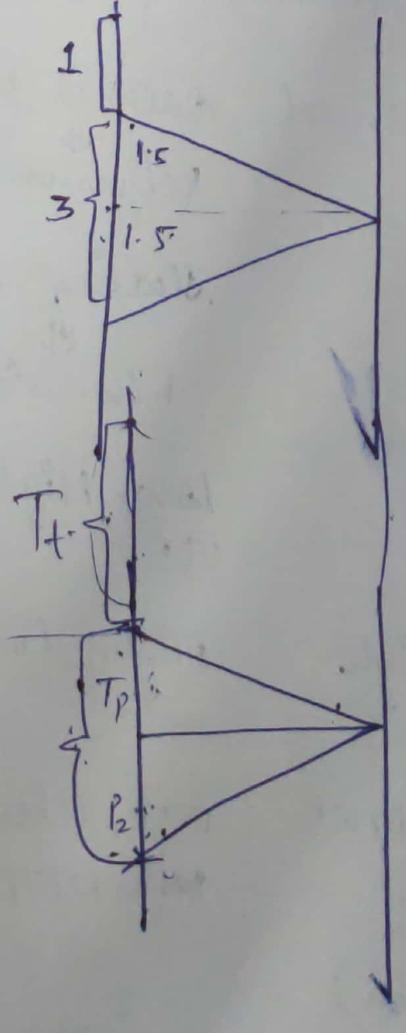
$T_t = 1$ ms.

$T_p = 1.5$ ms.

$\eta = ?$

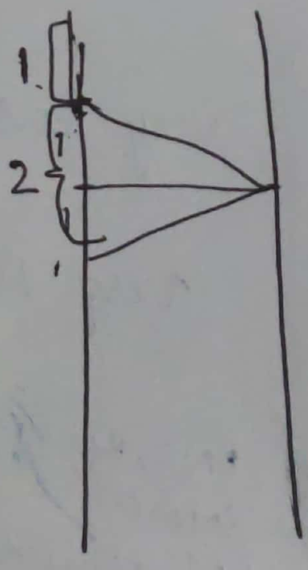
$L = 100$ Bits

$B = ?$



$= \frac{1}{4} = 0.2$

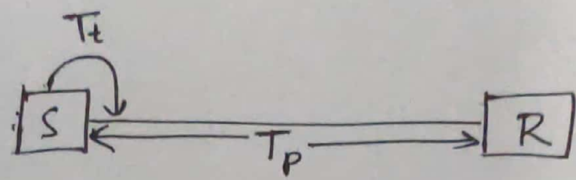
$\eta > ??$



$\frac{1}{3}$

LECTURE-21
Computer Network

Efficiency:



$$= \frac{\text{Useful Time}}{\text{Total Cycle Time}}$$

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

$$= \frac{1}{1 + \underbrace{(2T_p/T_t)}_{a}}$$

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

Throughput: Also known as -

$$= \text{Total Bits transmitted Successfully} \,/\, \text{Total Time}$$

$$= \frac{L}{T_t + 2T_p} \Rightarrow \frac{L \times \frac{B}{B}}{T_t + 2T_p} \Rightarrow \frac{\left(\frac{L}{B}\right) \times B}{T_t + 2T_p}$$

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

$$\boxed{T = \eta \cdot B}$$

To achieve Efficiency ≥ 0.5

$$\eta \geq 0.5$$

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

$$\cancel{2}T_t \geq \cancel{T_t} + 2T_p$$

$$T_t \geq 2T_p$$

$$\boxed{T_t \geq 2T_p}$$

§ Length of packet for achieving efficiency ≥ 0.5 (50%)

$$T_t \geq 2T_p$$

$$\left(\frac{L}{B}\right) \geq 2T_p$$

$$\boxed{L \geq 2T_p * B}$$

Q. $B = 4$ Mbps
$T_p = 1$ msec
$\eta \geq 0.5$

What is packet length (L)?

Sol^n

$$T_t \geq 2T_p$$

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

$$L \geq 2T_p * B$$

$$L \geq 2 * 1 * 4 \times 10^6 \times 10^{-3}$$

$$L \geq 2 \times 4 \times 10^3$$

$$L \geq 8 \times 10^3$$

$$\boxed{L = 8 Kb}$$

Ans.

Conclusion : Stop & Wait Protocol

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

$$= \frac{1}{1+2\,T_p/T_t} \Rightarrow \frac{1}{1+2\left(\frac{d}{v}\Big/\frac{L}{B}\right)}$$

$$= \frac{1}{1+2*\left(\frac{d}{v}*\frac{B}{L}\right)} \longrightarrow \text{Fixed}$$

Increase

$\Rightarrow d\uparrow \;\longrightarrow\; \eta\downarrow$ (Short distance Comm^{n}.)

$\Rightarrow \underbrace{L\uparrow \;\longrightarrow\; \eta\uparrow}_{\text{Preferable to LANs.}} \longrightarrow$ (Bursty Data Transmission

~~Proff~~ Preferable to LANs.

Q.

$B = 4\ Mbps$

$T_p = 1\ ms$

$\eta \geq 0.5\ (50\%)$

What should be the length of packet (L)

$L = ?$

$$\boxed{L \geq 2T_p \times B}$$

$$T_t \geq 2T_p$$

$$\downarrow$$

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

$$\boxed{L \geq 2T_p * B}$$

Length of the packet must be greater than or equal to "$2T_p * B$"

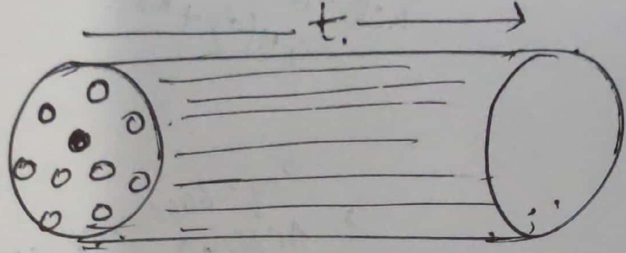
~~100100~~

10011100101 → 10011100101

1001 1110101 $\boxed{10011110101}$

↓ Error

$P_1 =$ 1



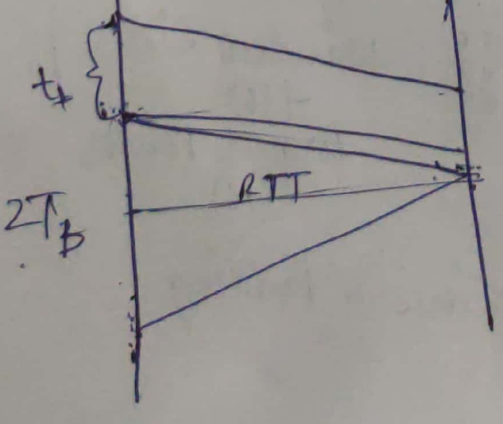
$$t_p = \frac{d}{v}$$

1 — 1 Sec

10 — 10 …

L Bits = $\frac{L}{B}$

$$\boxed{T_t = \frac{L}{B}}$$



$B = 100$ bps

$\eta = 0.5\%$

$= \eta \cdot B$

$= \cancel{100}\ 0.5 \times 100$

$= \frac{100}{2}$

$\boxed{= 50 \text{ bps}}$

Ruf

$$\eta = \frac{\text{Usful Time}}{\text{Total Time Cycle}} = \frac{T_t}{T_t + 2T_p}$$

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

Throughput :

E.B
B.W

$$= \frac{\text{Total Data}}{T_t + \cancel{2T_t/T_p}\, 2T_p} = \frac{L \frac{B}{B}}{T_t + 2T_p}$$

$$= \frac{T_t \times B}{T_t + 2T_p/\cancel{T_t}}$$

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

$$= \eta \cdot B$$

LECTURE-2
Computer Network

Stop & Wait Protocol Draw-back

$T_t \xRightarrow{sec.} 1$ pckt.

1 Sec. $\frac{1}{T_t}$ Packet

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

$$= (1 + 2T_p/T_t)$$

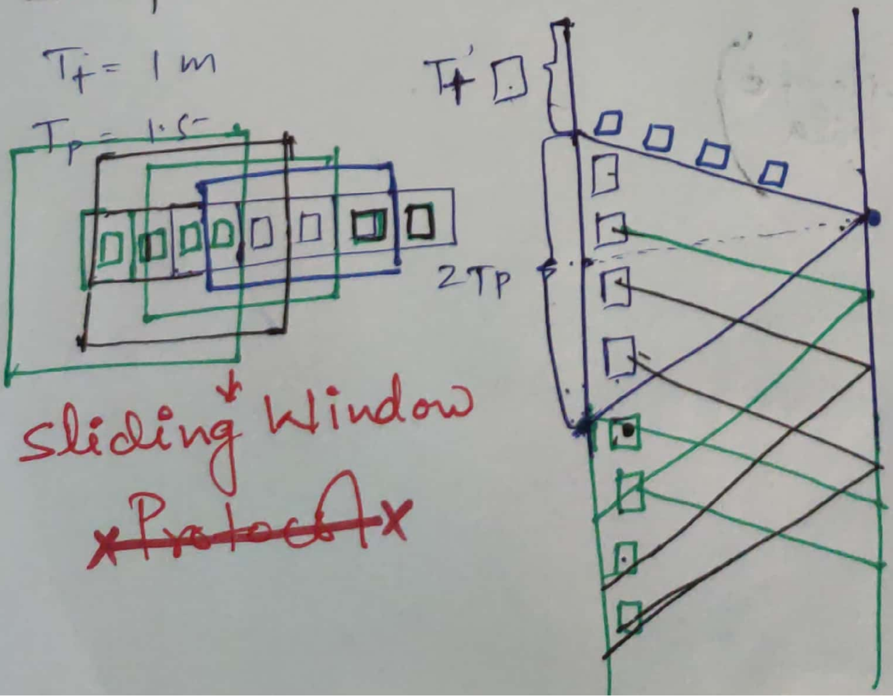
$$\boxed{1+2a}$$

Thus in a total time of $(T_t + 2T_p)$ the sender could have sent $(1+2a)$ packets but it actually send only 1 packet in S&W protocol which is the drawback of this protocol.

Improvisation in S&W :

$T_t = 1m$

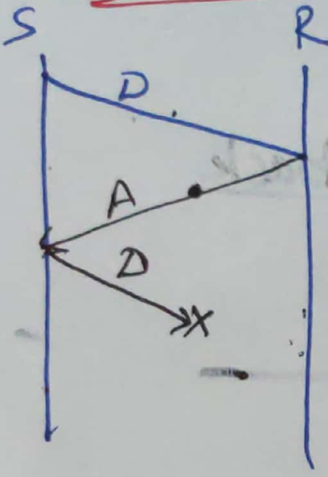
$T_p = 1.5$



Sliding Window

~~Protocol~~

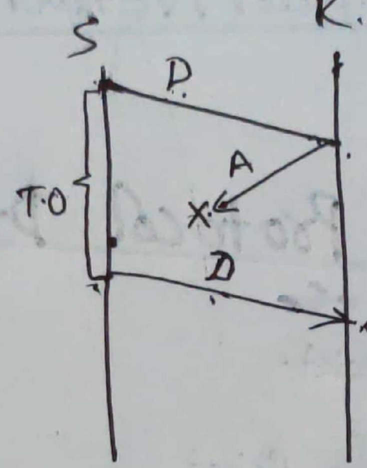
1 Lost Packet Problem



S·W. + Timeout Timer

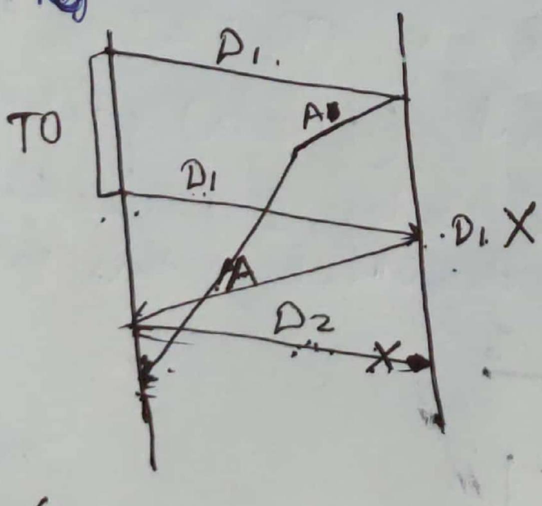
(S&W-ARQ)

2 Lost Ack Problem



S&W + TO.
+
Seq. No on Data Packet

3 Delayed Ack Problem:



This Solution is Resulted in Sliding Window Protocol

(S&W + T.O + Seq. No. of Data + Seq of Ack.)

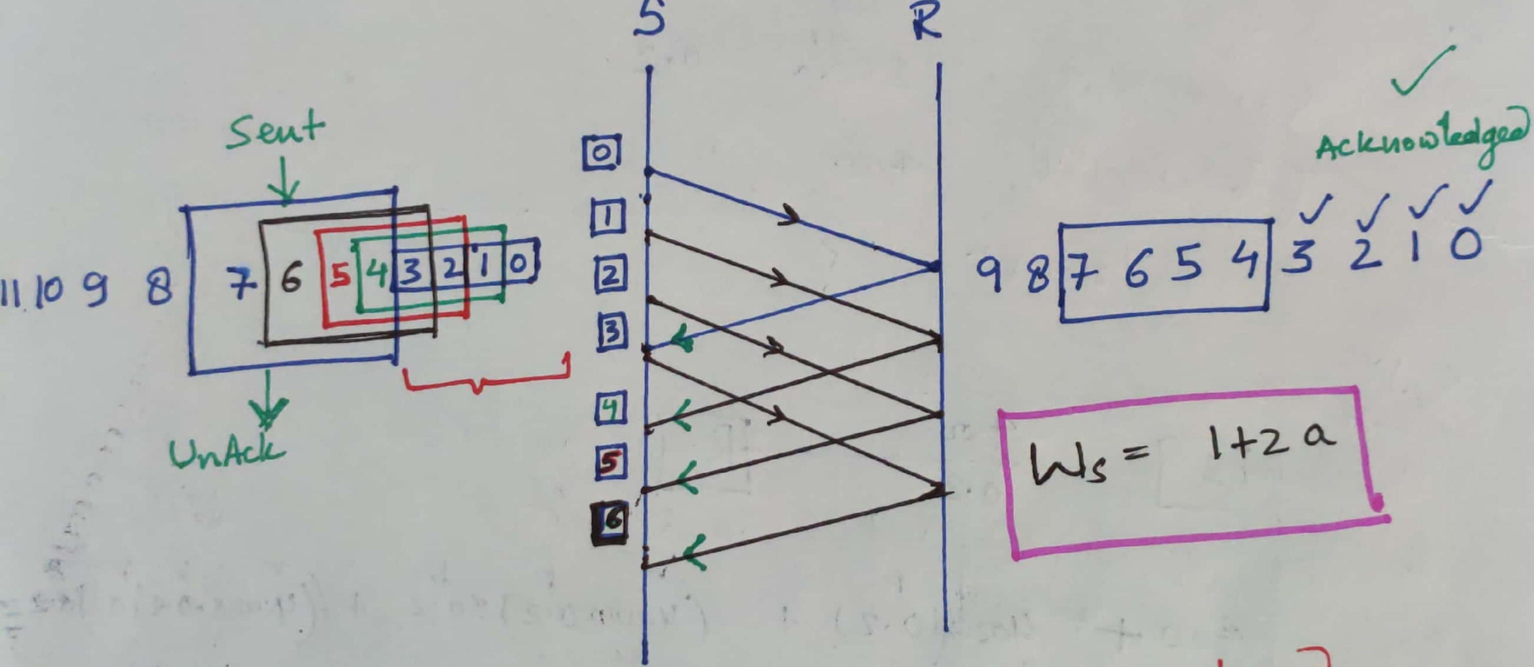
SLIDING WINDOW CONCEPT:

$T_t = 1$ m sec

$T_p = 1.5$ ms

$$\frac{1}{1+2a} = \frac{1}{1+2\times1.5} = \frac{1}{4}$$

$\boxed{\eta = 0.25}$ 25% only in S&W



$\boxed{W_s = 1+2a}$

Seq. No.

Large Seq. No. will cause extra overhead into packet header therefore small set of no. for sequence numbers (diffrentialing the size of window) are used.

Window Size(W_s) It depends upon the fact that how many packets can be sent without waiting for an acknowledgement which in turn depend on the Transmission(T_t) time and Round Trip Time (RTT) eg: $2T_p$ (Propagation Time)

$$\boxed{W_s = 1+2a}$$

Questions on S & W Protocol

Q. 10 Packets

S & W

Lost evry 4th Packet

No. of Transmissions ?

1, 2, 3, ~~4~~ 4 5. 6, ~~7~~ 7 8 9 ~~10~~ 10

= 13 Transmissions

Q. S & W

Error Rate = 20% 0.2

Total Packet = 400

No. of Transsn = ?

Soln

$$\boxed{S} \xrightarrow[0.2]{400} \boxed{R}$$

$$= \overset{n}{400} + \underbrace{400 \times (\overset{p}{0.2})} + (\overset{n}{400 \times 0.2}) \times \overset{p}{0.2} + ((\overset{n}{400 \times 0.2})\overset{p}{0.2})\overset{p}{0.2} \cdots + \cdots$$

$$= n + n \cdot p + n \cdot p^2 + n \cdot p^3 + \cdots$$

$$= n(1 + p + p^2 + p^3 + p^4 \cdots)$$

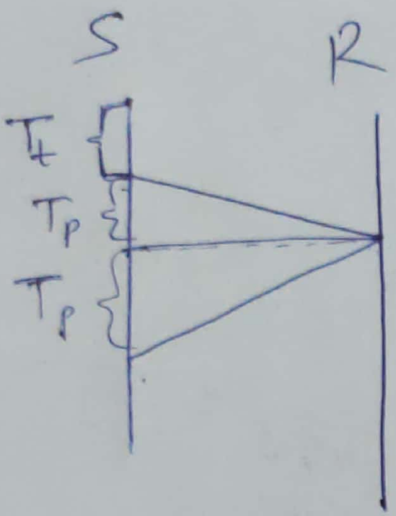
$$= n\left(\frac{1}{1-p}\right)$$

$$= 400\left(\frac{1}{1-0.2}\right) \Rightarrow \frac{\cancel{4000}^{500}}{\cancel{0.8}} = 500$$

$$\boxed{= 500 \text{ Transmission}}$$

RUF

Stop & Wait : Flow Control. Ruf



$$\text{Total Time} = (T_t + 2T_p)$$

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

1 sec - 1 pckt

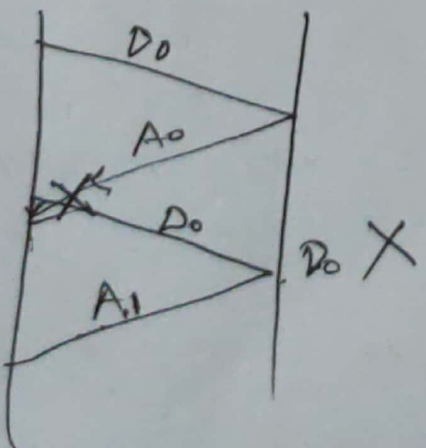
$T_t = T_t.$

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

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

$$= 1 + 2\underbrace{(T_p/T_t)}_{a}$$

$$= (1 + a)$$



$$\cancel{1.00} + \underbrace{(10.0 \times 0.2)}_{\cancel{20} \downarrow 20} = 20 \times 0.2$$

4000

LECTURE-22

Lomputer Network

AKBAR SHAH

Stop & Wait Protocol Draw-back

$T_t \xRightarrow{sec.}$ 1 pckt.

1 Sec. $\frac{1}{T_t}$ Packet

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

$$= (1 + 2T_p/T_t)$$

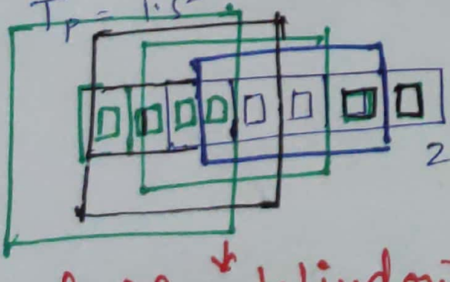
$$\boxed{1+2a}$$

Thus in a total time of $(T_t + 2T_p)$ the sender could have sent $(1+2a)$ packets but it actually send only 1 packet in S&W protocol which is the drawback of this protocol.

Improvisation in S&W :

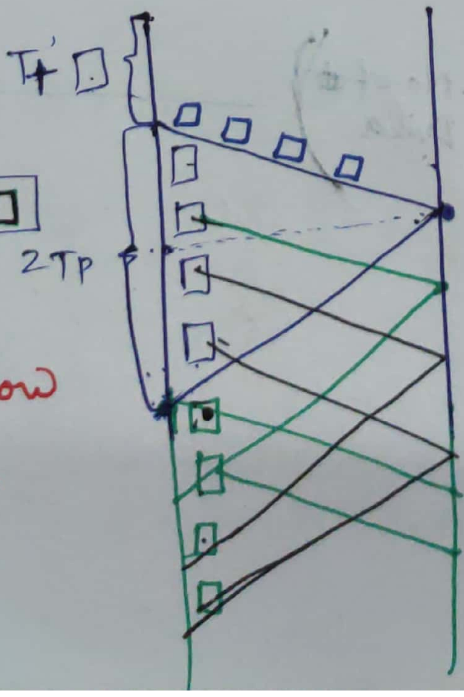
$T_t = 1m$

$T_p = 1.5$



Sliding Window

~~Protocol~~



LECTURE-23

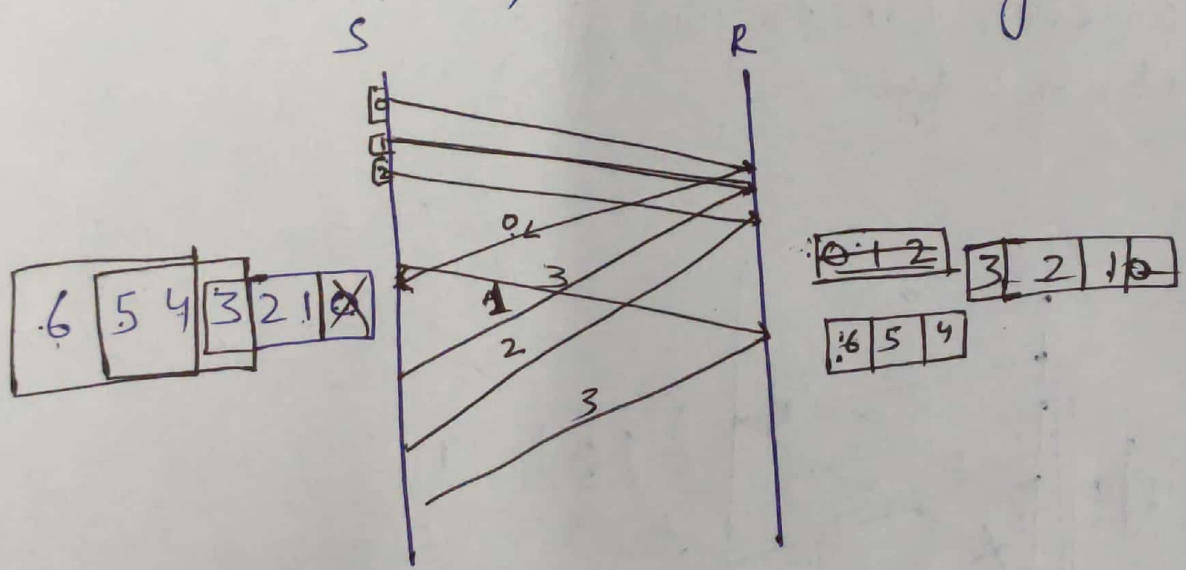
Computer Network

15.10.20

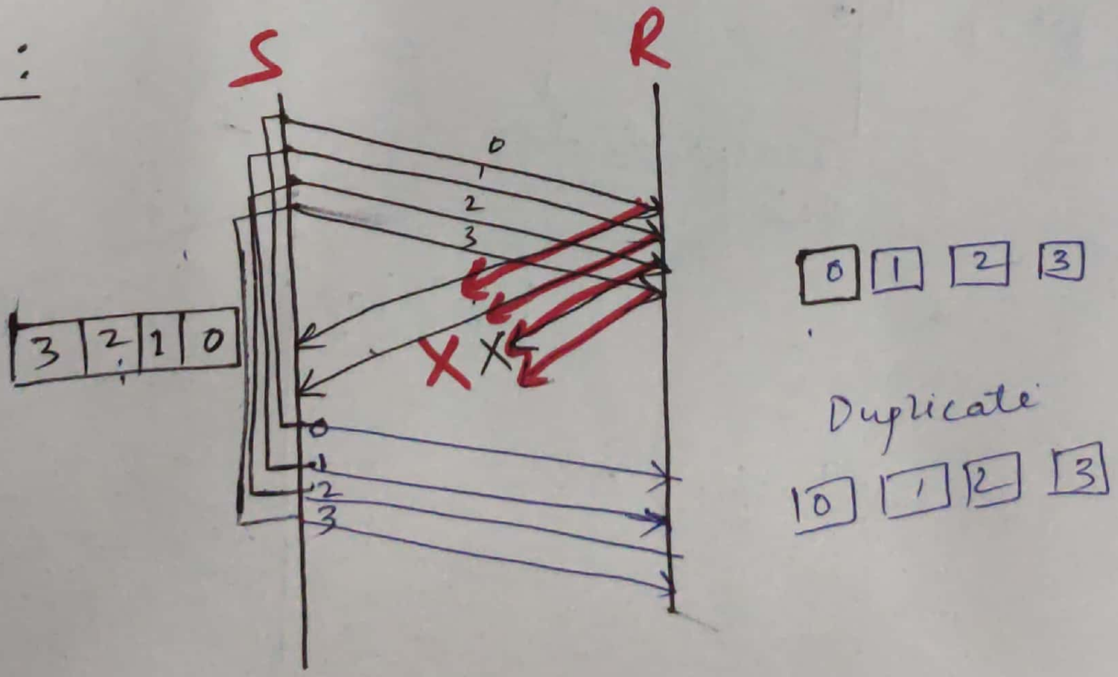
COMPUTER NETWORK

SLIDING WINDOW PROTOCOL:

There is a buffer (window) at sender side & reciver side. The sender's window holds packets which have been sent without waiting for acknowledgament. Similarly Reciever's side window can accept the no. of packets without sending acknowledgent.



Problem:



Sliding Window

Go Back N (GBN)

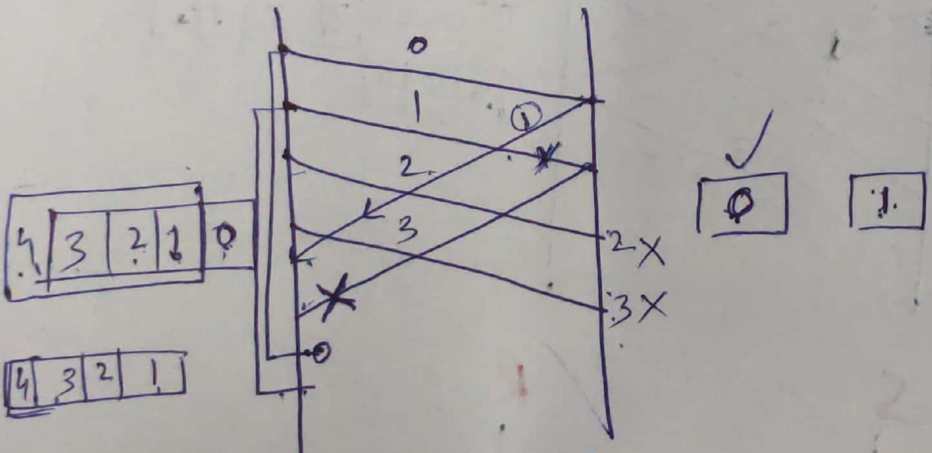
N: size of window

Selective Repeat (SR)

1) Sender Window Size (W_S)
2) Reciever Window Size (W_R)
3) Acknowledgement

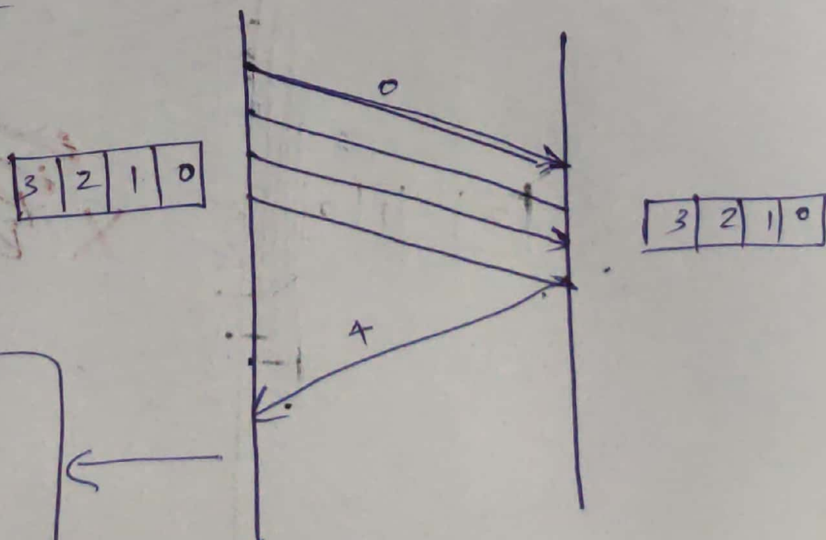
Lost

Last



Independent Ack

Adv:



less Traffic : Adv

less Reliable Drawback

Cumulative Ack.

Sliding Window

Ws

Max Window Size at Sender.

$W_s = 1+2a$

Max ~~Max~~ Seg. ~~no~~ = $1+2a$

Min. No. of bit for Seg. no. field = $2^n = 1+2a$

$$\boxed{n = \lceil \log_2 (1+2a) \rceil}$$

Conflict

$\boxed{1\ 0\ 1\ 0}$

$W_s = 4$

Seq. = 02

therefore the seq. no. atleast should be "1+2a" equal to window size.

Seq. No. Limit

Although sequence no. of a Window could be as large as 1+2a which may range upto ∞ infinity, but ~~it is~~ this no. (n) is restricted to a certain limit to prevent the over-head in packet transmission

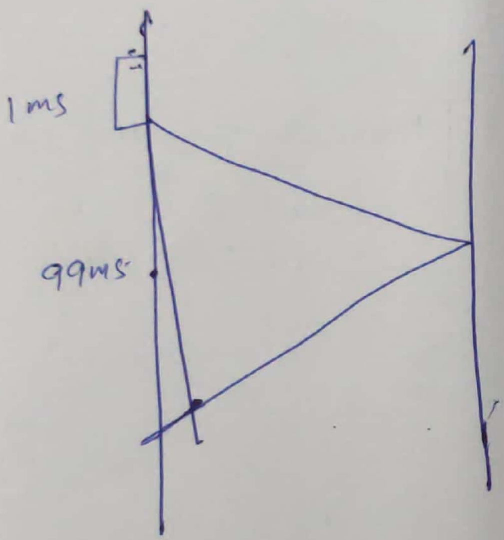
If we would be using an extreamly large no. for seq., then a large no. of bit in the same proportion would be required ~~for~~ in the header of the packet hence it would lead to extra over-head for ~~packet~~ a defined standard packet size.

Note: "Packet Header format is Predefined only the payload can vary." --

Q- $T_t = 1ms$

$T_p = 49.5 ms$

$W_s = ?$ for η_{max} efficiency $\frac{(1+2a)}{(1+2a)}$



$W_s = 1+2a$

$\boxed{W_s = 100}$

$\boxed{\text{Seq No} = 100}$ } $n = \lceil \log_2(1+2a) \rceil$

$n = \log_2 100 = \lceil 7.5 \rceil$

$\boxed{n = 7} \leftarrow \boxed{n=7}$

What if seq. no. bit is predifined & limitted to be "6"

In this case—

Max seq no. $= 2^6 = 64$

therefore we can use only 64 buffer space out of 100

So the efficiency will be $\frac{64}{100} = 64\%$ only

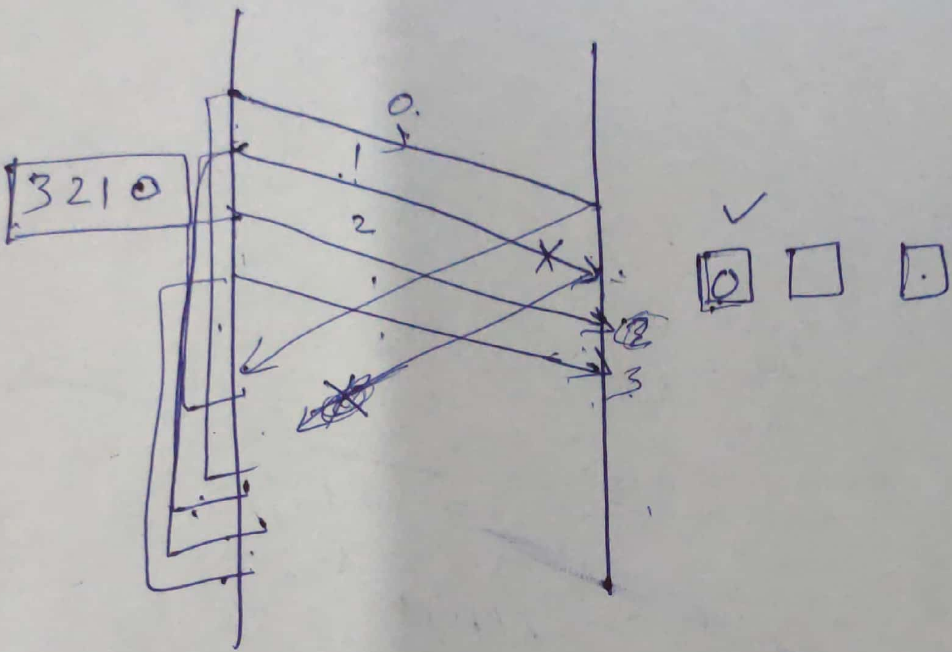
In actual,

$W_s = \text{Min}(1+2a, 2^n)$

Due to the restriction over the the packet header field (seq.) bit length whichever would be less, it will be used.

became $1+2a \underset{may}{\geq} 2^n$ (no. of bit available for seq no)

Ruf



$\underbrace{1\ 2,\ \cancel{3}\ 3,\ 4,\ \cancel{5}\ 5,\ 6,\ \cancel{7},\ 7,\ 8,\ \cancel{9},\ 9,\ 10}_{\text{S\&W}}$

1, 2, 3, 4, 5, 5, 6, 7. 8, ~~9~~, 9, 10

12

In GBN

AS N — ?

$\boxed{0, 1, 2, 3}$

$2^3 = 8$

$2^2 = 4$

3

2.3.2.

2

$2^2 = 4$

Ruf

Q- In GB10

$T_t = 1$ ~~sec~~ ms $N = 10$

$T_p = 49.5$ ms

$\eta : ?$

$$\eta = \frac{10}{1+2a} \rightarrow T_p/T_t$$

$$\eta = \frac{10}{1+2(49.1/1)} = \frac{10}{100}$$

$$\boxed{\eta = 10\%}$$

BW = 40

Throughput

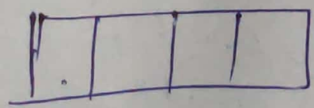
Effective B.

$= B * \eta$

$= \cancel{40 \times 10}$

$40 \times 10^6 \times 0.1$

$= \boxed{4 \text{ Mbps}}$



Q— $W_s = ?$

Q— Seq. = ?

Q — No. Bits. Req. to represent seq.

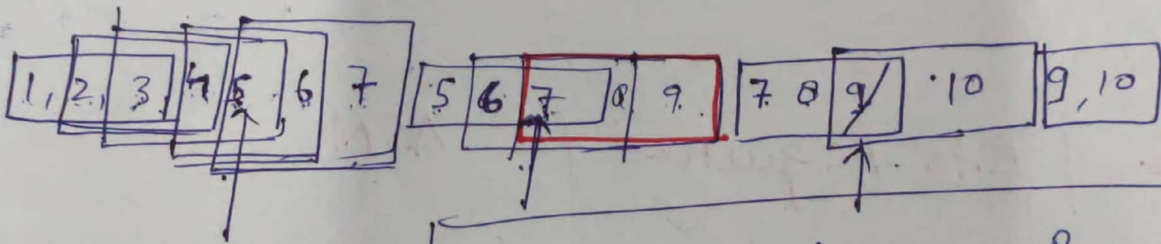
Lecture-24

Computer Network

Sliding Window Protocols:

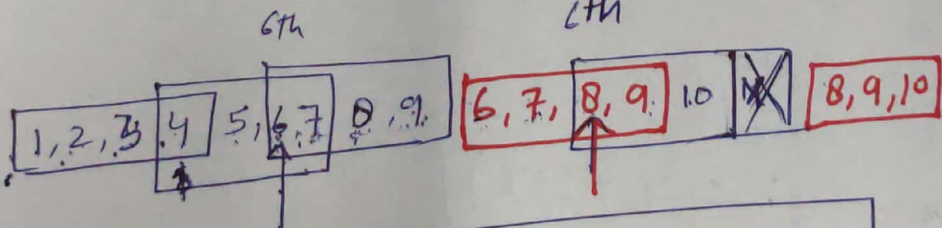
1) GBN ✓ (W_s, Seq.No. Bits for Seq.No.)
2) S.R.

Q- In GB-3, if every 5^{th} packet is lost during transmission then how many transmissions will be required for sending 10 packets.



$\boxed{\text{18 - Transmissions Required}}$

Q- In GB4, if every 6^{th} packet is lost during Transmⁿ; for sending 10 packets, how many transmⁿ req.

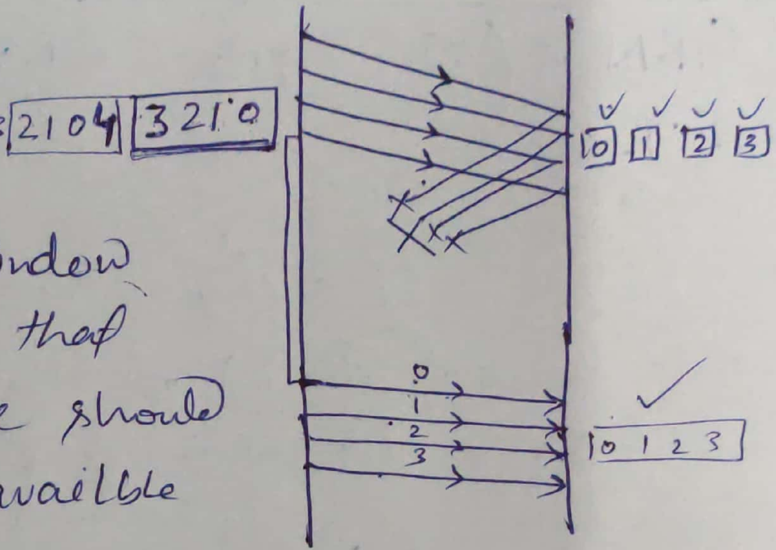


$\boxed{\text{Total Transⁿ = 17}}$

Window Size & Sequence No.:

Available Sequence No. (ASN)

$$ASN \geq (W_S + W_R) \quad \text{—— (1)}$$



ASN should alway be greater than sender window size or we can say that the sender window size should always one less than available sequence no.

No. of Bits Required for ASN

$$GB(N) \longrightarrow N$$

ASN? $\quad W_S + W_R$

$$\boxed{ASN = N + 1}$$

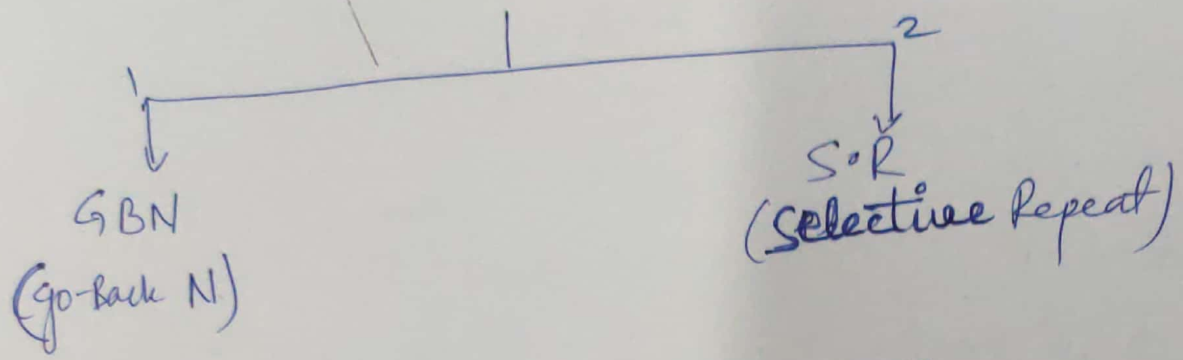
$$2^x = N + 1$$

$$x = \lceil \log_2 (N+1) \rceil$$

No. of Bit for ASN - in GBN.

$$\boxed{x = \lceil \log_2 (N+1) \rceil}$$

Sliding Window Types:

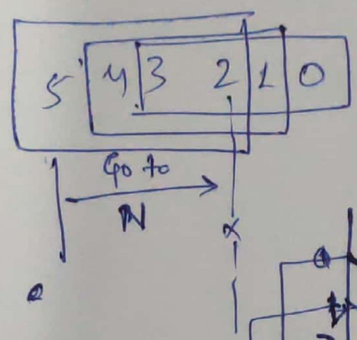


1. Sender $W_s = N$

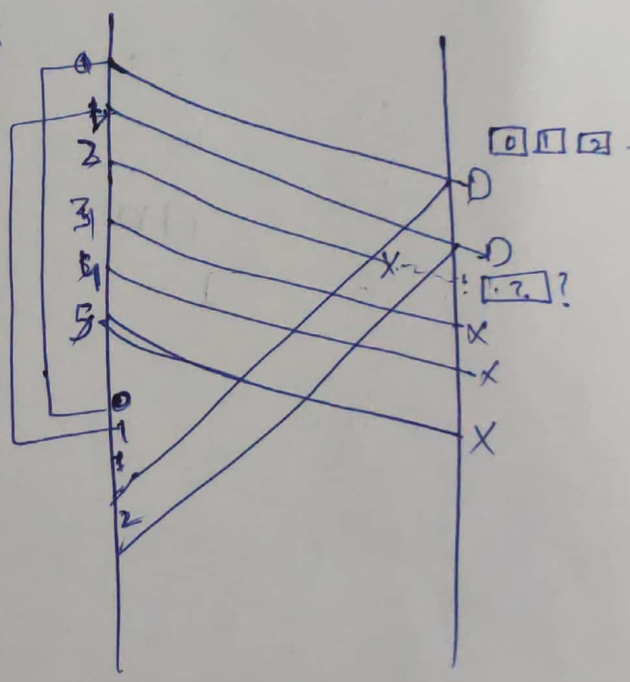
   eg GB10 ⇒ $N=10$

   where $N > 1$

   if $N = 1$ then it will be become Stop & Wait



2. Reciever Ws ~~should~~ always be $\boxed{W_s = 1}$
   (only one packet)
   each packet is acknowledged the moment it comes one by one ~~without~~ no. packet is acknowledged out of order.



Go Back-N

① ★ Window Size of Sender should be

$\boxed{W_S = N > 1}$

Otherwise it will become stop-&-wait case

② ★ Reciever Window Size should be

$\boxed{W_R = 1}$

③ ★ A reciever side ~~all~~ each packet is processed strictly one by one in order, if any one packet is lost at reciever end no packet after that sequence no. packet (Lost one) would be entertained by reciever thereby sender will has to retransmit the all thoes packet after the lost one sq. pckt even though they would have already been sent earlier

⊛ Hence each packet will be allowed to reside in buffer if and only if the previous (just) packet is processed & acknowledged successfully.

Hence, in Retransmission sender has to go back-N no. of packets

④ Acknowledgement from Reciever can be of two types —

ⓐ Cumulative Ack

ⓑ Independent Ack

Cumulative Ack

Advantag: Less Traffic

DisAdv. : Less Reliable

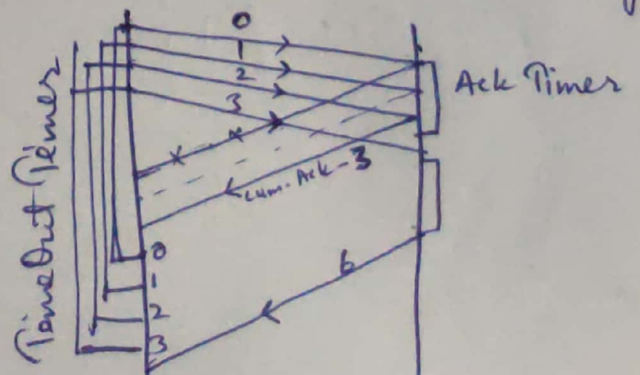
Independent Ack

Adv: Highly Reliable

Dis: High Traffic.

⑤ Timer for Ack & Timeout

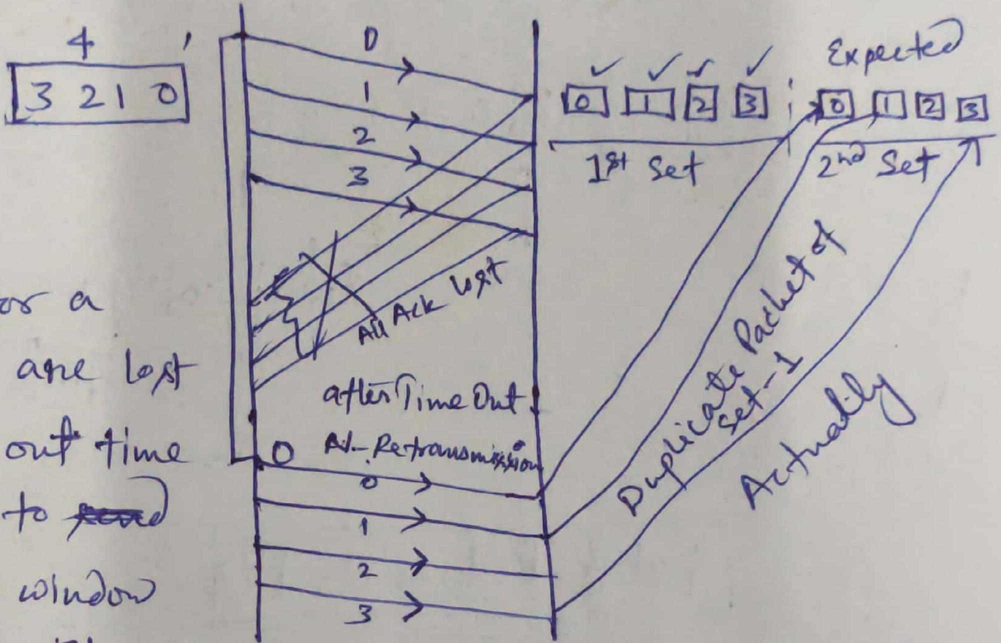
★ In cumulative Ack, the total no. of the packets that can be acknowledged cumulatively in one go is decided by Time out Timer for "Ack" by reciever. Therefore Ack neigther to be too less or too long



Go Back-N Continued---

Relationship b/w Window Size and Seq. No.

Example GB4



Problem

~~To prevent~~

If Reciever's All Ack's for a complete window are lost then after time out time sender will going to ~~send~~ resend entire window frame(N) which may be well expected by reciever because reciever will be waiting for all those same seq. no. packets for 2n set of window ~~but~~ will be actually recieving the duplicate frame of set-1.

Soln If "N" is the ~~total~~ window size. The we should use seq No N+1

Hence, for Any Window Protocol

$$W_S + W_R \leq \text{Availble Seq. No. (ASN)}$$

( ) ( )

Incase of Go Back-N

$W_S = N$

$W_R = 1$

24.5 2020

Therefor

Min	Seq. = N+1

No. of Bits(n) ~~= 1~~

$2^{n} = N+1$

$n \log 2 = \log N+1$

$n = \log_2 N+1$

Relative Calculations on values of Win Size of Sender & Receivers, Seq. No. Bits.

1) $W_S = N$, $W_R = 1$ | $Seq = N+1$
 Bits $= \lceil \log_2(N+1) \rceil$

---

2) $Seq = N$ $W_S = N-1$, $W_R = 1$
 GB4 $W_s = 3$ $W_R = 1$

---

3) Bits $= k$, $Seq = 2^k$ = $W_s = 2^k - 1$
 $W_R = 1$

Q. $T_t = 1ms$ $N = 6$ bits.
$T_p = 49.5\,ms$

$(\text{Size of Window})_{max} = 1 + 2a \Rightarrow 1 + 2\frac{T_p}{T_t}$
$= 1 + 2 \times 49.5/1 = 1 + 99/1 =$

Possible Win Size $= 100$

Req. No. of Bits to represent 100 diffrent Seq No $= 2^n = 100$

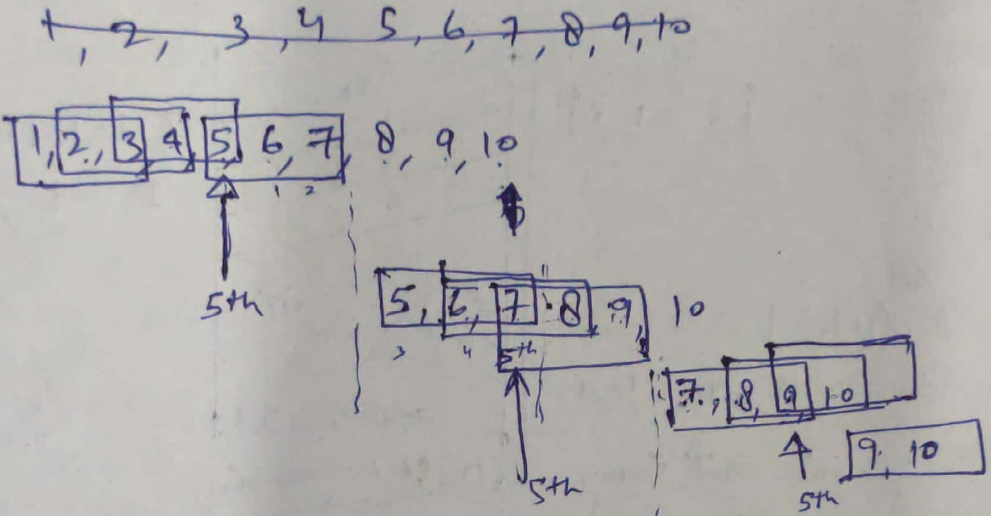
$2^n = 100 + 1$
$n = \log_2(100 + 1)$
$n \cong 6$ bits. (which is already given)

Since we can send 100 packets but due having seq. bit limited to '6' we can send only $2^6 = 64$ ~~frames~~ packets only. therefore efficeiency will be compromised by 36%.

$\eta = \frac{\text{actual}}{\text{Total}} = \frac{64}{100} = 64\%$

Q: GB4, 6 th, 10 pck

In GB3 if every 5^{th} packet is being transmitted is lost and if we have to send 10-packet, then how may packet trans^n are required



$\boxed{\text{Total Re-Trans}^n = 18}$

Q- ① $W_s = N$, $W_R = 1$, $Seq = N+1$

$S\text{-Bits} = \lceil \log_2(N+1) \rceil$?

② $Seq. = N$

$W_s = ?$ $(N-1)$

$W_R = ?$ (1)

③ $Bits = k$

$Seq = 2^k$

$W_s = ?$ $2^k - 1$

$W_R =$ - 1

Go Back N

Q. for a GB10, given that

$T_t = 1ms$

$T_p = 49.5ms$

$B = 40 mbps$

What is throughput

$$\boxed{T = \eta \cdot B}$$

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

$$\eta = \frac{N}{1+2 \cdot T_p/T_t}$$

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

$$\boxed{\eta = 10\%}$$

Therefore

$$\text{Throughput} = \frac{10}{100} \times 40 \text{ mbps.}$$

$\boxed{T = 4 \text{ mbps}}$ only.