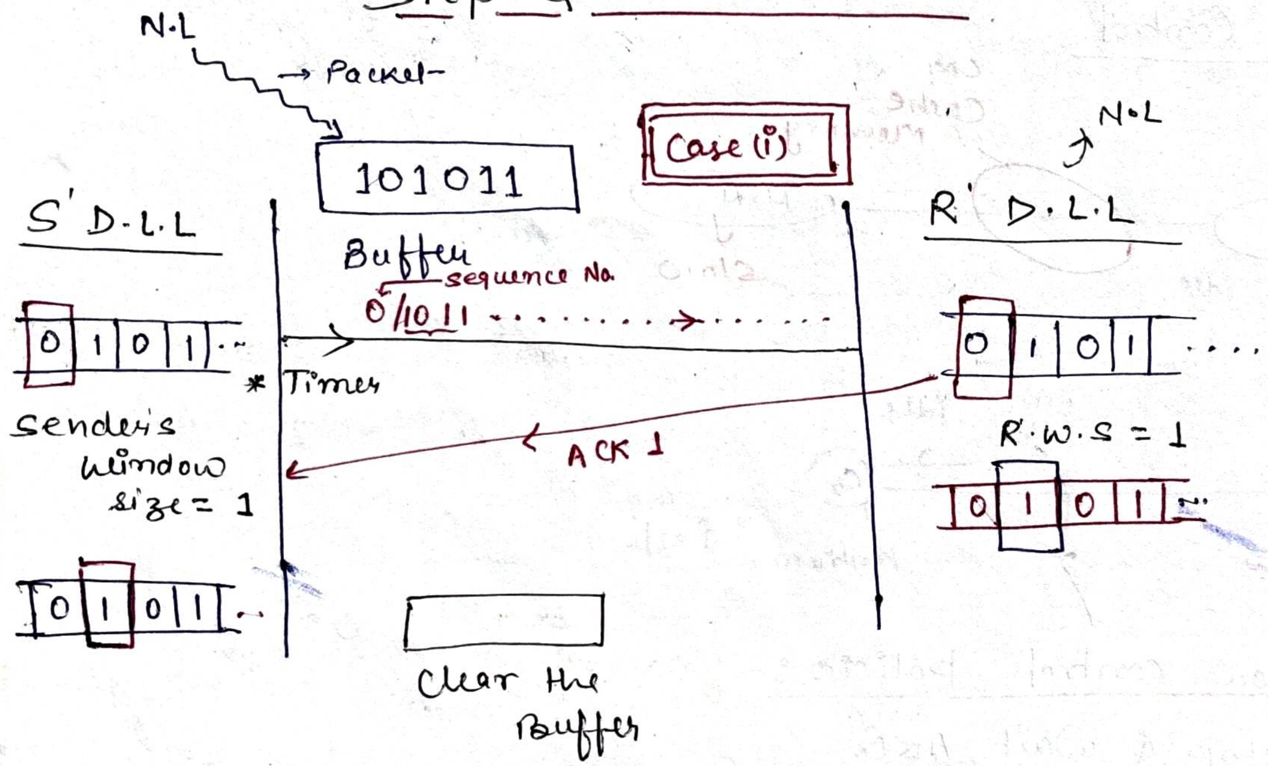
Error Correction Policy → Ex. Hamming Code

Error detection Policy → Ex. ① Parity
② Checksum
③ CRC

*** Flow Control Policies of Data Link Layer

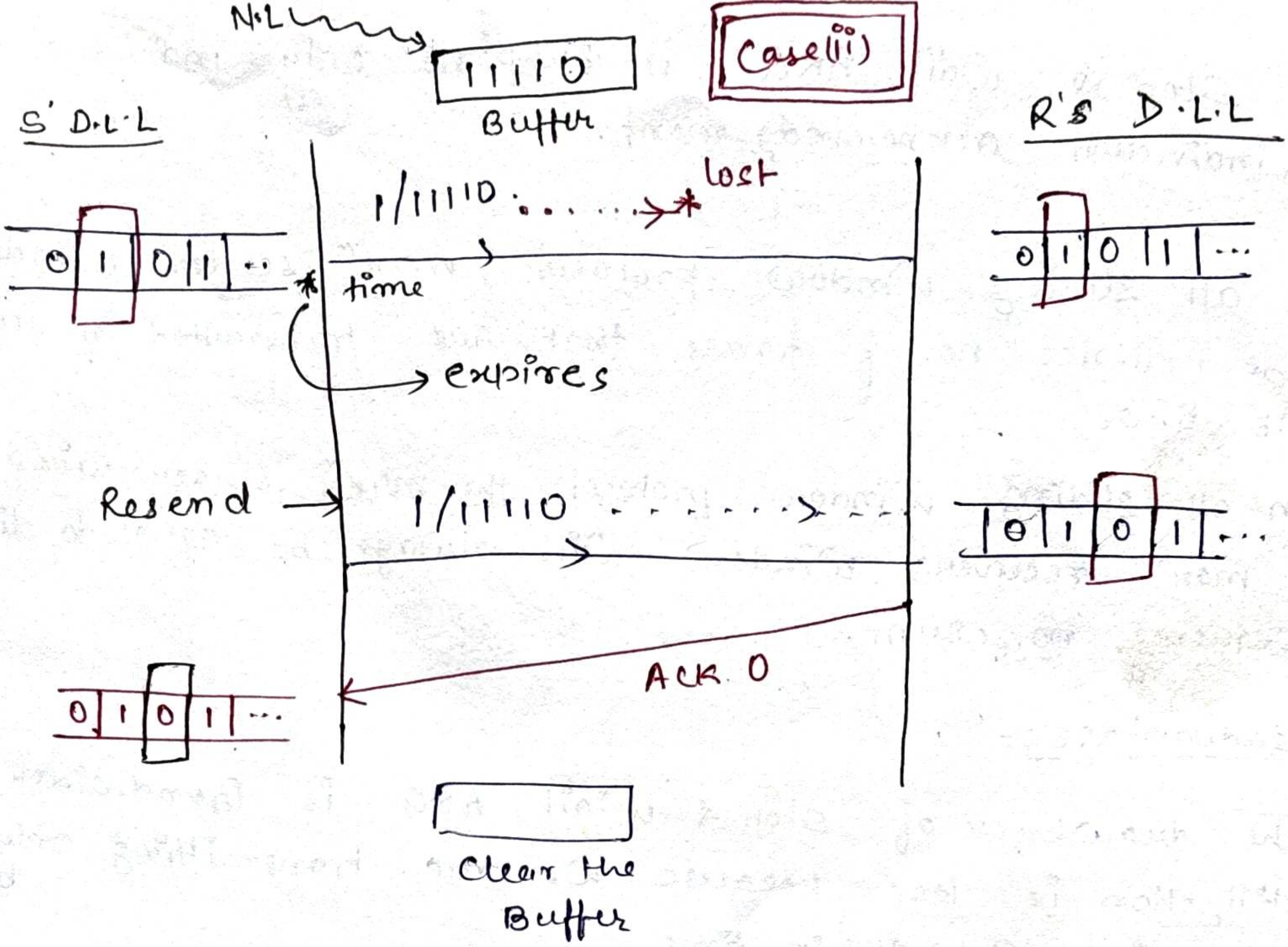
Stop & Wait ARQ
← Automatic Repeat Request



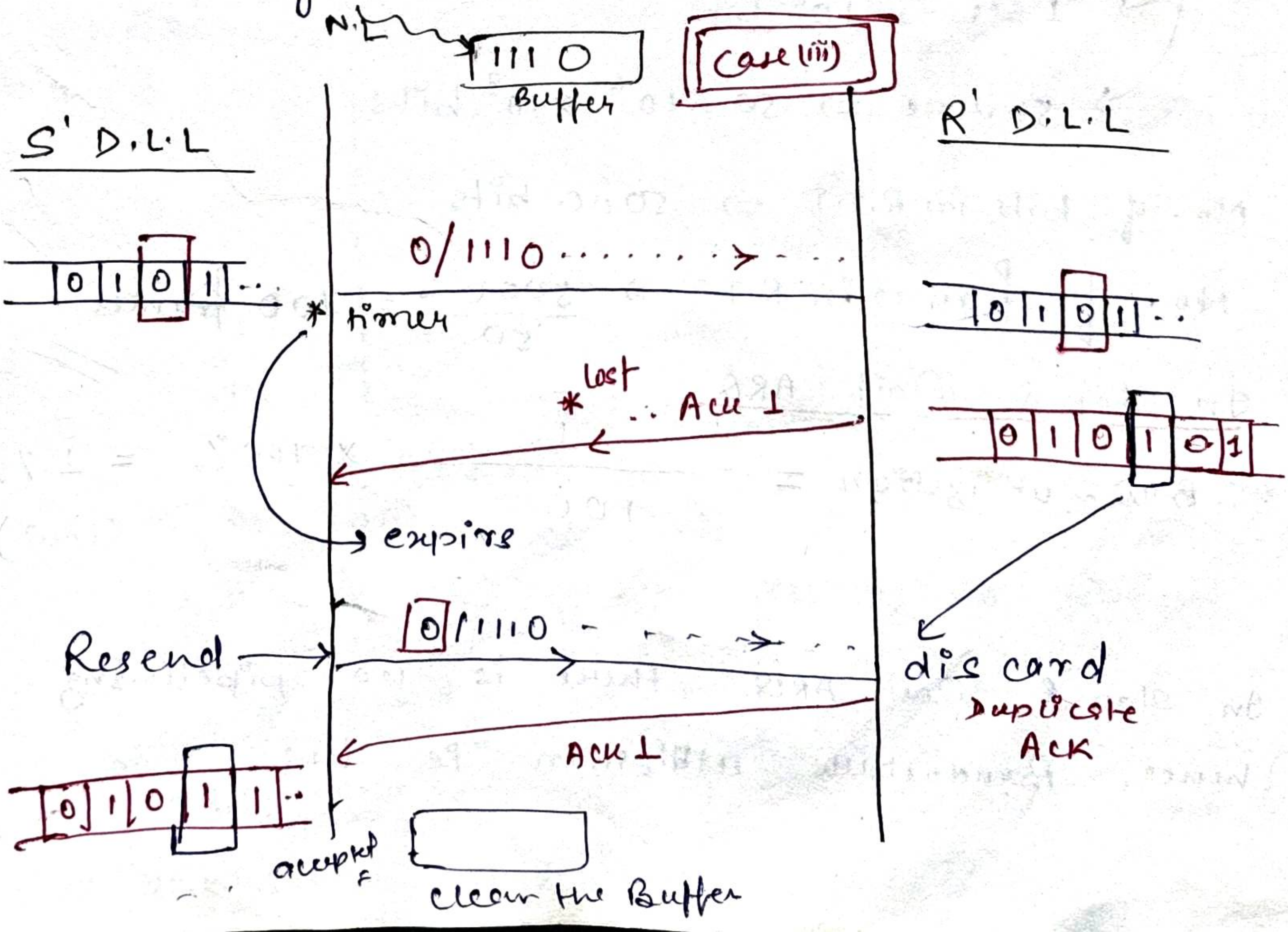
* Steps:-

(i) Once the data reaches to reciver, the sequence no. of the data is compare with the recivers sliding window no. If both are matched data is accepted otherwise it is discarded.

(ii) The acknowledgement no. will always be the sequence no. of the next expected data then only the ack is accept..



→ Once the data is lost, automatically timer will expire the protocol will take the data from buffer and re-transmit this data is accepted & the ack is also accepted then say that protocol is working.



→ In Stop & Wait ARQ, it supports only individual frames & individual acknowledgement.

→ In all sliding window protocol, max^m sender window size indicates no. of frames that are transmitted in round trip time.

→ In all sliding window protocol the max^m sender window + max^m receivers window will always be equal to distinct sequence no. count.

Disadvantage:-

The drawback of stop & wait ARQ is Bandwidth utilization is less because we are transmitting only one frame in Round-trip time.

Ex. B.W = 100 Mbps

R.T.T = 50 μ sec.

frame size = 50 bits.

1 sec ⟹ 10^8 bits

50 μsec ⟹ $50 \times 10^{-6} \times 10^8$ bits

No. of bits in R.T.T ⟹ 5000 bits

No. of frames in R.T.T ⟹ $\frac{5000}{50}$ = 100 frames

→ In Stop & Wait ARQ

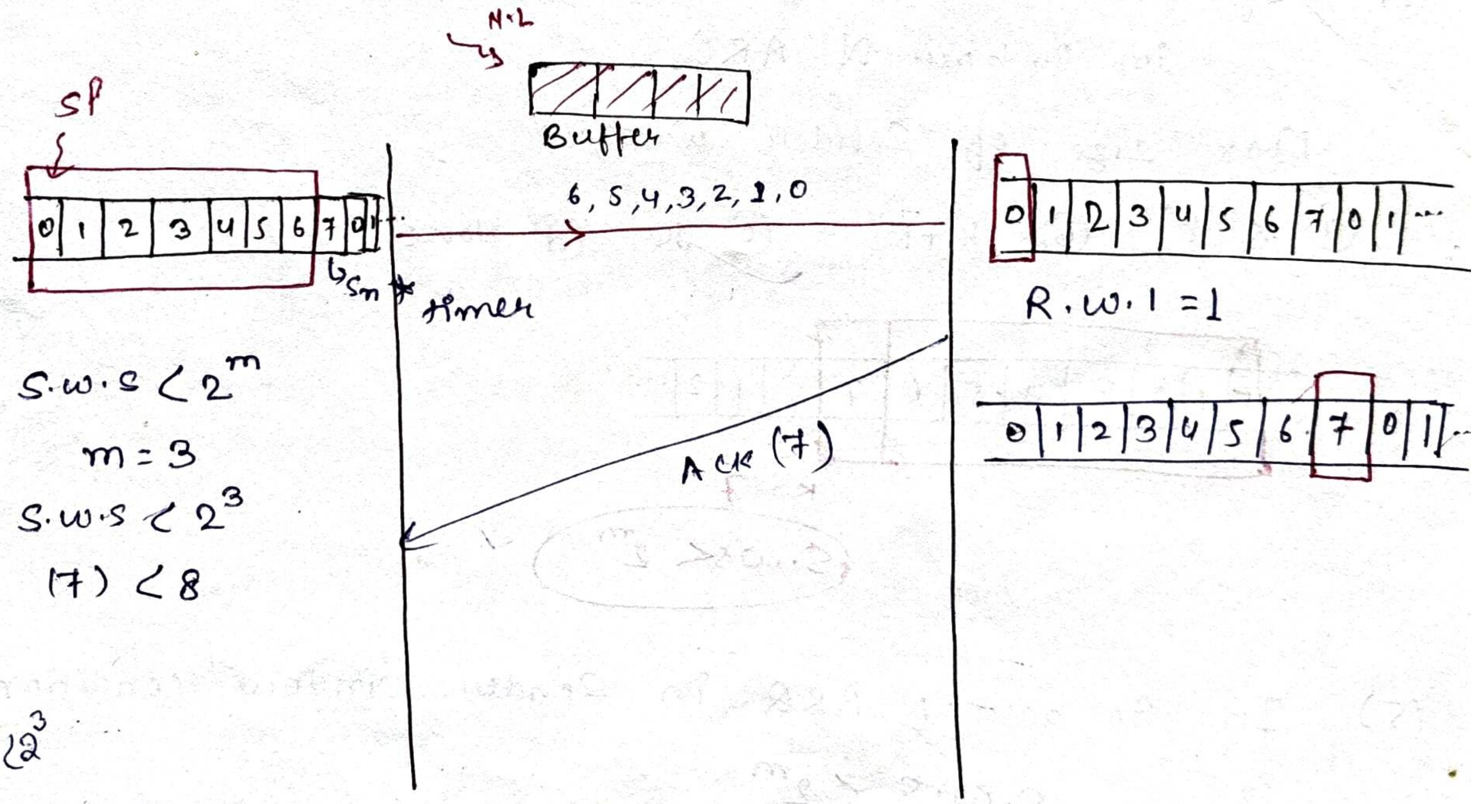
$$B.W \text{ utilization} = \frac{1}{100} \times 100\% = 1\%$$

(Low)

→ In Stop & Wait ARQ, there is no pipelining hence, Bandwidth utilization is less.

Go Back N ARQ

Sequence bits		Sequence No.	
1 →		0, 1	$(2^1 = 2)$
2 →	00 01 10 11	0, 1, 2, 3	$(2^2 = 4)$
3 →	000 001 ⋮ 111	0, 1, 2, 3, 4, 5, 6, 7	$(2^3 = 8)$



$S.w.s < 2^m$

$m = 3$

$S.w.s < 2^3$

$(7) < 8$

$7 < 2^3$

→ In Go back N ARQ, it supports cummalative frames & cummlative acknowledgements.

→ (1) In Go back N ARQ 4-bit sequence no. is used then what is the max^n S.w.S & R.w.S = ?

$S.w.s < 2^4$

$(15) < 16$

2^4

	S.w.s	R.w.s
Go Back N ARQ	15	1

(2) Max sender window in GoBack N ARQ = 7

No. of sequence bits $= \log_2(7+1) = 3$ bits

S.w.s $< 2^m$

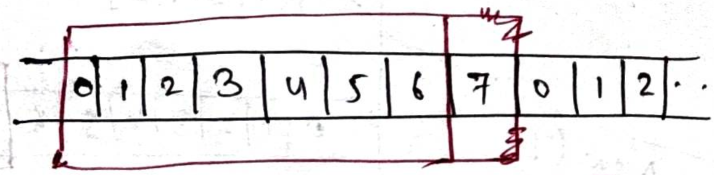
$$S.w.s_{max} = 2^m - 1$$

$$\Rightarrow m = \log_2(1 + S.w.s_{max})$$

(3) If max sender window in Go back N ARQ = "Q"

$$\boxed{\text{No. of Sequence bit} = \log_2(1+Q)}$$

(4) If max sequence number = K
in Go back N ARQ
Max size of Sender window
(a) K − 1 (b) K + 1 (c) K (d) None



K = 7

S.w.s $< 2^m$

(5) In Go back N ARQ in Sender window condition

S.w.s $< 2^m$
when $m = 1$
it behaves as
S.w.s $< 2^1$
(1) < 2
S.w.s $= 1$

→ Go back N ARQ supports individual Ack's as well as cummlative Ack's.

→ Both Stop & wait ARQ & Go Back N ARQ accepts only inorder frames because receiver window size is 1.

(6) B.W = 100 Mbps
R.T.T = 50 μsec
framesize = 50 bits
window size = No. of frames in R.T.T
No. of sequence bit required in Go Back N ARQ =

1 sec = 10^8 bits

50 μsec = $50 \times 10^{-6} \times 10^8$ bits
= 5000 bits

No. of bits transmitted in R.TT ⇒ 5000 bits.

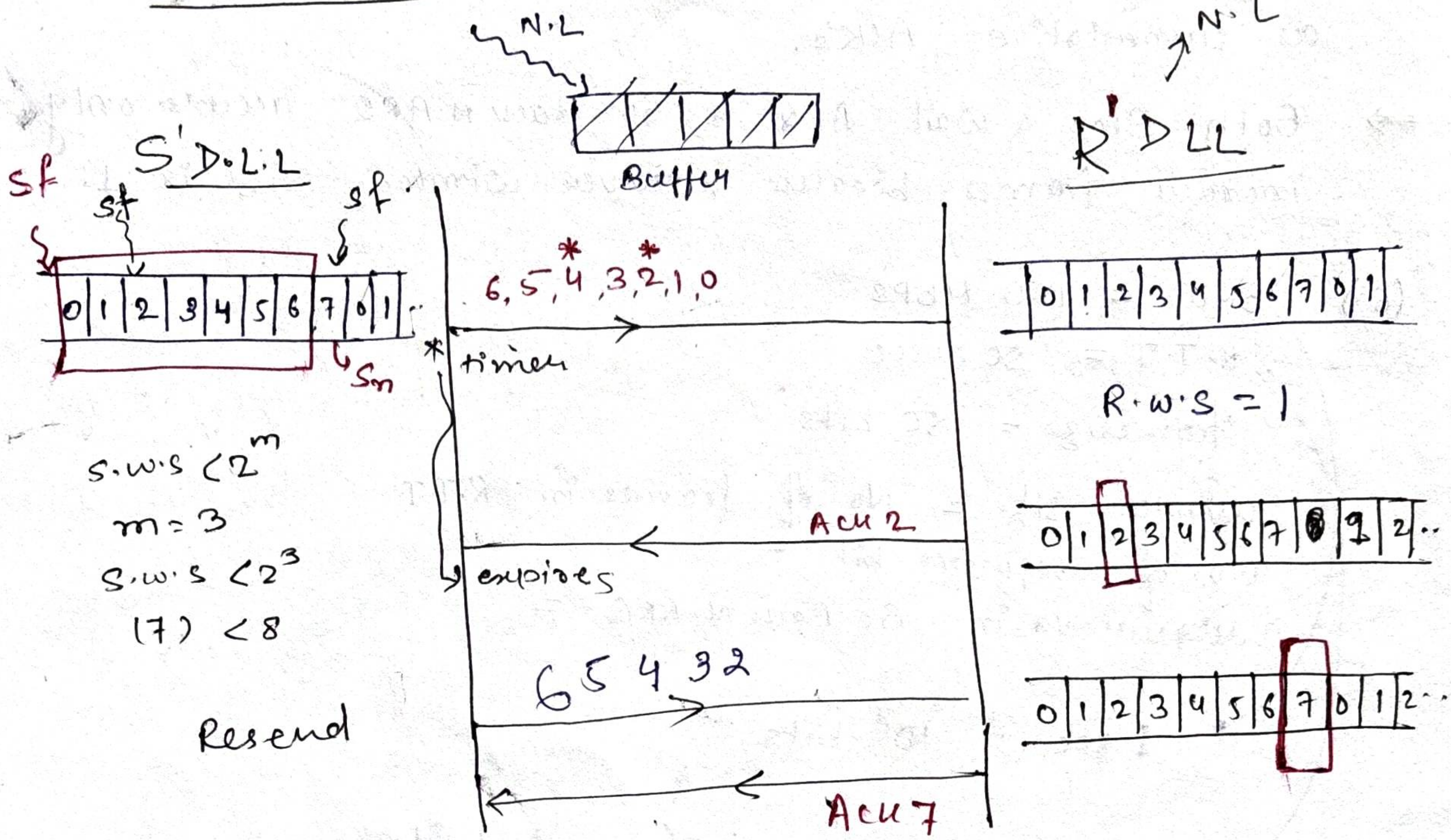
window size = No. of frames in R.T.T = $\frac{5000}{50} = 100$

6 bits ⇒ 2^6 ⇒ 64

7 bits ⇒ 2^7 ⇒ 128

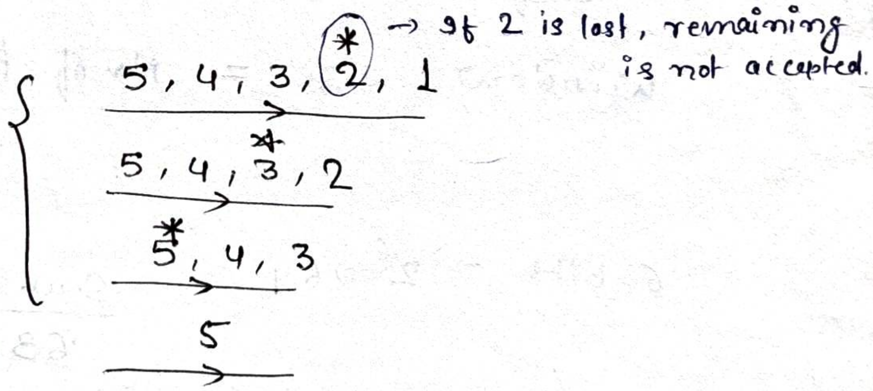
S.W.S	R.W.S
63 ✗	1
100 is not satisfied here	
127 ✓	1
100 is satisfied	

Go Back N ARQ

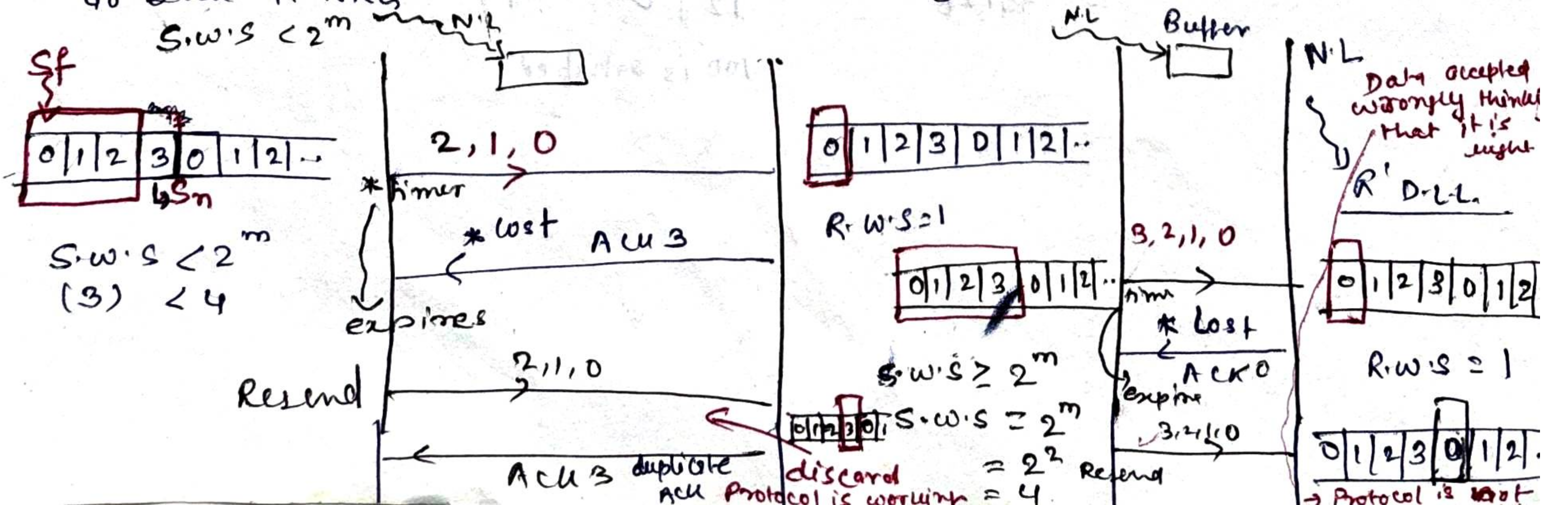


→ In Go back N ARQ when a frame is lost then that frame as well as all following frames should be retransmit.

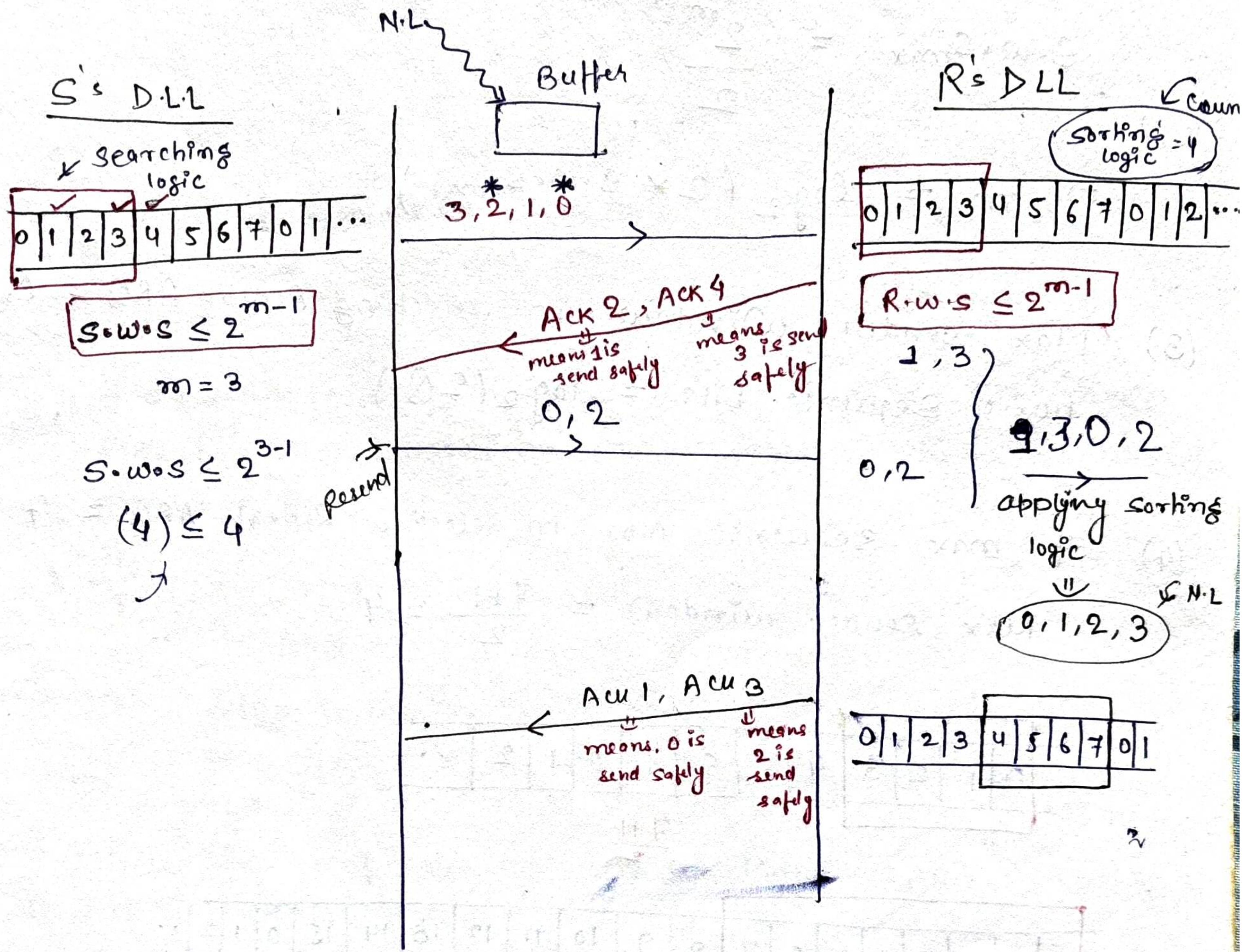
for noisy channel retransmit →



→ for noisy channel there is more no. of retransmission in Go Back N ARQ. So, overall utilization will decreases.



(3) Selective Repeat ARQ



→ In Selective Repeat ARQ sender required searching logic & receiver required sorting logic.

(1) 5 bit sequence no. in selective Repeat ARQ

$2^5 = 32$

$S.W.S \le 2^{m-1}$

$\le 2^{5-1}$

$16 \le 16$

	S.W.S	R.W.S
Selective Repeat ARQ	16	16
Go Back N ARQ	31	1

$S.W.S < 2^m$

(2) Max Sender window in selective repeat ARQ = 4

No. of Sequence bit = $\log_2(2*4) = 3$ bits

$S.W.S \le 2^{m-1}$

$$S.W.S_{max} = 2^{m-1}$$

$$S.W.S_{max} = \frac{2^m}{2}$$

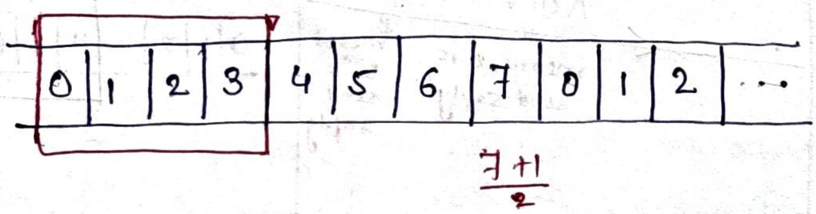
$$\Rightarrow m = \log_2(2 * S.W.S_{max})$$

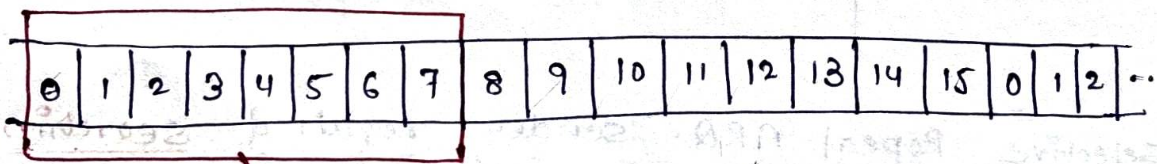
(3) Max sender window in selecting Repeat ARQ = "Q"

no. of Sequence bits = $\log_2(2Q)$

(4) If max sequence No. in selective Repeat ARQ = 7

Max sender window = $\frac{7+1}{2} = 4$





$S.W.S \le 2^{m-1}$

$\frac{15+1}{2} = 8$

2^{m-1}

(5) If max sequence no. in selective Repeat ARQ = N

$\therefore$ $\boxed{\text{Max Sender Window} = \frac{N+1}{2}}$

(6) B.W = 10 Mbps

R.T.T = 50 µsec.

frame size = 25 bits

window size = 20

No. of sequence bit in S.Repeat ARQ = 6 bit $(2m-1)$ / No. of sequ. bit in Go back N ARQ = 5 bit.

1 sec = 10^7 bit

R.T.T => 50 μsec => $50 \times 10^{-6} \times 10^7$ bits

No. of bits in R.T.T = 500 bits

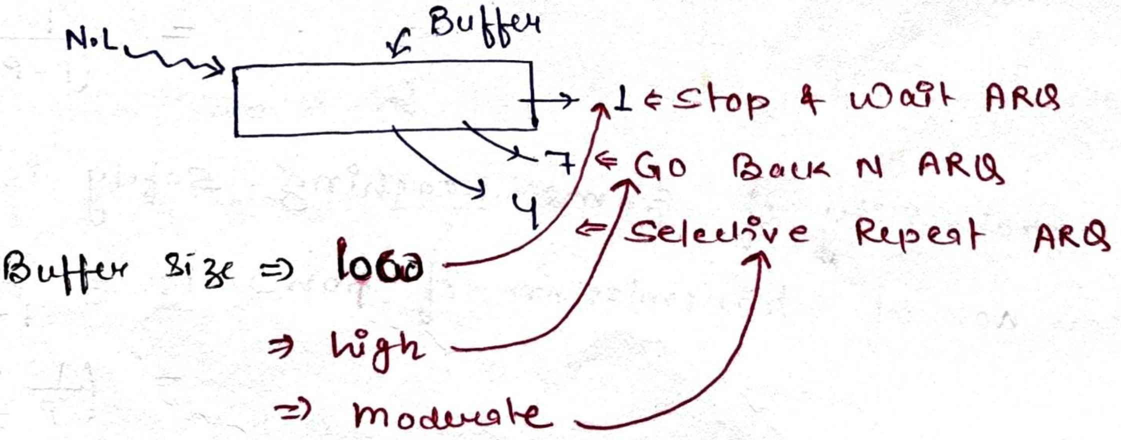
No. of frames in R.T.T = $\frac{500 \text{ bit}}{25} = 20$

→ for maintaining same window size selective Repeat ARQ required more sequence bit compared to Go Back N ARQ.

→ Stop & Wait is a theoritical protocol whereas Stop & Wait ARQ is a practical protocol.

→ As Stop & Wait is without sliding windows whereas Stop & Wait ARQ is with sliding windows.

→ There is a pipelining in Go Back N ARQ & Selective repeat ARQ.

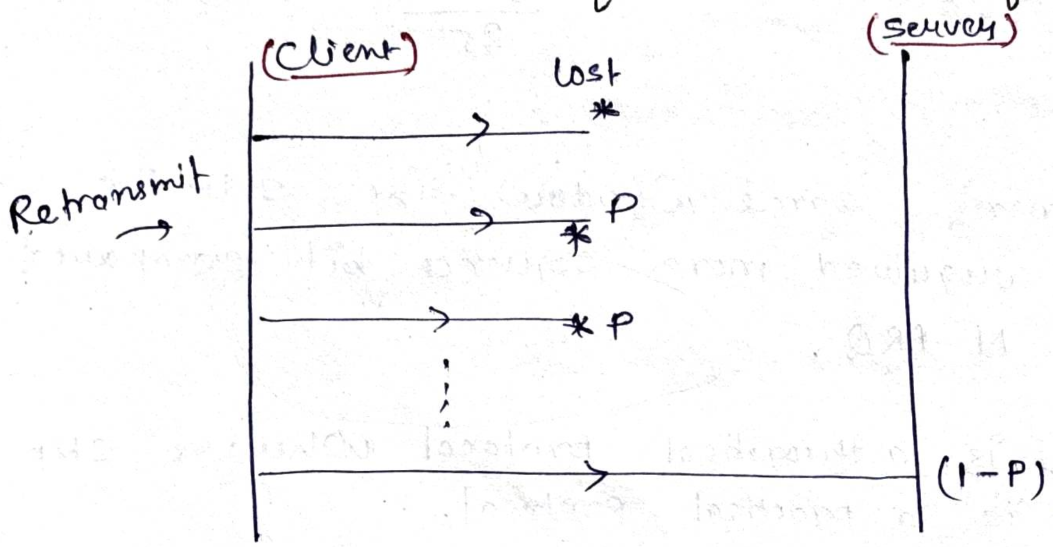


for
(i) Noisy-less channel, Max^m utilization → we can go for Go Back N ARQ protocol (is used)

(ii) Noisy-channel, Max^m utilization → Selective repeat ARQ is used.

→ When the Bandwidth is limited, utilization of selective Repeat ARQ is better then compared to Go Back N ARQ.

(1) Probability of frame being lost is P
then mean no. of transmissions of a frame?



$$\overbrace{\underbrace{P, P, P, \ldots}_{(K-1)}\ \underbrace{(P-1)}_{K^{th}\ \text{tim} \ (1\ \text{tim}}}^{K}$$

$$E(K) = \sum_{K=1}^{\infty} K * P(K)$$

$$= \sum_{K=1}^{\infty} K * P * (1-P)$$

$$= (1-P) \sum_{K=1}^{\infty} K P^{K-1}$$

$$= (1-P)\left[1 + 2P^1 + 3P^2 + 4P^3 + \cdots\right]$$

$$= (1-P) * (1-P)^{-2}$$

$$= \frac{1}{(1-P)} \text{ Ans}$$

$$\boxed{\begin{array}{l} 1 + 2x^1 + 3x^2 + 4x^3 + \cdots = (1-x)^{-2} \\ 1 + x + x^2 + x^3 + \cdots = (1-x)^{-1} \end{array}}$$

(2) If probability of frame reaching safely is P
Mean no. of transmission of frame is $= \frac{1}{1-(1-P)}$

$$= \left(\frac{1}{P}\right)$$

(3) If probability of frame reaching safely = 0.1
Mean no. of transmission of frame $= \frac{1}{0.1} = 10$