- Jab sender k buffer mein kya hai f1, f2, and f3. Now aab jaisehi f1 ka acknowledgement aagaya, toh yeh f1 kya hojayegi sender ki window se bhar.

- Jab aab sender ki window mein kya aagayi f2, f3 and f4.

- Now f2 ka acknowledgement aagaya, toh aab Send k window mein kya hoga f3, f4 & f5.

- Jab sender ki ~~fram~~ window mein konsi frame rahati hai, jab sender send toh kar chuka hai lekin unka acknowledgement nahi aaya hai.

- Jaisehi kisi frame ka acknowledgement aata hai toh woh frame sender window se bhar hojati hai.

- Aur jab tak woh frame transmit nahi hua hai, woh bhi sender window ka part nahi hai.

- Jaha sender ne usko transmit kiya, aur jab tak uska acknowledgement nahi aaya, woh frame sender window ka part hogi.

- Agar sender window size 3 hai it means sender window will contain three unacknowledgement frames.

- ~~Jab~~ Now Sliding window protocol ki efficiency kitani hoti hai -

Efficiency of Sliding window protocol:→

→ Agar hum window size w le, toh efficiency is difine as -

$$\eta = \frac{w\,t_x}{t_x + 2t_p}$$

w → window size

- Yaha par Sliding word kyo use kiya because yaha par window Slide ho rahi hai, exchange hoti jarahai hai change hoti jarahai hai.
- Isliye is protocol ko sliding window protocol kaha gaya hai.

Ques: Consider a channel with the speed of 4kbps and one-way propogation delay of 20ms. If frame size is 16 bits, then what is the efficiency of the protocol, if sliding window protocol is used with window size of 10.

Ans→

$$\eta = \frac{w\,t_x}{t_x + 2t_p} \quad \Big| \quad t_x = \frac{L}{D} = \frac{16}{4*10^3} = 4ms$$

Ans:→ $$\eta = \frac{10*4}{4+40} = \frac{40}{44} = 0.9090 = 90.90\%$$

Ques:- Consider above question data, for what window size do we will get 100% efficiency ya phir bola hai ki what will be the optimal window size.

Ans. Toh optimal window size kaise nikalegy, toh uske liye efficiency kitani rak do one.

$$\eta = \frac{w t_x}{t_x + 2t_p} = 1 = \frac{w t_x}{t_x + 2t_p} \Rightarrow t_x + 2t_p = w t_x$$

$$= 4 + 40 = w * 4$$

$$= \frac{44}{4} = w$$

$$= \boxed{w = 11}$$

Optimal window size = 11

→ Agar $w = 12$ kar di toh efficiency kitane hojayegi more than one, toh efficiency more than one possible nahi hai.

• Par yeh jo efficiency ka formula hai yeh toh return karega efficiency ki value more than one.

* Agar efficiency ek se jada jarahai hai toh hamara formula kya hota hai efficiency kitani hogi one.

✓ Sliding window protocol mein, Sender first frame send kr,

• Now sliding window protocol hai, Sender ne bahut saari frames send ki, first ka ack aagaya, second lost hogi, third ka ack aagaya toh aab receiver ko kaise pata chalega ki, second frame is lost or a particular frame is lost. Ya phir kohi frame repeat hogayi toh yeh kaise pata chalega ki

Woh repeat hogayi hai.

- Toh clearly is problem ko dur karne k liye aapko kya karna parega har frame ko ek sequence number dena parega.

- Toh, sliding window protocol mein bhi har frame ko ek sequence number allocate hota hai.

* Usually hamari sequence number ki scheme kya hoti hai, ki agar window size 4 hai, toh aap kya sequence number use karo 0, 1, 2, 3.

- Pahali frame aayi with frame sequence number 0, then f1 then f2 then f3. Now 5th frame ka sequence number again kitana hojayega 0, 6th frame ka again kitana hojayega one and so on repeat hota jayegey.

* If window size is w then sequence number starts from 0 to w-1.

- Sender ne frame 0, 1, 2, 3 send kiya, Reciever ko frame 0 mili, 1 nahi mili, 2 mil gayi 3 nahi mili, kyo?? error aane k karan nahi mili.

- Error aane par hum ~~frame ko send~~ window mein jitani frames hai sab ko retransmit karegi ki, selectivity jis frame mein error aayi hai usko hi retransmit karegey.

- On an error aapka Sliding Window protocol

Channel capacity = Bandwith * tp / (for half duplex)

For Full duplex → (2 * B * tp)

Kaise behave karta hai, uske according hamne usko do categories mein divide kiya hai -

- Selective Repeat ARQ
- Go-back-N ARQ

- ARQ: Automatic Repeat Request.

* In selective Repeat, un frames ko hi retransmit kiya jata hai ki jinme error aayi hai.

* Aur Go-back N mein, jisper error aayi hai uske baad jitani bhi send kar chuke ho, un frames ko retransmit karna parega.

- Go-back N mein yeh N kya represent karta hai window size represent karta hai.

- Abhi tak hum ek hi word use kar rahe hai sender ki window size,

- Reciever ki window size kya hoti hai, kya sender ki window size aur reciever ki window size same hoti hai kya, ki different hoti hai. ??

- Joh Sender Aur reciever ki window size same bhi ho sakta hai aur different bhi hosakta hai, Stamesa same ho kohi jaruri nahi hai.

- Kyo same nahi ho aaisa kyo jaruri nahi hai ?? Sender ko kyo buffer karna pare yeh toh samaj

mein aata hai, par Receiver ko frames aapne pass kyo rakhni hai, usko buffer mein kyo rakhne ki as such requirement nahi hai.

- Agar Receiver ki window size one bhi hai toh bhi chalega. Because jaisehi frame receiver k pass aaye check kiya kohi error hai kya, agar nahi hai toh ~~then~~ Network layer ko pass kardi.

- Receiver aur sender ki window size same ho kohi jaruri nahi hai.

- Now Receiver ki window size 1 kab problem karegi. frame number one aayi thik hai usne kisko de di network layer ko, 2 nahi aayi 3 aagayi, toh data link layer ~~f~~ 3 network layer ko nahi de sakta.

- Because datalink layer ko frame kis order mein dena hai sequence order mein dena Network layer ko.

- yeh nayi frame hai toh isko discard bhi nahi kar sakta aur Higher layer ko de bhi nahi sakta.

- Toh is case mein Receiver k pass buffer hona chahiye.

* Toh agar selective Repeat protocol use kiya jata hai toh sender ki window size, receiver k window size k equal hi honi chahiye.

* Lekin agar hum go-back N protocol use karrahai hai, toh receiver ki window size one bhi hogi toh bhi chalega.

- Toh konsa protocol efficient hai sliding window protocol ki go- back N.

→ Toh Selective Repeat jada efficient hai kyo because hamare liye memory kohi matter nahi karte hai, but go- back N mein hamari bandwidth waste horaha hai because joh correct receive hua hai unko bhi wapas se send karna parega.

→ Toh proper bandwidth k liye Selective Repeat protocol better hai as compare to go-back N.

- But agar receiver k pass memory hi nahi hai, toh aapke pass kya option bachata hai Go-back N.

- Agar receiver k pass sufficient buffer available nahi hai, then only we prefer go- back N otherwise hum kya perfer karegy Selective Repeat.

* Agar Sender ki window size aur receiver ki window size same hai toh go- back N use karne ka kohi sense hi nahi hai.

* Agar receiver ki window size one hai tabhi daq go-back N use karna jaruri hai, otherwise as such uski kohi requirement nahi hai.

Now Efficiency kitana hogi, →

* Lekin agar hum go-back N protocol use karrahai hai, toh receiver ki window size one bhi hogi toh bhi chalega.

- Toh konsa protocol efficient hai sliding window protocol ki go- back N.

→ Toh Selective Repeat jada efficient hai kyo because hamare liye memory kohi matter nahi karte hai, but go-back N mein hamari bandwidth waste horaha hai because jo correct recieve hua hai unko bhi wapas se send karna parega.

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* Agar Sender ki window size aur receiver ki window size same hai toh go-back N use karna ka kohi sense hi nahi hai.

* Agar receiver ki window size one hai tabhi dono go-back N use karna jaruri hai, otherwise as such uski kohi requirement nahi hai.

Now Efficiency kitana hogi, →

Sequence No. = $W_R + W_S$

$$\eta = \frac{W t_x}{t_x + 2t_p}$$

- Efficiency min W kiski window size represent karta (Sender) ki window size.

Sliding window protocol mein sequence number kaha se kaha tak vary hota hai -

0 to W-1

→ Jo Largest sequence number kya hoga W-1, usko hum kya kaha rahe hai MAX Sequence Number.

→ Yaha → W-1 = MAX SEQUENCE

W = MAX SEQUENCE + 1

→ Lekin agar hum Selective Repeat use karte hai aur hamne yehi scheme follow ki → ki agar W=4 hai toh sequence number kaha se kaha tak vary hogey 0 to 3 to is scheme se problem kya hogi -

0_1 ✓
1_1 ✓
2_1 ✓
3_1 ⊗ → Lost
0_2 ✓
1_2
2_2

- Independent ack hota hai Selective Repeat mein aur Go-back N mein cummative + No concept of Negative ack.

- Now agar 3_1 ka ack lost hogaya toh, woh sender k pass pachuch gaye but uska ack receiver k pass nahi pachucha now receiver kya kra except kar raha ki frame 3 aayegi 2 set ki

- But since 3_1 ka ack nahi hai toh sender ne phir se 3_1 send ki now aab receiver kya except kar raha f3 but 2 set ki but usko first set k mil gaye aur receiver ussi ki second set ki 3th frame samaj k rakh lega

- Toh isliye problem ko avoid karne k liye - aap kya karo ki jab sequence number aap I set mein use kar rahai ho usko second set mein use hi mat karo.

- 0 1 2 3 (I set) 4 5 6 7 (II set) 0 1 2 3 (III set) 0 1 2 3

- In Selective repeat window size aur Sequence Number mein kya relationship hai -

$$\text{MAX SEQUENCE} = 2W - 1$$

$$\Rightarrow \frac{\text{MAX SEQUENCE} + 1}{2} = W$$

- Go-back N relationship :-

Window Size = MAX Sequence

Ques:- If window size is 5, what should be the Maximum Sequence Number for -

(a) Sliding Window protocol
(b) Selective Repeat Protocol
(c) Go- Back N protocol.

Solution

MAX Sequence = W - 1 } → Sliding window Protocol
= 5 - 1 = 4

Selective Repeat Protocol :-

MAX SEQUENCE = 2W - 1 = 2*5 - 1 = 9

Go - Back N protocol :-

MAX SEQUENCE = W = 5

Ques:- If window size is 5, then how many bits long your sequence number be ?? For -

Ans:- (a) Sliding window Protocol
(b) Selective Repeat Protocol
(c) Go- Back N Protcol

Ans:- (a) Sliding window Protocol

$\lceil \log_2(4) \rceil + 1 = 3$ bit

(b) Selective Repeat Protocol :-

$\lceil \log_2(9) \rceil + 1 = 3 + 1 = 4$ bit

(c) Go- Back-N Protocol :-

$\lceil \log_2 5 \rceil + 1 = 2 + 1 = 3$ bit