# CS & IT ENGINEERING

## COMPUTER NETWORKS

Flow Control

**Lecture No-9**

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# TOPICS TO BE COVERED

- Problem solving on GB-N
- SR Protocal

# Problem Solving

# on

# GB-N Protocol

Q.1

In Go-back-N protocol, if the maximum window size is 512 what is the range of sequence number

(A) 0 to 513

(B) 1 to 513

(C) 0 to 512

(D) 1 to 512

Q.2

A 20 Kbps satellite link has a propagation delay of 400 ms. The transmitter employs the “go back n ARQ” scheme with n set to 10. Assuming that each frame is 100 bytes long, what is the maximum data rate possible?

GATE-2004

(A) 5 Kbps

(B) 10 Kbps

(C) 15 Kbps

(D) 20 Kbps

Q.3 Assume we need to design Go-back-N sliding window protocol for a network in which bandwidth is 1 Mbps and average distance between sender and receiver is 5000 Km. Assume that average packet size is 5000 bits. Propagation speed in the media is $2 \times 108$ m/sec. In GB-10 If process delay is 0.5 Msec and queuing delay is 2msec then what is the efficiency.

(A) 99%

(B) 57%

(C) 87%

(D) 67%

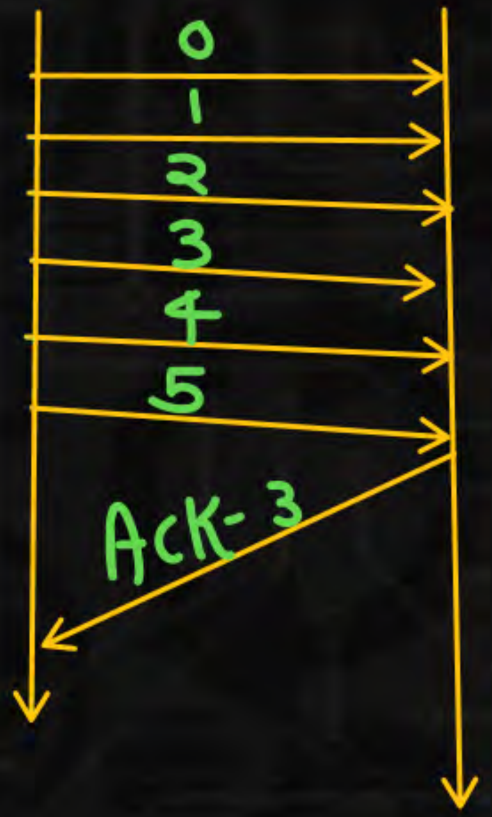
**Q.4** Assume a sender send 6 packet 0, 1, 2, 3, 4 and 5. The sender receivers an acknowledgement with AckNo = 3. what is the interpretation if the system in using GB-N

(A) ~~It means that packet 3 has been received uncorrupted~~

(B) ✓ It means packet 0, 1, 2 have received uncorrupted and receiver is expected packet 3

(C) Ack does not say anything about other packet

(D) All the above



**Q.5** In a sliding window ARQ scheme, the transmitter's window size is N and the receiver's window size is M. The minimum number of distinct sequence numbers required to ensure correct operation of the ARQ scheme is

**GATE-IT-2004**

(A) min (M, N)

(B) max (M, N)

(C) M + N

(D) MN

| $W_S$ | $W_R$ | min sequence No required |
|---|---|---|
| N | M | M+N |

Q.6

Consider packet size is 1000 bits and distance between two hosts is 5 km, 1 Mbps link with signal speed 2 ms/km (ms per km) is used, the efficiency in percentage if GB-N protocol is used and N is set to 7 33.3.

Soln: Packet size = 1000 bits
or
Frame size

distance (d) = 5 km

Bandwidth = 1 Mbps
$= 10^6$ bits/sec

Propagation time for 1 km = 2 msec

Propagation time For 5 km = 5 * 2 msec
= 10 msec

N = 7

$$T_d(\text{frame}) = \frac{\text{Frame size}}{\text{Bandwidth}} = \frac{1000 \text{ bits}}{10^6 \text{ bits/sec}} = 10^{-3} \text{ sec} = 1 \text{ msec}$$

$$\text{efficiency} = \frac{\text{useful time}}{\text{total time}}$$

$$= \frac{N * T_d(\text{frame})}{T_d(\text{frame}) + 2 * P_d + \cancel{Q_d} + \cancel{P_{rd}} + \cancel{T_d(\text{ACK})}}$$

$$= \frac{7 * 1}{1 + 2 * 10}$$

$$= \frac{\cancel{7}}{\cancel{21}} = \frac{1}{3} = 0.333$$

$$\boxed{\eta = 33.3\%}$$

**Q.7** In GB-N Protocol the packet size is 1000 bytes transmission time for one packet is 1ms. If distance between hosts is 10km and signal speed is 5ms per km (5ms/km) and frame sequence number are 6 bit long in frame format then the throughput (in Mbps) is (4.99 mbps)

Pkt size = 1000 Byte = 8000 bits
or
Framesize

$T_d = 1 \text{msec} = 10^{-3} \text{sec}$

d = 10 km

Propagation time for 1 km = 5 msec

Propagation time For 10 km = 10 * 5 msec
= 50 msec

Seq No = 6 bits

Throughput = $\eta * B$

$= \frac{63}{101} * 8\,mbps$

$= 4.99\,mbps$

$\simeq 5\,mbps$

efficiency = $\frac{\text{useful time}}{\text{total time}}$

$= \frac{N * T_d(\text{frame})}{T_d(\text{frame}) + 2 * P_d + \cancel{Q_d} + \cancel{P_{rd}} + \cancel{T_d(\text{Ack})}}$

$= \frac{63 * 1}{1 + 2 * 50}$

$= \frac{63\,m\cancel{sec}}{101\,m\cancel{sec}}$

GB-N

SeqNo = K bit

| $W_S$ | $W_R$ |
|---|---|
| $2^K - 1$ | 1 |

SeqNo = 6 bits

| $W_S$ | $W_R$ |
|---|---|
| $2^6 - 1$ | 1 |
| 63 | 1 |

$\Downarrow$

(N)

$$T_d(\text{frame}) = \frac{\text{Frame size}}{\text{Bandwidth}}$$

$$\frac{10^{-3}\,\text{sec}}{1} = \frac{8000\text{ bits}}{B}$$

$$B = \frac{8000\text{ bits}}{10^{-3}\text{ sec}}$$

$$B = 8 * 10^3 * 10^3 \text{ bits/sec}$$

$$B = 8 * 10^6 \text{ bits/sec}$$

$$B = 8\text{ MbPs}$$

OR

$$\text{throughput} = \frac{N * \text{Frame size}}{\text{total time}}$$

$$= \frac{63 * 8000\text{ bits}}{101\text{ msec}}$$

$$= \frac{63 * 8000\text{ bits}}{101 * 10^{-3}\text{ sec}}$$

$$= \frac{63}{101} * 8 * 10^3 * 10^3 \text{ bits/sec}$$

$$= \frac{63}{101} * 8 * 10^6 \text{ bits/sec}$$

$$= \frac{63}{101} * 8\text{ mbPs} = 4.99\text{ MbPs}$$

Q.8

Host A is sending data to host B over a full duplex link. A and B are using the sliding window protocol for flow control. The send and receive window sizes are 5 packets each. Data packets (sent only from A to B) are all 1000 bytes long and the transmission time for such a packet is 50μ sec. Acknowledgement packets (sent only from B to A) are very small and require negligible transmission time. The propagation delay over the link is 200 μ sec. What is the maximum achievable throughput in this communication?

(A) $7.69 \times 10^6$ Bps

(B) $11.11 \times 10^6$ Bps

(C) $12.33 \times 10^6$ Bps

(D) $15.00 \times 10^6$ Bps

$W_s = 5$, $W_R = 5$

Packet size = 1000 Byte
or
Framesize

$T_d(\text{Frame}) = 50\mu sec$

$P_d = 200\,\mu sec$

$$\text{Throughput} = \frac{W_s * \text{Frame size}}{\text{total time}}$$

$$= \frac{5 * 1000\text{ Byte}}{T_d(\text{frame}) + 2*P_d + \cancel{Q_d}^{0} + \cancel{P_{rd}}^{0} + T_d(\cancel{Ack})^{0}}$$

$$= \frac{5000\text{ Byte}}{50\mu sec + 2*200\mu sec}$$

$$= \frac{5000\text{ Byte}}{450\mu sec}$$

$$= \frac{500\cancel{0}\text{ Byte}}{45\cancel{0} * 10^{-6} sec}$$

$$= 11.11 * 10^{6}\text{ Byte/sec}$$

**Q.9**

Consider GB-N ARQ is used for flow control, frame size is 4000 bits, data transfer rate of channel is 1 Mbps and one way propagation delay is 18 ms. then what should be the minimum value of sender window size and minimum number of bits required for sequence number field for maximum utilization is

(A) 10 , 4

(B) 11 , 4

(C) 10 ,11

(D) 11 , 3

Frame size = 4000 bits , $B = 1\text{ mbps} = 10^6$ bits/sec , $P_d = 18$ msec

$$T_d(\text{frame}) = \frac{\text{Frame size}}{\text{Bandwidth}} = \frac{4000\ \cancel{\text{bits}}}{10^6\ \cancel{\text{bits}}/\text{sec}} = 4 * 10^{-3}\text{ sec} = 4\text{ msec}$$

$$\eta = \frac{\text{Useful time}}{\text{total time}}$$

$$1 = \frac{N * T_d(\text{frame})}{T_d(\text{frame}) + 2 * P_d + \cancel{Q_d} + \cancel{P_{rd}} + \cancel{T_d(\text{Ack})}}$$

$\cancel{Q_d} \to 0$, $\cancel{P_{rd}} \to 0$, $\cancel{T_d(\text{Ack})} \to 0$

$$\frac{1}{1} = \frac{N * 4}{4 + 2 * 18}$$

$$N = \frac{4\cancel{0}}{\cancel{4}}$$

$N = 10$

↓

sender window size = 10

minimum sequence No required = 10 + 1 = 11

$2^K = 11$

$2^K = 2^4$

$K = 4$ bit

min No. of bits required in the seq No. field = $\lceil \log_2 11 \rceil$ = 4 bit

In GBN If sender window size = N

min. sequence No required = N + 1

**Q.10** Consider a network connecting two systems located 8000 kilometres apart. The bandwidth of the network is $500 \times 10^6$ bits per second. The propagation speed of the media is $4 \times 10^6$ meters per second. It is needed to design a Go-Back-N sliding window protocol for this network. The average packet size is $10^7$ bits. The network is to be used to its full capacity. Assume that processing delays at nodes are negligible. Then, the minimum size in bits of the sequence number field has to be 8.

**GATE-2015**

'd' = 8000 Km , $B = 500 * 10^6$ bits|sec

$V = 4 * 10^6$ m|sec , Pktsize = $10^7$ bits

$V = 4 * 10^3$ Km|sec or Frame size

$$T_d(\text{frame}) = \frac{\text{Frame size}}{\text{Bandwidth}}$$

$$= \frac{\cancel{10^7}\ \cancel{\text{bits}}}{50\cancel{0} * \cancel{10^6}\ \cancel{\text{bits}}/\text{sec}}$$

$$= 0.02\ \text{sec}$$

$$P_d = \frac{d}{v} = \frac{\cancel{8000}\ \cancel{\text{km}}}{\cancel{4 * 10^3}\ \cancel{\text{km}}/\text{sec}}$$

$$P_d = 2\ \text{sec}$$

$$\eta = \frac{\text{Useful time}}{\text{total time}}$$

$$1 = \frac{N * T_d(\text{frame})}{T_d(\text{frame}) + 2 * P_d + \cancel{Q_d} + \cancel{P_{rd}} + T_d(\cancel{\text{Ack}})}$$

$$\frac{1}{1} = \frac{N * 0.02}{0.02 + 2 * 2}$$

$$N = \frac{4.02}{0.02}$$

$$N = \frac{4\cancel{02}}{\cancel{2}}$$

$$N = 201 \text{ (sender window size)}$$

minimum sequence No. required $= 201 + 1$

$= 202$

$$2^K = 202$$

$$2^K = 2^8$$

$$\boxed{K = 8\ \text{bit}}$$

**Q.11**

Consider a $512 \times 10^{3}$[redacted] bits/second satellite communication link with one way propagation delay of 150 milliseconds. GO Back-N protocol is used on this link to send data with a frame size of 1 kilobyte. Acknowledgement size is 64 byte, and frame processing time is 5 ms. Then what should be the minimum window size---21------

$B = 512 * 10^3$ bits/sec

$P_d = 150$ msec

Frame size = 1 KByte
= 1024 Byte
= 8*1024 bits
= 8192 bits

Ack size = 64 Byte
= 8*64 bits
= 512 bits

$P_{rd} = 5$ msec

$$T_d(\text{frame}) = \frac{\text{Frame size}}{\text{Bandwidth}}$$

$$= \frac{8 * \cancel{1024}^{\,2} \ \cancel{\text{bits}}}{\cancel{512} * 10^3 \ \cancel{\text{bits}}/\text{sec}}$$

$$= 16 * 10^{-3} \text{ sec}$$

$$= 16 \text{ msec}$$

$$T_d(\text{Ack}) = \frac{\text{Ack size}}{\text{Bandwidth}}$$

$$= \frac{\cancel{512} \ \cancel{\text{bits}}}{\cancel{512} * 10^3 \ \cancel{\text{bits}}/\text{sec}}$$

$$= 10^{-3} \text{ sec} = 1 \text{ msec}$$

$$\text{efficiency} = \frac{\text{useful time}}{\text{total time}}$$

$$1 = \frac{N * T_d(\text{frame})}{T_d(\text{frame}) + 2 * P_d + \underbrace{\cancel{Q_d}}_{0} + P_{rd} + T_d(\text{Ack})}$$

$$1 = \frac{N * 16}{16 + 2 * 150 + 5 + 1}$$

$$\frac{1}{1} = \frac{N * 16}{322}$$

$$N = \frac{322}{16}$$

$$N = 20.125$$

$$N = \lceil 20.125 \rceil = 21$$

$$N = 20$$

$$= \frac{20 * 16}{16 + 2 * 150 + 5 + 1}$$

$$= \frac{320}{322}$$

$$= 0.99$$

Q.12 The distance between two stations M and N is L kilometers. All frames are K bits long. The propagation delay per kilometer is t seconds. Let R bits/second be the channel capacity. Assuming that processing delay is negligible, the minimum number of bits for the sequence number field in a frame for maximum utilization, when the sliding window protocol is used, is

GATE

(A) $\left\lceil \log_2 \frac{2LtR+2K}{K} \right\rceil$

(B) $\left\lceil \log_2 \frac{2LtR}{K} \right\rceil$

(C) $\left\lceil \log_2 \frac{2LtR+K}{K} \right\rceil$

(D) $\left\lceil \log_2 \frac{2LtR+K}{2K} \right\rceil$


Frame size = K bits , B = R bits/sec

Propagation delay For 1 km = 't' sec

Propagation delay For 'L' km = Lt 'sec'

$$T_d(\text{frame}) = \frac{\text{Frame size}}{\text{Bandwidth}}$$

$$= \frac{K\ \cancel{\text{bits}}}{R\ \cancel{\text{bits}}/\text{sec}}$$

$$= \frac{K}{R}\ \text{sec}$$

$$\text{efficiency} = \frac{\text{useful time}}{\text{total time}}$$

$$1 = \frac{W_s * T_d(\text{frame})}{T_d(\text{frame}) + 2 * P_d + Q_d + Pr_d + T_d(\text{ACK})}$$

$$1 = \frac{W_s * \frac{K}{R}}{\frac{K}{R} + 2 * Lt}$$

$$1 = \frac{W_s * \frac{K}{R}}{\frac{K + 2LtR}{R}}$$

$$1 = W_s * \frac{K}{\cancel{R}} * \frac{\cancel{R}}{K+2LtR}$$

$$\frac{1}{1} = W_s * \frac{K}{K+2LtR}$$

$$W_s = \frac{K+2LtR}{K}$$

minimum seq No required $= \frac{K+2LtR}{K}$

min No. of bits required in the seq No. field $\left\lceil \log_2 \frac{K+2LtR}{K} \right\rceil$

Q.13

Consider two hosts are connected with direct link having data transfer rate 10 Mbps and signal speed 3 ms per km, distance between them is 6 km and packet size is 5000 Bytes. The sequence number field in frame format is 3 bits long, and go back N ARQ protocol is used for flow control then the maximum amount of time that sender remain Idle (in ms) is 12 msec

$d = 6$ km, Packet size or Frame size $= 5000$ Byte

$= 8 * 5000$

$= 40{,}000$ bits

$B = 10$ mbps $= 10 * 10^6$ bits/sec

Propagation time for 1 km $= 3$ msec

Propagation time for 6 km $= 6 * 3$ msec

$= 18$ msec

$$T_d(\text{frame}) = \frac{\text{Frame size}}{\text{Bandwidth}}$$

$$= \frac{40{,}000 \text{ bits}}{10^7 \text{ bits/sec}} = 4 * 10^{-3} \text{ sec} = 4 \text{ msec}$$

SeqNo = 3bit, Total SeqNo = $2^3$

$= 8(0-7)$

GB-N

SeqNo = K bit

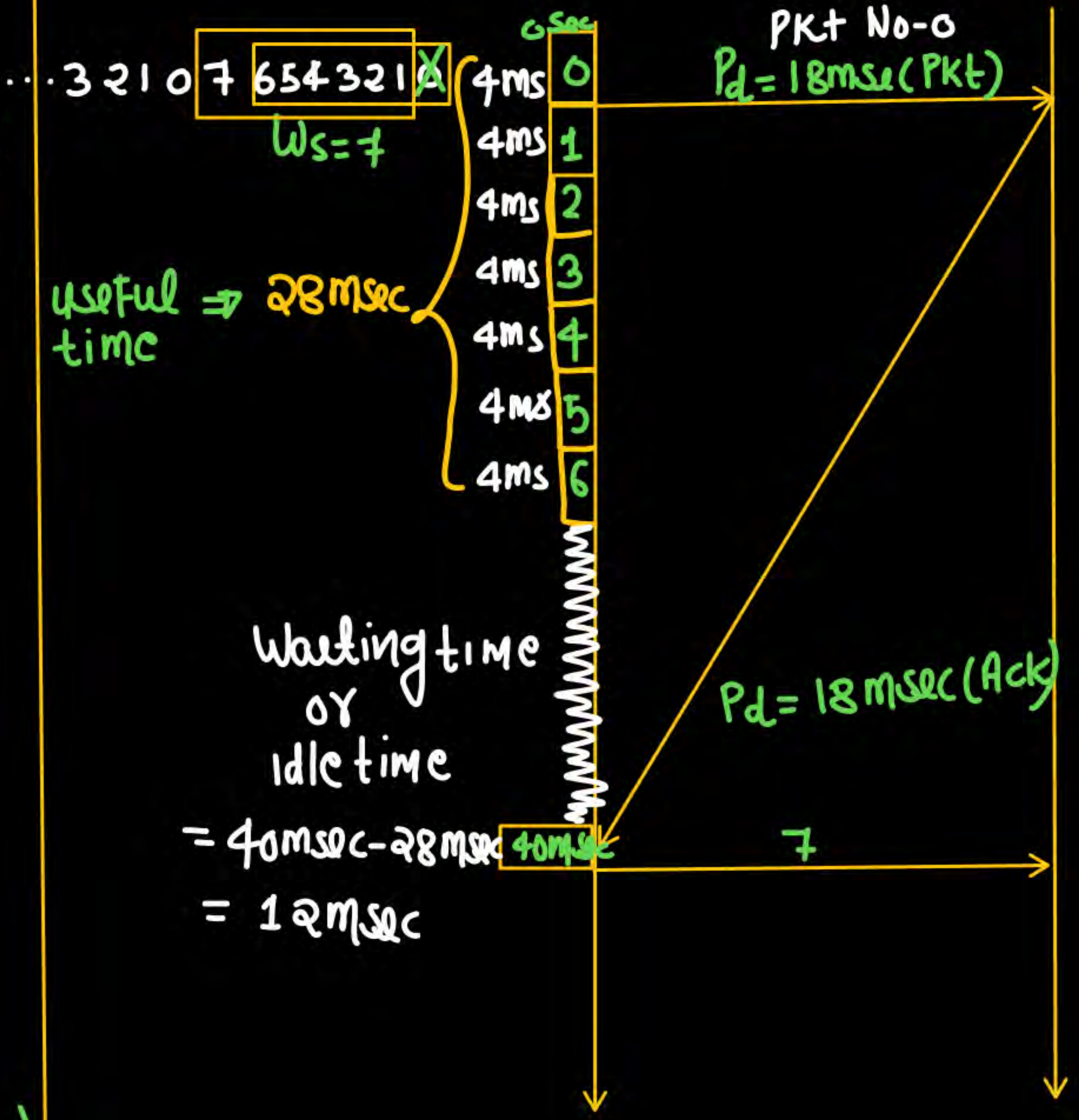
| $W_S$ | $W_R$ |
|---|---|
| $2^K-1$ | 1 |

K = 3bit

| $W_S$ | $W_R$ |
|---|---|
| $2^3-1$ | 1 |
| 7 | 1 |

$\Downarrow$

N = 7 (sender window size in GBN)



Maximum Amount of time the sender Remain idle = Total time − useful time

$$= \boxed{\text{Total time} - N * T_d(\text{frame})}$$

$$= 40\,\text{msec} - 7 * 4\,\text{msec}$$

$$= 40\,\text{msec} - 28\,\text{msec}$$

$$= 12\,\text{msec}$$

Total time OR RTT Time $= T_d(\text{frame}) + 2 * P_d + \cancel{Q_d}_{0} + \cancel{P_{rd}}_{0} + \cancel{T_d(\text{ACK})}_{0}$

$$= 4\,\text{msec} + 2 * 18\,\text{msec}$$

Total time $= 40\,\text{msec}$

# NAT

A 1Mbps satellite link connects two ground stations. The altitude of the satellite is 36,504 km and speed of the signal is $3 \times 10^8$ m/s. What should be the packet size for a channel utilization of 25% for a satellite link using go-back- 127 sliding window protocol? Assume that the acknowledgment packets are negligible in size and that there are no errors during communication.

[GATE- 2008- CN- 2M]

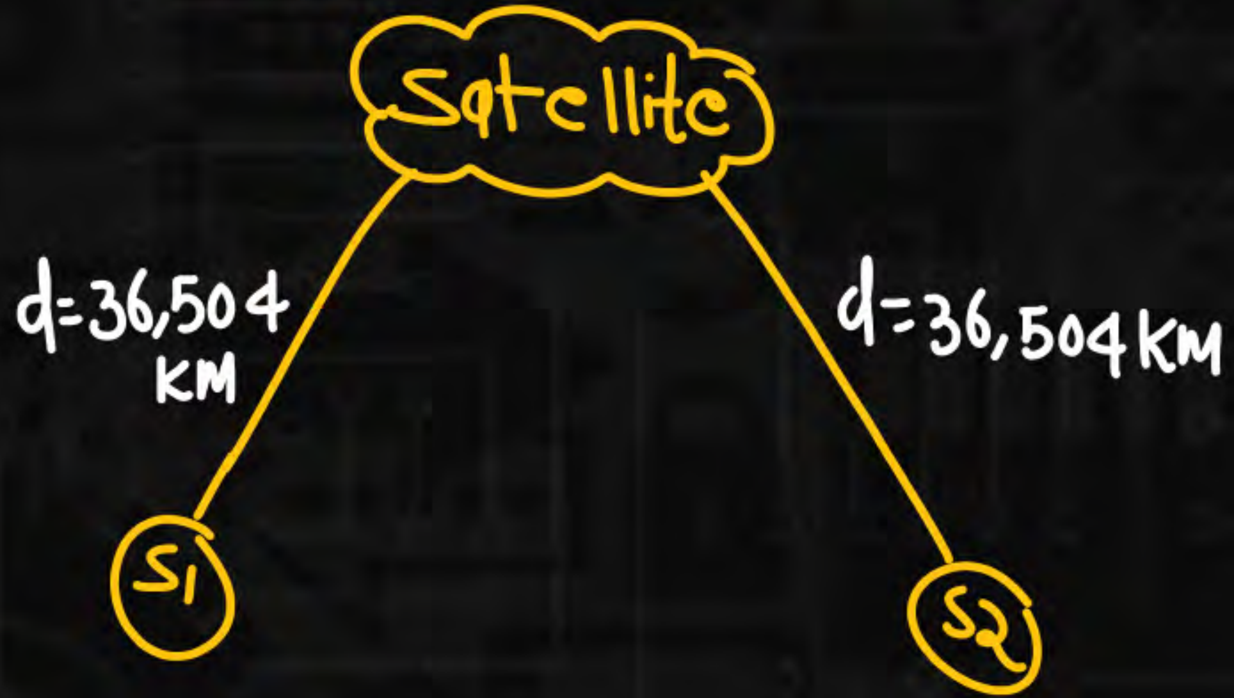
$B = 1 \text{ MbPS} = 10^6 \text{ bits/sec}$

(A) 120 bytes

(B) 60 bytes

(C) 240 bytes

(D) 90 bytes




$v = 3 * 10^8 \text{ m/sec} = 3 * 10^5 \text{ km/s}$

distance $= 2 * 36,504$

$= 73,008 \text{ KM}$

Packet size = ?

$\eta = 25\% = \frac{1}{4}$, GB-127

N=127

$$\text{efficiency} = \frac{\text{useful time}}{\text{total time}}$$

$$\frac{1}{4} = \frac{N * T_d(\text{frame})}{T_d(\text{frame}) + 2 * P_d + \cancel{Q_d} + \cancel{P_{rd}} + \cancel{T_d(\text{ack})}}$$

$$\frac{1}{4} = \frac{127 * T_d}{T_d + 2 * P_d}$$

$$127 * 4 * T_d = T_d + 2 * P_d$$

$$508\, T_d = T_d + 2 * P_d$$

$$507\, T_d = 2 * P_d$$

$$T_d = \frac{2 * P_d}{507}$$

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

$$= \frac{73{,}008\ \text{km}}{3 * 10^5\ \text{km/sec}}$$

$$= 24336 * 10^{-5}\ \text{sec}$$

$$= .24336\ \text{sec}$$

$$T_d = \frac{2 * .24336\, sec}{507}$$

$$\frac{L}{B} = \frac{2 * .24336\, sec}{507}$$

$$L = \frac{2 * .24336\, \cancel{sec} * 10^6\, bits/\cancel{sec}}{507}$$

$$L = 960\ bits$$

$$L = \frac{960}{8}\ Byte$$

$$L = 120\ Byte$$

## Common Data for Next Two Questions

Frames of 1000 bits are sent over a $10^6$ bps duplex link between two hosts. The propagation time is 25ms. Frames are to be transmitted into this link to maximally pack them in transit (within the link).

Capacity of a Link

What is the minimum number of bits (I) that will be required to represent the sequence numbers distinctly? Assume that no time gap needs to be given between transmission of two frames.

[GATE- 2009- CN- 2M]

Frame size = 1000 bits

Bandwidth = $10^6$ bits/sec

$P_d$ = 25 msec

(A) I = 2

(B) I = 3

(C) I = 4

(D) I = 5

Capacity OF Link = $B * P_d$

$= 10^{\cancel{6}} \text{ bits}/\cancel{\text{sec}} * 25 * 10^{-\cancel{3}} \cancel{\text{sec}}$

$= 10^3 * 25 \text{ bits}$

$= 25{,}000 \text{ bits}$

Capacity OF Link (in terms of Frame) $= \dfrac{(\text{Capacity OF Link}) \text{ bits}}{(\text{Frame size}) \text{ bits}}$

$= \dfrac{25\cancel{,000} \cancel{\text{bits}}}{1\cancel{000} \cancel{\text{bits}}}$

No. OF Frames = 25

$2^l = 25, \quad 2^l = 2^5$

$l = 5$ bit

## Common Data for Next Two Questions

Let I be the minimum number of bits (I) that will be required to represent the sequence numbers distinctly assuming that no time gap needs to be given between transmission of two frames.

Suppose that the sliding window protocol is used with the sender window size of $2^I$, where I is the numbers of bits as mentioned earlier and acknowledgements are always piggy backed. After sending $2^I$ frames, what is the minimum time the sender will have to wait before starting transmission of the next frame? (Identify the closest choice ignoring the frame processing time)

[GATE- 2009- CN- 2M]

(A) 16ms

(B) 18 ms

(C) 20ms

(D) 22ms

Sender window size $= 2^l = 2^5 = 32$

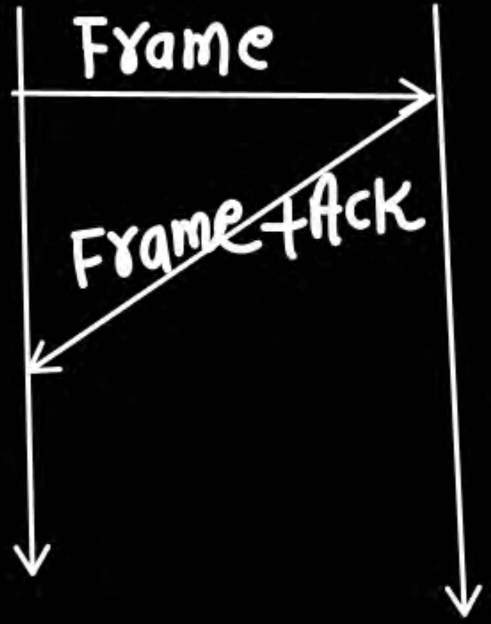
min time sender Have to wait before starting Transmission OF Next Frame $=$ Total time $-$ useful time

$= \text{Total time} - N * T_d(\text{frame})$

$= 52\text{msec} - 32 * 1\text{msec}$

$= 20\text{msec}$

(where N is sender window size)




$T_d(\text{frame}) = \dfrac{\text{Frame size}}{\text{Bandwidth}}$

$= \dfrac{1000 \text{ bits}}{10^6 \text{ bits/sec}}$

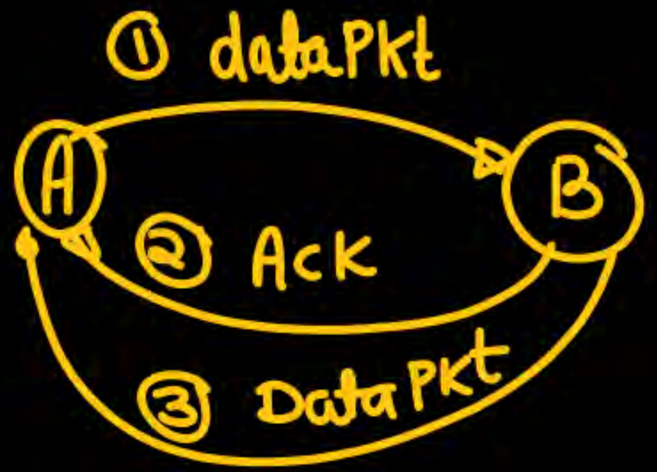
$= 10^{-3}\text{sec} = 1\text{msec}$

$\text{Total time} = T_d(\text{Frame}) + 2 * P_d + \overset{0}{\cancel{Q_d}} + \overset{0}{\cancel{P_{rd}}} + T_d(\text{Ack})$

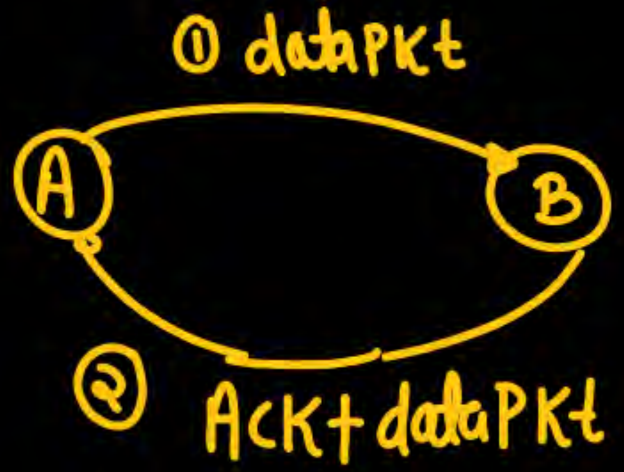
$= 1\text{msec} + 2 * 25 + 1$

$= 52\text{msec}$

## General Approch




## Piggybacking



# Selective Repeat ARQ

# Selective Repeat/ Selective Reject ARQ

1. In SR Protocol window sender size is equal to window receiver size.
2. SR Protocol uses independent acknowledgement, and acknowledgement number defines number of error free packet received
3. SR receiver can receive out of order packet but packets are delivered to upper layer in order.
4. In SR protocol searching and sorting logic is required. Searching is done by sender and sorting is done by receiver.
5. Timer is maintained for each and every frame in the window at sender side

1. For $1^{st}$ out of order delivery or if packet received is corrupted then NAK for respective packet is sent by receiver to sender.

2. When sender receive NAK 3 then it will search in the window for packet 3 & immediately packet 3 is retransmitted even though its timer is not expired.

# Comparison between stop & wait, GB-N and SR

| | Stop & wait | GBN | SR |
|---|---|---|---|
| **Efficiency** | $\eta = \frac{1}{1+2a}$ or $\eta = \frac{\text{useful time}}{\text{Total time}}$ or $\eta = \frac{T_d}{Total\ time}$ | $\eta = \frac{N}{1+2a}$ or $\eta = \frac{\text{useful time}}{\text{Total time}}$ or $\eta = \frac{N * T_d}{\text{Total time}}$ | $\eta = \frac{W_S}{1+2a}$ or $\eta = \frac{\text{useful time}}{\text{Total time}}$ or $\eta = \frac{W_S * T_d}{\text{Total time}}$ |
| **Throughput** | $\frac{\text{Length of } the\ frame}{\text{Total time}}$ or $\eta * B$ | $\frac{N * \text{Length of } the\ frame}{\text{Total time}}$ or $\eta * B$ | $\frac{W_S * \text{Length of } the\ frame}{\text{Total time}}$ or $\eta * B$ |
| **Buffer** | 1 + 1 | N + 1 | N + N |
| **Seq No.** | 2 | N + 1 | 2N |
| **Seq. No. = K bit** | | $\frac{W_S}{2^K - 1}$ $\frac{W_R}{1}$ | $\frac{W_S}{2^{K-1}}$ $\frac{W_R}{2^{K-1}}$ |

# Problem Solving
# on
# SR Protocol

Q.1 The maximum window size for data transmission using the selective reject protocol with $n$-bit frame sequence numbers is:

(A) $2^n$

(B) $2^{(n-1)}$

(C) $2^{n-1}$

(D) $2^{(n-2)}$

Q.2 If senders Window size($W_S$) is 75. What will be sequence numbers required in Go-Back-N and SR protocol?

(A) 0 to 75 and 0 to 76

(B) 0 to 75 and 0 to 149

(C) 0 to 75 and 0 to 150

(D) 0 to 74 and 0 to 150

Q.3 If 'N' is the maximum sequence number then window size in GB-N and SR is

(A) $\frac{N}{2}$, $N - 1$

(B) $N - 1$, $\frac{N}{2}$

(C) $N$, $\frac{N+1}{2}$

(D) $\frac{N+1}{2}$, $N$

Q.4

Suppose sliding window ARQ is used for flow control and optimal window size for maximum utilization of link is 5. If stop & wait ARQ is used instead of sliding window then the link utilization (in percent) is _____ .

Q.5

Consider minimum number of bits required for sequence number field in selective repeat ARQ for maximum utilization are 4 then the efficiency of stop & wait ARQ (in percent) is ____ .

Q.6

Assume we need to design selective repeat protocol for a network in which bandwidth is 1 Mbps and average distance between sender and receiver is 5000 Km. Assume that average packet size is 5000 bits. Propagation speed in the media is $2 \times 108$ m/sec. If window sender size is 8 and process delay is 0.5 Msec and queuing delay is 2msec then what is the efficiency.

(A) 99%

(B) 57%

(C) 87%

(D) 70%

Q.7

In selective repeat ARQ, packet size is 2000 bytes transmission time for one packet is 1ms. If distance between hosts is 10km and signal speed is 4ms per km (4ms/km) and frame sequence number are 6 bit long in frame format then the throughput (in Mbps) is ____.

Q.8

Suppose you are designing a sliding window protocol for a 1-Mbps point to point link to the moon, which has a one way latency (delay) of 1.25 seconds. Assuming that each frame carries 1 KB of data, the minimum number of bits you need for the sequence number

(i) for RWS = 1 (GBN) and

(ii) for SWS = RWS (SR) is

(A) 6, 7

(B) 7, 8

(C) 8, 9

(D) 9, 10

**Q.9**

Consider a $12^8 \times 10^3$ bits/second satellite communication link with one way propagation delay of 150 milliseconds. Selective retransmission (repeat) protocol is used on this link to send data with a frame size of 1 kilobyte. Neglect the transmission time of acknowledgment. The minimum number of bits required for the sequence number field to achieve 100% utilization is ____.

**GATE-2016**

Q.10 A 3000 km long trunk operating at 1.536 Mbps is used to transmit 64 bytes frames and uses SWP. If the propagation speed is 6 μsec/km, then the number of bits should the sequence numbers be

(A) 5

(B) 6

(C) 7

(D) 8

Q.11

Consider selective repeat ARQ is used for flow control, frame size is 4000 bits, data transfer rate of channel is 1 Mbps and one way propagation delay is 18 ms then minimum number of bits required for sequence number field for maximum utilization is ____ .

**Q.12** Consider the sliding window flow-control protocol operating between a sender and a receiver over a full-duplex error-free link. Assume the following:

- The time taken for processing the data frame by the receiver is negligible.
- The time taken for processing the acknowledgement frame by the sender is negligible.
- The sender has infinite number of frames available for transmission.
- The size of the data frame is 2,000 bits and the size of the acknowledgement frame is 10 bits.
- The link data rate in each direction is 1 Mbps (= 106 bits per second).
- One way propagation delay of the link is 100 milliseconds.
- The minimum value of the sender's window size in terms of the number of frames, (rounded to the nearest integer) needed to achieve a link utilization of 50% is__________.

**GATE-2021**

Q.13 Station A uses 32 bytes packets to transmit messages to Station B using a sliding window protocol. The round trip delay between A and B is 80 milliseconds and the bottleneck bandwidth on the path between A and B is 128 kbps. What is the optimal window size that A should use?

(A) 20

(B) 40

(C) 160

(D) 41

# AD steps to solve SWP Problem

1. Calculate RTT
2. Based on the given Bandwidth and RTT calculate No. of bits we are able to transfer with in RTT and Equate it as window in terms of bits ($W_{bits}$) = B*RTT
3. $W_{pkt}$ or $W_p = \dfrac{W_{bits}}{(\text{Packet size})\ \text{bits}}$
4. Minimum sequence No. required = $W_p$
5. $2^K = W_P$

   Where K = No. of bits required in the sequence number field

Q.14

Consider two node A and B round trip delay between these is 80 ms and bottle neck bandwidth of link between A and B is 512 KBps, the optimal window size (in packets) if the packet size is 64 Byte _____.


THANK YOU
GW
SOLDIERS !