CS & IT ENGINEERING

COMPUTER NETWORKS

Flow Control

Lecture No-10

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TOPICS TO BE COVERED

Problem solving on GB-N

Problem Solving
on
GB-N Protocol

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?

Gate-2016

(A) 7.69×10^6 Bps

(B) 11.11×10^6 Bps

(C) 12.33×10^6 Bps

(D) 15.00×10^6 Bps

$W_S = 5$, $W_R = 5$

Packet size or Frame size = 1000 Byte

$T_d(F) = 50\mu sec$

$P_d = 200\mu sec$

$$\text{Throughput} = \frac{W_S * \text{Frame size}}{\text{Total time}}$$

$$= \frac{5 * 1000\,\text{Byte}}{T_d(F) + 2 * P_d + \cancel{Q_d}_{0} + \cancel{P_{rd}}_{0} + \cancel{T_d(A)}_{0}}$$

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

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

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

Throughput $= 11.11 \times 10^6$ 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

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

$P_d = 18 \text{ msec}$

$T_d(F) = \frac{\text{Frame size}}{\text{Bandwidth}} = \frac{4000 \text{ bits}}{10^6 \text{ bits/sec}}$

$= 4 \times 10^{-3} \text{ sec}$

$= 4 \text{ msec}$

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

$$1 = \frac{N * T_d(F)}{T_d(F) + 2 * P_d + \cancel{Q_d}^{\,0} + \cancel{P_{rd}}^{\,0} + \cancel{T_d(A)}^{\,0}}$$

$$\frac{1}{1} = \frac{N * T_d(F)}{T_d(F) + 2 * P_d}$$

$$N * T_d(F) = T_d(F) + 2 * P_d$$

$$N = \frac{T_d(F) + 2 * P_d}{T_d(F)}$$

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

$$N = \frac{\cancel{40}}{\cancel{4}}$$

$$N = 10$$

sender window size

minimum sequence No required in GBN $= N + 1$

$= 10 + 1 = 11$

$$2^k = 11$$

$$2^k = 2^4$$

$$\boxed{k = 4 \text{ bit}}$$

OR

min No. of bits required in the seq No field $= \lceil \log_2 N+1 \rceil$

$= \lceil \log_2 11 \rceil = 4$ bits

Q.10 Consider a network connecting two systems located 8000 kilometres apart. The bandwidth of the network is 500×10^6 bits per second. The propagation speed of the media is 4×10^6 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, Packet size or Frame size $= 10^7$ bits

$v = 4 * 10^6\, m/sec$

$= 4 * 10^3\, km/sec$

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

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

$$P_d = 2\,sec$$

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

$$= \frac{\cancel{10^7}\ bits}{\cancel{500} * \cancel{10^6}\ bits/sec}$$

$$= 0.02\,sec$$

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

$$1 = \frac{N * T_d(F)}{T_d(F) + 2 * P_d + \underbrace{\cancel{Q_d}}_{0} + \underbrace{\cancel{P_d}}_{0} + \underbrace{\cancel{T_d(A)}}_{0}}$$

$$\frac{1}{1} = \frac{N * T_d(F)}{T_d(F) + 2 * P_d}$$

$$N = \frac{T_d(F) + 2 * P_d}{T_d(F)}$$

$$N = \frac{0.02\,sec + 2 * 2\,sec}{0.02\,sec}$$

$$N = \frac{4.02\,\cancel{sec}}{0.02\,\cancel{sec}}$$

$$N = 201$$

↳ sender window size

minimum sequence No required in GBN $= N + 1 = 201 + 1 = 202$

$$2^k = 202$$

$$2^k = 2^8$$

$$\boxed{k = 8\,bit}$$

Q.11

Consider a 512×10^3 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--------

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

$P_d = 150$ msec

Frame size $= 1$ KB
$= 1024$ Byte
$= 8 * 1024$ bits

Ack size $= 64$ Byte $= 64 * 8$ bits $= 512$ bits, $P_{rd} = 5$ msec

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

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

$= 16 * 10^{-3}$ sec $= 16$ msec

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

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

$= 1 * 10^{-3}$ sec $= 1$ msec

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

$$1 = \frac{N * Td(F)}{Td(F) + 2*Pd + \cancel{Qd}^{\,0} + Prd + Td(A)}$$

$$\left[\ \frac{20*16}{322} = \frac{320}{322} = 0.99\ \right]$$

$$1 = \frac{N*16}{16 + 2*150 + 0 + 5 + 1}$$

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

$$N = \lceil 20.125 \rceil$$

$$N = 21$$

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) $\left[\log_2 \frac{2LtR+2K}{K}\right]$

(B) $\left[\log_2 \frac{2LtR}{K}\right]$

(C) $\left[\log_2 \frac{2LtR+K}{K}\right]$

(D) $\left[\log_2 \frac{2LtR+K}{2K}\right]$

$M \xrightarrow{\quad L\,km \quad} N$

$d = L\,km$

Framesize(L) = K bits

Propagation delay For 1 km = t sec

Propagation delay For L km = Lt sec

$B = R$ bits/sec

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

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

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

$$1 = \frac{N * T_d(F)}{T_d(F) + 2 * P_d}$$

$$1 = \frac{N * \frac{K}{R} \text{ sec}}{\frac{K}{R} + 2 * Lt}$$

$$1 = \frac{N * \frac{K}{R} \text{ sec}}{\frac{K + 2LtR}{R}}$$

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

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

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

→ sender window size

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

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

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

Propagation delay for 1 km = 3 msec

Propagation delay for 6 km = 6 * 3 msec
= 18 msec

Packet size or Frame size = 5000 Byte
= 8 * 5000 = 40,000 bits

$T_d(F) = \dfrac{\text{Frame size}}{\text{Bandwidth}} = \dfrac{\cancel{40{,}000\ \text{bits}}}{\cancel{10} * 10^{\cancel{6}}\ \cancel{\text{bits}}/\text{sec}}$

$= 4 * 10^{-3}\ \text{sec} = 4\ \text{msec}$

SeqNo = 3 bit

···· 2 1 0 7 6 5 4 3 2 1 0 $\boxed{7 \; \boxed{6\;5\;4\;3\;2\;1\;\cancel{0}}}$

$\underbrace{}_{W_s = 7}$

GB-N

SeqNo = k bit

W_s	W_R
$2^k - 1$	1

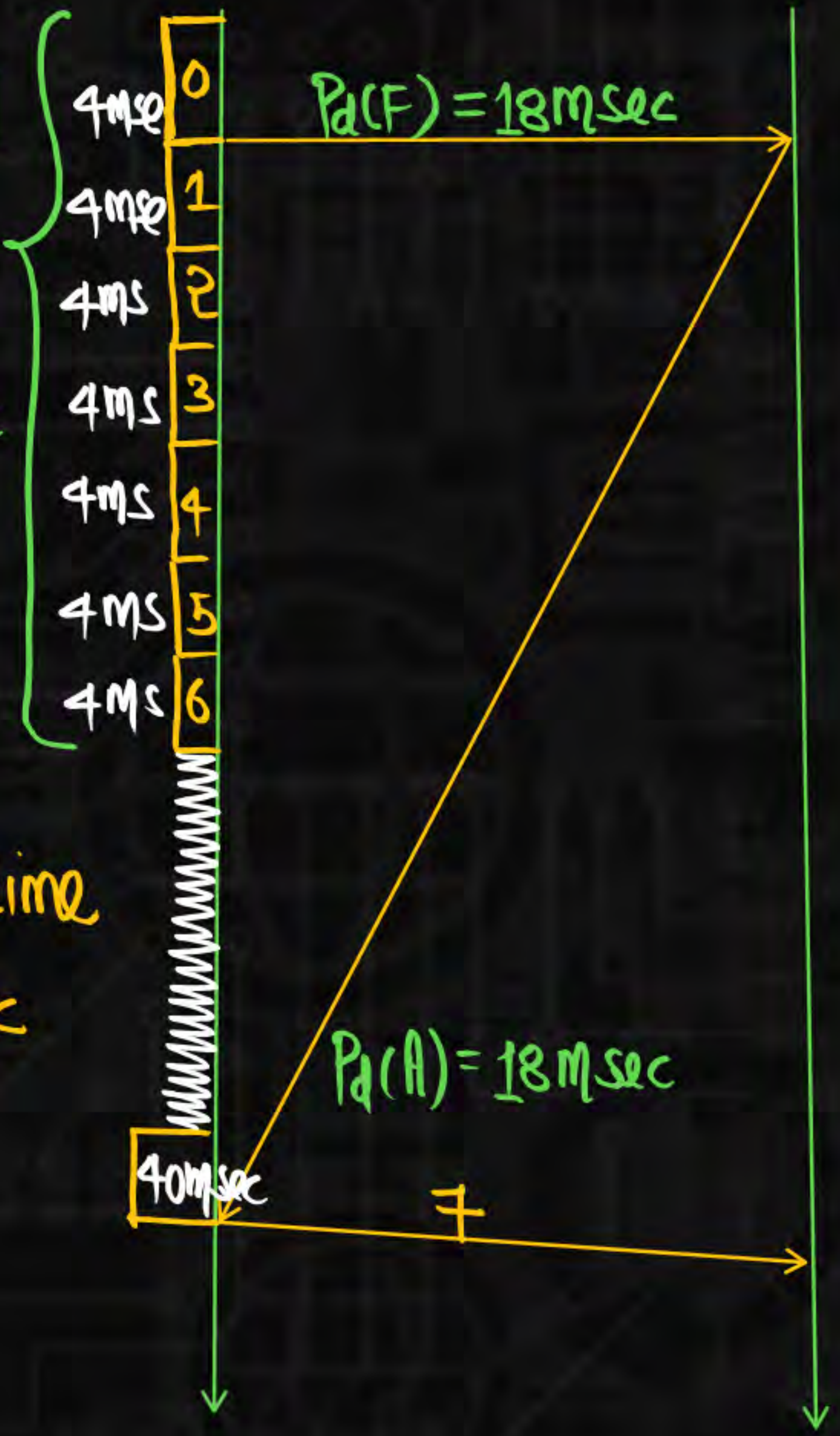
Useful time ⇒ 28 msec

SeqNo = 3 bit, total SeqNo $= 2^3 = 8\,[0-7]$

W_s	W_R
$2^3 - 1$	1
7 ✓	1

(N)

Waiting time = 12 msec



$$\text{maximum Amount of time that sender Remain idle} = \text{Total time} - \text{useful time}$$

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

$$= 40\,msec - 7 \times 4\,msec$$

$$= 40\,msec - 28\,msec = 12\,msec$$

$$\text{Total time} = T_d(F) + 2 * P_d + \overset{0}{\cancel{Q_d}} + \overset{0}{\cancel{P_d}} + \overset{0}{\cancel{T_d(A)}}$$

$$= 4\,msec + 2 * 18\,msec$$

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

[redacted]

A 1Mbps satellite link connects two ground stations. The altitude of the satellite is 36,504 km and speed of the signal is 3×10^8 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]

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

$v = 3 * 10^8$ m/sec, $v = 3 * 10^5$ km/s

Packet size (L) = ?

$\eta = 25\% = \frac{1}{4}$

GB-127, $N = 127$

(A) 120 bytes

(B) 60 bytes

(C) 240 bytes

(D) 90 bytes

$d = 2 * 36,504 \text{ km}$

$d = 73008 \text{ KM}$

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

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

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

$P_d = .24336 \text{ sec}$

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

$$\frac{1}{4} = \frac{N * T_d(F)}{T_d(F) + 2 * P_d + \underbrace{\cancel{Q_d}}_{0} + \underbrace{\cancel{P_{sec}}}_{0} + \underbrace{\cancel{T_d(A)}}_{0}}$$

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

$508 \, T_d(F) = T_d(F) + 2 * P_d$

$507 \, T_d(F) = 2 * P_d$

$$T_d(F) = \frac{2 * P_d}{507}$$

$$\frac{L}{B} = \frac{2 * P_d}{507}$$

$507 L = 2 * P_d * B$

$$L = \frac{2 * P_d * B}{507}$$

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

$L = 960 \text{ bits}$

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

$L = 120 \text{ Byte}$

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 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]

A) $I = 2$

B) $I = 3$

C) $I = 4$

D) $I = 5$

Frame size = 1000 bits

$B = 10^6$ bits/sec

$P_d = 25$ msec $= 25 \times 10^{-3}$ sec

Capacity OF Link = $B * P_d$

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

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

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

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

$= \dfrac{25\cancel{000}}{1\cancel{000}} = 25$ Frames

No. OF Frames = 25

$2^l = 25$

$2^l = 2^5$

$\boxed{l = 5\ \text{bits}}$

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]

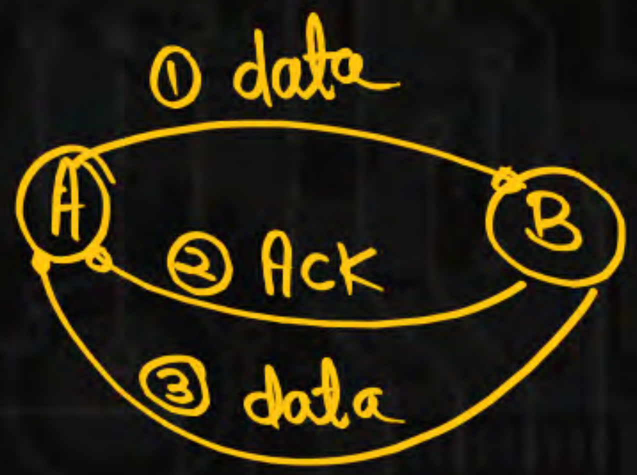
(A) 16ms

(B) 18 ms

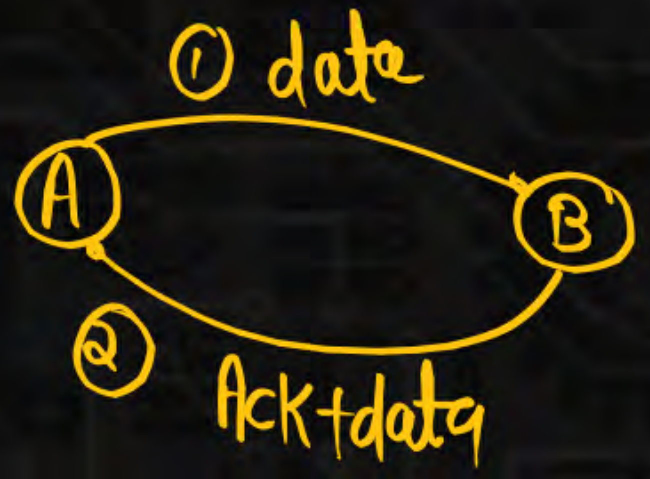
(C) 20ms

(D) 22ms

General Approach



Piggybacking




THANK YOU
GW
SOLDIERS !