CS & IT ENGINEERING

COMPUTER NETWORKS

Flow Control

Lecture No-13

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TOPICS TO BE COVERED

Selective Repeat ARQ

Q.9

Consider a 128×10^3 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

$B = 128 \times 10^3$ bits/sec, $P_d = 150$ msec, SR Protocal, Framesize $= 1$ KB

$= 1024$ Byte

$= 8 \times 1024$ bits

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

$$= \frac{8 * \cancel{1024}^{\,2^3} \cancel{\text{bits}}}{\cancel{128} * 10^3 \cancel{\text{bits}}/\text{sec}}$$

$$= 64 * 10^{-3} \text{sec}$$

$$= 64 \text{ msec}$$

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

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

$$\frac{1}{1} = \frac{W_s * 64}{64 + 2 * 150}$$

$$W_s = \frac{364}{64}$$

$$W_s = \lceil 5.68 \rceil = 6$$

minimum sequence No. required in SR $= 6 + 6 = 12$

$$2^K = 12$$

$$2^K = 2^4$$

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

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

Sliding window Protocal

(A) 5

(B) 6

(C) 7

(D) 8

$d = 3000\,km$, $B = 1.536\,mbps = 1.536 * 10^6$ bits/sec, Frame size $= 64$ Byte $= 8*64$ bits $= 512$ bits

Propagation time For 1 km = 6 μsec

Propagation time For 3000km = 3000 × 6 μsec = 18000 μsec

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

$$= \frac{512 \text{ bits}}{1.536 \times 10^6 \text{ bits/sec}}$$

$$= 333.33 \times 10^{-6} \text{ sec}$$

$$= 333.33 \ \mu\text{sec}$$

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

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

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

$$N = \frac{333.33 + 2 * 18000}{333.33}$$

$$N = \lceil 109.00108 \rceil = 110$$

minimum sequence No. required in sliding window = 110

$$2^k = 110$$

$$2^k = 2^7$$

$$\boxed{k = 7 \text{ bit}}$$

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 ____ .

Frame size = 4000 bits

$B = 10^6$ bits/sec

$P_d = 18$ msec

$$T_d(F) = \frac{\text{Frame size}}{\text{Bandwidth}} = \frac{4\cancel{000}\ \cancel{\text{bits}}}{10^{\cancel{6}}\ \cancel{\text{bits}}/\text{sec}} = 4 \times 10^{-3}\ \text{sec} = 4\ \text{msec}$$

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

$$\frac{1}{T} = \frac{W_s * T_d(F)}{T_d(F) + 2 * P_d + \cancel{Q_d} + \cancel{P_{\text{rod}}} + \cancel{T_d(A)}}$$

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

$$W_s = \frac{4 + 2 \times 18}{4}$$

$$W_s = 10$$

minimum sequence No. required in SR $= 10 + 10 = 20$

$$2^K = 20$$

$$2^K = 2^5$$

$$\boxed{K = 5 \text{ bit}}$$

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 (= 10^6 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 (50-52).

GATE-2021

Frame size = 2000 bits

$B = 10^6$ bits/sec

$P_d = 100$ msec

$\eta = 50\% = \frac{1}{2}$

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

$$= \frac{2000 \text{ bits}}{10^6 \text{ bits/sec}}$$

$= 2 * 10^{-3}$ sec

$= 2$ msec

Ack size = 10 bits

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

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

$= 10^{-5}$ sec

$= 10^{-5} * 10^3$ msec

$= 10^{-2}$ msec

$= \frac{1}{100}$ msec

$= 0.01$ msec

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

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

$$\frac{1}{2} = \frac{W_s \times 2}{2 + 2*100 + 0.01}$$

$4 * W_s = 202.01$

$$W_s = \frac{202.01}{4}$$

$W_s = \lceil 50.50 \rceil$, $W_s = 51$

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

Gate 2005

Frame size = 32 Byte = 32×8 bits = 256 bits , B = 128 KbPS = 128×10^3 bits/sec

RTT = 80 msec

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

$$= \frac{\cancel{256}\ \cancel{\text{bits}}}{\cancel{128} * 10^3\ \cancel{\text{bits}}/\text{sec}}$$

$$= 2 * 10^{-3}\ \text{sec}$$

$$= 2\ \text{msec}$$

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

$$\frac{1}{1} = \frac{W_s * T_d(F)}{RTT}$$

$$W_s = \frac{RTT}{T_d(F)}$$

$$W_s = \frac{\cancel{80}\ \cancel{\text{msec}}}{\cancel{2}\ \cancel{\text{msec}}}$$

$$\boxed{W_s = 40}$$

AD steps to solve SWP Problem

1. Calculate RTT $= 80 msec$
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 $\boxed{(W_{bits}) = B^*RTT}$
   $W_{bits} = 128 * \cancel{10^3} \text{ bits}/\cancel{sec} * 80 * \cancel{10^{-3}} \cancel{sec} = 128*80 \text{ bits}$
3. $W_{pkt} \text{ or } W_p = \dfrac{W_{bits}}{(\text{Packet size})\text{ bits}}$
   $W_{pkt} = \dfrac{1\cancel{28} \times 8\cancel{0}}{\cancel{256}\ \cancel{2}} = 40 \text{ pkt}$
4. Minimum sequence No. required $= W_p = 40$
5. $2^K = W_P$ $\quad 2^K = 40, \quad 2^K = 2^6, \quad K = 6 \text{ bit}$

   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 $\boxed{512 \text{ KBps}}$, the optimal window size (in packets) if the packet size is 64 Byte ______.

A.D steps

$B = 512\,KBPs = 512 \times 10^3 \times 8$ bits/sec

$RTT = 80\,msec$

① $RTT = 80\,msec$

② $W_{bits} = B \times RTT = 512 \times \cancel{10^3} \times 8\ bits/\cancel{sec} \times 80 \times \cancel{10^{-3}}\ \cancel{sec} = 512 \times 8 \times 80$ bits

③ $W_{Pkt} = \dfrac{W_{bits}}{(Packet\,size)_{bits}} = \dfrac{\overset{2^3}{\cancel{512}} \times \cancel{8} \times 80\ \cancel{bits}}{\cancel{64} \times \cancel{8}\ \cancel{bits}} = 8 \times 80 = 640$ Pkt

OR

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

$$= \frac{\cancel{64} * \cancel{8} \text{ bits}}{\cancel{512} * 10^3 * 8 \text{ bits/sec}}$$

$$= \frac{1}{8} * 10^{-3} \text{ sec}$$

$$= \frac{1}{8} \text{ msec}$$

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

$$\frac{1}{1} = \frac{W_s * T_d(F)}{RTT}$$

$$W_s = \frac{RTT}{T_d(F)}$$

$$W_s = \frac{80 \cancel{\text{msec}}}{\frac{1}{8} \cancel{\text{msec}}}$$

$W_s = 80 \times 8 = 640$ Packet or Frame


THANK YOU
GW
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