PRACTICE PROBLEMS BASED ON SLIDING WINDOW PROTOCOL-

Problem-01:

A 3000 km long trunk operates at 1.536 Mbps and is used to transmit 64 byte frames and uses sliding window protocol. If the propagation speed is 6 μsec / km, how many bits should the sequence number field be?

Solution-

Given-

- Distance = 3000 km
- Bandwidth = 1.536 Mbps
- Packet size = 64 bytes
- Propagation speed = 6 μsec / km

Calculating Transmission Delay-

Transmission delay (T_t)

= Packet size / Bandwidth

= 64 bytes / 1.536 Mbps

= (64 x 8 bits) / (1.536 x 10^6 bits per sec)

= 333.33 μsec

Calculating Propagation Delay-

For 1 km, propagation delay = 6 μsec

For 3000 km, propagation delay = 3000 x 6 μsec = 18000 μsec

Calculating Value Of ‘a’-

$a = T_p / T_t$

$a = 18000 \mu sec / 333.33 \mu sec$

$a = 54$

Calculating Bits Required in Sequence Number Field-

Bits required in sequence number field

$= \lceil \log_2(1+2a) \rceil$

$= \lceil \log_2(1 + 2 \times 54) \rceil$

$= \lceil \log_2(109) \rceil$

$= \lceil 6.76 \rceil$

= 7 bits

Thus,

- Minimum number of bits required in sequence number field = 7
- With 7 bits, number of sequence numbers possible = 128
- We use only (1+2a) = 109 sequence numbers and rest remains unused.

Problem-02:

Compute approximate optimal window size when packet size is 53 bytes, RTT is 60 msec and bottleneck bandwidth is 155 Mbps.

Solution-

Given-

- Packet size = 53 bytes
- RTT = 60 msec
- Bandwidth = 155 Mbps

Calculating Transmission Delay-

Transmission delay (T_t)

= Packet size / Bandwidth

= 53 bytes / 155 Mbps

= (53 x 8 bits) / (155 x 10^6 bits per sec)

= 2.735 μsec

Calculating Propagation Delay-

Propagation delay (T_p)

= Round Trip Time / 2

= 60 msec / 2

= 30 msec

Calculating Value of 'a'-

a = T_p / T_t

a = 30 msec / 2.735 μsec

a = 10968.921

Calculating Optimal Window Size-

Optimal window size

= 1 + 2a

= 1 + 2 x 10968.921

= 21938.84

Thus, approximate optimal window size = 21938 frames.

Problem-03:

A sliding window protocol is designed for a 1 Mbps point to point link to the moon which has a one way latency (delay) of 1.25 sec. Assuming that each frame carries 1 KB of data, what is the minimum number of bits needed for the sequence number?

Solution-

Given-

- Bandwidth = 1 Mbps
- Propagation delay (T_p) = 1.25 sec
- Packet size = 1 KB

Calculating Transmission Delay-

Transmission delay (T_t)

= Packet size / Bandwidth

= 1 KB / 1 Mbps

= (2^{10} x 8 bits) / (10^6 bits per sec)

= 8.192 msec

Calculating Value of 'a'-

$a = T_p / T_t$

a = 1.25 sec / 8.192 msec

a = 152.59

Calculating Bits Required in Sequence Number Field-

Bits required in sequence number field

$= \lceil \log_2(1+2a) \rceil$

$= \lceil \log_2(1 + 2 \times 152.59) \rceil$

$= \lceil \log_2(306.176) \rceil$

$= \lceil 8.25 \rceil$

= 9 bits

Thus,

- Minimum number of bits required in sequence number field = 9
- With 9 bits, number of sequence numbers possible = 512.
- We use only (1+2a) sequence numbers and rest remains unused.

Problem-04:

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 50 μs. Acknowledgement packets (sent only from B to A) are very small and require negligible transmission time. The propagation delay over the link is 200 μs. What is the maximum achievable throughput in this communication?

1. 7.69×10^6 Bps
2. 11.11×10^6 Bps
3. 12.33×10^6 Bps
4. 15.00×10^6 Bps

Solution-

Given-

- Sender window size = Receiver window size = 5
- Packet size = 1000 bytes
- Transmission delay (T_t) = 50 μs
- Propagation delay (T_p) = 200 μs

Calculating Bandwidth-

We know,

Transmission delay = Packet size / Bandwidth

So, Bandwidth

= Packet Size / Transmission delay (T_t)

= 1000 bytes / 50 μs

= (1000 x 8 bits) / (50 x 10^{-6} sec)

= 160 Mbps

Calculating Value of ‘a’-

a = T_p / T_t

a = 200 μsec / 50 μsec

a = 4

Calculating Optimal Window Size-

Optimal window size

= 1 + 2a

= 1 + 2 x 4

= 9

Calculating Efficiency-

Efficiency (η)

= Sender window size / Optimal window size

= 5 / 9

= 0.5555

= 55.55%

Calculating Maximum Achievable Throughput-

Maximum achievable throughput

= Efficiency (η) x Bandwidth

= 0.5555 x 160 Mbps

= 88.88 Mbps

= 88.88 x 10^6 bps or 11.11 x 10^6 Bps

Thus, Option (B) is correct.

Problem-05:

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

1. 20
2. 40
3. 160
4. 320

Solution-

Given-

- Packet size = 32 bytes
- Round Trip Time = 80 msec
- Bandwidth = 128 Kbps

Calculating Transmission Delay-

Transmission delay (T_t)

= Packet size / Bandwidth

= 32 bytes / 128 Kbps

$= (32 \times 8 \text{ bits}) / (128 \times 10^3 \text{ bits per sec})$

= 2 msec

Calculating Propagation Delay-

Propagation delay (T_p)

= Round Trip Time / 2

= 80 msec / 2

= 40 msec

Calculating Value of 'a'-

$a = T_p / T_t$

a = 40 msec / 2 msec

a = 20

Calculating Optimal Window Size-

Optimal window size

= 1 + 2a

$= 1 + 2 \times 20$

= 41 which is close to option (B)

Thus, Option (B) is correct.