Assignment # 3

Name : M. Talha Farooqi

ID : F2022065010

Section : W-2

Question # 1

Given Data :

SampleRTTs = 106 ms , 120 ms , 140 ms ,
90 ms , 115 ms

Initial Estimated RTT = 100 ms

Initial DevRTT = 5 ms

$\alpha = 0.125$

$\beta = 0.25$

Required :

For each SampleRTT we have to calculate :

1) EstimatedRTT = ?
2) DevRTT = ?
3) Timeout Interval = ?

1st Sample RTT = 106 ms

EstimatedRTT :

EstimatedRTT = α * SampleRTT + $(1-\alpha)$ * Estima

Putting Values,

$= 0.125 \times 106 + (1 - 0.125) \times 100$

$= 0.125 \times 106 + 0.875 \times 100$

$= 13.25 + 87.5$

$= 100.75$ ms

DevRTT :

DevRTT = $(1-\beta)$ * DevRTT + β * |SampleRTT − EstimatedRTT|

Putting Values,

$= (1 - 0.25) \times 5 + 0.25 \times |106 - 100.75|$

$= 0.75 \times 5 + 0.25 \times 5.25$

$= 3.75 + 1.3125$

$= 5.0625$ ms

Timeout Interval :

Timeout Interval = Estimated RTT + 4 * DevRTT

Putting Values,

$= 100.75 + 4 \times 5.0625$

$= 121$ ms

2nd Sample RTT = 120 ms

d RTT:

According to formula,

Estimated RTT = $0.125 \times 120 + (1 - 0.125) \times 100.75$

$= 0.125 \times 120 + 0.875 \times 100.75$

$= 15 + 88.15625$

$= 103.1562$ ms

DevRTT :

According to formula,

DevRTT = $(1 - 0.25) \times 5.0625 + 0.25 \times |120 - 103.1562|$

$= 0.75 \times 5.0625 + 0.25 \times 16.84$

$= 3.79 + 4.21$

$= 8$ ms

Timeout Interval :

According to formula,

Timeout Interval = $103.15 + 4 \times 8$

$= 103.15 + 32$

$= 135.15$ ms

3rd Sample RTT = 140ms

Estimated RTT :

According to formula,

$$\text{EstimatedRTT} = 0.125 \times 140 + (1 - 0.125) \times 103.15$$
$$= 0.125 \times 140 + 0.875 \times 103.15$$
$$= 17.5 + 90.26$$
$$= 107.75$$

DevRTT :

According to formula,

$$\text{DevRTT} = (1 - 0.25) \times 8 + 0.25 \times |140 - 107.75|$$
$$= 0.75 \times 8 + 0.25 \times 32.25$$
$$= 6 + 8.06$$
$$= 14.06 \text{ ms}$$

Timeout Interval :

According to formula,

$$\text{Timeout Interval} = 107.75 + 4 \times 14.06$$
$$= 164 \text{ ms}$$

4th Sample RTT = 90 ms

RTT :

According to formula,

Estimated RTT = $0.125 \times 90 + (1-0.125) \times 107.75$

$= 0.125 \times 90 + 0.875 \times 107.75$

$= 11.25 + 94.28$

$= 105.53$ ms

DevRTT :

According to formula,

DevRTT = $(1-0.25) \times 14.06 + 0.25 \times |90 - 105.53|$

$= 0.75 \times 14.06 + 0.25 \times 15.53$

$= 10.545 + 3.88$

$= 14.42$ ms

Timeout Interval :

Timeout Interval = $105.53 + 4 \times 14.42$

$= 163.21$ ms

5th Sample RTT = 115 ms

Estimated RTT :

According to formula,

$$\text{Estimated RTT} = 0.125 \times 115 + (1 - 0.125) \times 105.53$$

$$= 0.125 \times 115 + 0.875 \times 105.53$$

$$= 14.375 + 92.34$$

$$= 106.715 \text{ ms}$$

Dev RTT :

$$\text{Dev RTT} = (1 - 0.25) \times 14.42 + 0.25 \times |115 - 106.715|$$

$$= 0.75 \times 14.42 + 0.25 \times 8.285$$

$$= 10.815 + 2.07$$

$$= 12.885 \text{ ms}$$

Timeout Interval :

According to formula,

$$\text{Timeout Interval} = 106.715 + 4 \times 12.885$$

$$= 158.255 \text{ ms}$$

Question # 2

Relationship b/w variables, Sendbase and LastByteRcvd

SendBase - 1 <= LastByteRcvd

Explanation:

- SendBase - 1 is used to find "Sequence No." of the last byte.
- LastByteRcvd is used to find "number of last byte" in the stream of data arrival from network to buffer. So, SendBase is the LastByteRcvd at the receiver end.

Question # 3

TCP waits for 3 DupACK befor Fast Retransmit

Suppose packets n, $n+1$ and $n+2$ are transmitted and packet n is successfully received and acknowledged. If packets $n+1$ and $n+2$ are reordered along

the end to end path (they arrive in the n+2, n+1), the arrival of packet n+2 will re. in DupAcks for pocket n, leading to retransmiss under a policy that waits for only the 2nd DupAck to trigger retransmission.

By adopting a policy of waiting for a third DupAck, it ensures that two packets following packet n are correctly received while packet n+1 is not received. The developers of Triple DupAcks strategy likely determined that waiting for two subsequent packets (instead of just one) strikes the right balance b/w initiating prompt retransmission when neccessary and avoiding premature retransmissi in case of packet reordering.

Question # 4

Analysis of Graph

According to graph given in the question :

(a) TCP slow start is operating between intervals of time

→ 1 to 6

→ 23 to 26

(b) TCP congestion avoidance is operating between intervals of time

→ 6 to 23

(c) After 16th transmission round, the segment loss is detected by "Triple Duplicate ACK"

(d) After 22nd transmission round, the segment loss is detected by "Timeout".

(e) The initial value of ssthresh at Ist transmission round is 32.

(f) The value of ssthresh at 18th transmission round is 21.

(g) The value of ssthresh at 24th transmission round is 13.

(h) The 70th segment is sent at 7th transmission round.

(i) If a packet loss is detected after 22nd by the receipt of a triple DupAck, then value is

(j) If TCP Tahoe is used (instead of Reno) and triple DupACKs are received at 16th round, then ssthresh and congestion window size at 19th round is 1 and transmission round is 21.

(K) Again if TCP Tahoe is used and there is timeout event at 22nd round then the packets have been sent out from 17th round till 22nd round (inclusive) is 52.

Question # 5

(a)

Assuming cwnd increases by 1 MSS every time a batch of ACKs is received and assuming approximately constant round trip times.
Following steps will be taken for cwnd ~~from~~ to increase from 6 MSS to 12 MSS:

- After 1 RTT, CWND = 7 MSS
- After 2 RTTs, CWND = 8 MSS
- After 3 RTTs, CWND = 9 MSS

er 4 RTTs, CWND = 10 MSS

fter 5 RTTs, CWND = 11 MSS

- After 6 RTTs, CWND = 12 MSS

(b)

Connection up through time] = 6 RTT

Total segments sent over Ist 6 RTTs] = 6 + 7 + 8 + 9 + 10 + 11

= 51 MSS

Hence,

Average Throughput [in terms of MSS & RTT] = $\frac{\text{Total MSS Segment sent}}{\text{RTT taken}}$

= $\frac{51}{6}$

= 8.5 MSS/RTT

Ans.

Question # 6

Given Data:

Sample RTT = 116 ms, 125 ms, 110 ms

Initial Estimated RTT = 120 ms

Initial DevRTT = 2 ms

$\alpha = 0.125$

$\beta = 0.25$

Required:

For each sample RTT, we have to calculate:

(i) Estimated RTT = ?

(ii) DevRTT = ?

(iii) Timeout Interval = ?

2nd Sample RTT = 116

edRTT :

Estimated RTT $= \alpha * \text{Sample RTT} + (1-\alpha) * \text{Estimated RTT}$

$= 0.125 \times 116 + (1-\alpha) \times 120$

$= 14.5 + (1-0.125) \times 120$

$= 14.5 + 0.875 \times 120$

$= 14.5 + 105 = 119.5$ ms

DevRTT :

$\text{DevRTT} = (1-\beta) * \text{DevRTT} + \beta * |\text{Sample RTT} - \text{Estimated RTT}|$

$= (1-0.25) \times 2 + 0.25 \times |116 - 120|$

$= 0.75 \times 2 + 0.25 \times 4$

$= 1.5 + 1$

$= 2.5$ ms

Timeout Interval :

$\text{Timeout Interval} = \text{Estimated RTT} + 4 * \text{DevRTT}$

$= 119.5 + 4 \times 2.5$

$= 129$ ms

2nd SampleRTT = 125

EstimatedRTT :

According to formula,

$$\text{Estimated RTT} = 0.125 \times 125 + (1 - 0.125) \times 119.5$$

$$= 0.125 \times 125 + 0.875 \times 119.5$$

$$= 15.625 + 104.5625$$

$$= 120.1875 \text{ ms}$$

DevRTT :

According to formula,

$$\text{Dev RTT} = (1 - 0.25) \times 2.5 + 0.25 \times |125 - 120.1875|$$

$$= 0.75 \times 2.5 + 0.25 \times 4.8125$$

$$= 1.875 + 1.203125$$

$$= 3.078125 \text{ ms}$$

nterval :

According to formula,

Timeout Interval = $120.1875 + 4 \times 3.078125$

$= 120.1875 + 12.3125$

$= 132.5$ ms

3rd Sample RTT = 110

Estimated RTT :

According to formula,

Estimated RTT = $0.125 \times 110 + (1 - 0.125) \times 120.1875$

$= 0.125 \times 110 + 0.875 \times 120.1875$

$= 13.75 + 105.1640625$

$= 118.9140625$

DevRTT :

According to formula,

$$\text{DevRTT} = (1 - 0.25) \times 3.078125 + 0.25 \times |110 - 118.9140625|$$

$$= 0.75 \times 3.078125 + 0.25 \times 8.9140625$$

$$= 2.308593 + 2.228515$$

$$= 5.14473 \text{ ms}$$

Timeout Interval :

$$\text{Timeout Interval} = 118.9140625 + 4 \times 5.14473$$

$$= 118.9140625 + 20.57892$$

$$= 139.49298 \text{ ms}$$

Question # 7

TCP Transmission Congestion Window Graph

Given Data:

Transmission b/w Source A → Sink A = TCP1 (TCP Tahoe)

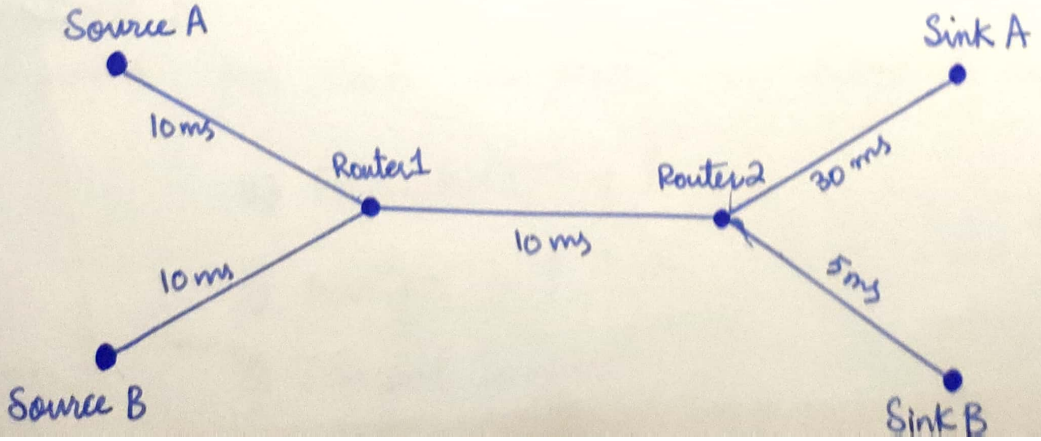
Transmission b/w Source B → Sink B = TCP2 (TCP Reno)

Initial Threshold = 32

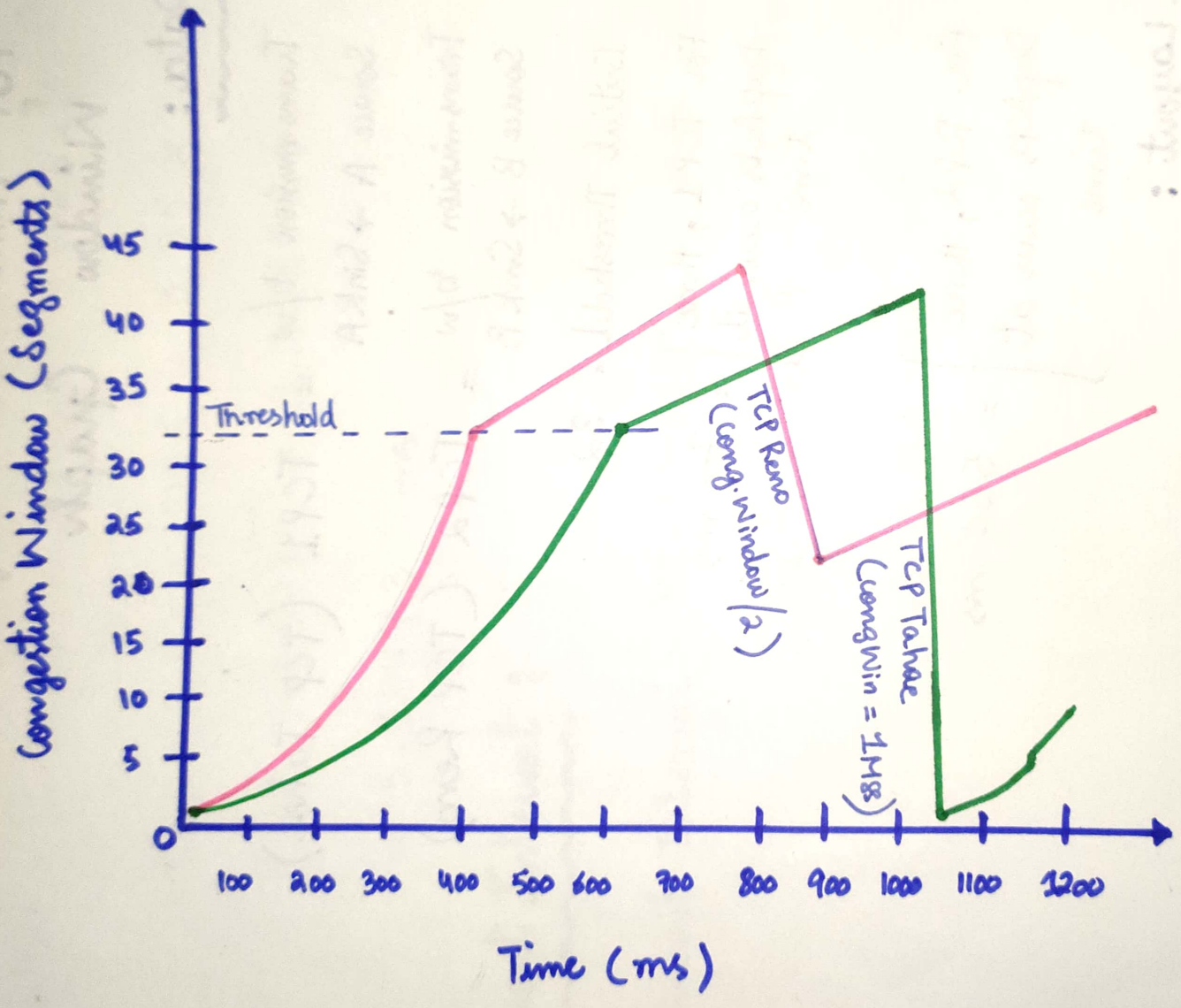
For TCP1, three DupAcks occur at time = 700 ms

For TCP2, three DupACKs occur at time = 550 ms

Network Layout:



Graph


TCP2 (Reno)
TCP1 (Tahoe)
Congestion Window (Segments)
45
40
35
30
25
20
15
10
5
0
Threshold
TCP Reno (cong. window/2)
TCP Tahoe (congWin = 1MSS)
100
200
300
400
500
600
700
800
900
1000
1100
1200
Time (ms)