# Mokhtari (9831143) – Computer Networks 2 - HW 05

**P38** from Chapter **3** of Kurose & Ross's Computer Networking, A Top-D own Approach, **8**th edition:

In simple steps, here's how it works:

When the loss event occurs, the sender's rate is approximately equal to cwnd segments per RTT.

The variable cwnd is controlled by a congestion-control mechanism on the sender side. It is used to limit the sender's network traffic rate.

The variable ssthresh is used to store the second state value, as it's known as the "slow start threshold."

When a segment loss event occurs and the TCP sender detects the loss, the value of ssthresh is reset to cwnd/2.

As a result, the sender rate is cwnd/RTT.

# Mokhtari (9831143) – Computer Networks 2 - HW 05

**P40** from Chapter **3** of Kurose & Ross's Computer Networking, A Top-Down Approach, **8**th edition:

Let's solve this problem by observing the graph.

a) In the 1st, 2nd, 3rd, and 4th rounds, the congestion windows slowly started and increased speed from round to round.

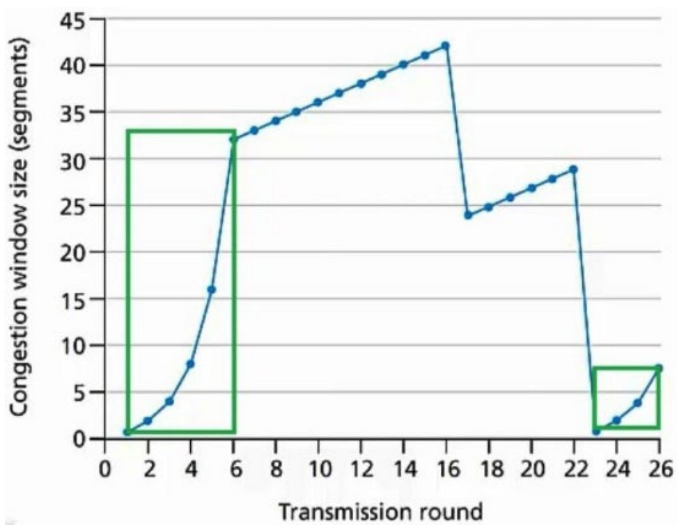
   In the 5th and 6th rounds, the congestion window expanded exponentially during the slow start.

   Hence, the operating interval for slow starts is from round 1 to 6. That is [1, 6].

   The segment loss is detected after rounds 16 and 22. Again, the congestion window started the operation off slowly.

   The congestion windows gradually began and increased in speed from round to round in the rounds of the 23rd, 24th, 25th, and 26th.

   Hence, the operating interval for slow starts is from round 23 to 26. Thats [23, 26].



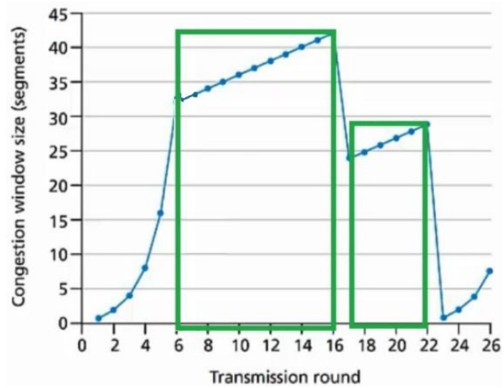

   As a result, the slow start operating interval occurred twice, at [1, 6] and [23, 26].

b) When there is no congestion in TCP, then with an increase in rounds, there is a linear increment in the window size.

   Between rounds 6 and 16, the window size is increasing linearly. Therefore, the congestion-avoiding interval is [6, 16].

   A drop in the window size is observed between rounds 16 and 17. Between rounds 17 and 22, the window size is increasing linearly.

Therefore, the congestion-avoiding interval is [17, 22]. The two operating intervals of TCP congestion avoidance are marked with green boxes in the following graph:




Therefore, TCP congestion avoidance operating time intervals are [6, 16], [17, 22].

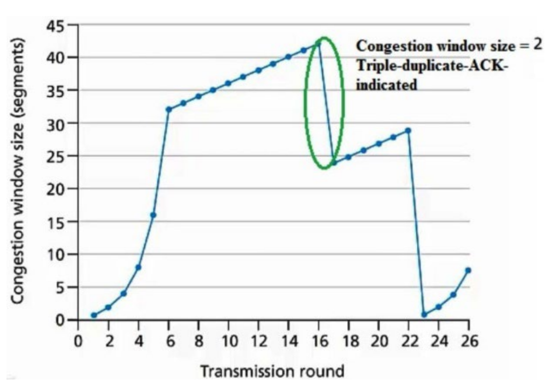
c) Packet (segment) loss can be detected based on the congestion window size after the packet loss.

If the congestion window size is dropped to 1 after the packet loss, then the loss indicated by the timeout.

If the congestion window size is reduced but not dropped to 1 after the packet loss, then the loss is indicated by a triple-duplicate ACK.

The congestion window size is reduced to 21 (not dropped to 1). The packet loss is indicated by a triple-duplicate-ACK.

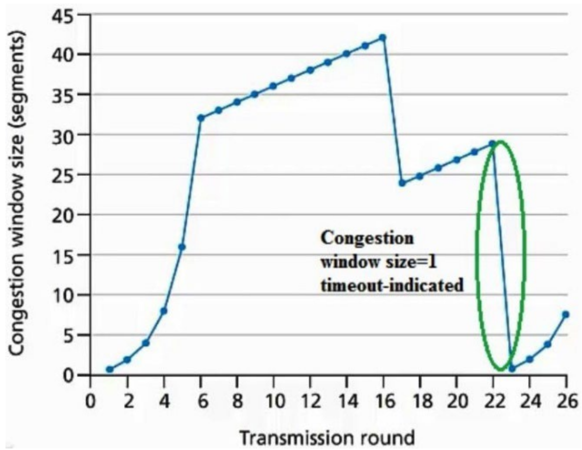
The drop in the congestion window size after the 16th round is marked with a green box in the following graph:




Therfore, a triple-duplicated ACK indicates segment loss detected after the 16th transmission round.

d) Let's observe the graph for segment loss after the 22nd transmission round. The congestion window size has been dropped to 1. The packet loss is indicated by the timeout.

The drop in the congestion window size after the 22nd round is marked with a green box in the following graph:




*So far, I've illustrated areas on the graph, but let's move quickly and complete the remaining ones without visualization.*

e) The threshold is initially set at 32 because this is the point at which slow start ends and congestion avoidance begins.

f) As soon as packet loss is identified, the threshold is reduced to half the congestion window's value. As a result, the congestion window size is 29 when the loss is discovered during transmission round 22.

g) Packet 1 is sent during the first transmission round.

In the second transmission round, packets 3-4 are sent.

Packets 4-7 are sent in the third transmission round; packets 8-15 are sent in the fourth transmission round; and packets 16-31 are sent in the fifth transmission round.

Packets 32-63 are sent in the sixth transmission round, and packets 64-96 are sent in the seventh.

As a result, packet 70 is sent in the seventh transmission round.

h) When the loss occurs, the threshold will be set to half the current value of the congestion window, which is now 8, and the congestion window will be set to the new threshold value plus 3 MSS. (This is mentioned at the bottom of page 299.)

As a result, the threshold will now have a value of 4, and the window will now have a value of 7.

i) The congestion window size is 1, and the threshold is 21.

j) One packet will be sent in round 17. In round 18, two packets will be sent; in round 19, four packets will be sent.

In round 20, eight packets will be sent. Round 21 will have 16 packets, and round 22 will have 21 packets.

Therefore, there are 52 packets in total.

# Mokhtari (9831143) – Computer Networks 2 - HW 05

**P44** from Chapter **3** of Kurose & Ross's Computer Networking, A Top-Down Approach, **8**th edition:

Let's simplify the question as follows: Assume TCP has a transmission rate of W bytes and a current round-trip time of RTT seconds. TCP's transmission rate is then (w) / RTT (approx. ), and cwnd grows by 1 MSS for each batch of ACKs received.

Let's now answer the next two questions:

a) The following is the time required for cwnd to increase from 6 MSS to 12 MSS:
   I. One RTT is required to increase the cycle from 6 to 7 MSS.
   II. Two RTTs are required to increase the cycle to 8 MSS.
   III. Three RTTs are required to increase the cycle to 9 MSS.
   IV. Four RTTs are required to increase the cycle to 10 MSS.
   V. Five RTTs are required to increase the cycle to 11 MSS.
   VI. Six RTTs are required to increase the cycle to 12 MSS.

b) Therefore:
   I. In the first RTT, 6 MSS was sent.
   II. In the second RTT, 7 MSS was sent.
   III. In the third RTT, 8 MSS was sent.
   IV. In the fourth RTT, 9 MSS was sent.
   V. In the fifth RTT, 10 MSS was sent.
   VI. In the sixth RTT, 11 MSS was sent.
   VII. Thus, by 6 RTTs, 6+7+8+9+10+11 = 51 MSS had been sent and acked.
   VIII. The average throughput up to time 6 RTT = (6 + 7 + 8 + 9 + 10 + 11)/6 = 51 MSS / 6 RTT = 8.5 MSS / RTT