**b. (6 points) Suppose that the congestion window CongWin, of a TCP connection is currently at 9KB, and the threshold=20KB. The sender sends 6 TCP data segments, each of size 1500 bytes. (Here we assume that 1KB=1000 bytes; and the TCP maximum segment size (MSS)= 1500 bytes.) The last segment of the 6 data segments sent carries a sequence number 2003000.(in decimal representation and not binary representation). The sender then receives three acknowledgements from the receiver, each acknowledging the receipt of two consecutive data segments. In particular, the last acknowledgement from the receiver carries the acknowledgement number 2004500. What will the sender set the CongWin to at the end?**

Answer:

Before attempting the calculation, we observe the following-

* We are sending 6 segments of size 1500 each. As expected, this value is same as our CongWin.
* CongWin = 9 KB = 6 \*1500 bytes = 6MSS
* Sequence number of the 6 segment is 2003000 so the acknowledge number expected is 2003000 + MSS = 2003000 + 1500 = 2004500. Since TCp provides cumulative acknowledgements, this implies that all segments sent were received and there were no segments missed.
* Note that, even though the sequence number 2003500 is greater than the threshold 20000 bytes. It does not affect out calculation because CogWin has nothing to do with sequence numbers. Sequence numbers can start from any number, can be reset and its value will also depend of how long transmission has been happening.

The calculation:

The CongWin = 9 KB is approximately half the threshold, i.e. 20/2 ~9. So, in order to avoid congestion resulting from doubling the CongWin during the next acknowledgement, we can do one of the following:

1. increase the CongWin by 1/CongWin for every acknowledgement as suggested in the book

Since, there are three acknowledgements for 6 segments; we have to increase CongWin by

3\*1/6 MSS = ½ MSS = 1500/2=750bytes.

Therefore, the new size of CongWin =9000+750=9750 bytes

Since, the CongWin is usually a multiple of MSS. We do not use this approach.

1. A more intuitive approach is-

Since, we get an acknowledgement for every two segments we can also increase CongWin by 2/CongWin per acknowledgement

3\*2/6 MSS = 1 MSS = 1500 bytes. Therefore new value of CongWin=9000+1500=10500 bytes. This is still less than the threshold.

**c. (6 points) Suppose that during the next round of data transmission after b., a timeout event occurs at the sender side. What will be the value(in bytes) of CongWin after this event? What will be the value(in bytes) of the threshold?**

Answer: In the event of a timeout, CongWin is set to 1 and threshold is set to ½ the size of CongWin

The value of CongWin = 1 MSS = 1500 bytes

The value of threshold = ½ CongWin before timeout

From the CongWin calculated in part b. , Threshold = ½ \*10500 bytes = 5250 bytes