Exercises – 2 – Chapter 4

1. How long does it take to send a message of 1.5 x 10^6 bytes over a link with a transmission rate of 1 Mbps? Assuming that the data packets are 1500B, the ACK size is 50B, and propagation delay is 10 ms. It is not necessary to consider the bytes of the protocol headers used at different levels in packets.
   a) If the flow control used is stop and wait.
   b) If the flow control used is of sliding window, with the maximum size of the 7 pack transmission window.

Solution:

transmission rate = 1 x 10^6 bps
propagation delay = 10 ms = 10 x 10^{-3} s
Number of packets to transmit= 1,5 x 10^6/1.500=1.500x 10^3/1.500=1.000 packets
ACK size = 50B = 50 x 8 = 400 bits
packet size = 1.500 x 8 = 12.000 bits
packet_trans_delay = packet-size/trans_rate = 12.000/ 1 x 10^6 = 12 x 10^{-3} s
ACK_trans_delay = ACK-size/trans_rate = 4.000/ 1 x 10^6 = 0,4 x 10^{-3} s

RTT = the transmission time to send the packet by the sender + the propagation time to propagate the packet from sender to receiver + the transmission time to send the ACK by the receiver + the propagation time to propagate the ACK from the receiver to the sender of the packet
RTT = (12 + 10 +0,4 + 10) x 10^{-3} seg, = 32,4 x 10^{-3} s

a) Total time stop and wait

When stop and wait flow control is applied, the sender sends a packet, and stop and wait until ACK arrives, so that packets are sent one after the other without transmissions overlapping. Thus, the total time to transmit the entire message will take 1000 RTTs.
Total_time= 1000 x 32,4x 10^{-3} = 32,4 s

b) Total time – sliding window

RTT = 32,4 x 10^{-3} seg. and the time to transmit a packet (packet_trans_delay) is 12 x 10^{-3} s.
As RTT/ packet_trans_delay = 32,4 x 10^{-3} s/12 x 10^{-3} s = 2,7
Thus before finishing the 3rd packet transmission, the ACK of the 1st packet will arrive. Therefore, we can conclude that a sliding window of 3 packet size would allow the source to fill the pipe, then, the arrival of acknowledgements would maintain and adjust a continuous flow of data.
Thus the total time to transmit the entire message will be:

the number of packets * time to transmit a packet + the propagation time to propagate the packet from sender to receiver + the transmission time to send the ACK by the receiver + the propagation time to propagate the ACK from the receiver to the sender of the packet

$$Total\_time = 1000 \times 12 \times 10^{-3} + 10 \times 10^{-3} + 0{,}4 \times 10^{-3} + 10 \times 10^{-3} = 12{,}0204 \text{ seconds}$$

2. The following table shows the evolution of the transmission window of a TCP connection. Complete it with the corresponding values and identify in which moments each of the congestion control mechanisms are acting. Unless the evolution of twnd can't be explained by another way, rwnd remains constant.

RTT	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
V_{trans}	2	4	8	16	16	16	8	9	10	11	12	13	1	2	
V_{cong}	2														
Umbral															

Solution:

RTT	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
V_{trans}	2	4	8	16	16	16	8	9	10	11	12	13	1	2	4
V_{cong}	2	4	8	16	17	18	8	9	10	11	12	13	1	2	4
Umbral	16	16	16	16	16	16	8	8	8	8	8	8	6,5	6,5	6,5

Slow Start RTT's 1 to 4, and from 13 to 15
Congestion Avoidance from RTT 5 to 12
3 duplicated ACK's received at RTT 6
Retransmission timer timeout at RTT 12