AON Homework - 3

Question 1.

RTT = 2 * (distance / propagation velocity)
= 2 * (4500 km / 3*10^8 m/s)
= 0.03 seconds

Window size = (bandwidth * RTT) / packet size
= (1 Gbps * 0.03 s) / 1500 bits
= 20,000 packets

So, to achieve at least 98% utilization, we need a window size of 19,600 packets.
Throughput = (1 - P) * (bandwidth * window size) / packet size
Throughput = (1 - 0.1) * (1 Gbps * 20000) / 1500 bits
= 96 Gbps

Throughput would be reduced to 96% of its original value if 10% of frames were received in error.

Question 2.

Transmission Time = Packet Size / Bit rate = 1 kilobit / 100 kilobits / sec = 0.01 sec
RTT of Link A = 2 * 20msec + 0.01 sec = 40.01msec.

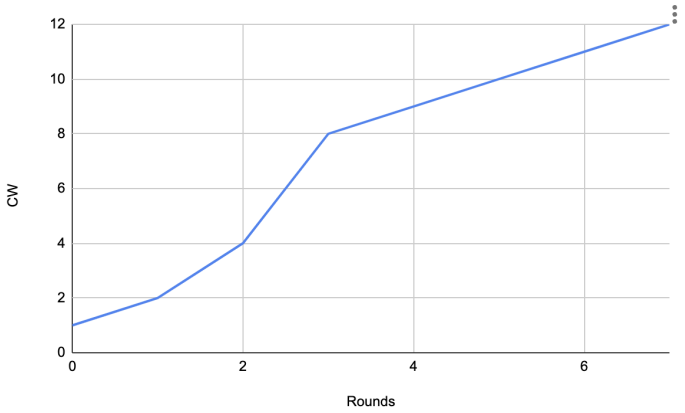
Maximum achievable throughput of Link A:
Throughput = Window Size / RTT = 3 / 0.04001 sec = 74.99 packets/sec

Maximum achievable throughput of the system:
Throughput = Throughput of Link A / (1 + (Propagation Time of Link B / RTT))
Throughput = 74.99 / (1 + (5msec / 40.01msec)) = 65.49 packets/sec

Question 3.

A.
All the packets are received without any problems and the acknowledgements are also received correctly. This indicates that there is no network congestion or packet loss, so TCP can continue to increase the congestion window (CW) according to the slow start

algorithm. During each round of transmission, the CW is doubled until it reaches the ssthresh value. Once it reaches that value, TCP enters into congestion avoidance mode, and the CW increases linearly. The CW at each round of transmission can be represented in a graph. During the slow start phase, the graph will show a steep increase that follows a logarithmic pattern. After reaching the ssthresh value, the growth of the graph will follow a straight line, indicating linear growth during the congestion avoidance phase.



B.

There is a timeout after six more rounds of transmitting packets, but the subsequent packets were received correctly along with their acknowledgments. This means that there might have been a loss of packets or too much traffic on the network. As a result, TCP goes into the congestion control phase, where the congestion window size and slow start threshold are reduced. We can graph the congestion window size at each round, and it will show a slow and steady increase during the slow start phase, followed by a sudden drop to the reduced slow start threshold value when a timeout occurs. After this, the congestion window enters a linear increase phase until the next timeout occurs, and the process repeats. Due to the repeating timeouts and retransmissions, the graph will show a sawtooth pattern.