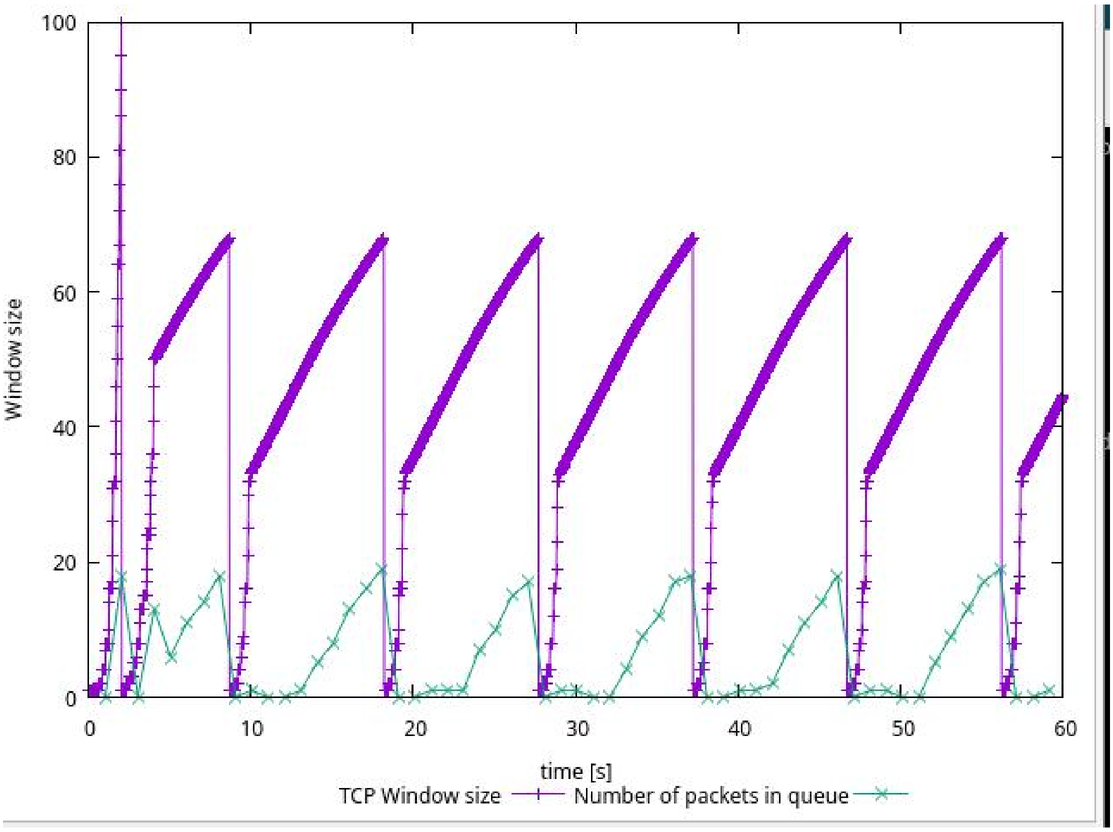
Exercise 1: Understanding TCP Congestion Control using ns-2 (4 Marks)



(a) In this case, what is the maximum size of the congestion window that the TCP flow reaches?

100 packets.

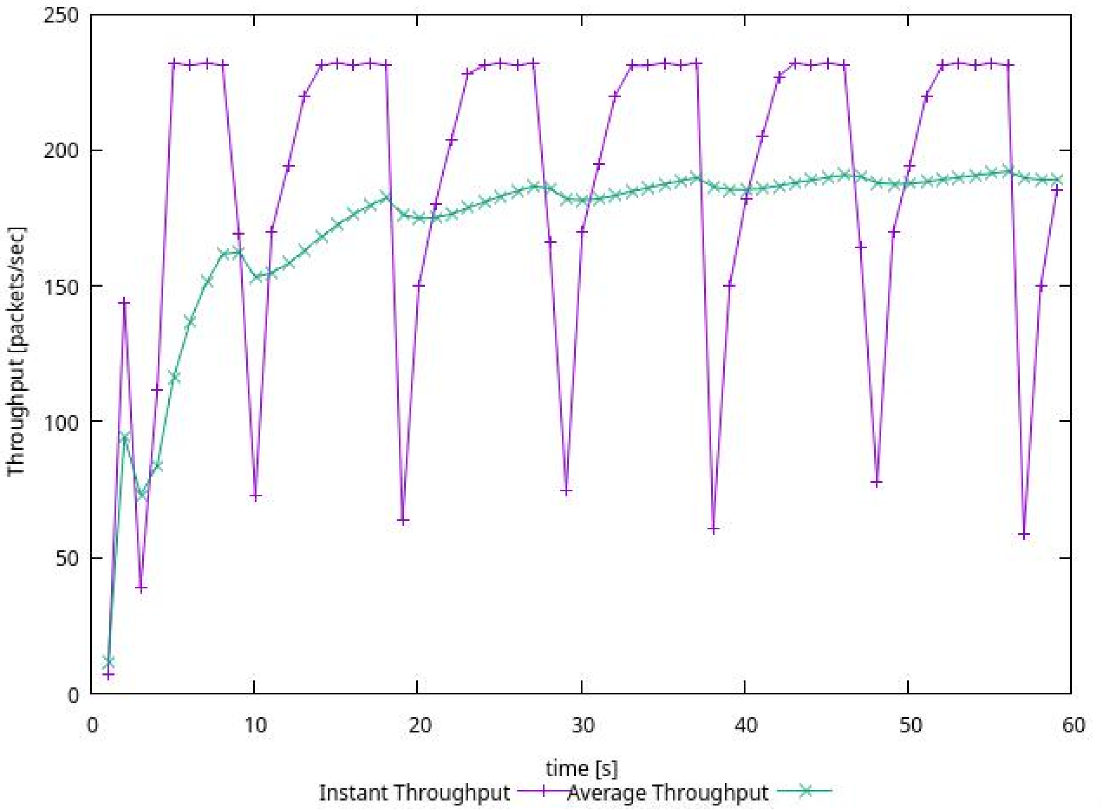
(b) What does the TCP flow do when the congestion window reaches this value? Why?

Congestion window will experience packet loss.

(c) What happens next?

The congestion window will drop to 1 packet.

Question 2: From the simulation script we used, we know that the packet's payload is 500 Bytes. Keep in mind that the size of the IP and TCP headers is 20 Bytes each. Neglect any other headers. What is the average throughput of TCP in this case? (both in number of packets per second and bps)

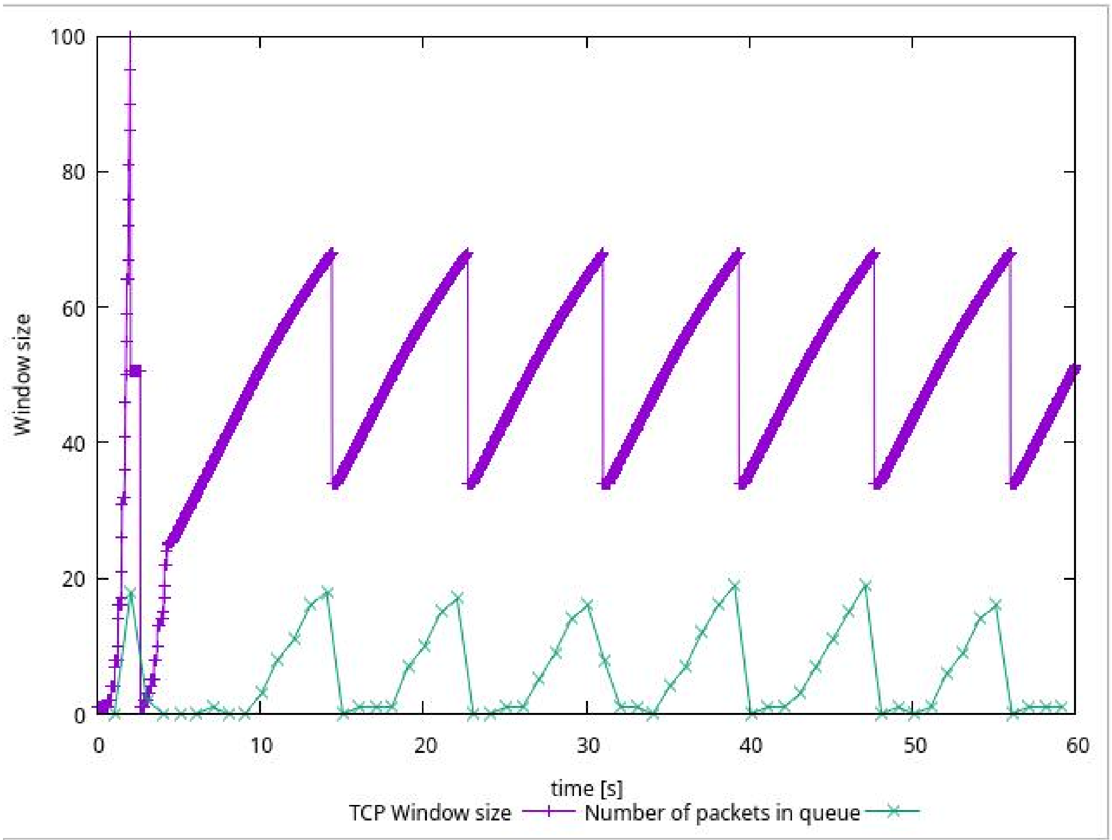


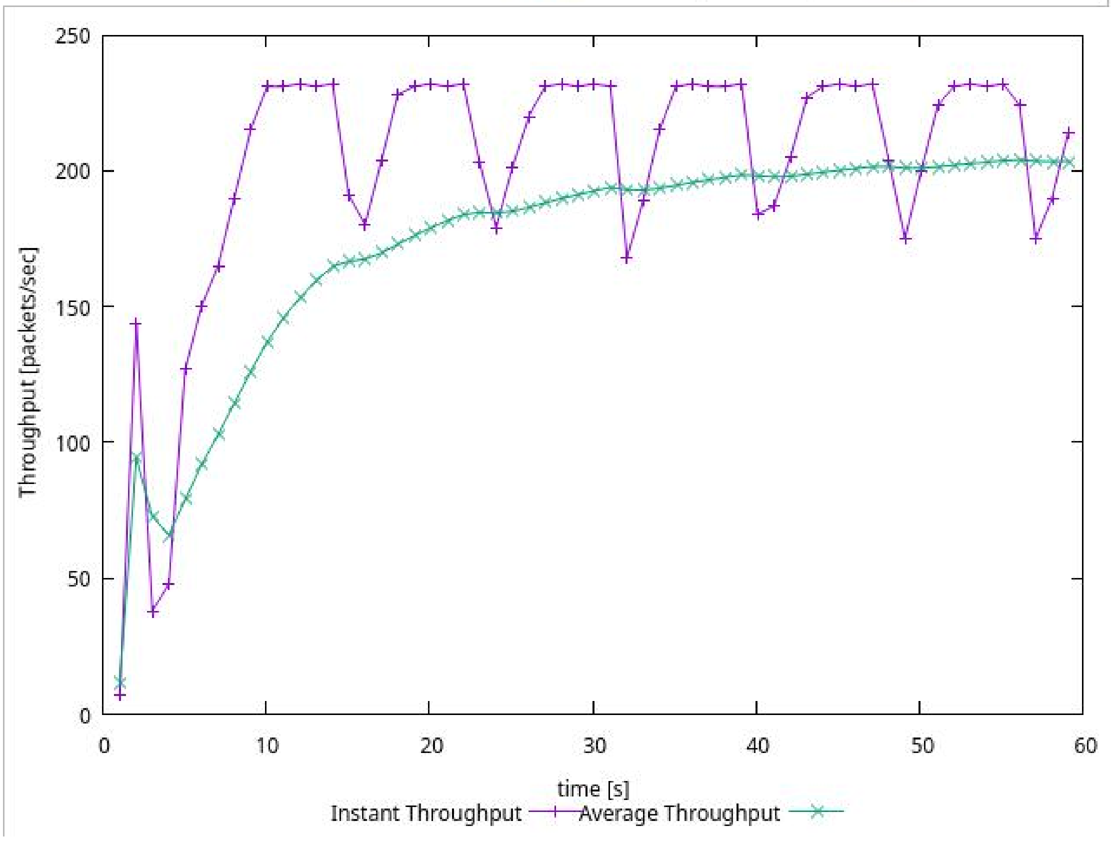
Let average throughput be around 185 packets/sec

Throughput of Packet = data / transmission time = packet size * throughput packets/ sec = 500 * 185
= 92500 bytes/sec = 740000 bits / sec

Throughput of Packet including IP and TCP = (500 + 20 + 20)*185
= 99900 bytes/sec = 799200 bits / sec

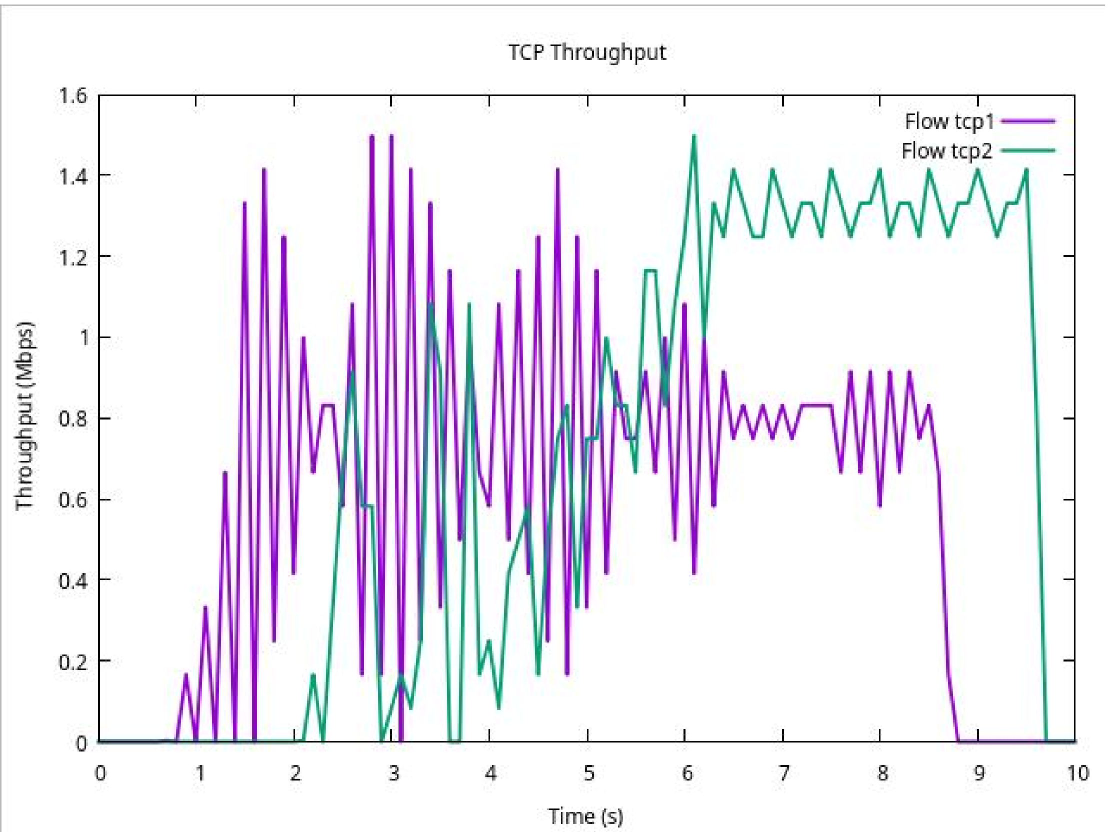
Question 3: Repeat the steps outlined in Questions 1 and 2 (NOT Question 3) but for TCP Reno. Compare the graphs for the two implementations and explain the differences. (Hint: compare the number of times the congestion window returns to zero in each case). How does the average throughput differ in both implementations?





Tahoe will drops to 1 packet after the packet loss.
Reno will drops to half of the max window size after the packet loss.
Tahoe's average throughput is around 185.
Reno's average throughput is around 200.

Exercise 2: Setting up NS2 simulation for measuring TCP throughput (3.5 marks)



Question 1: Why is the throughput achieved by flow tcp2 higher than tcp1 between 6 sec to 8 sec?
Flow tcp2 has less RTT than RTT for tcp1 thus TCP2 gets higher share of the bandwidth on link n2-n4 and eventually higher throughput is recorded at n5.

Question 2: Why does the throughput for flow tcp1 fluctuate between a time span of 0.5 sec to 2 sec?
Flow tcp1 is probing for available bandwidth using slow start mechanism.

Exercise 3: Understanding the Impact of Network Dynamics on Routing (2.5 marks)

Question 1: Which nodes communicate with which other nodes? Which route do the packets follow? Does it change over time?

Node 0 communicates with Node 5.
0->1->4->5.
The route doesn't change over time.

Question 2: What happens at time 1.0 and time 1.2? Does the route between the communicating nodes change as a result?
Time 1.0, link 1-4 is down, route doesn't change. 0 can't reach node 5.

Time 1.2, link 1-4 is up, packets waiting at node 1 to node 4 to node 5.

Question 3: Did you observe additional traffic compared to Step 3 above? How does the network react to the changes that take place at time 1.0 and time 1.2 now?
Yes.
When nodes 1-4 is down, a different route is used.
When nodes 1-4 is up, it goes back to the original route.

Question 4: How does this change affect the routing? Explain why.
It changes the cost of link 1-4 to cost=3. the flow will use
0->1->2->3->5 when it is lower than the cost of link 0->1->4->5.

Question 5: Describe what happens and deduce the effect of the line you just uncommented.
The routes now have equal cost to the dest.