Assignment - 3

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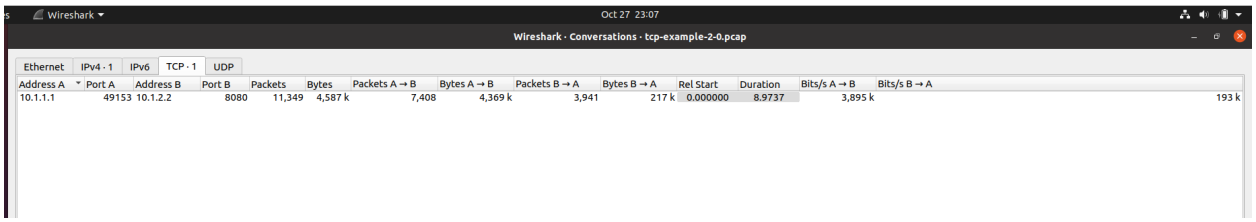
Question 1

a)
We have a maximum expected throughput of 5Mbps because it is the bottleneck bandwidth for the given default parameters.

b)
BDP(Bandwidth delay product) = Bandwidth*(Round Trip Time)
BDP=5Mbps*(d1+d2)*2=5+(10+15)*2=250000bits

For Packets we have
BDP=250000/(1460*8)= 21.4 packets

c)

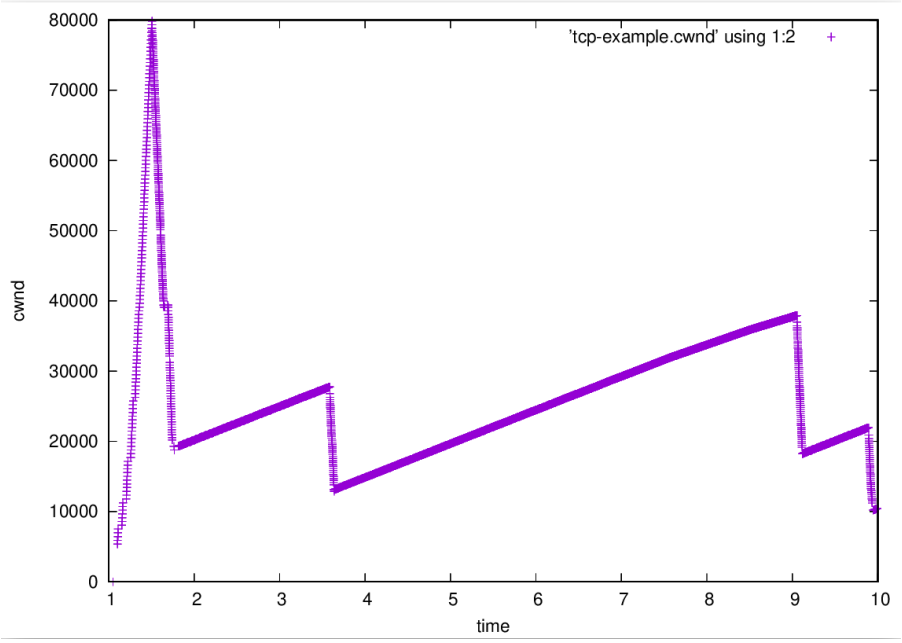


Average throughput = Total payload / duration = 4587k*8/8.9737 bits/s = 4089.28k bits/s

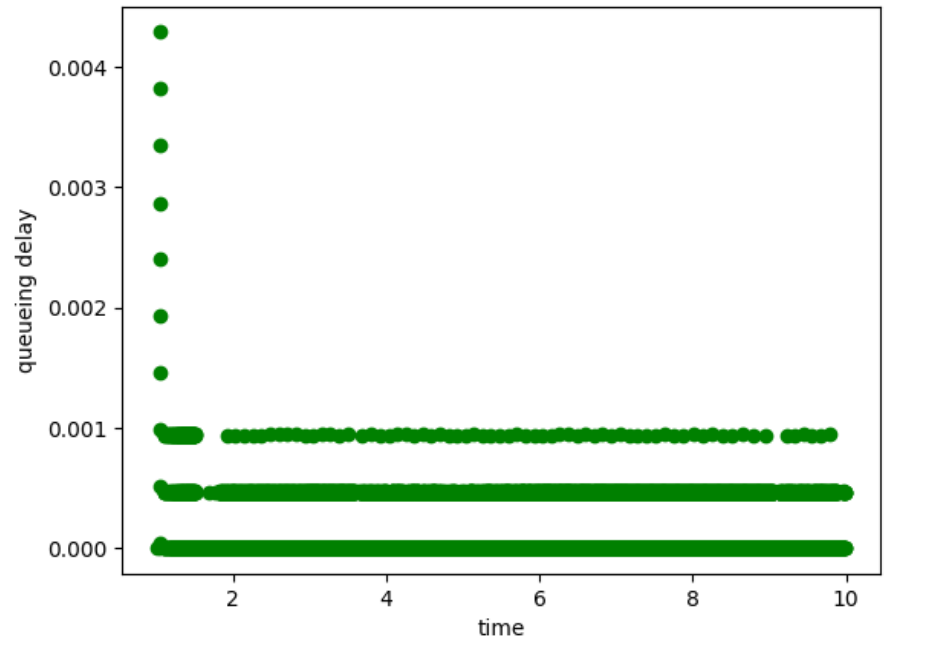
d)

No, the throughput is not equal to the maximum expected throughput because we have a channel delay in simulation and packet loss at node n1.

e)


'tcp-example.cwnd' using 1:2
cwnd
time
80000
70000
60000
50000
40000
30000
20000
10000
0
1
2
3
4
5
6
7
8
9
10

f)

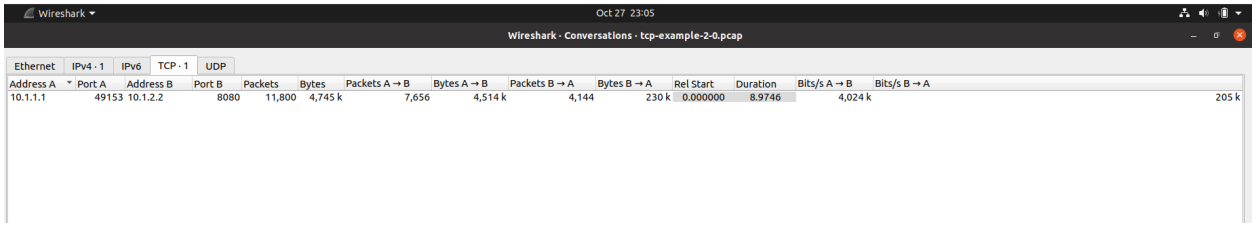

queueing delay
time
0.004
0.003
0.002
0.001
0.000
2
4
6
8
10

g)

Yes, the graphs are related,
As we observe at the start, we have a high transmission rate, hence we see an increase in the congestion window size, which indeed increases the queueing delay proportionally.
Now once we a drop in packets, we can say that the TCP is going into congestion avoidance, which in turn reduces the queuing delay and it becomes constant for the remaining period.

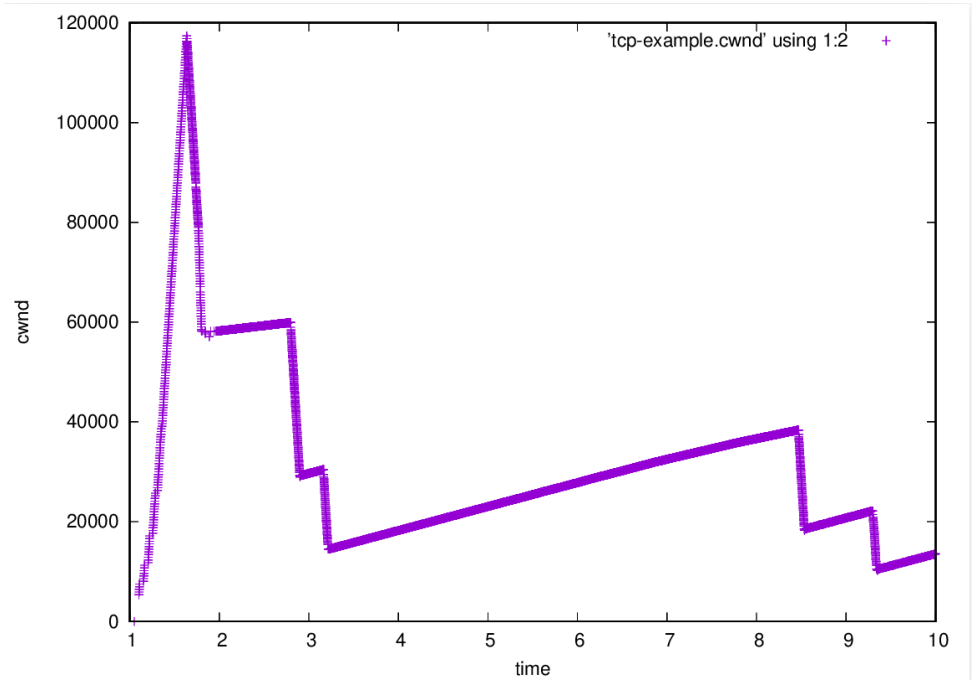
Question 2

a)

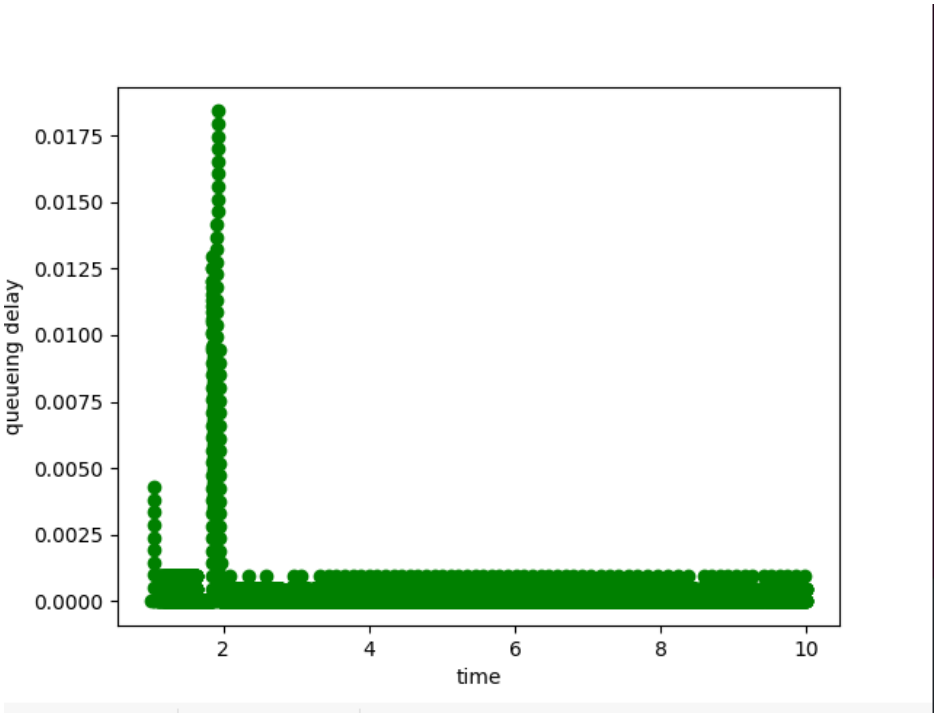


Average throughput = Total payload / duration = 4745k * 8/8.9746 bits/s. = 4229.71 bits/s

b



c)

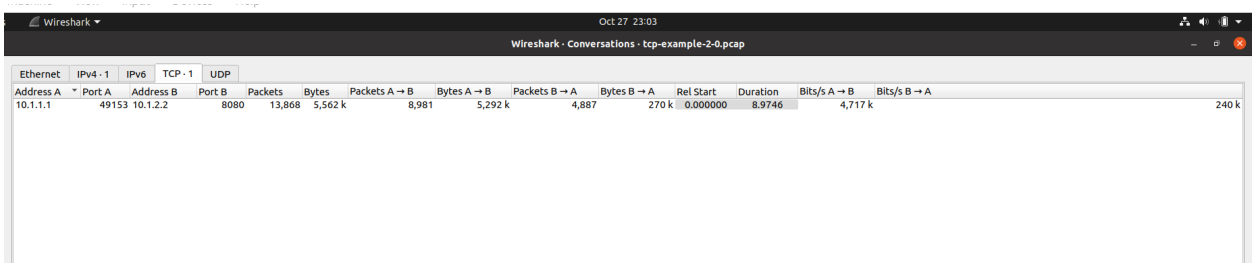


d)

In the plot of the second question, we observe a higher congestion window size due to the increase of the queue size meaning that the packets will wait longer before being sent, which results in greater congestion and higher queueing delay, and the same is observed in the plots.

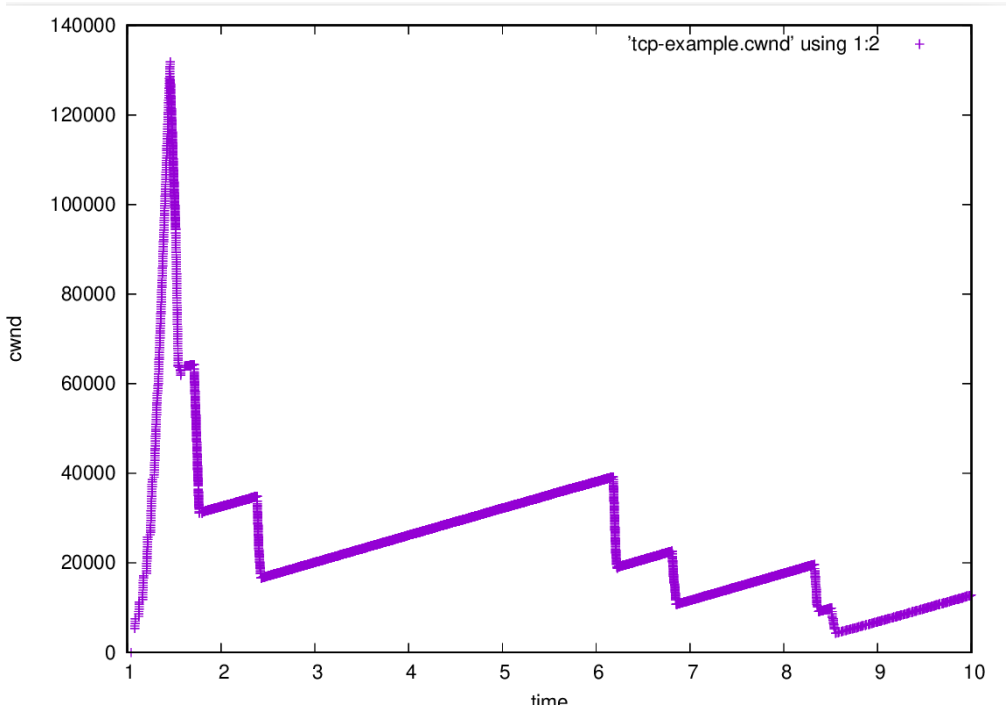
Question 3)

a)

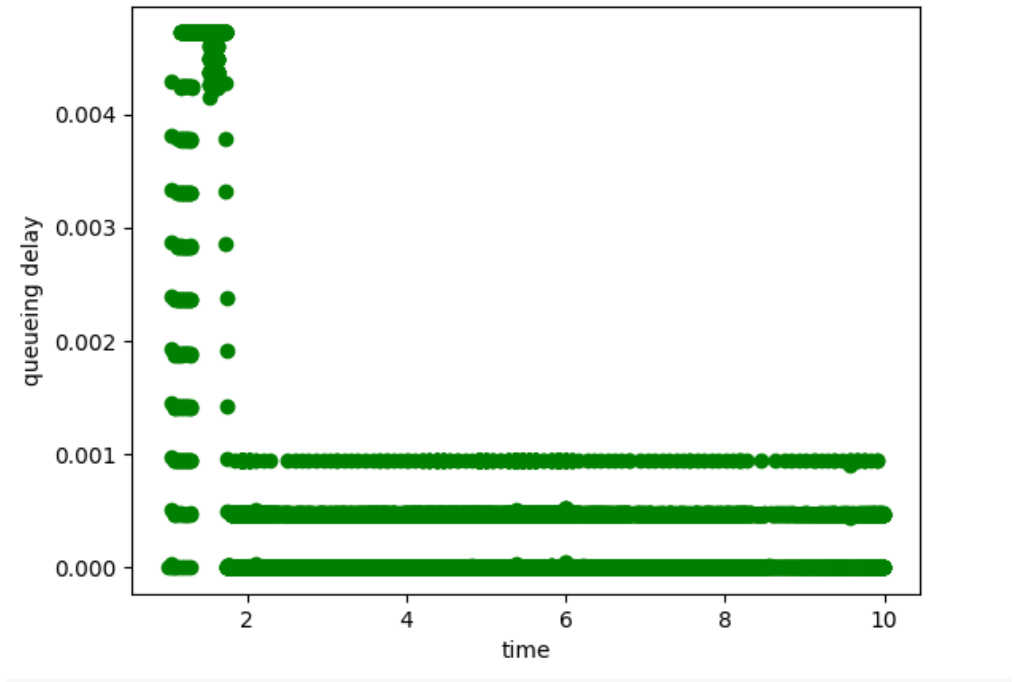


Average throughput = Total payload / duration = 5562k * 8/8.9746 bits/s = 4957.99k bits/s

b)


'tcp-example.cwnd' using 1:2
cwnd
time
140000
120000
100000
80000
60000
40000
20000
0
1
2
3
4
5
6
7
8
9
10

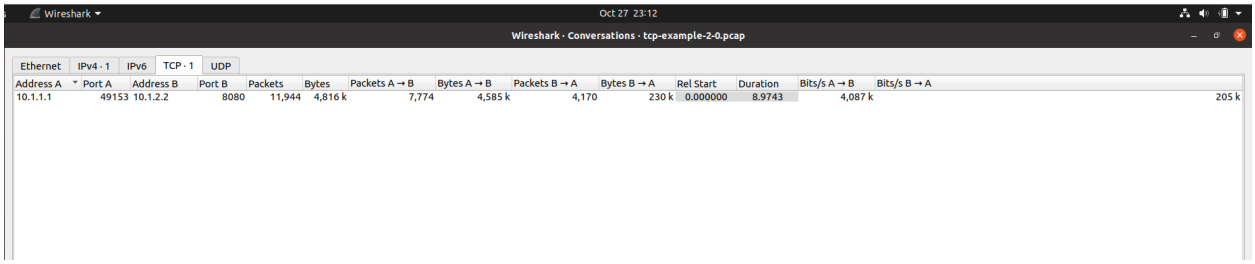
c)


queueing delay
time
0.004
0.003
0.002
0.001
0.000
2
4
6
8
10

d)
Here we have the bandwidth of both the link as the same, in question 1, smaller bandwidth served as a bottleneck, causing queueing.
In question 3, we have the same bandwidth hence faster transmission, which we can see from the increased size of the congestion window in the plot.

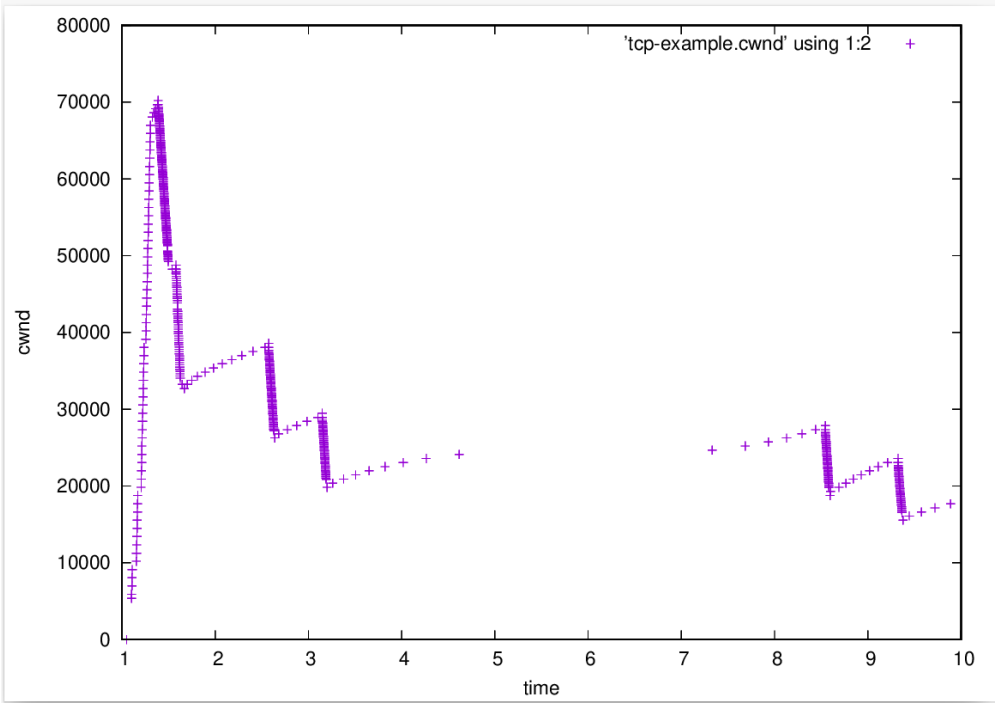
Question 4)

a)



Average throughput = Total payload / duration = = 4816k * 8/8.9743 bits/s = 4293.15k bits/s

b)



c)
We got the following things -

- We have better congestion avoidance, we don’t see the steep decline as we saw in question 1.
- We have a fast recovery, as in question 1 after declining, we see it increasing slowly, but here we can see it increasing as soon as it decreases.
- We observe that the transmission rate increases more in comparison to question 1.