ASSIGNMENT-3

Sol 1:

a)

Bandwidth : N0-N1 = 10Mbps

Bandwidth: N1 - N2 = 7Mbps

Maximum Throughput (Theoretical) = 7Mbps

(min{10Mbps, 7Mbps}, because on a path with multiple bandwidth we take bottleneck bandwidth. Therefore, maximum throughput is 7Mbps)

b)

BDP for link N0-N1

Total packets transmitted per second = 10Mbps / 1460 bytes = $(10*10^6)/1460*8$

= 856.1643 ~ 856 packets

RTT b/w N0 and N1 = 10ms * 2 = 20ms = 0.02s

BDP = packets per sec * RTT = 856.1643*0.02 = 17.123 packets

BDP for link N1-N2

Total packets transmitted per second = 7Mbps/1460 bytes = $(7*10^6)/1460*8$

= 599.315 packets ~ 599 packets

RTT b/w N1 and N2 = 100ms*2 = 200ms

BDP = packets per sec * RTT = 599.315*0.2s = 119.863 packets ~ 120 packets

BDP for link N0-N2

Total packets transmitted per second = 7Mbps/1460 bytes = $(7*10^6)/(1460*8)$

= 599.315 packets ~ 599 packets

// Here we used bottleneck bandwidth

RTT b/w N0 and N2 = 110ms*2 = 220ms (total delay = 10ms+100ms)

BDP = = packets per sec * RTT = 599.315*0.220 = 131.8493 packets ~ 132 packets

c)

Average computed throughput of the TCP transfer is 3261k bits per second which is basically 3.261Mbps

(Number of bits transferred / total time taken = 3623994*8/8.889 = 3261Kbps)

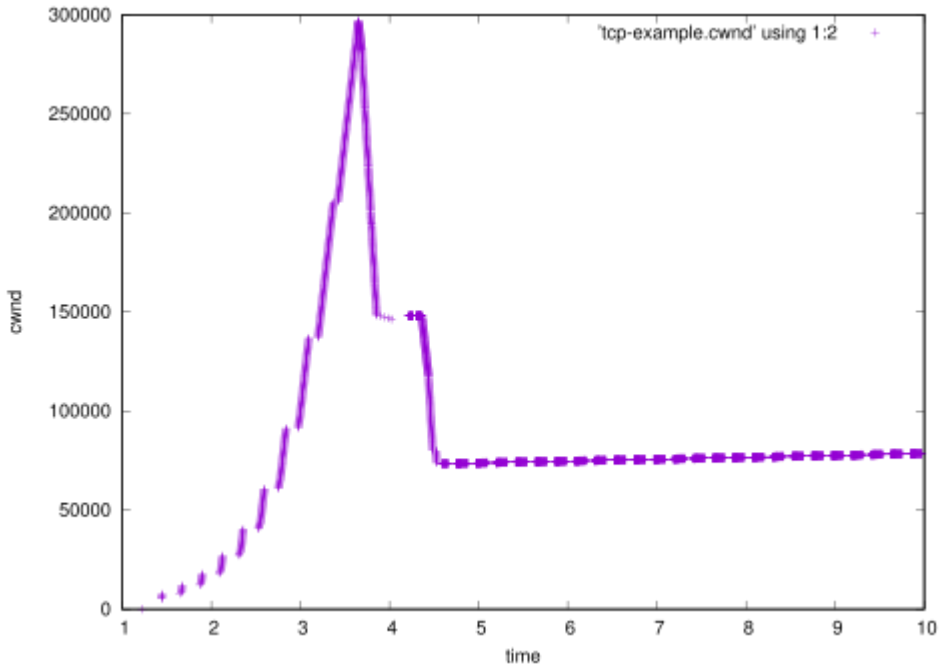
Statistics

Measurement	Captured	Displayed	Marked
Packets	9239	9239 (100.0%)	—
Time span, s	8.889	8.889	—
Average pps	1039.3	1039.3	—
Average packet size, B	392	392	—
Bytes	3623994	3623994 (100.0%)	0
Average bytes/s	407 k	407 k	—
Average bits/s	3,261 k	3,261 k	—

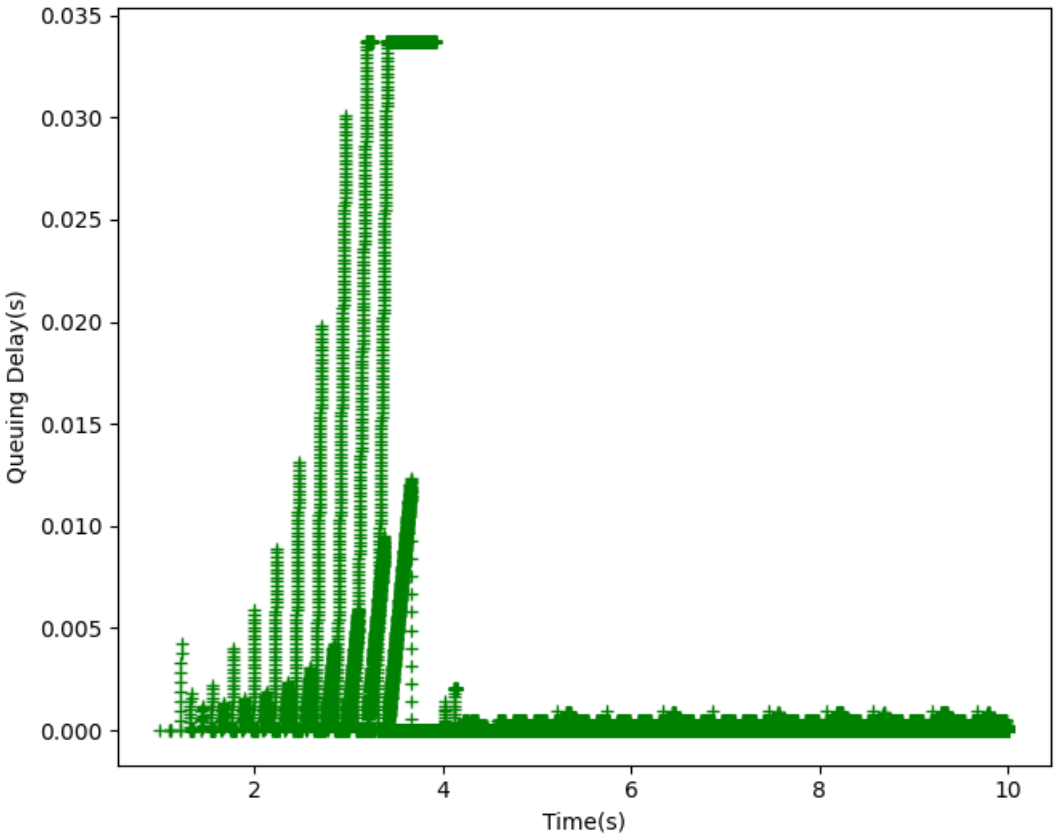
d)

Achieved throughput is not equal to the maximum expected value of throughput it is lower than the theoretical value because in theoretical we usually not consider delays, but in practical application or simulations we have different types of delays like queuing delays, transmission delays, and much more.

e)



f)



g)

Yes, both plots are related. As we know as the packets in the queue increases as the size of the congestion window increases. Similarly, we can see in above graphs as the congestion window increases queuing delay also increases.

Sol2 :

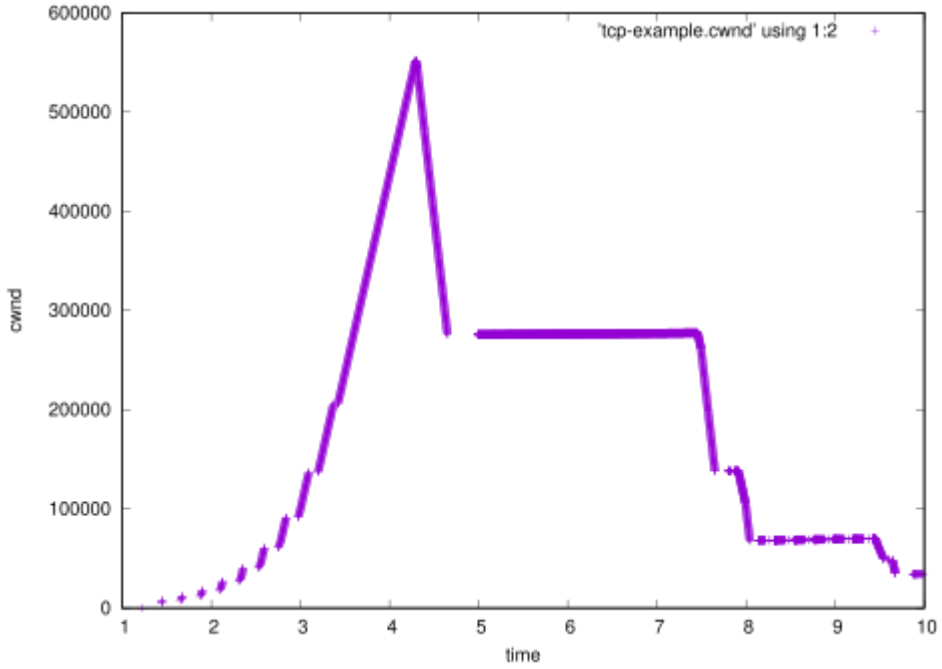
a)

Average computed throughput of TCP transfer is 4835Kbps i.e., 4.835Mbps.

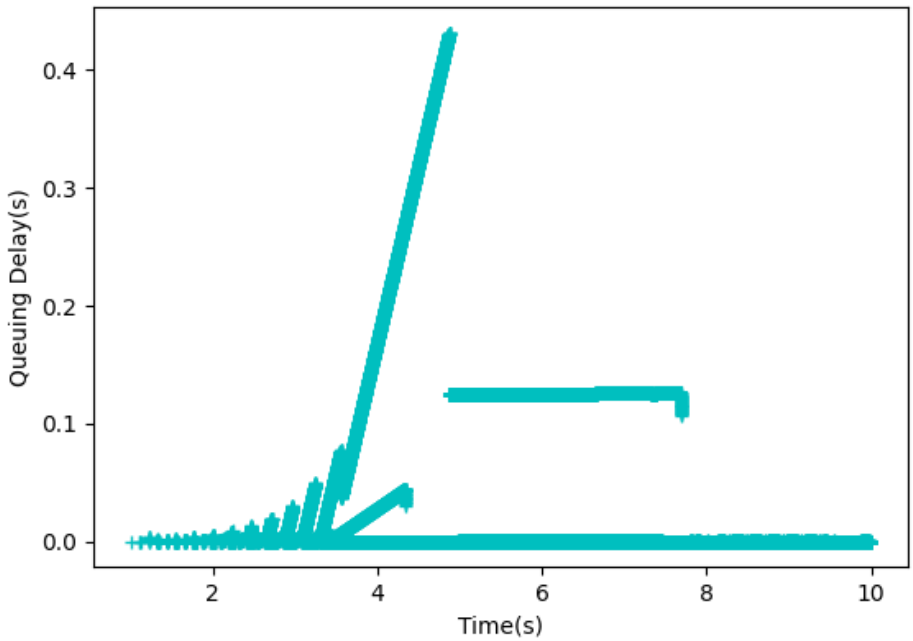
Statistics

Measurement	Captured	Displayed	Marked
Packets	13885	13885 (100.0%)	—
Time span, s	8.889	8.889	—
Average pps	1562.1	1562.1	—
Average packet size, B	387	387	—
Bytes	5372342	5372342 (100.0%)	0
Average bytes/s	604 k	604 k	—
Average bits/s	4,835 k	4,835 k	—

b)



c)



d)

From both of the graphs we can observe that in the first scenario when number of packets are 50 we have roughly 300000bytes congestion window size and in second case when number of packets are 1000, congestion window size

increased and becomes approximately 570000 bytes. This is because we have increased queuing size hence, packet storing capacity increased and during high data flow congestion window (which is increased now , in 2nd question) increases thus increasing queuing time i.e., now packets have to wait for a longer time for transmission.

Sol3 :

a)

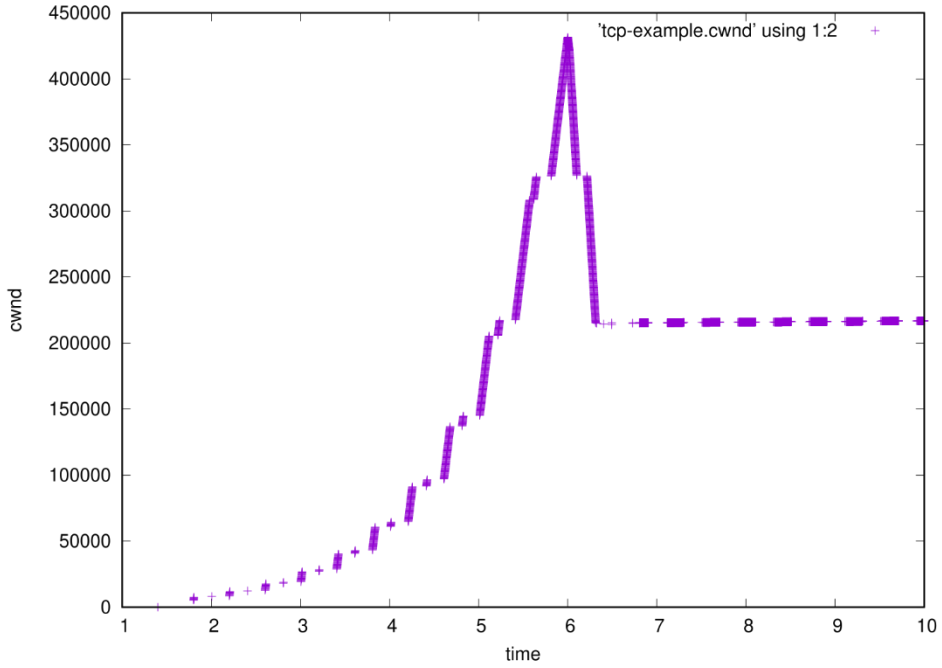
Average computed throughput of the TCP transfer is 3450Kbps i.e., 3.450Mbps

(Number of bits transferred / total time taken = 3758974*8 / 8.714 = 3450Kbps)

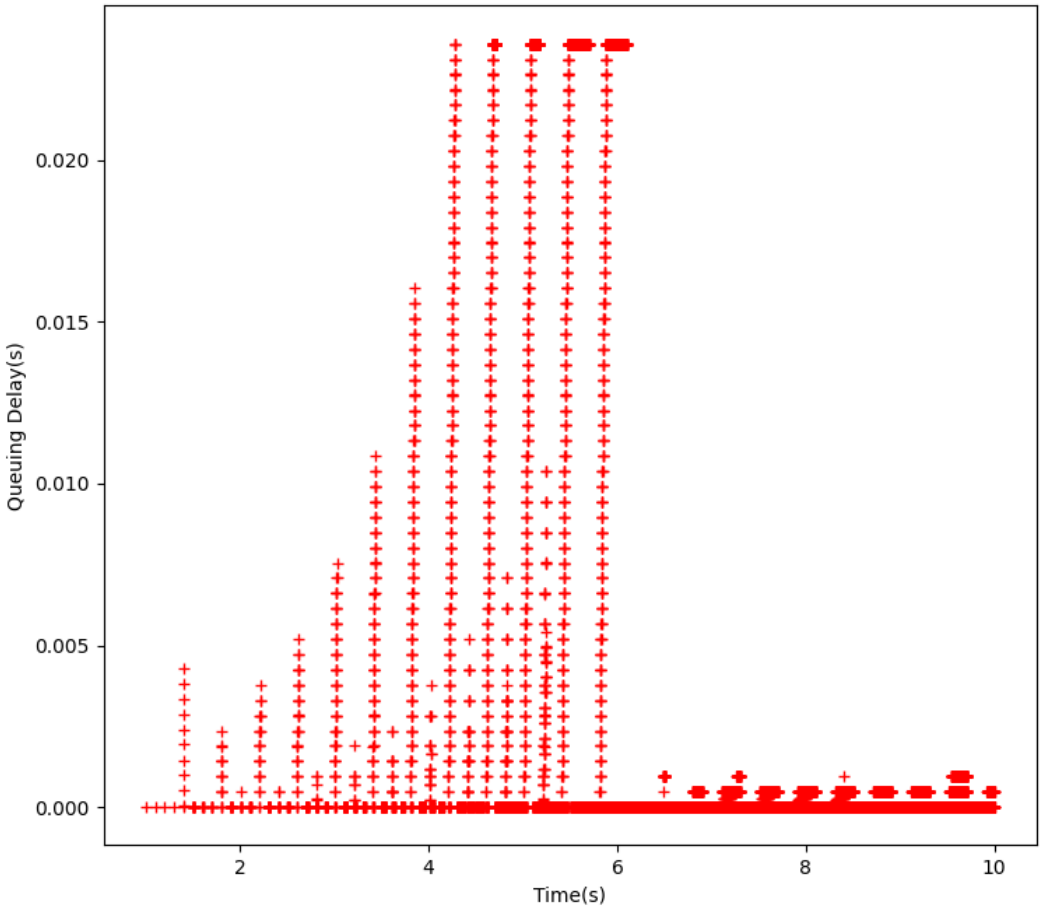
Statistics

Measurement	Captured	Displayed	Marked
Packets	9549	9549 (100.0%)	—
Time span, s	8.714	8.714	—
Average pps	1095.8	1095.8	—
Average packet size, B	394	394	—
Bytes	3758974	3758974 (100.0%)	0
Average bytes/s	431 k	431 k	—
Average bits/s	3,450 k	3,450 k	—

b)



c)



d)

In this part bandwidth of both links are equal i.e., 10Mbps. Thus, incoming and outgoing rate of packets are same (at N1). Hence, from this we can easily deduce that there is very less queuing happening at N1 which implies queuing delays of packets are also low. Which on the other hand in Question is quite higher as incoming rate is higher as compared to outgoing rate at N1 node. Hence, with time queue will keep getting increase with time and queuing delay of packets will increase.