Ans:CN Assignment 3
Q.1. Run the simulation with the default parameters (provided in the table) and answer the following questions.

a. What is the maximum expected value (theoretical) of throughput (in Mbps)? Why?

Ans: The maximum expected value of throughput is determined by the bottleneck link between n0-n1 and n1-n2. In this case, it is the link between n1-n2. Hence, the maximum expected throughput is 7Mbps.

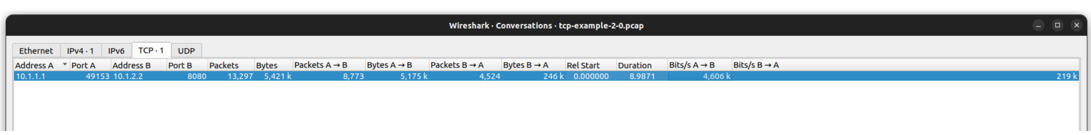
b. How much is Bandwidth-Delay-Product (BDP)? Express your answer in terms of the number of packets. [1]
Ans: BDP = Bandwidth Delay Product

Throughput = $7*10^6$ bits per second
RTT = $2*(100+10)*10^{-3}$ sec = $2*110*10^{-3}$ sec = $220*10^{-3}$ sec
Packet size = 1460 Bytes = 1460 * 8 bits

BDP = Throughput * RTT
= $7*10^6 * 220*10^{-3}$
= $7*220*10^3$ bits
= $1540*10^3$ bits

BDP (in terms of packet) = (1540*1000)/(1460*8)
= 131.849315068 packets

c. What is the average computed throughput of the TCP transfer? [2]
Ans:



Address A	Port A	Address B	Port B	Packets	Bytes	Packets A → B	Bytes A → B	Packets B → A	Bytes B → A	Rel Start	Duration	Bits/s A → B	Bits/s B → A
10.1.1.1	49153	10.1.2.2	8080	13,297	5,421 k	8,773	5,175 k	4,524	246 k	0.000000	8.9871	4,606 k	219 k

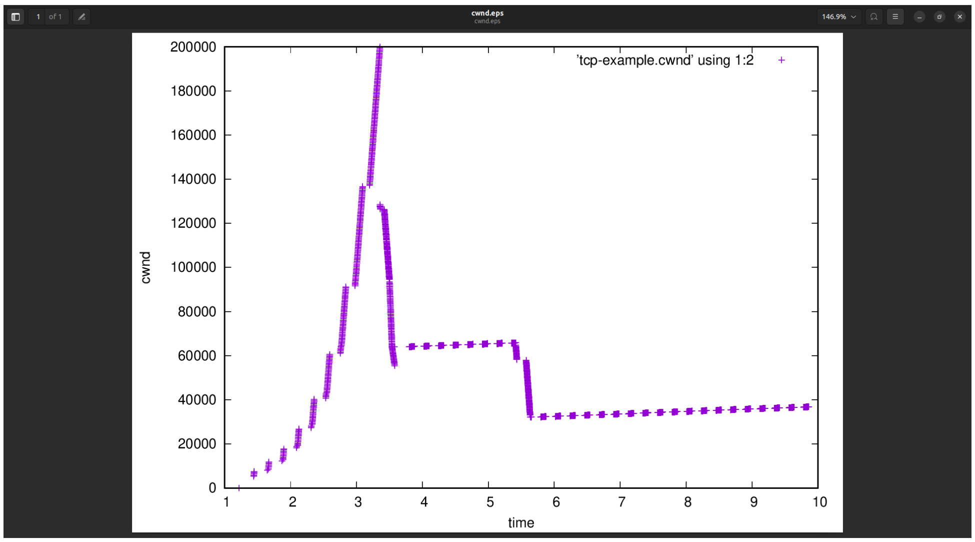
Average throughput by Wireshark is 4.606 Mbps. (Bits/s A → B)

d. Is the achieved throughput approximately equal to the maximum expected value? If it is not, explain the reason for the difference. [1+1]
Ans: No the average throughput achieved using wireshark and maximum expected value is different. There are many factors which may decrease the maximum throughput in the actual network:

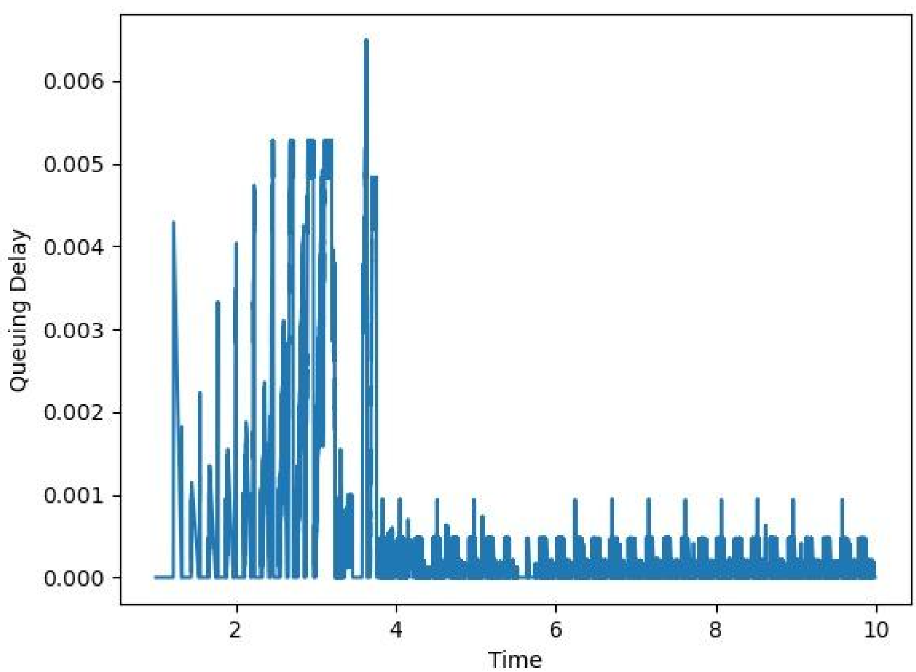
Queuing delays: When the rate of sending of data from n0 is greater than rate of sending of data at n1, then the packets will keep on piling up at n1 node. These packets will get queued at n1 and will contribute to some delays.

Processing delays: There are also processing delays to consider which occur due to the processing at each of the nodes individually but get missed in maximum expected throughput.
Packet loss rate: It is given in the question that packets will be generated with an error rate specified in the question, hence there will be some packet drops. These packets will then need to be retransmitted which will reduce the average throughput even further.

e. Plot Congestion Window (CWND) with time [1]
Ans:



f. Plot queueing delay with time [1]
Ans:

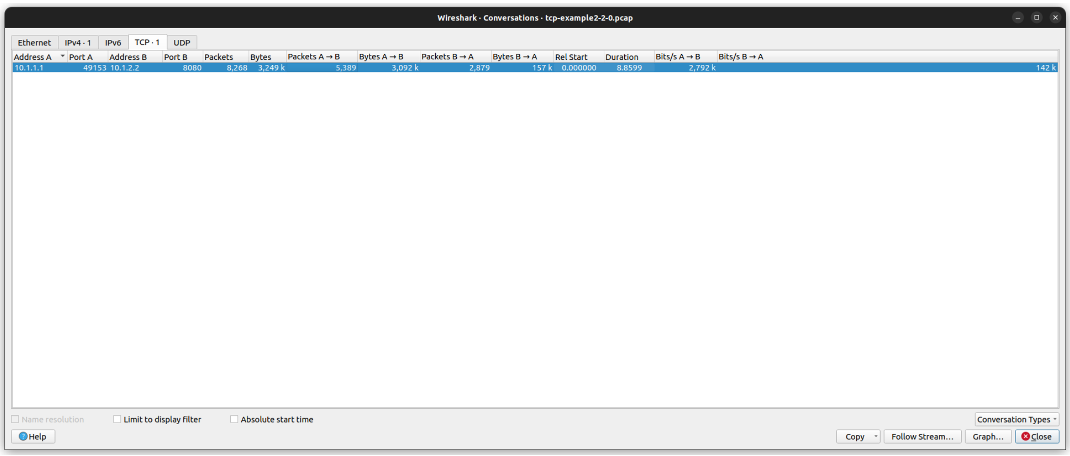


g. Are the plots in 1(e) and 1(f) related? [1]

Ans: Yes there is a relationship between graph 1(e) and 1(f). Both of the graphs show similar behavior ie, when one increases so does the other and one when one decreases so does the other. This is because as the congestion window increases, the congestion in the network also increases, and hence the queueing delay increases. We can also see the congestion window increasing exponentially during the first 3 seconds, which indicates the slow start phase, and then there must have been a packet drop due to which the system shifted to fast recovery phase and started linearly increasing the congestion window size. Then after 5 seconds, the same thing happens again.

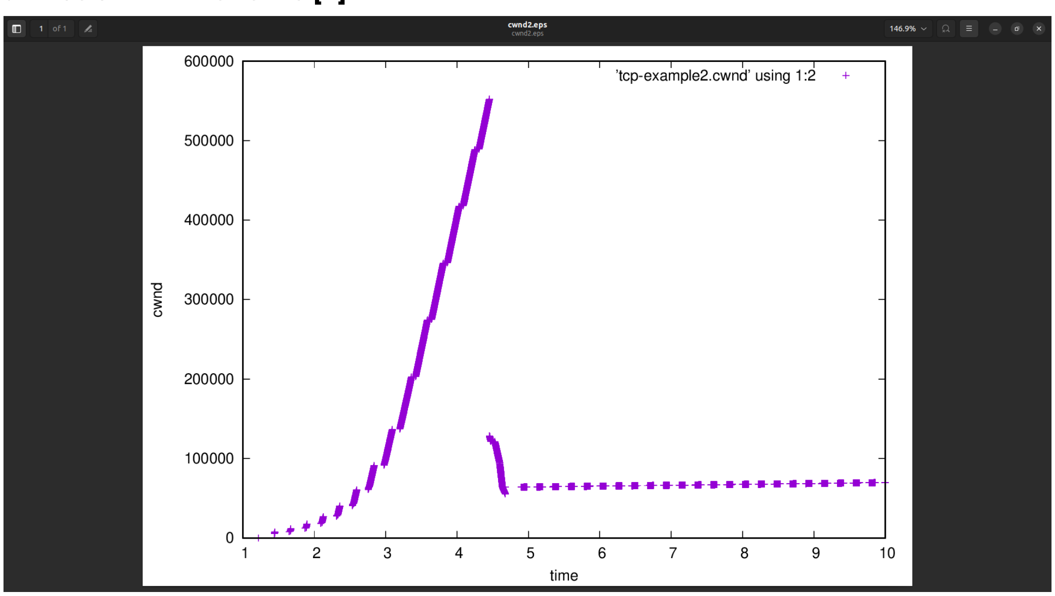
Q.2. Change queue size to 1000 (rest of the parameter values are same as default values)

a. What is the average computed throughput of the TCP transfer? [1]

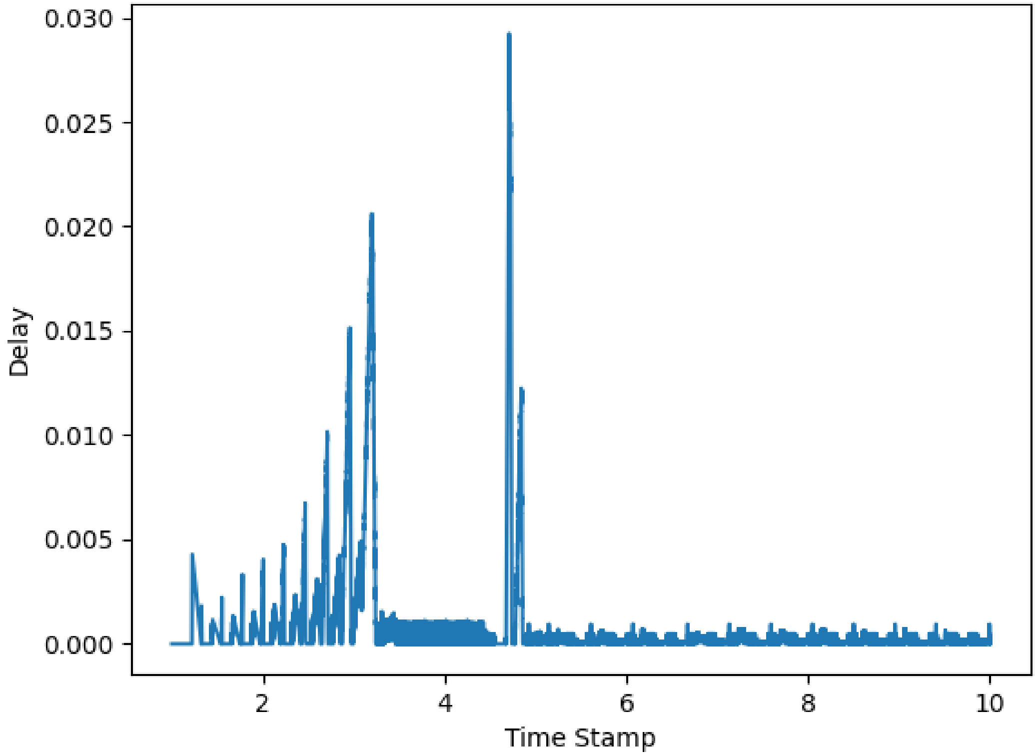


Average throughput by Wireshark is 2.792 Mbps. (Bits/s A → B)

b. Plot CWND with time [1]

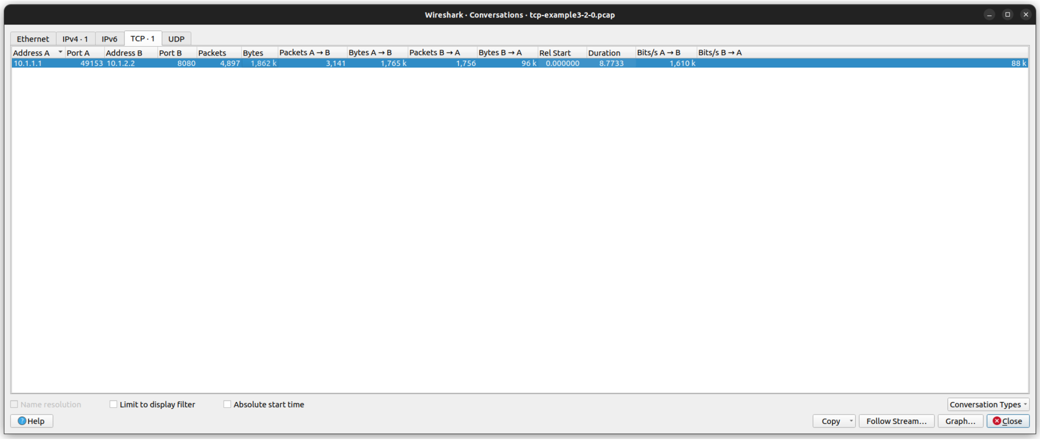


c. Plot queueing delay with time [1]



d. Compare CWND plots of Q.1. and Q.2., what insights did you gain? [1]
Ans: When we compare the congestion window graphs of Q1 and Q2, it can be noticed that the congestion window graph of Q1 has more fluctuations, spikes and congestion peaks as compared to Q1. We can also see that the peak in Q2 is a lot higher than the peak in Q1. This is due to the large helps to avoid congestion avoidance phase till much later. The sent packets will also have to wait longer and hence cause congestion. However, once the congestion avoidance phase starts, both tend to behave similarly.

Q.3. Change N1-N2 bandwidth to 10 Mbps and N1-N2 delay as 100ms (rest of the parameter values are same as default values)
a. What is the average computed throughput of the TCP transfer? [1]

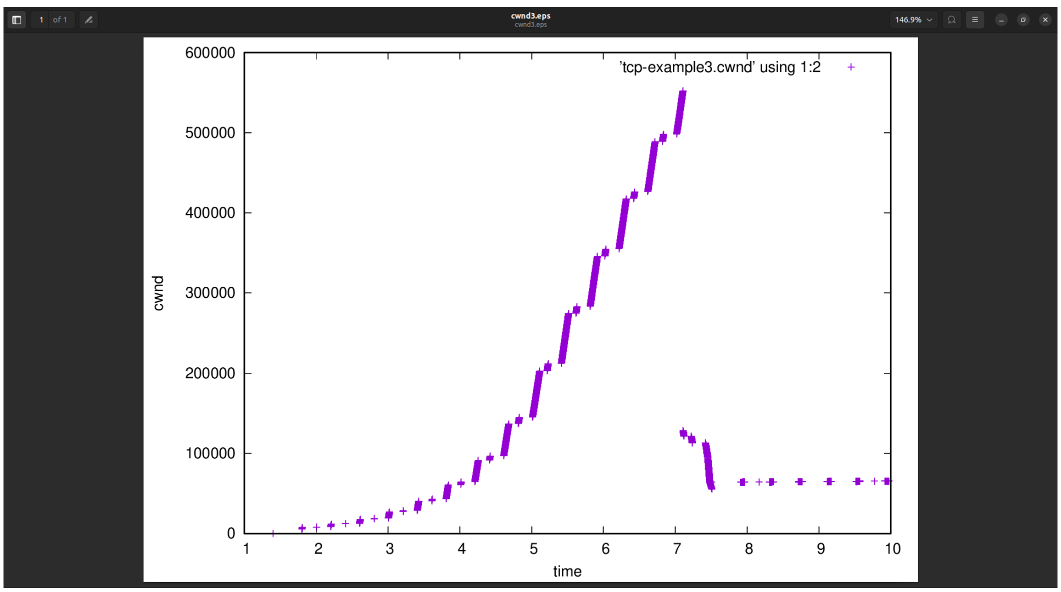


Wireshark · Conversations · tcp-example3-2-0.pcap

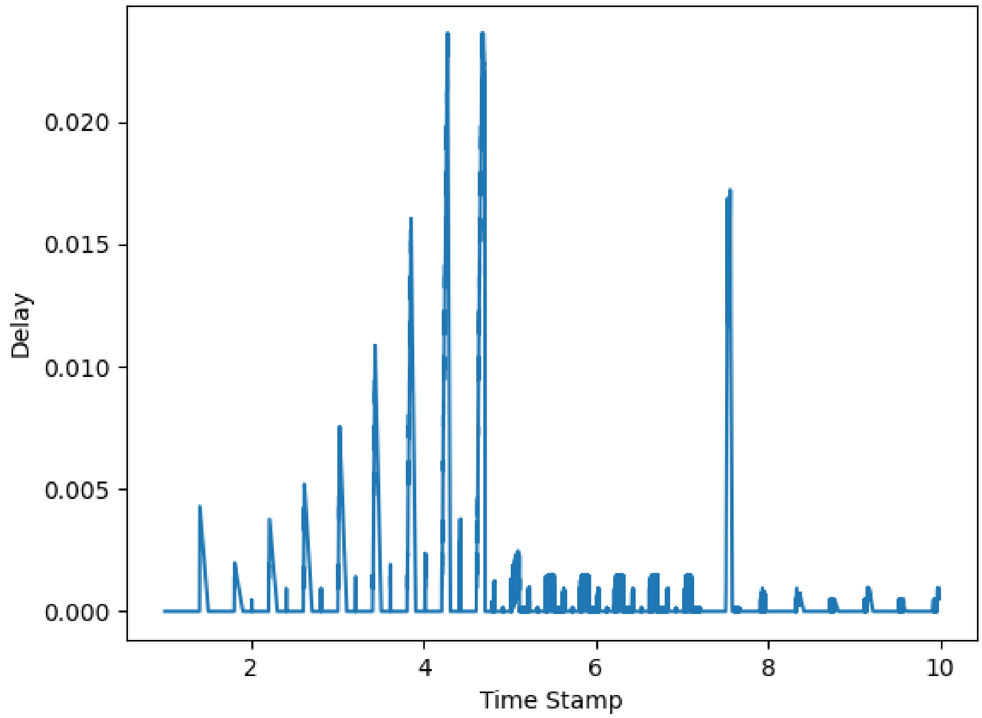
Address A	Port A	Address B	Port B	Packets	Bytes	Packets A → B	Bytes A → B	Packets B → A	Bytes B → A	Rel Start	Duration	Bits/s A → B	Bits/s B → A
10.1.1.1	49153	10.1.2.2	8080	4,897	1,862 k	3,141	1,765 k	1,756	96 k	0.000000	8.7733	1,610 k	88 k

Average throughput by Wireshark is 1.610 Mbps. (Bits/s A → B)

b. Plot CWND with time [1]



c. Plot queueing delay with time [1]



d. Compare queuing delay plots of Q.1. and Q.3., what insights did you gain?

Ans: When we compare the queueing delay graph of Q1 with Q3, we can see that the Q3 graph has a lot of peaks and the peak values are also greater than in Q1. This is because we have increased the bandwidth from 7 to 10 Mbps and also decreased the delay from 10 ms to 100 ms. This facilitates the transmission of packets in a smoother and faster manner and hence, we can achieve greater size of the congestion windows since now packets are being transmitted from n1 at a faster rate due to increased bandwidth.