CSE 232: Computer Network

REPORT

Assignment 3: Network simulation using ns3

Submitted By
Dolly Sidar
2019304
CSD

Question 1:

a. Maximum expected value (theoretical) of throughput (in Mbps) = 5mbps.
Because the bottleneck value is 5mbps between the two links and as we know, bottleneck link on the path constraints end-end throughput. Hence maximum throughput is 5mbps.

b. Formula for BDP
Bandwidth Delay Product = RTT(Round Trip Time)*Bandwidth

Total bandwidth = 5mbps
d1(b/w node0 and node1) =10ms , d2(b/w node1 and node2) = 15ms
Total Delay = d1+d2
= 25ms
RTT = 2*25 = 50ms
Bandwidth Delay Product = 5mbps * 50ms
= 250 kb
= 250000 bits
Application payload size = 1460 Bytes
= 1460 * 8 bits
Number of packets = Bandwidth/Application payload size
= 250000 / (1460 * 8) = 21.4packets

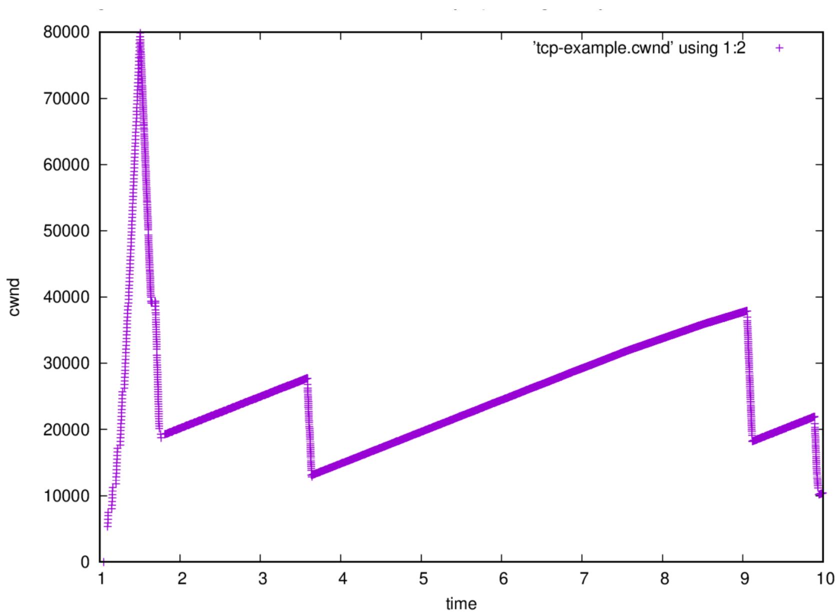
c. The average computed throughput of the TCP transfer comes out to be 3894kbits/s which is equal to 3.894mbps.

Ethernet | IPv4 · 1 | IPv6 | TCP · 1 | UDP

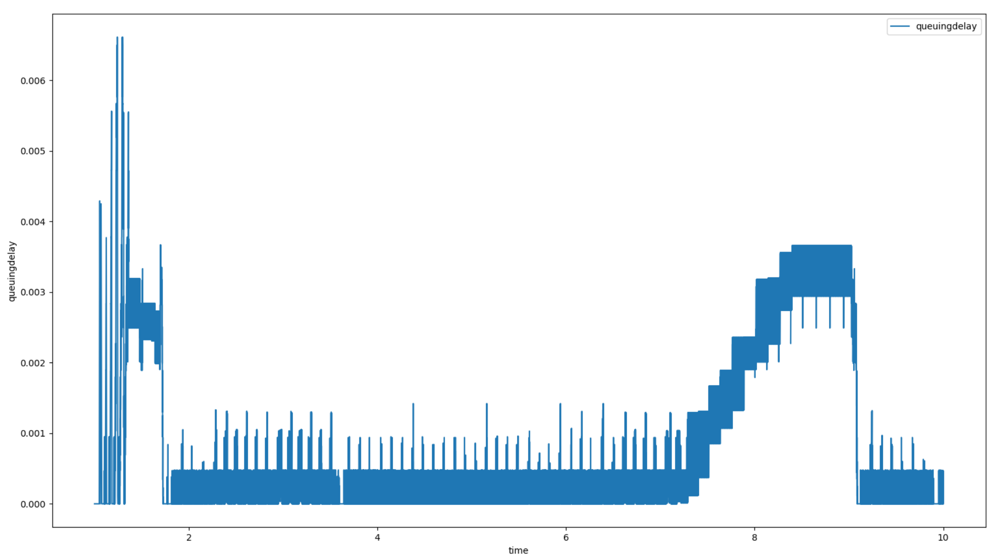
Address A	Port A	Address B	Port B	Packets	Bytes	Packets A → B	Bytes A → B	Packets B → A	Bytes B → A	Rel Start	Duration	Bits/s A → B	Bits/s B → A
10.1.1.1	49153	10.1.2.2	8080	11,360	4,596 k	7,424	4,379 k	3,936	217 k	0.000000	8.9965	3,894 k	193 k

d. No, achieved throughput is not equal to the maximum expected value; instead, it is sightly lower than the maximum throughput because when we compute theoretical values, we usually ignore the delays, but in reality, there is some delay like transmission delay, queuing delay, network congestion, many more during transmission of data.

e.



f.



g. Yes, the plots are related. Theoretically, the length of the queue line grows proportionally to the size of the congestion window such that if we increase the congestion window size, queuing delay is also increases. For example, we can see in plot 1(e), at first, the transmission rate increases, which implies an increase in queuing delay and congestion window size. But after 2-4 seconds, we can observe in the plot that there is a decrease in the transmission rate which in turn results in a decrease in queuing delay.

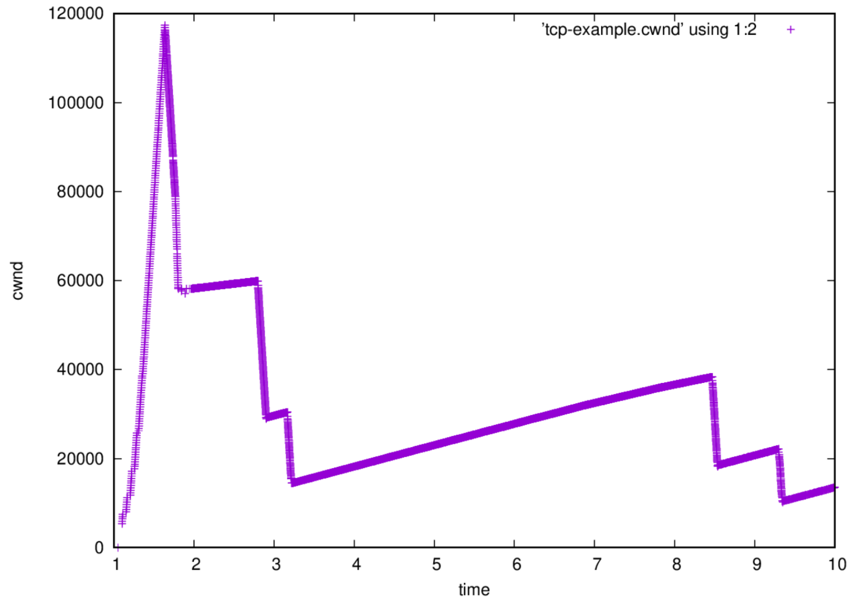
Question 2:

a. The average computed throughput of the TCP transfer comes out to be 4024Kbps which is equal to 4.024 Mbps.

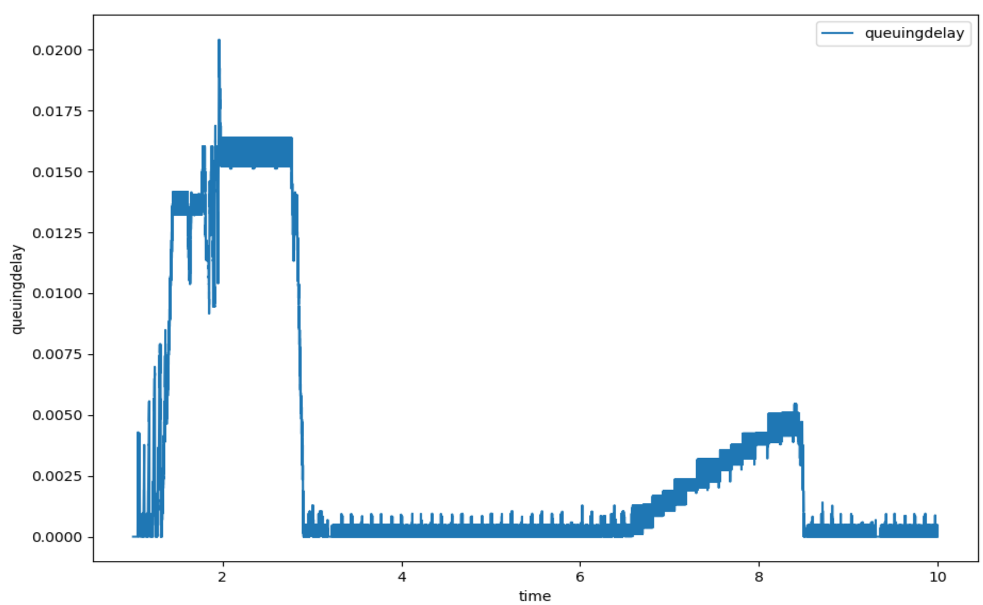
Ethernet | IPv4 · 1 | IPv6 | TCP · 1 | UDP

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	11,815	4,757 k	7,677	4,527 k	4,138	230 k	0.000000	8.9993	4,024 k	204 k

b.



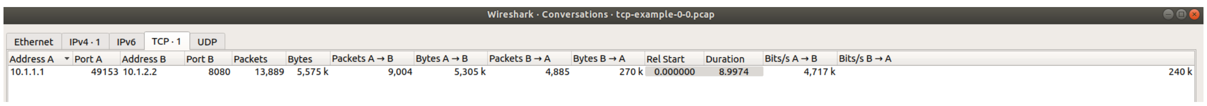
c.



d. In this case, we have increased the queue size, which allows for more packet capacity hence due to an increase in queue size we can store more packets in the queue, which implies we can send more packets on the link, thus increasing the congestion size.
Congestion size is quite higher in the Question2 plot in comparison with Question1. This is because when the queue size increases, then packets have to wait for a longer time in order to be transmitted, hence resulting in increased congestion window size and queuing delay.

Question 3:

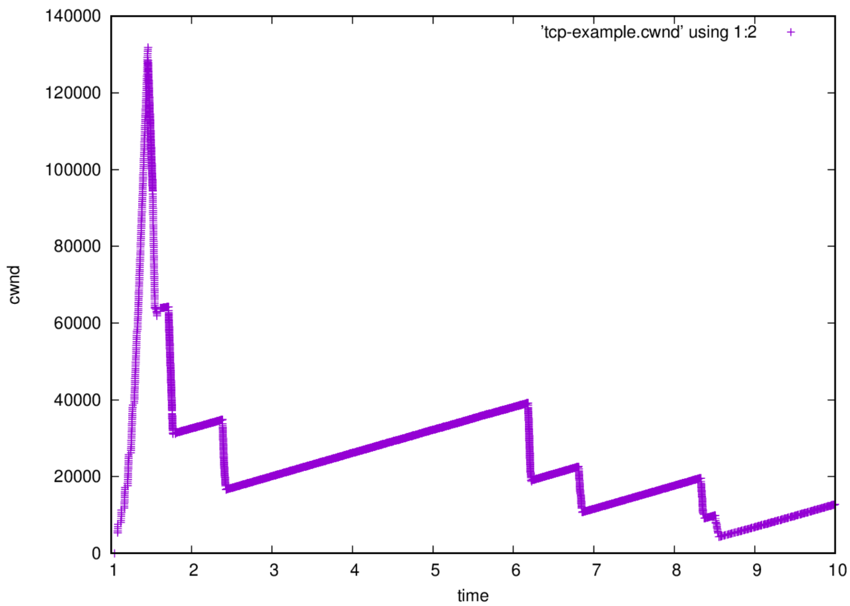
a. The average computed throughput of the TCP transfer comes out to be 4717Kbps which is equal to 4.717 Mbps.


Wireshark · Conversations · tcp-example-0-0.pcap

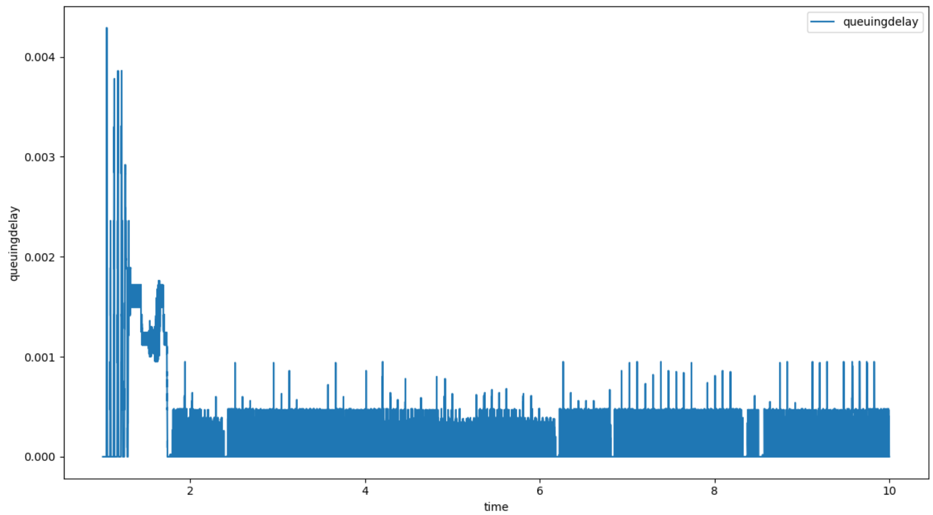
Ethernet | IPv4 · 1 | IPv6 | TCP · 1 | UDP

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	13,889	5,575 k	9,004	5,305 k	4,885	270 k	0.000000	8.9974	4,717 k	240 k

b.



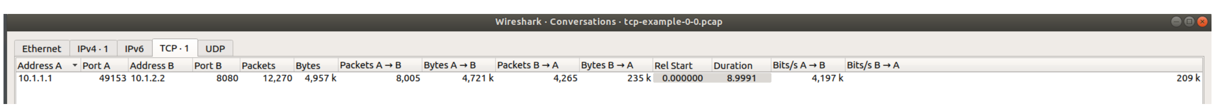
c.



d. In this question, we increase the bandwidth to 10mbps and decrease the delay to 10ms. Now we have the same bandwidth on both the links. The network's lower bandwidth functions as a bottleneck, resulting in a delay when packets travel from link N1 - N2. This can lead to a reduction in packet transmission capacity. So, this implies a reduced transmission rate as TCP affected Congestion Avoidance, resulting in a smaller congestion window size. Due to the same bandwidth, the congestion at the end of node N1 is highly decreased, and hence the transmission rate increases. Thus, all of this is observed in the above plot, which demonstrates an increase in the cwnd size with respect to Q1.

Question 4:

a. The average computed throughput of the TCP transfer comes out to be 4197Kbps which is equal to 4.197 Mbps.

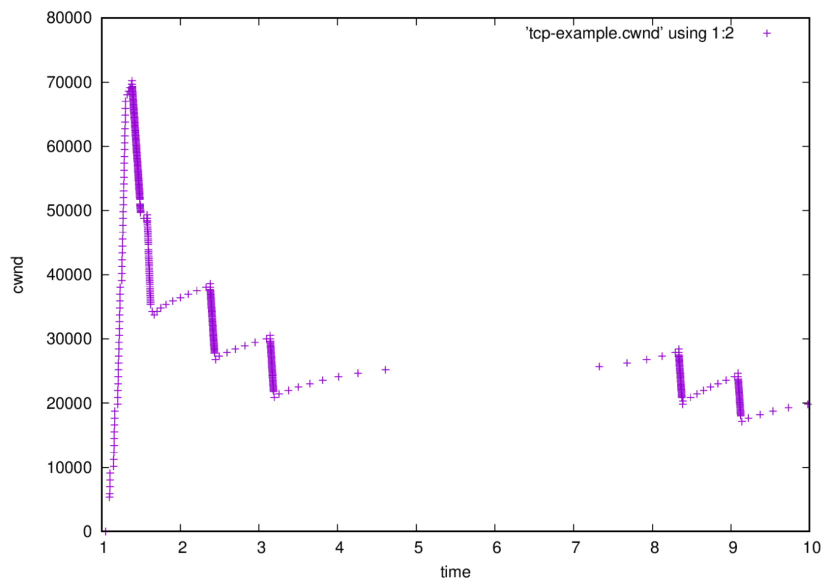


Wireshark · Conversations · tcp-example-0-0.pcap

Ethernet | IPv4 · 1 | IPv6 | TCP · 1 | UDP

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	12,270	4,957 k	8,005	4,721 k	4,265	235 k	0.000000	8.9991	4,197 k	209 k

b.



c. Insights from the above plots are :

● Better Congestion Avoidance - The main difference in both protocols is observed in the congestion avoidance phase. We can see from the above plot that it is converging towards the threshold with a lower rate in comparison with the Q1 plot. In tcpnewreno protocol, the congestion window size increases linearly to an optimal value, on the other hand in tcpcubic protocol, the congestion window size increases by a cubic function.

● Increased Transmission Rate - The figures demonstrate that because of the cubic function there is an increase in the cwnd size and as a result increase in the Transmission rate.

● Slow start and Faster Recover - The cwnd size initially decreases in Q1 and then slowly increases in Q2, but it then again small increases in Q4 due to TCP cubic function.