# COMPUTER NETWORKS 2022-SEC A
# ASSIGNMENT - 3

**-RITIKA NAGAR(2020112)**

Q.1)

a)

Bandwidth between N0-N1 (B1) : 10Mbps

Bandwidth between N1-N2 (B2) : 7Mbps

(Theoretical) maximum throughput = min(B1,B2)

= min(10Mbps,7Mbps)

= 7Mbps

b) For N0-N1:

Number of Packets transferred per second = Bandwidth / Payload size

= 10Mbps/ 1460bytes

= 1000000/ (1460*8) packets

= 856.16 packets

Total Round Ripped time (RTT) b/w N0 and N1 = 100ms*2 = 200ms = 0.2s

Bandwidth-delay product (BDP) = Packets /secs *RTT

= 856.16 * 0.2

= 171.2 packets

For N1-N2:

Number of Packets transferred per second = Bandwidth / Payload size

= 7Mbps/ 1460bytes

= 7000000/ (1460*8) packets

= 599.31 packets

Total Round Ripped time (RTT) b/w N1 and N2 = 10ms*2 = 20ms = 0.02s

Bandwidth-delay product (BDP) = Packets /secs *RTT

= 599.31 * 0.02

= 11.98 packets

From N0-N2

Number of Packets transferred per second = 7Mbps/ 1460bytes

= 7000000/ (1460 *8) packets

= 599.31 packets

Total Round Ripped time (RTT) b/w N0 and N1 = (100 +10 )ms*2 = 220ms = 0.22s

Bandwidth-delay product (BDP) = Packets /secs *RTT

= 599.31 * 0.22

= 131.84 packets

c)

Number of bits per sec transferred through N0-N1 = 176 Kb/s

Number of bits per sec transferred through N1-N2 = 3081Kb/s

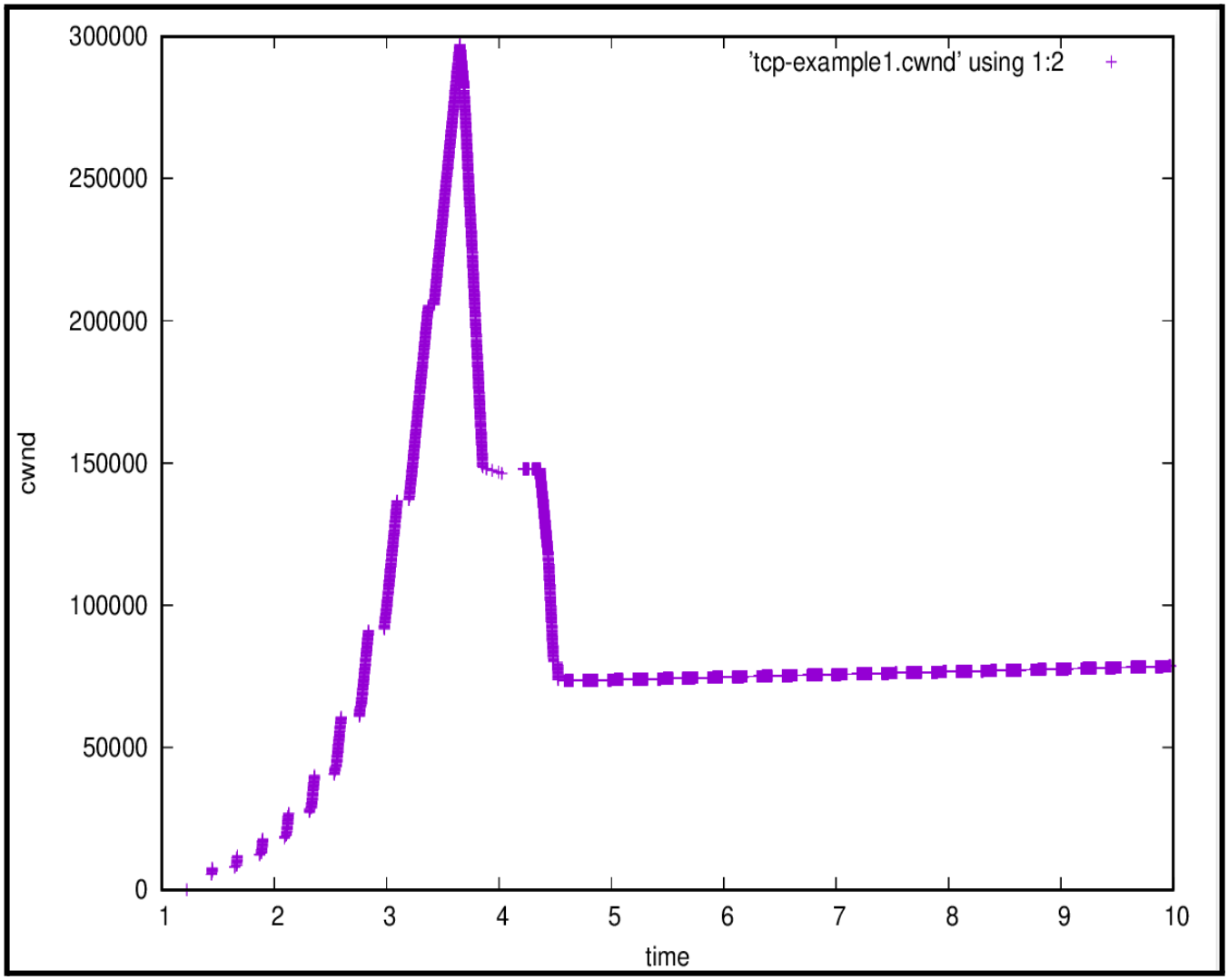
Average Throughput = 3,257Kb/s

= 3.257Mbps

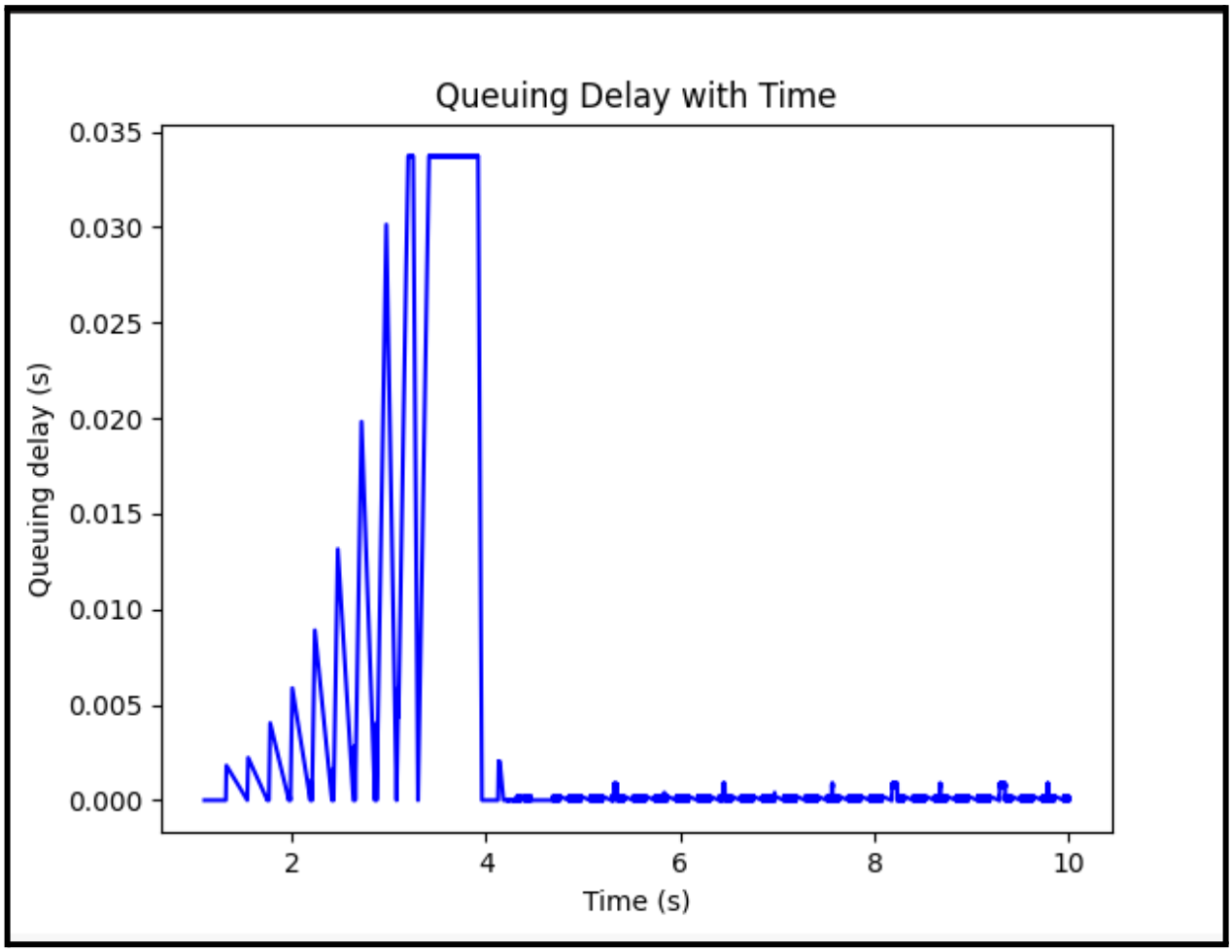
d) Achieved or the actual throughput is always lesser than the theoretical throughput value. The following are the reasons:

- ☐ Sometimes the buffer gets overflowed, due to which some packets get dropped, and they must be retransmitted by the sender. This causes additional time and adds to the total duration of packets sent.
- ☐ Sometimes, transmission capacity is used by the link up to the point where the packet dropped is wasted, which otherwise could have been sent to the other packet. This reduces the actual throughput.
- ☐ The sender might assume a packet is lost during transmission because of low timeout configuration; however, it is delayed in reaching the client and sending an acknowledgment. This also causes the retransmission of the packet.

e) **Graph for Command window vs Time**.



f) **Queueing delay vs Time**




g) Yes, the plots in 1(e) and 1(f) are related. This can be verified by from following reasons.

- ☐ There is an increase in queuing delay along with the increase in the Congestion window(CWND).
- ☐ The CWND increases until its size reaches the maximum capacity the link can handle or the threshold for the CWND has reached.

Q2)

a)

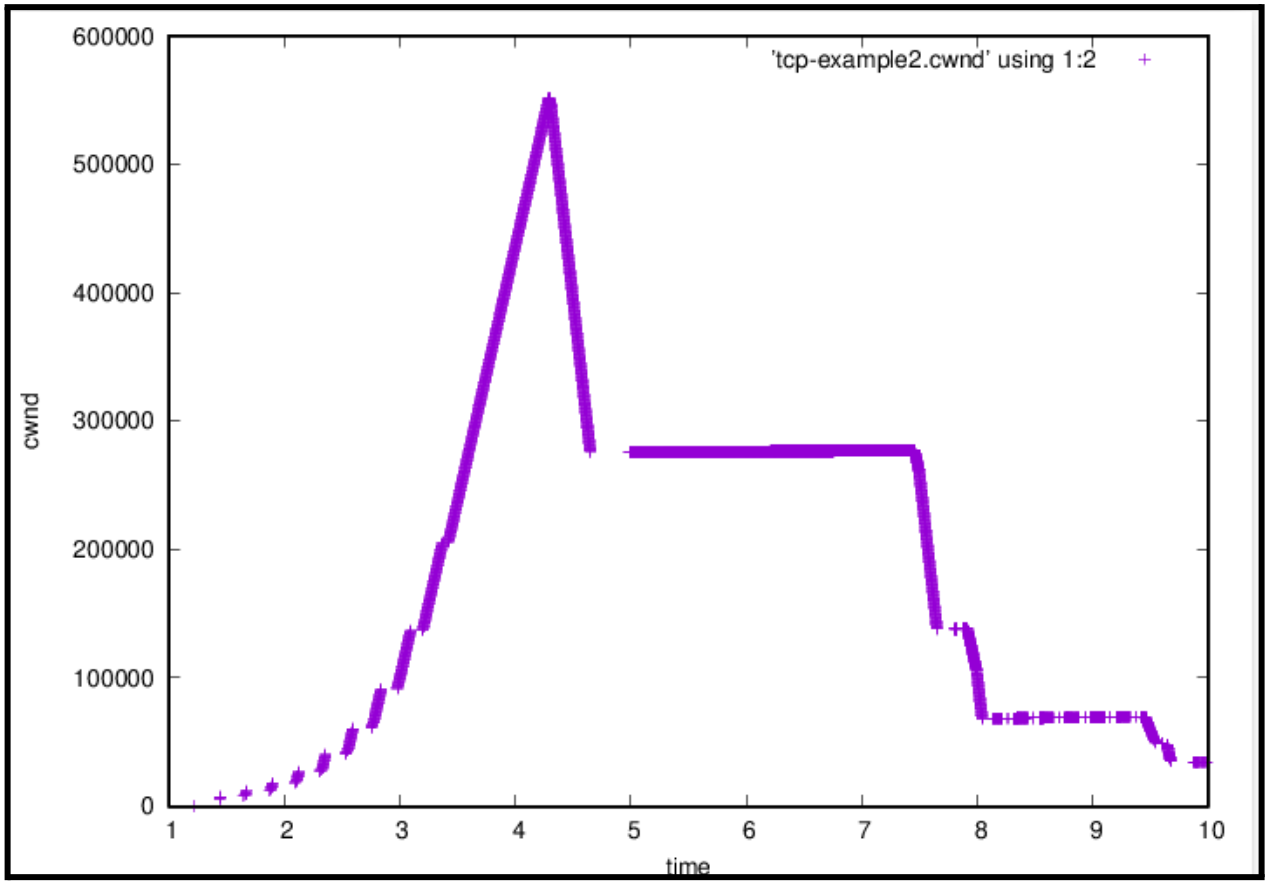
Number of bits per sec transferred through N0-N1 = 268 Kb/s

Number of bits per sec transferred through N1-N2 = 4563Kb/s

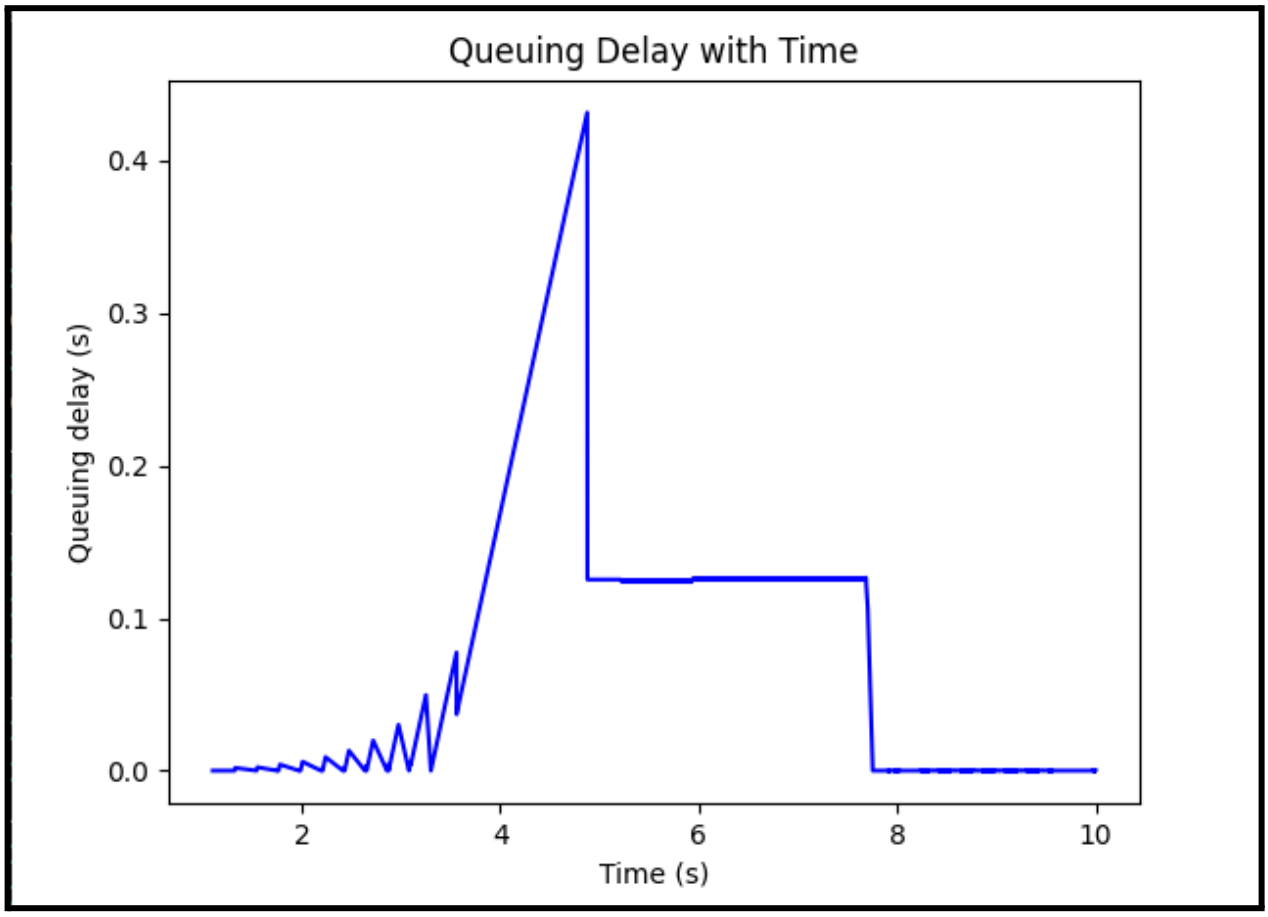
Average Throughput = 4,831Kb/s

= 4.831Mbps

b) **Graph for Command window vs Time**



c) **Queueing delay vs Time**




d) On comparing the CWND plots of Q.1. and Q.2., we can observe that the maximum congestion window size in Q1(300000 bytes) is almost 50 percent lesser than that of the maximum window size in Q2(550000 bytes). This is because of the larger queue size in Q2 compared to Q1. Due to this, buffer overflow took a longer time in Q2. Hence it allows the congestion window to increase for a longer period of time. The pattern followed, and the shape of the graph is almost identical for Q1 and Q2.

Q3)

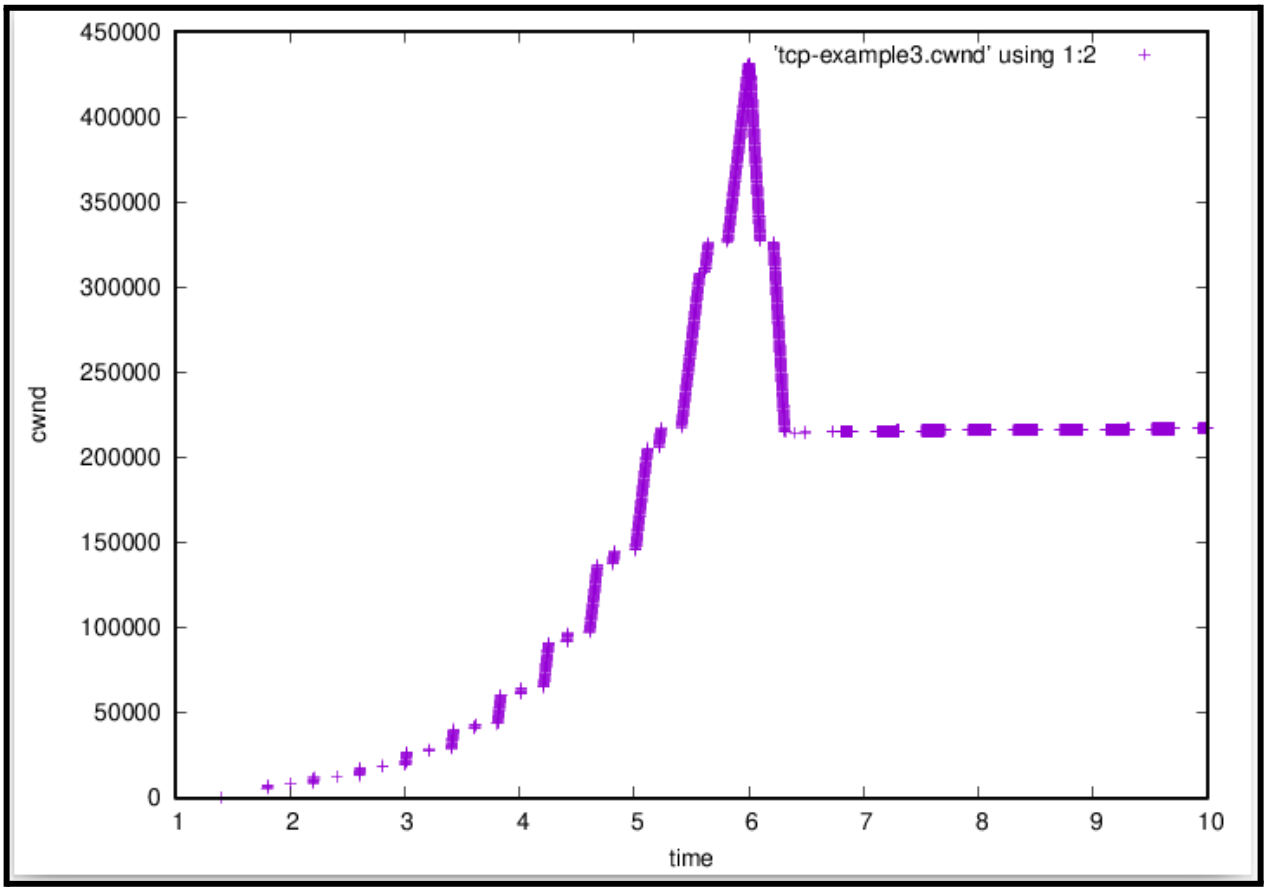
a) Number of bits per sec transferred through N0-N1 = 174 Kb/s

Number of bits per sec transferred through N1-N2 = 3,264Kb/s

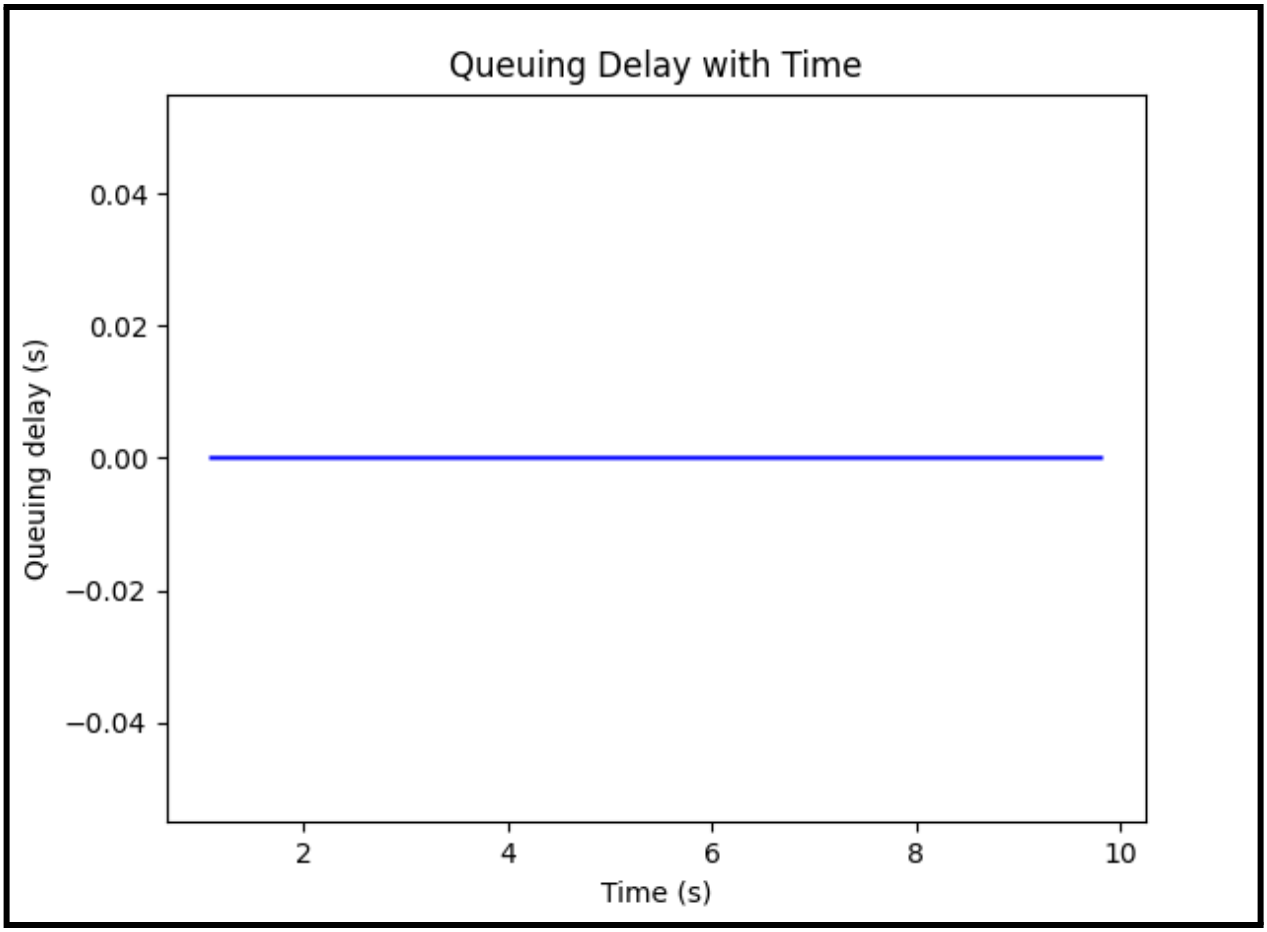
Average Throughput = 3,438Kb/s

= 3.438 Mbps

b) **Graph for Command window vs Time**




c) **Queueing delay vs Time**




d) In this question, things differ from our previous observation in 2d. Here bandwidth of the links N0-N1 and N1-N2 are equal, i.e., 10Mbps, and even the delays i.e. 100ms, are also equal. Therefore, the arrival rate of packets at N1 is almost equal to the rate at which packets leave from N1. Thus, there is very less queue build-up, and delays caused by queuing are also low.

Whereas on the other side, in Q1, the arrival rate of packets at N1 is greater than the rate at which the packets are leaving, thus a queue is built, and this causes a delay.