Assignment 3

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Answer 1

a) The maximum expected (theoretical) throughput value is 7 Mbps. The reason being is as the link bandwidth between the two nodes, N0-N1 & N1-N2, is 10Mbps and 7Mbps, respectively. Hence the bottleneck bandwidth is 7Mbps. Hence throughput is 7Mbps.

b) **Bandwidth Delay Product** = Bandwidth * Delay
Bandwidth = 7Mbps,
Delay = 2*(100+10)ms, (because the one-way delay of the link N0-N1 is 100ms and N1-N2 is 10ms. Therefore, the round trip delay would be 2*(100+10)ms)

BDP = 7Mbps*220ms = 1540000 bits
Payload size = 1460*8 = 11680 bits

Total packets = 131.8493 packets ~ 131 packets

c)

The average computed throughput of the TCP transfer is present in the screenshot above.
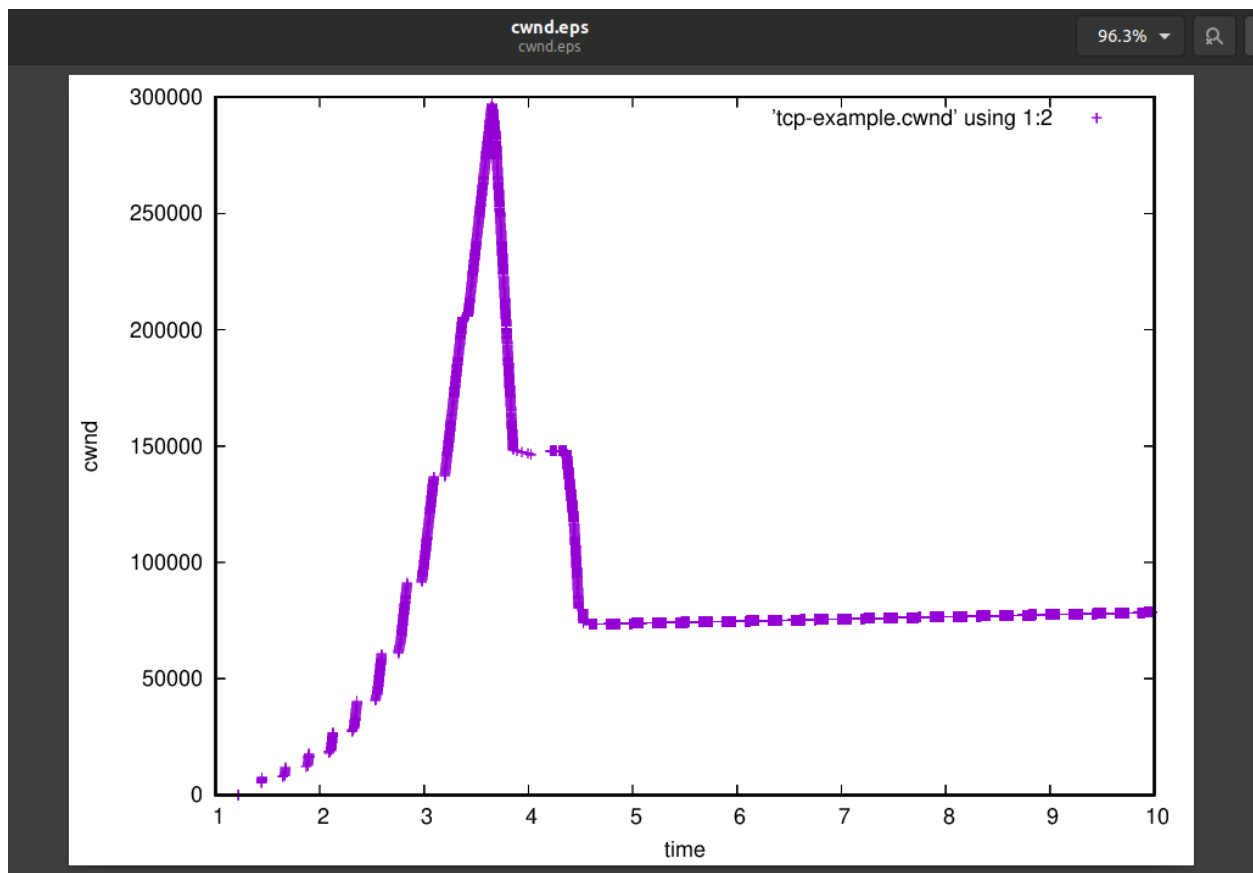
The "tcp-example-2-0.pcap" file was opened in Wireshark. Went to the capture file properties option, and under the statistics tab, "Average bits/sec", is given as 3261k bits/sec. Therefore, the average throughput is 3261000 bits/sec.

d) No, the average throughput is not equal to the maximum expected value. The achieved throughput is 3261k bits/sec and the theoretical throughput is 7Mbps = 7000k bits/sec. The difference is because actual data transfers have external factors which affect the throughput, such as queuing delays, errors in data transfer, packet losses and many more. Hence the actual throughput is less than the expected value.

e) Plotted using the steps given in the assignment.

f)
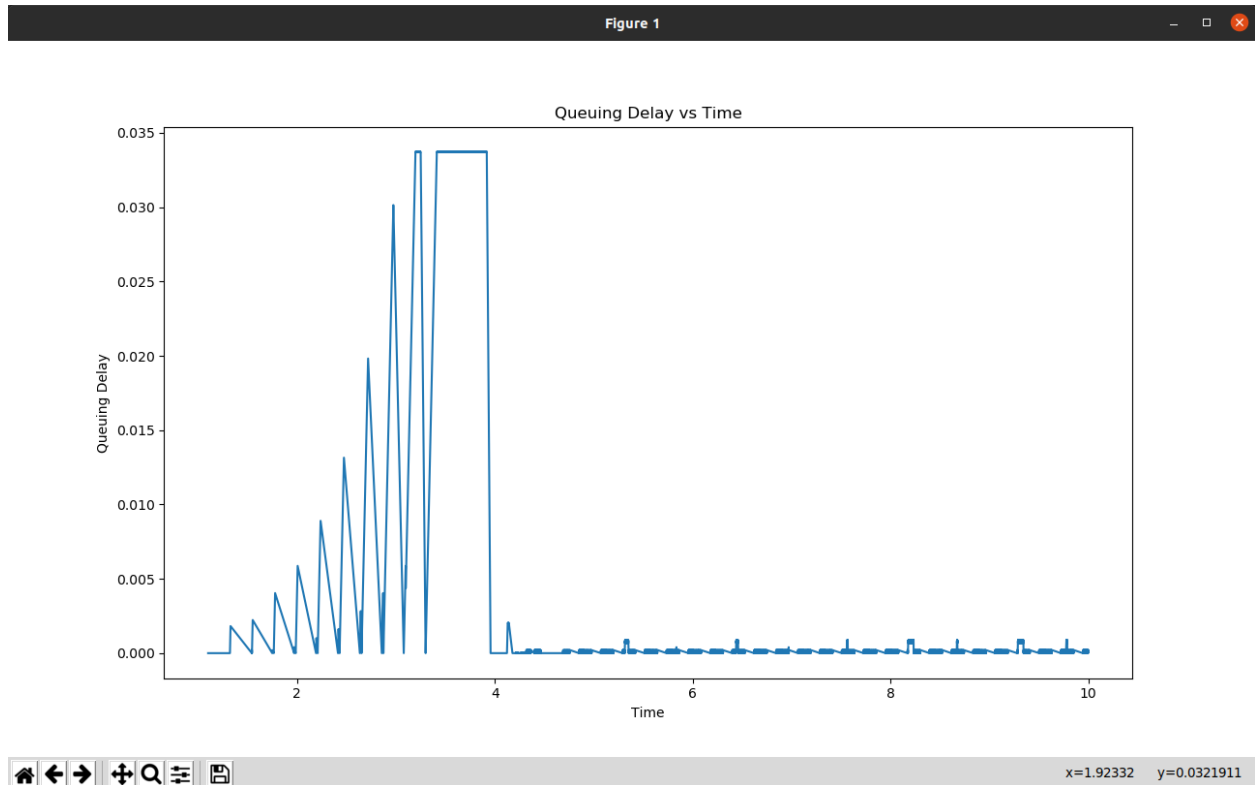
g) Yes, the plots in 1(e) and 1(f) are related,

The congestion window is increasing as packets increase with time. In the later part, we see that congestion-window(cwnd) becomes stable due to congestion avoidance, hence queuing delay also comes close to 0.
We see that when the congestion window(cwnd) becomes stable, queuing delay also stabilizes (becomes close to 0) because the number of packets sent through the links now, are the same throughout the whole time.
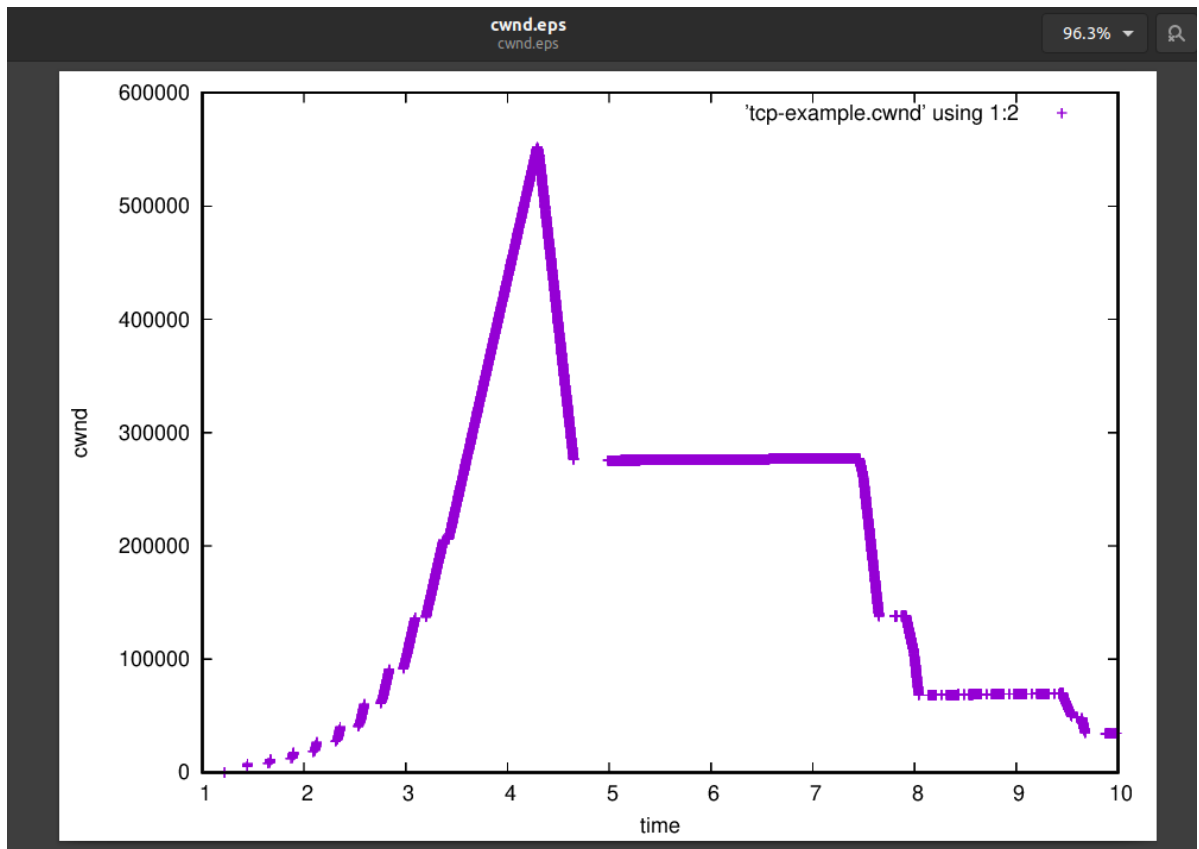
Answer 2

a) The average computed throughput of the TCP transfer is present in the
   screenshot below.

Wireshark · Capture File Properties · tcp-example-2-0.pcap

Details

Hash (SHA1): e808ab12e5b47e26eb0rae8b8279a1eca8cr7a19
Format: Wireshark/tcpdump/... - pcap
Encapsulation: PPP
Snapshot   65535
length:

Time

First packet: 1970-01-01 05:30:01
Last packet: 1970-01-01 05:30:09
Elapsed: 00:00:08

Capture

Hardware: Unknown
OS: Unknown
Application: Unknown

Interfaces

Interface	Dropped packets	Capture filter	Link type	Packet size limit
Unknown	Unknown	Unknown	PPP	65535 bytes

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	—

Capture file comments

[?Help] [⊠Refresh]   [✓Copy To Clipboard] [✗Close] [Save Comments]

The "tcp-example-2-0.pcap" file was opened in Wireshark. I went to the capture
file properties option, and under the statistics tab, "Average bits/sec" is given as
4835k bits/sec. Therefore, the average throughput is 4835000 bits/sec.

b) Plotted using the steps given in the assignment.

c) Plotted using the steps given in the assignment.
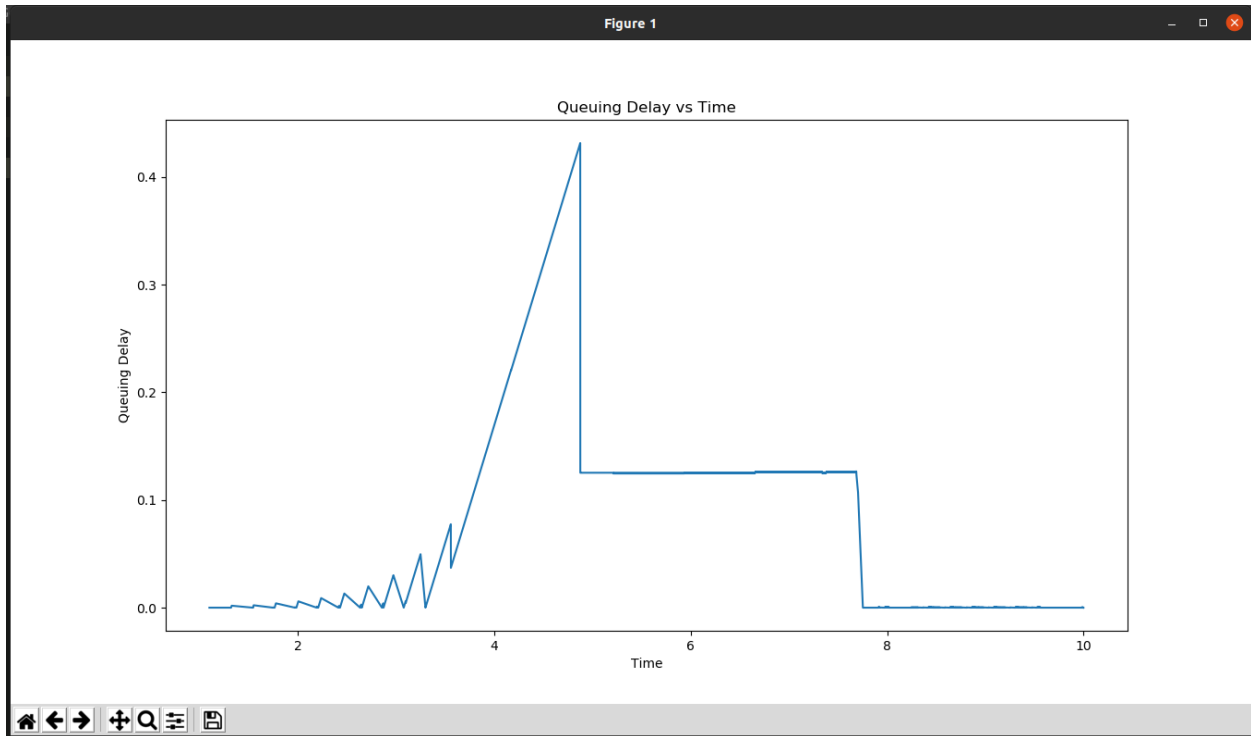
d)

In this part of the question, we increased the queue size to 1000 packets. In the first part, the queue size was 50 packets. Due to the increase in queue size, timeouts of packets would occur late. Hence there would be an increase in congestion window (evident from the graph, peak in the first part ~300000 and peak in second is ~550000).

Due to this, the number of packets in the congestion window would be more in the second part compared to the first part.

Answer 3

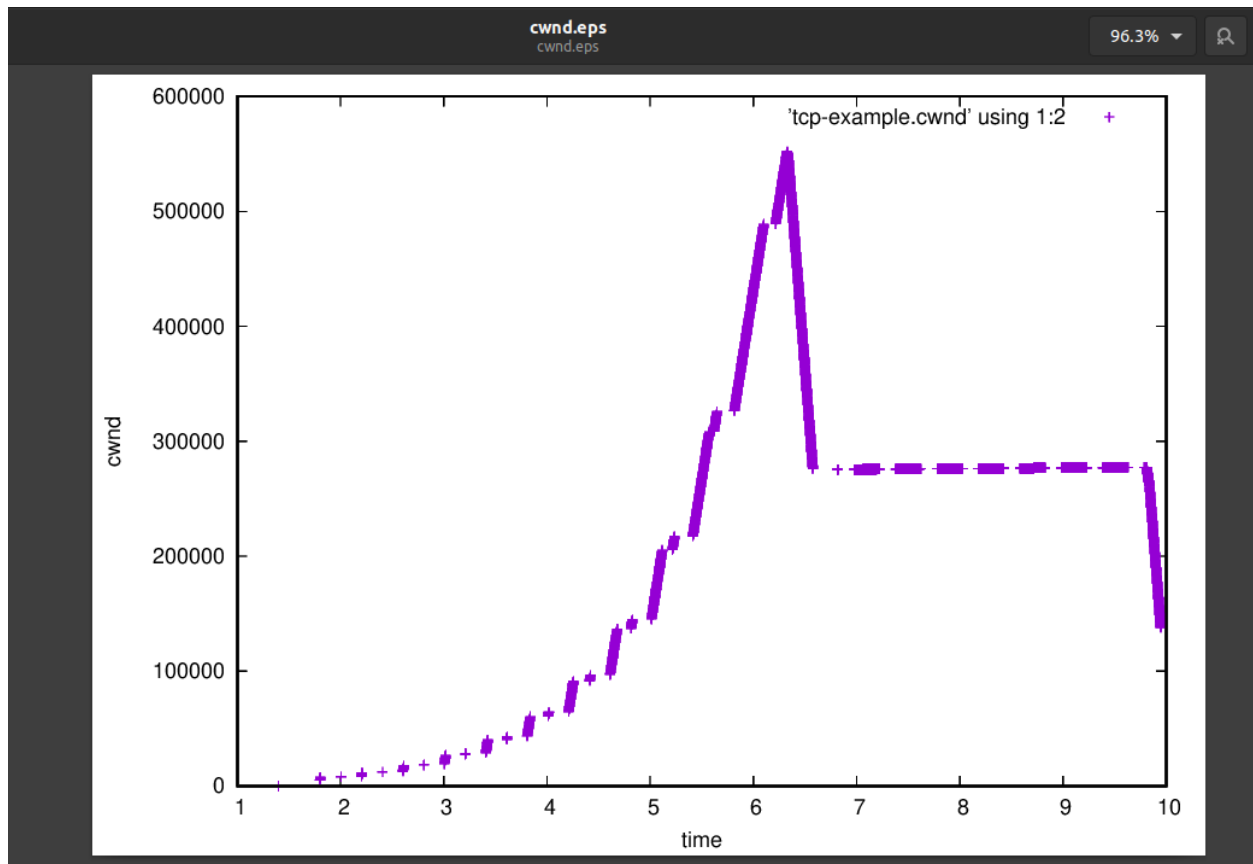a) The average computed throughput of the TCP transfer is present in the
   screenshot below.
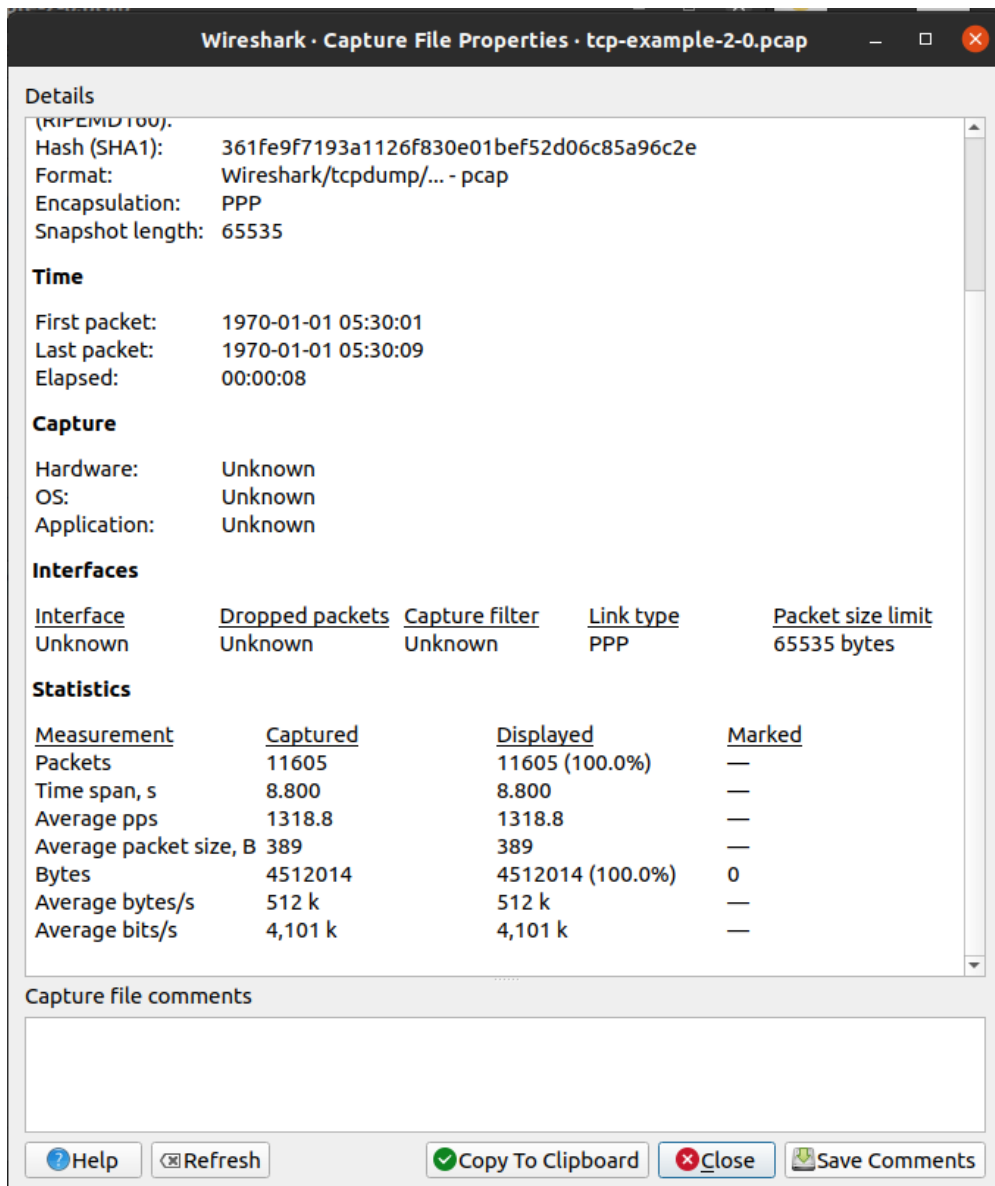
The "tcp-example-2-0.pcap" file was opened in Wireshark. Went to the
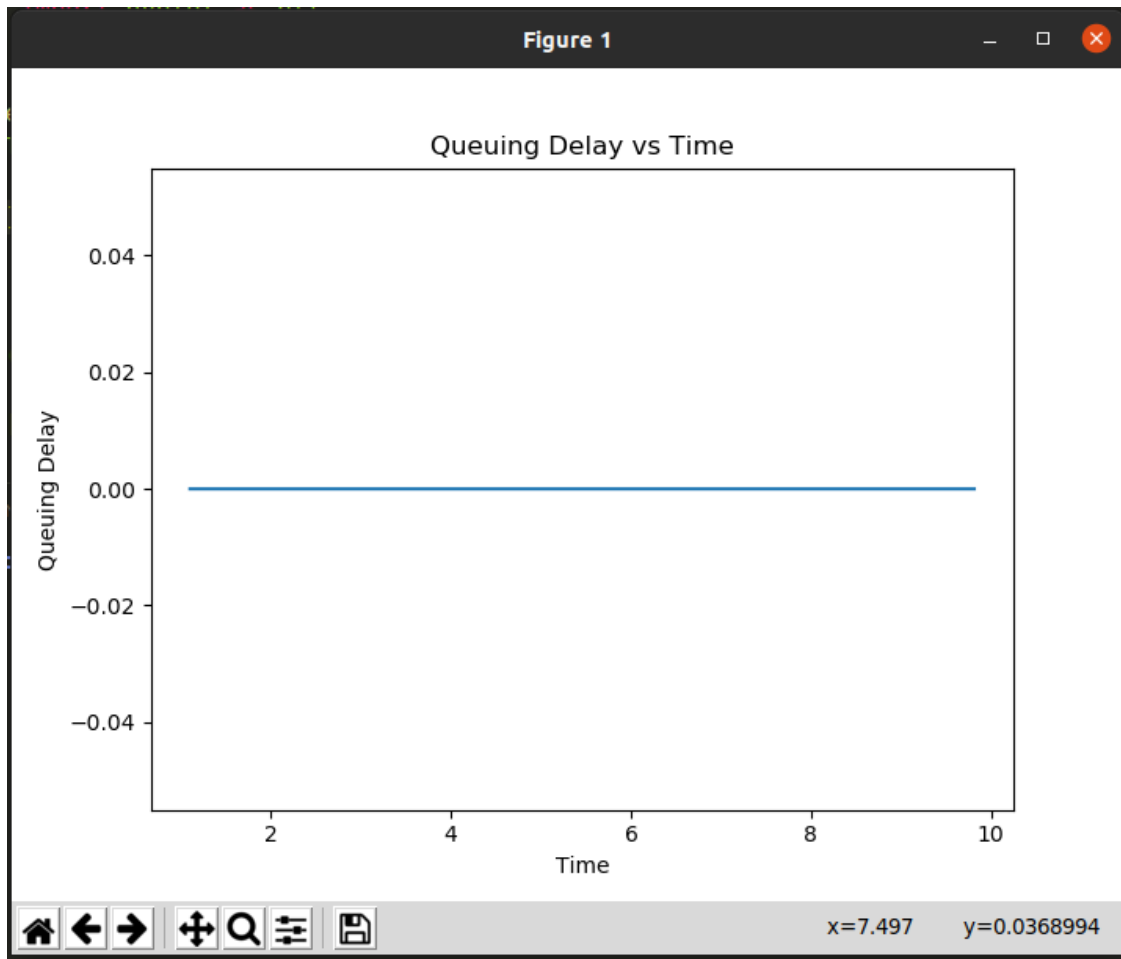capture file properties option, and under the statistics tab, "Average

bits/sec" is given as 4101k bits/sec. Therefore, the average throughput is
4101000 bits/sec.

b) Plotted using the steps given in the assignment.

c) Plotted using the steps given in the assignment.

d) The queuing delay in this part becomes 0 for all the packets but not in the first. The reason is that in this part, both the links N0-N1 and N1-N2 have the same delay and bandwidths (i.e., bandwidth = 10Mbps and delay = 100ms). As the delay and bandwidth for both the links are the same, therefore, there wouldn't be any queuing; due to this, the queuing delay is 0 for all the packets.