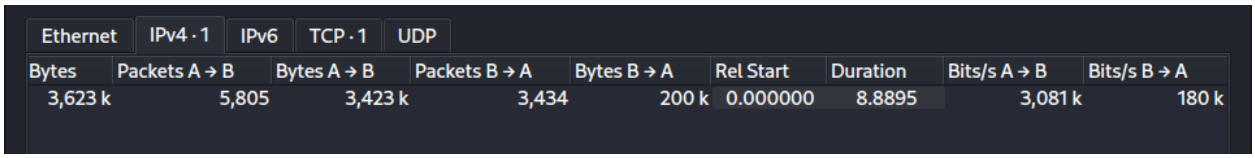
**Question 1**

a. The highest expected throughput is 7Mbps as it is the bottleneck in our network where bandwidth between N0-N1 is 10Mbps and that between N1-N2 is 7Mbps.

b. RTT = 2 * (total delay) = 2 * (100+10)ms = 220ms = 0.22s
BDP = Bandwidth * RTT
= (7Mbps) * (0.22s)
= 1.54 Mb
Application payload size = 1460bytes
BDP (in terms of packets) = $(1.54 * 10^6) / (1460*8)$
= 131.8 packets

c. The average throughput, as determined by Wireshark, is around 3081Kbps or 3.061Mbps.

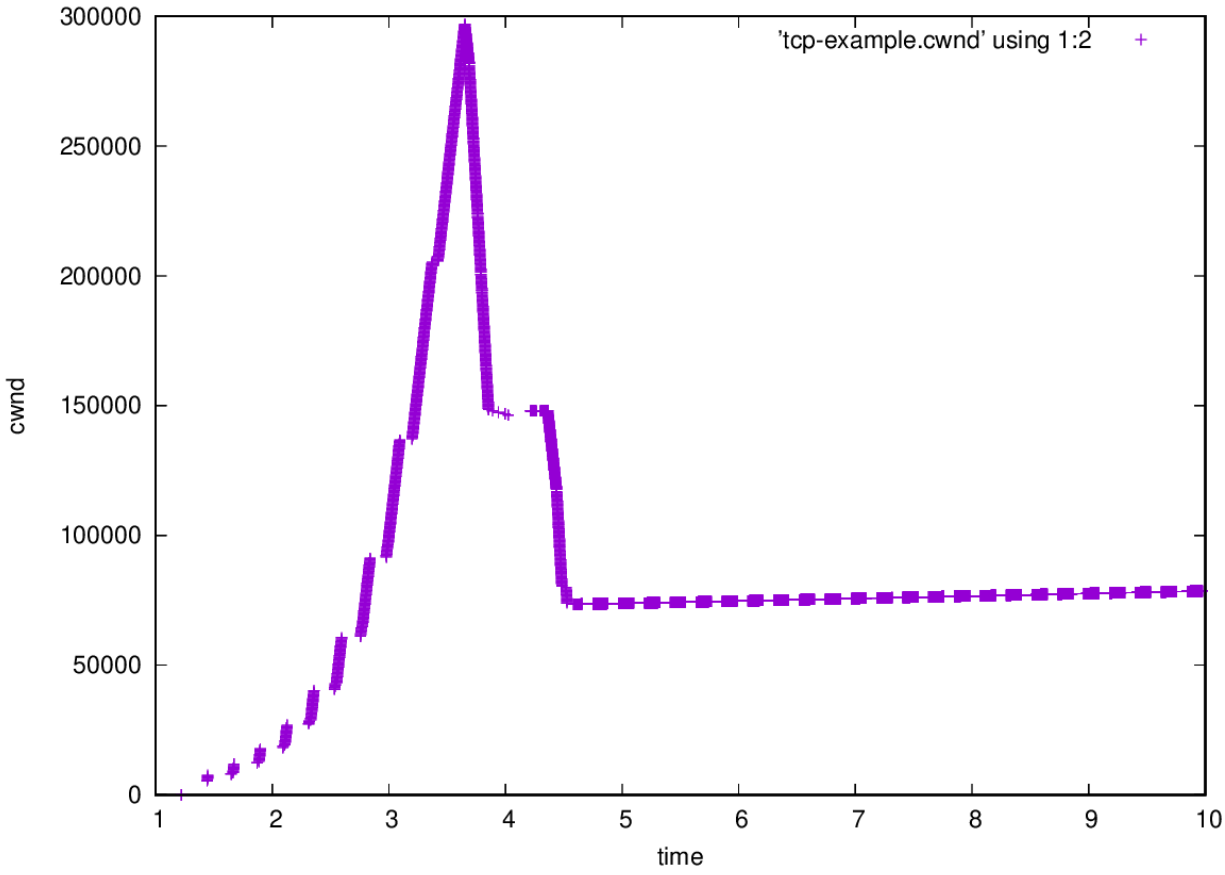


Ethernet | IPv4 · 1 | IPv6 | TCP · 1 | UDP

| Bytes | Packets A → B | Bytes A → B | Packets B → A | Bytes B → A | Rel Start | Duration | Bits/s A → B | Bits/s B → A |
|---|---|---|---|---|---|---|---|---|
| 3,623 k | 5,805 | 3,423 k | 3,434 | 200 k | 0.000000 | 8.8895 | 3,081 k | 180 k |

d. The maximum expected throughput is not same as the average throughput achieved. It may be due to the packet loss due to congestion in network or packet drop in the queue at node 1.

e. Congestion window vs time


'tcp-example.cwnd' using 1:2
cwnd
time
300000
250000
200000
150000
100000
50000
0
1
2
3
4
5
6
7
8
9
10