Assignment 2
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Ping

1. lab machine to raspberry pi, c10, i0.2:
10 packets transmitted, 10 received, 0% packet loss, time 1834ms
rtt min/avg/max/mdev = 0.384/0.455/0.476/0.026 ms

2. raspberry pi to lab machine, c10, i0.2:
10 packets transmitted, 10 received, 0% packet loss, time 1841ms
rtt min/avg/max/mdev = 0.409/0.478/0.520/0.040 ms

3. raspberry pi to lab machine, c100, i0.001:
100 packets transmitted, 100 received, 0% packet loss, time 99ms
rtt min/avg/max/mdev = 0.293/0.352/0.532/0.035 ms

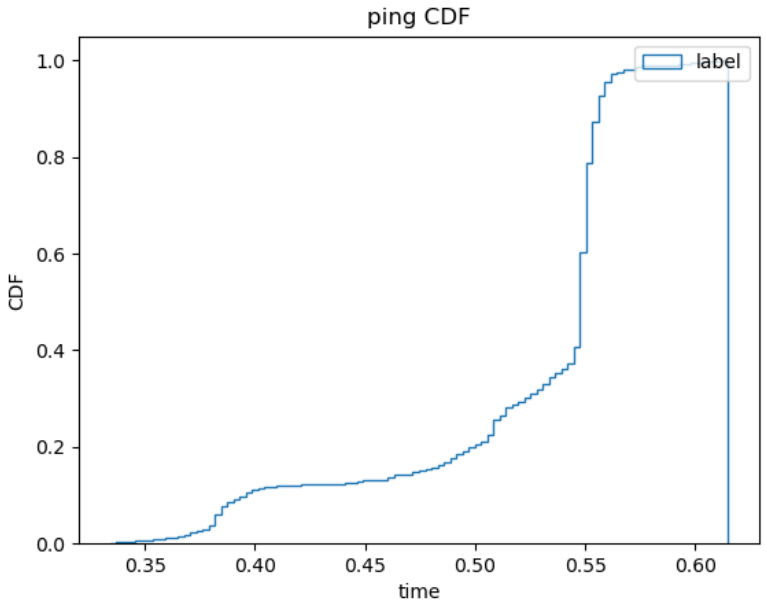
minimum is 0.293 maximum is 0.532 and mean is 0.352. Mean is closer to the minimum than the maximum – heavy tail?/sometimes travel takes longer but it rarely takes much less time

4. rasp pi to lab machine, c10000 using flooding (-f)
10000 packets transmitted, 10000 received, 0% packet loss, time 3550ms
rtt min/avg/max/mdev = 0.081/0.298/0.672/0.026 ms
ipg/ewma 0.355/0.300 ms

5. rasp pi to lab machine
c1000 for all

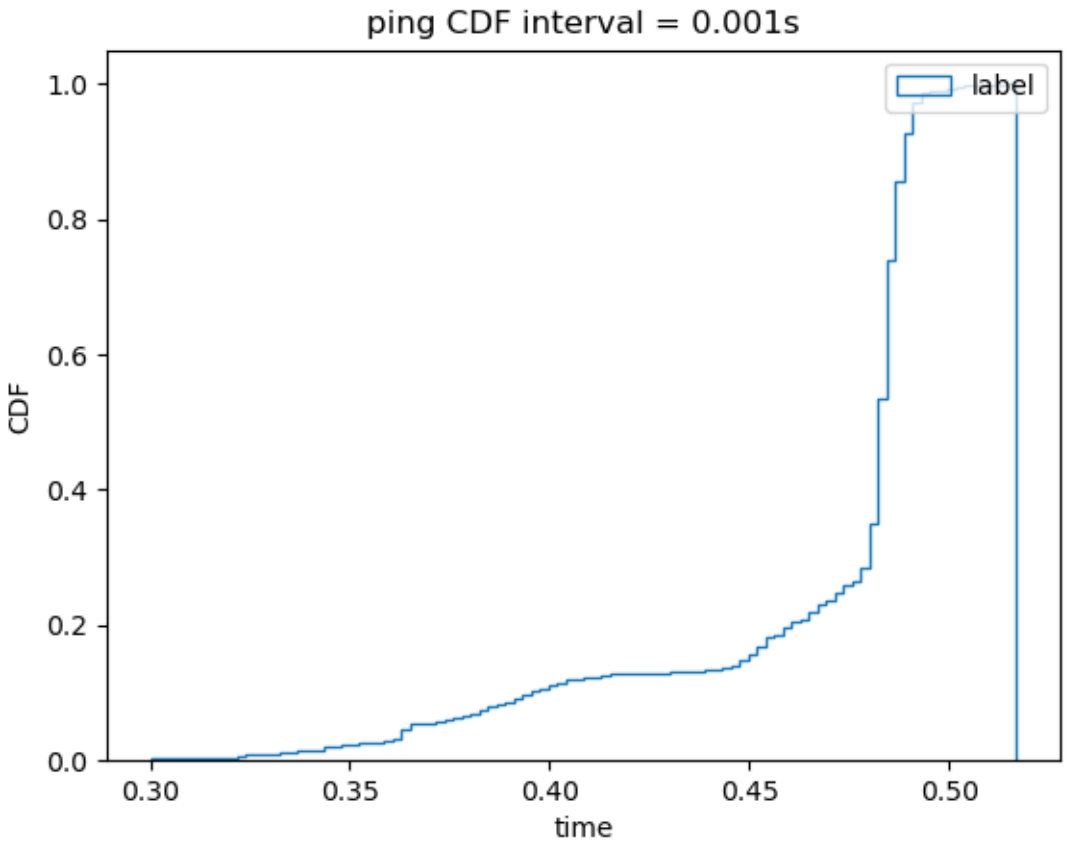
(a) i0.01
1000 packets transmitted, 1000 received, 0% packet loss, time 16087ms
rtt min/avg/max/mdev = 0.334/0.521/0.615/0.056 ms
saved in ping.log

CDF of results:



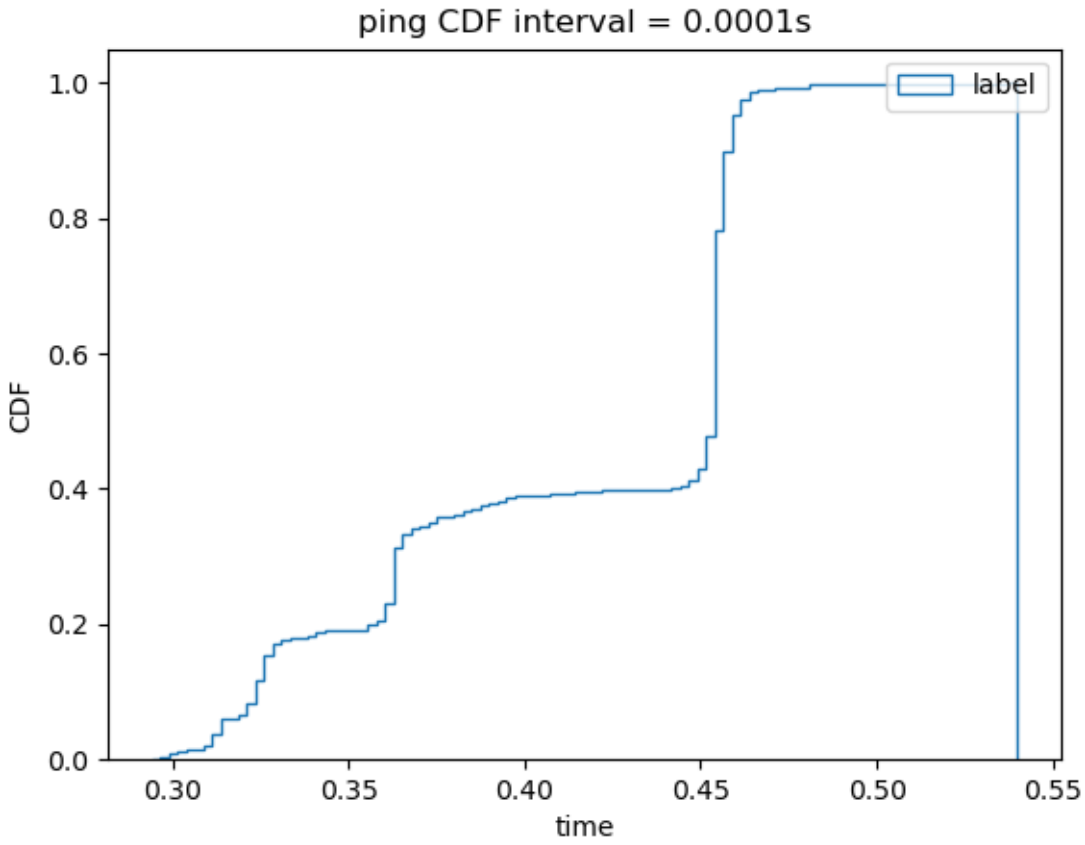
(b) i0.001
1000 packets transmitted, 1000 received, 0% packet loss, time 1003ms
rtt min/avg/max/mdev = 0.300/0.468/0.517/0.038 ms
saved in ping2.log

CDF of results:



(c) i0.0001
1000 packets transmitted, 1000 received, 0% packet loss, time 449ms
rtt min/avg/max/mdev = 0.294/0.413/0.540/0.056 ms
ipg/ewma 0.448/0.447 ms
saved in ping3.log

CDF of results:



6. why do different intervals lead to different round trip results?

Round trip times generally decrease as the interval between pings gets smaller.
Maybe this is because the raspberry pi works more efficiently if the pulses are sent with a smaller interval?

Average round trip time because it includes all measurements taken. Sometimes the network will be working at maximum capacity and sometimes it will be very slow, so the average is the most ‘useful’ measurement of propagation time.

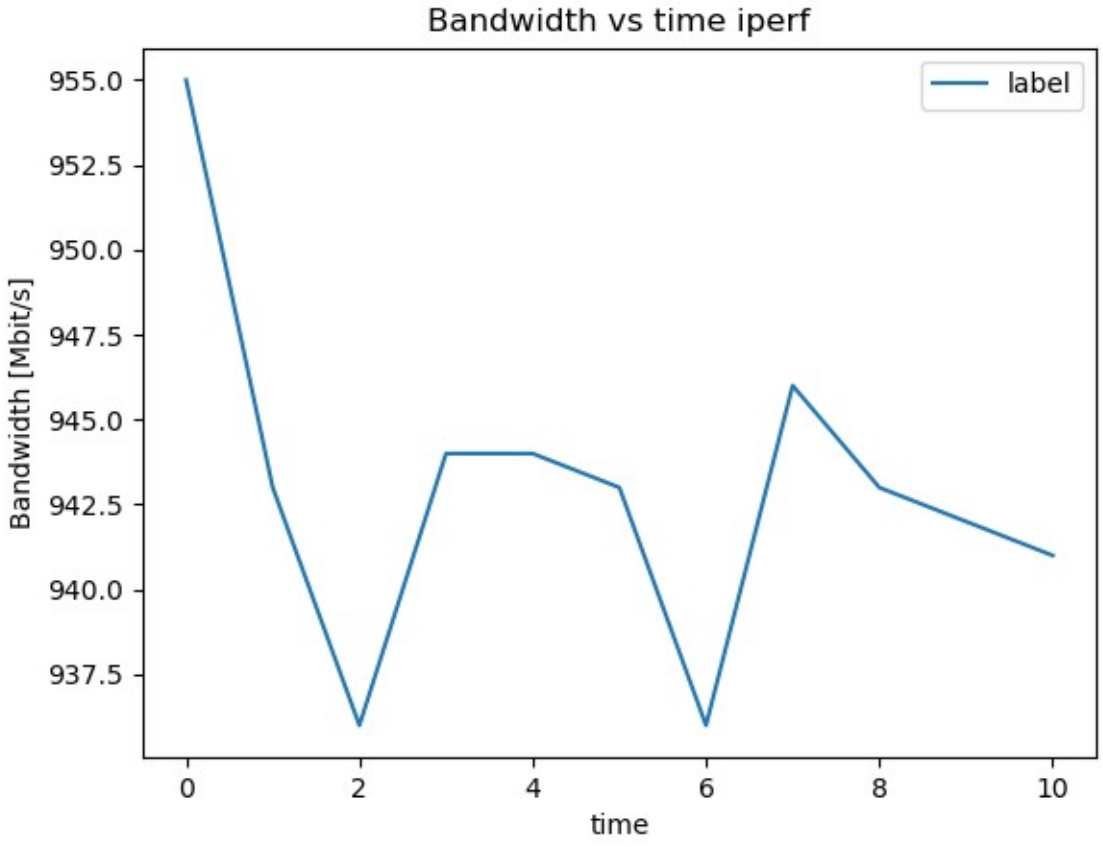
Iperf

1. server=lab machine, client=rasp pi
TCP
t10
(Interval: 0.0000-10.0029 sec, Transfer: 1.10 GBytes)

Bandwidth: 941 Mbits/sec

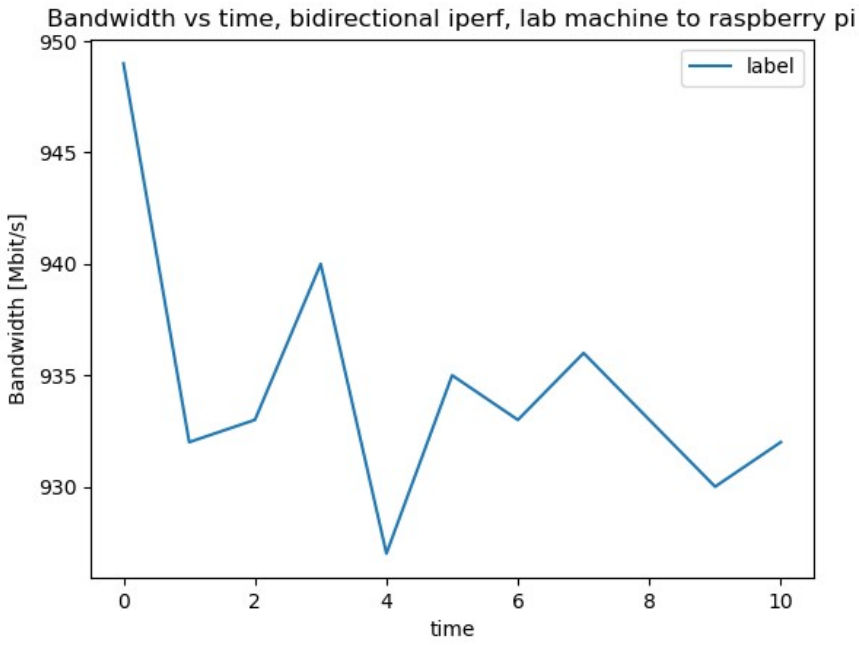
2. server=rasp pi, client=lab machine
TCP
t10
i1
iperf.log contains the measured bandwidths

Plot of measured bandwidths:

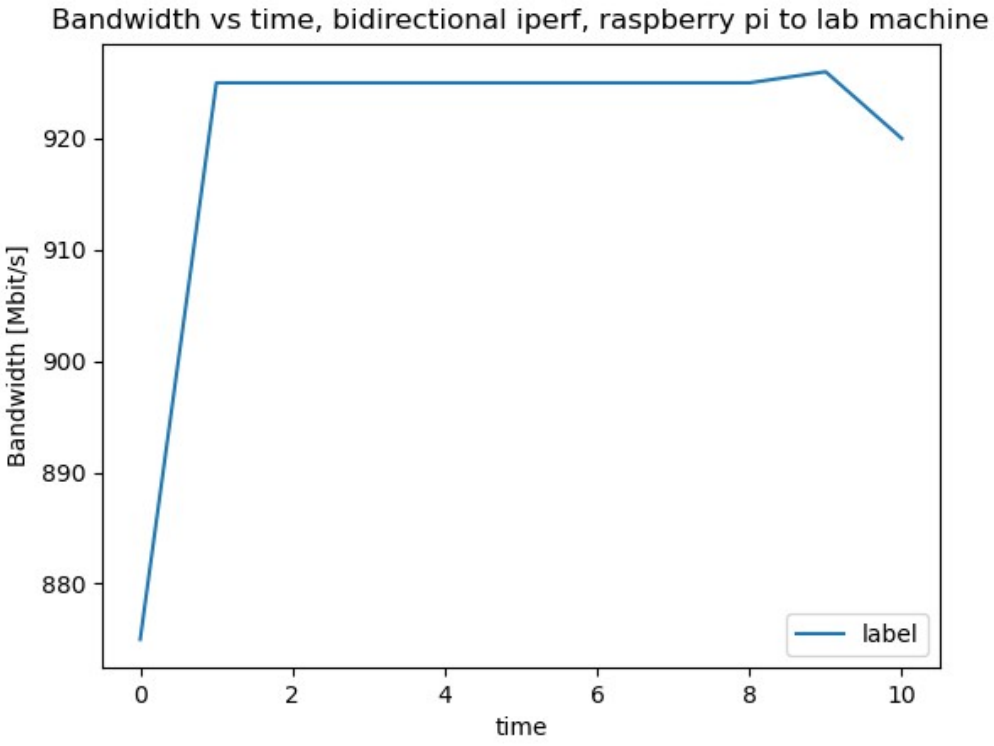


3. server=rasp pi, client=lab machine, bi-directional iperf
TCP, t10, i1
iperf-bi.log contains measured bandwidths in each direction

Plot of measured bandwidth in direction of lab machine to raspbarry pi:



Plot of measured bandwidth in direction of raspberry pi to lab machine:



4. one way iperf from lab machine to rasp pi (client = lab machine)
UDP, t5, varying bandwidths

100Kb/s > iperf-100K.log
Interval: 0.0000-5.1744 sec
Transfer: 66.0 KBytes
Bandwidth: 105 Kbits/sec (I repeated this test and repeatedly got a bandwidth of 105Kb/s even though 100Kb/s was specified)
Jitter: 0.004 ms
Lost/Total Datagrams: 0/46 (0%)

1Mb/s > iperf-1M.log
Interval: 0.0000-5.0215 sec
Transfer: 616 KBytes
Bandwidth: 1.00 Mbits/sec
Jitter: 0.003 ms
Lost/Total Datagrams: 0/429 (0%)

100Mb/s > iperf-100M.log
Interval: 0.0000-4.9998 sec
Transfer: 59.6 MBytes
Bandwidth: 100 Mbits/sec
Jitter: 0.007 ms
Lost/Total Datagrams: 0/42521 (0%)

No packets were dropped for all bandwidths tested.

Iperf3

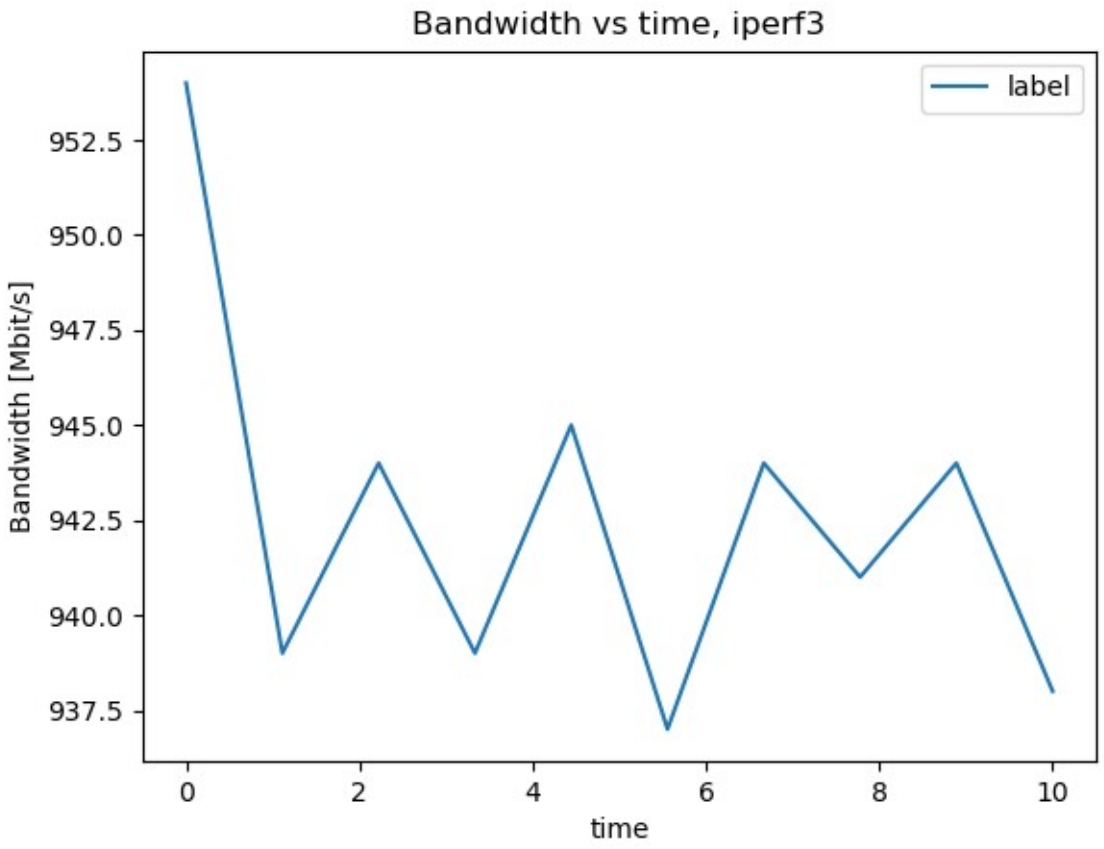
1. Server = rasp pi, client=lab machine
effective bandwidth btwn: TCP, t10, i1

Measured bandwidth saved in iperf3.log
Taking bandwidth as bit rate as no bandwidth measurements received, although I did get both bandwidth and bit rate measurements for the UDP tests.
Evidence of no bandwidth measurements:

```
ubuntu@ubuntu:~/CWM-ProgNets/assignment2$ iperf3 -c 192.168.10.2 -i 1 -t 10
Connecting to host 192.168.10.2, port 5201
[  5] local 192.168.10.1 port 55598 connected to 192.168.10.2 port 5201
[ ID] Interval           Transfer     Bitrate         Retr  Cwnd
[  5]   0.00-1.00   sec   114 MBytes   955 Mbits/sec    0    370 KBytes
[  5]   1.00-2.00   sec   112 MBytes   939 Mbits/sec    0    370 KBytes
[  5]   2.00-3.00   sec   112 MBytes   942 Mbits/sec    0    389 KBytes
[  5]   3.00-4.00   sec   112 MBytes   943 Mbits/sec    0    389 KBytes
[  5]   4.00-5.00   sec   112 MBytes   938 Mbits/sec    0    389 KBytes
[  5]   5.00-6.00   sec   113 MBytes   947 Mbits/sec    0    389 KBytes
[  5]   6.00-7.00   sec   112 MBytes   940 Mbits/sec    0    570 KBytes
[  5]   7.00-8.00   sec   113 MBytes   948 Mbits/sec    0    666 KBytes
[  5]   8.00-9.00   sec   112 MBytes   939 Mbits/sec    0    700 KBytes
[  5]   9.00-10.00  sec   112 MBytes   943 Mbits/sec    0    700 KBytes
- - - - - - - - - - - - - - - - - - - - - - - - -
[ ID] Interval           Transfer     Bitrate         Retr
[  5]   0.00-10.00  sec  1.10 GBytes   943 Mbits/sec    0             sender
[  5]   0.00-10.04  sec  1.10 GBytes   937 Mbits/sec                  receiver

iperf Done.
```

Plot of bandwidth:



2. server=rasp pi, client=lab machine
iperf3, UDP, t5, varying bandwidth
one way – we care about the receiver information, not the sender

bandwidth = 100Kb/s
Interval: 0.00-5.04   sec
Transfer: 62.2 KBytes
Bitrate: 101 Kbits/sec
Jitter: 0.009 ms
Lost/Total Datagrams: 0/44 (0%)

bandwidth = 1Mb/s
Interval: 0.00-5.04   sec
Transfer: 611 KBytes
Bitrate: 922 Kbits/sec
Jitter: 0.005 ms
Lost/Total Datagrams: 0/432 (0%)

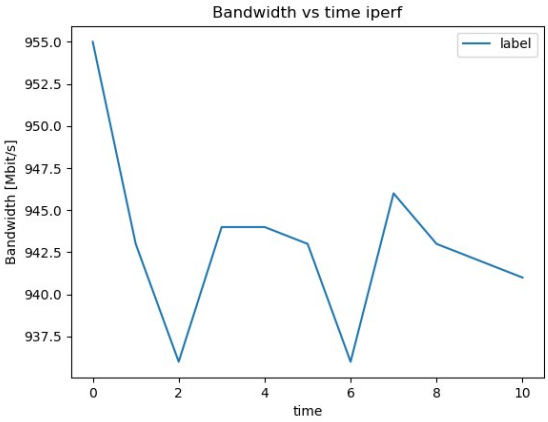
bandwidth = 100Mb/s
Interval: 0.00-5.04 sec
Transfer: 59.6 MBytes
Bitrate: 99.1 Mbits/sec
Jitter: 0.009 ms
Lost/Total Datagrams: 0/43157 (0%)

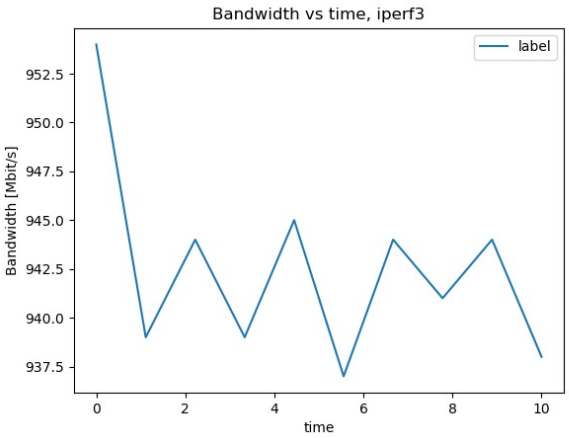
No packets were dropped for all of these bandwidths.

I increased the bandwidth until there were packets dropped, so it does happen, but just at a higher bandwidth than the bandwidths given in the exercise.

3. Differences between iperf and iperf3 results?

Comparing the same test done with iperf and iperf3:





Very similar spread of bandwidths over time, but iperf had slightly higher bit rates than iperf3 when the bandwidth was varied. The values do not differ by much, so the tests are nearly equivalent.

More jitter (latency variation) for iperf3. I’m not sure why this is.

Link to my repository: https://github.com/morodrigu/CWM-ProgNets