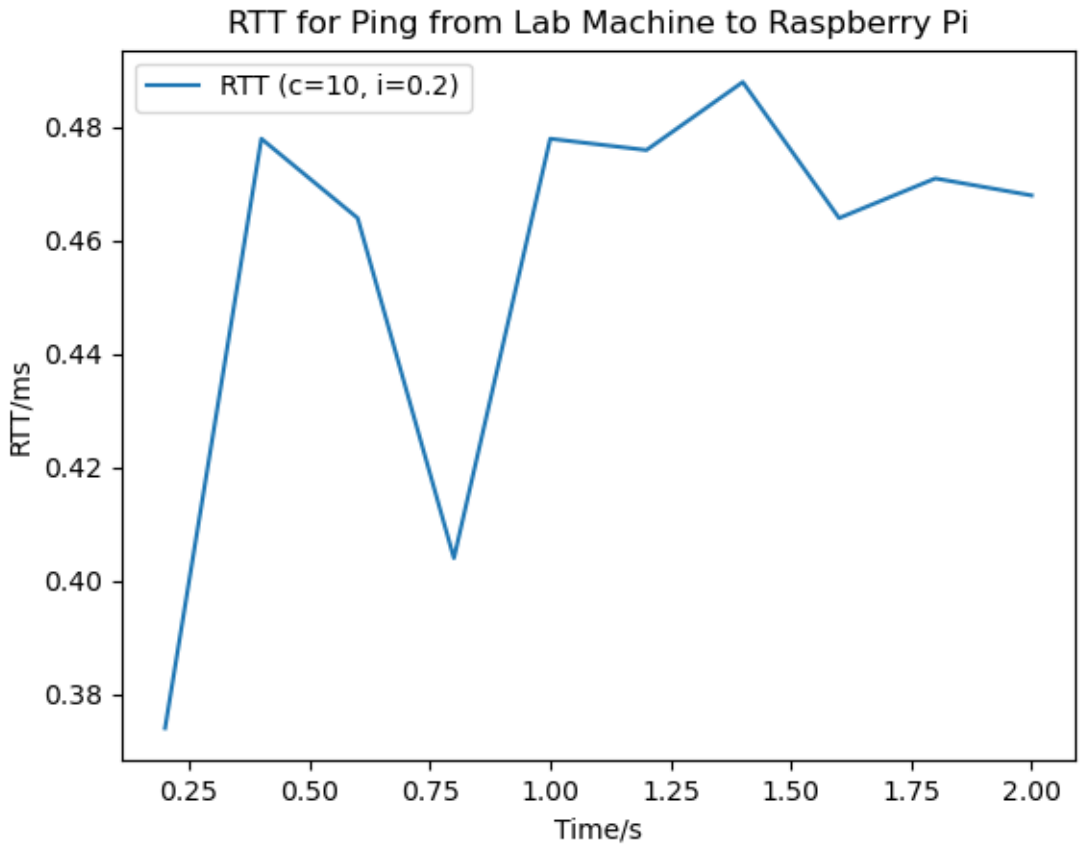
Exercise 2

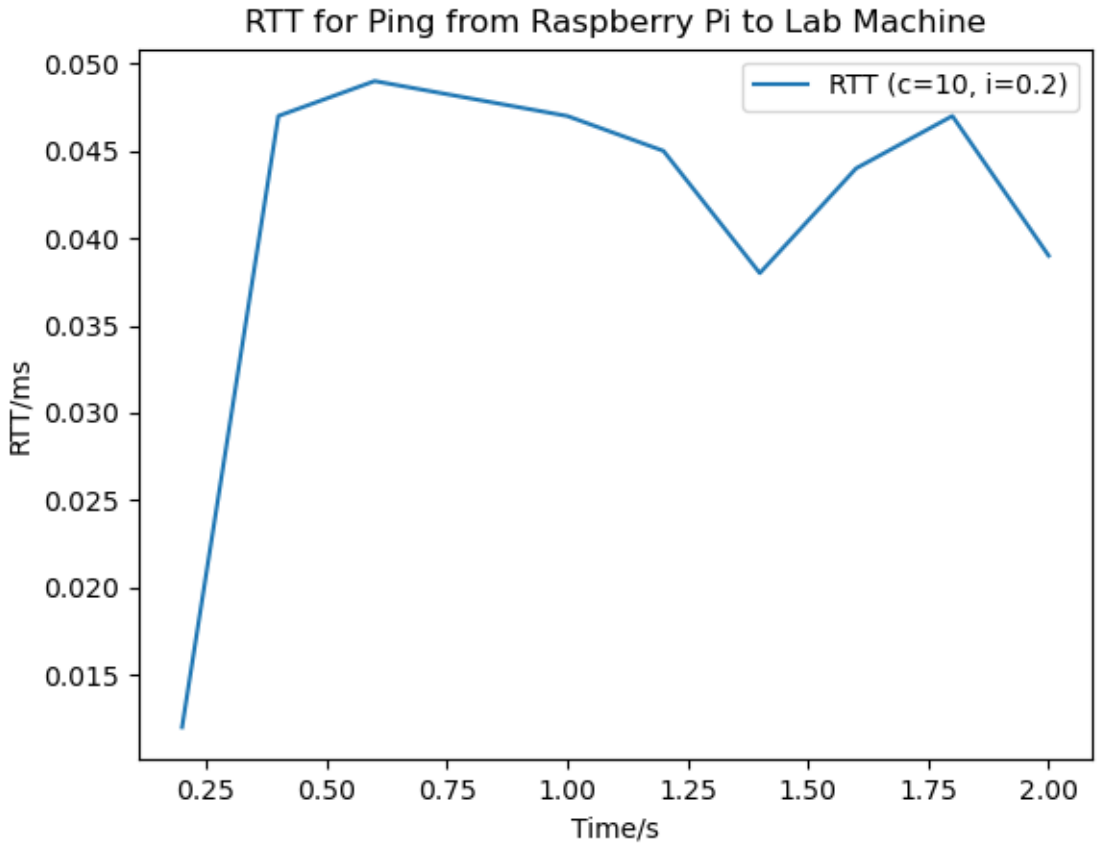
Ping:

1)



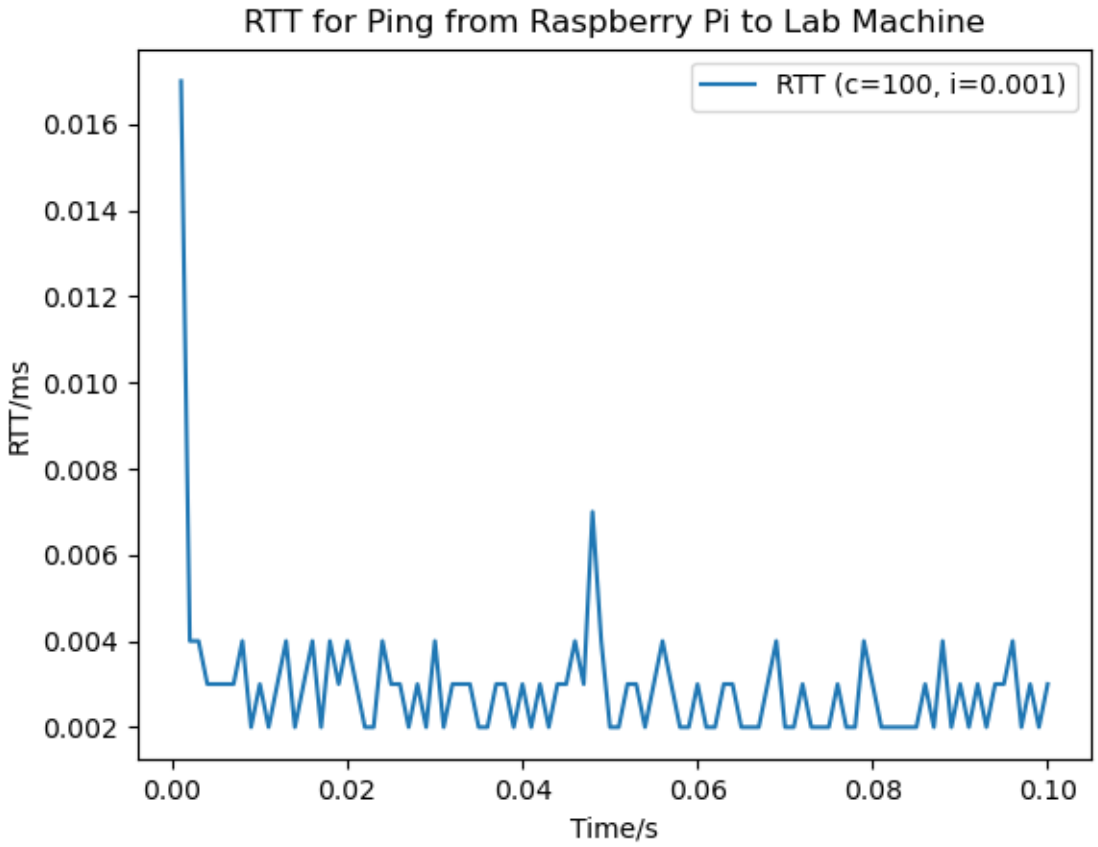
The rtt has a minimum value of 0.405 and a maximum value of 0.486.

2)



The rtt has a minimum value of 0.037 and a maximum value of 0.48.

3)



rtt has a minimum of 0.002, a mean of 0.003 and a maximum of 0.022

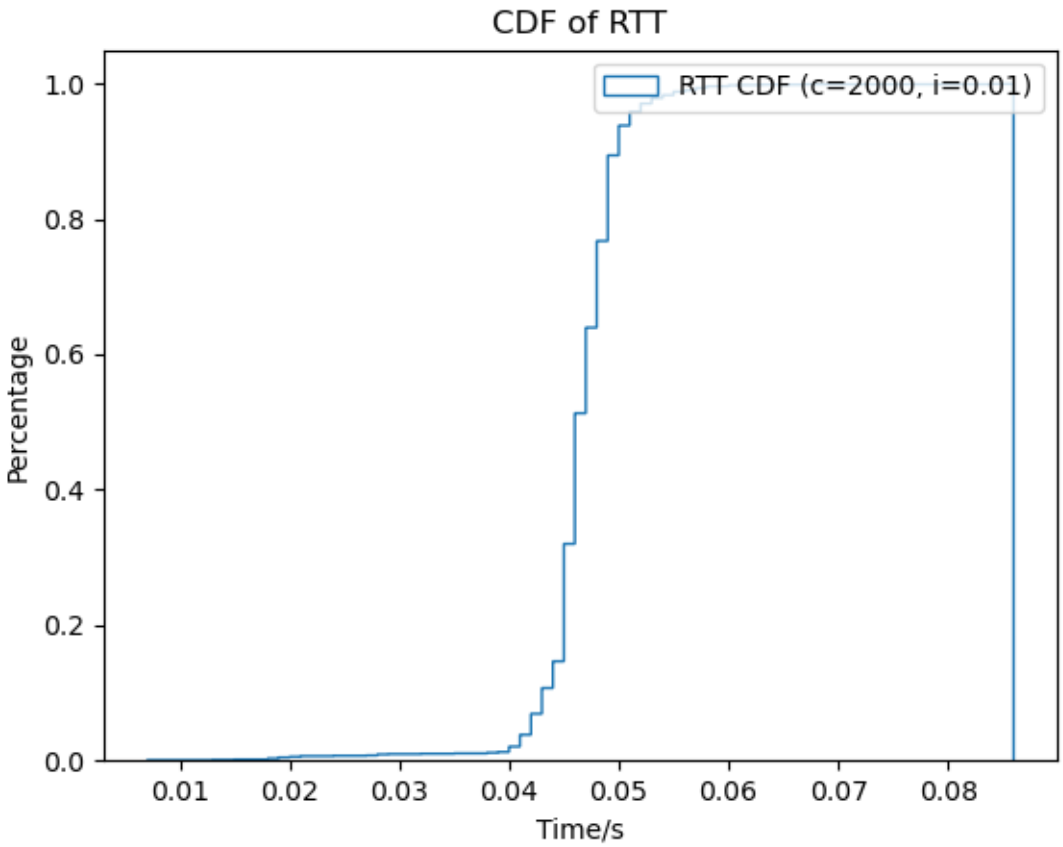
The peak at the start of the graph is due to the small time interval of 0.001. When the time interval is increased to 0.01, the spike disappears and the same happens for i=0.1.

4)

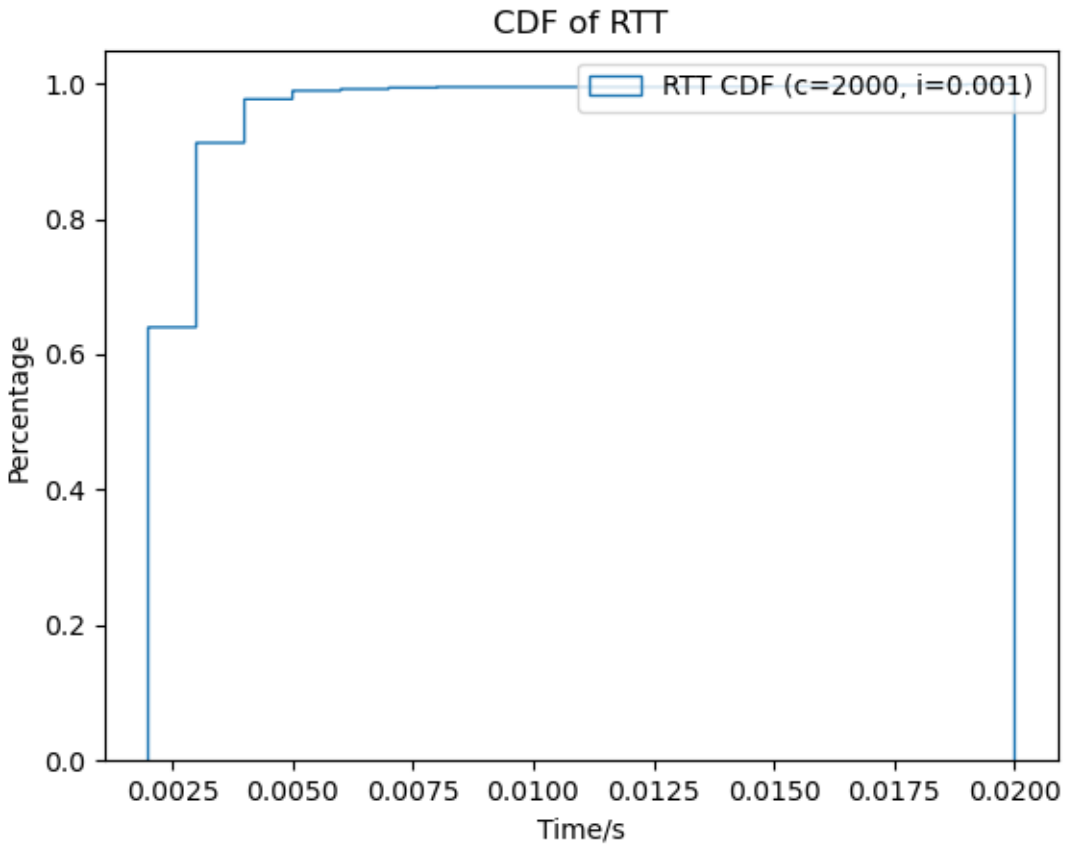
The rtt for flooding minimum is 0.002ms, the mean is 0.002ms and the maximum value is 0.033ms

5)

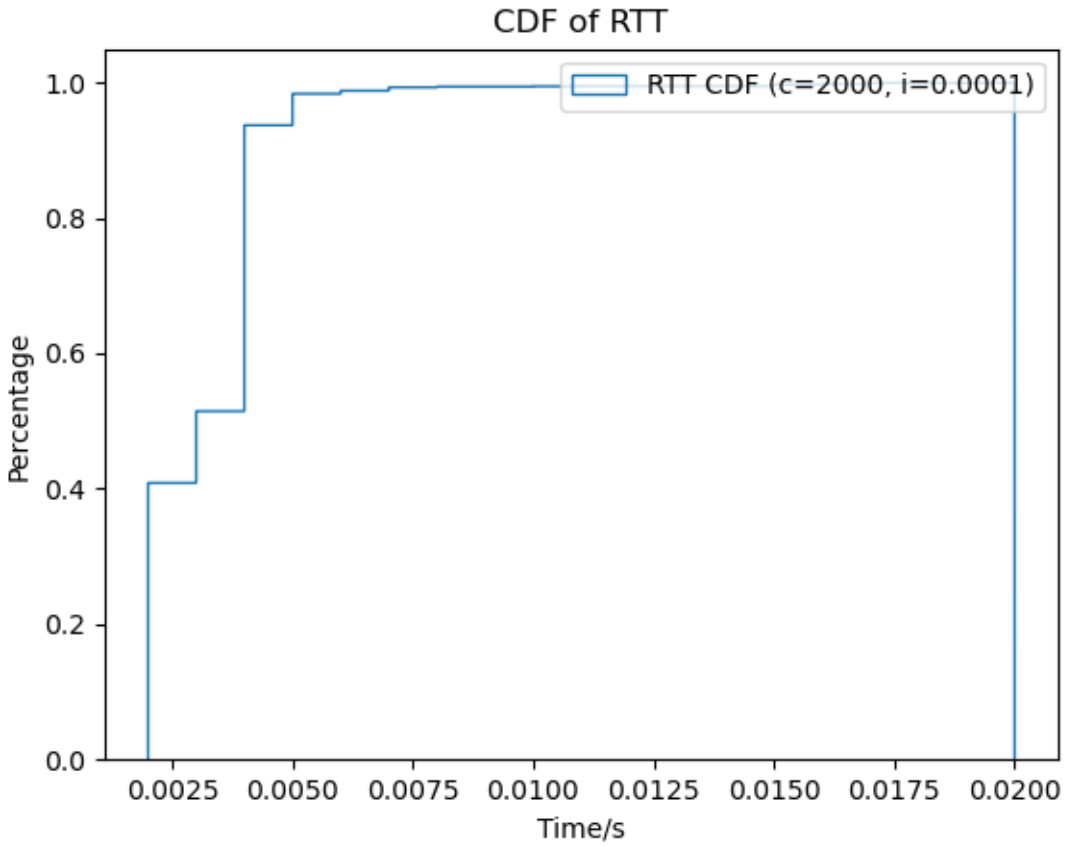
rtt min/avg/max/mdev = 0.016/0.044/0.099/0.005 ms



rtt min/avg/max/mdev = 0.002/0.002/0.026/0.001 ms



rtt min/avg/max/mdev = 0.002/0.003/0.031/0.001 ms, ipg/ewma 0.010/0.004 ms



6)
The CDF for 0.001 and 0.0001 are nearly identical since the shape is similar and the time scale is the same. The CDF for 0.01 is a typical CDF shape but the time scale is much larger.
I think the different intervals lead to different round trip times since the ping is trying to communicate at faster speeds so it requires the trip to be shorter. When the interval is too small, it caps out at a certain rtt distribution since the trips reach their maximum speed.

The mean is the most accurate measure to estimate propagation time since it takes into account all the values. The minimum and maximum are prone to outliers so they are not as reliable

iperf:

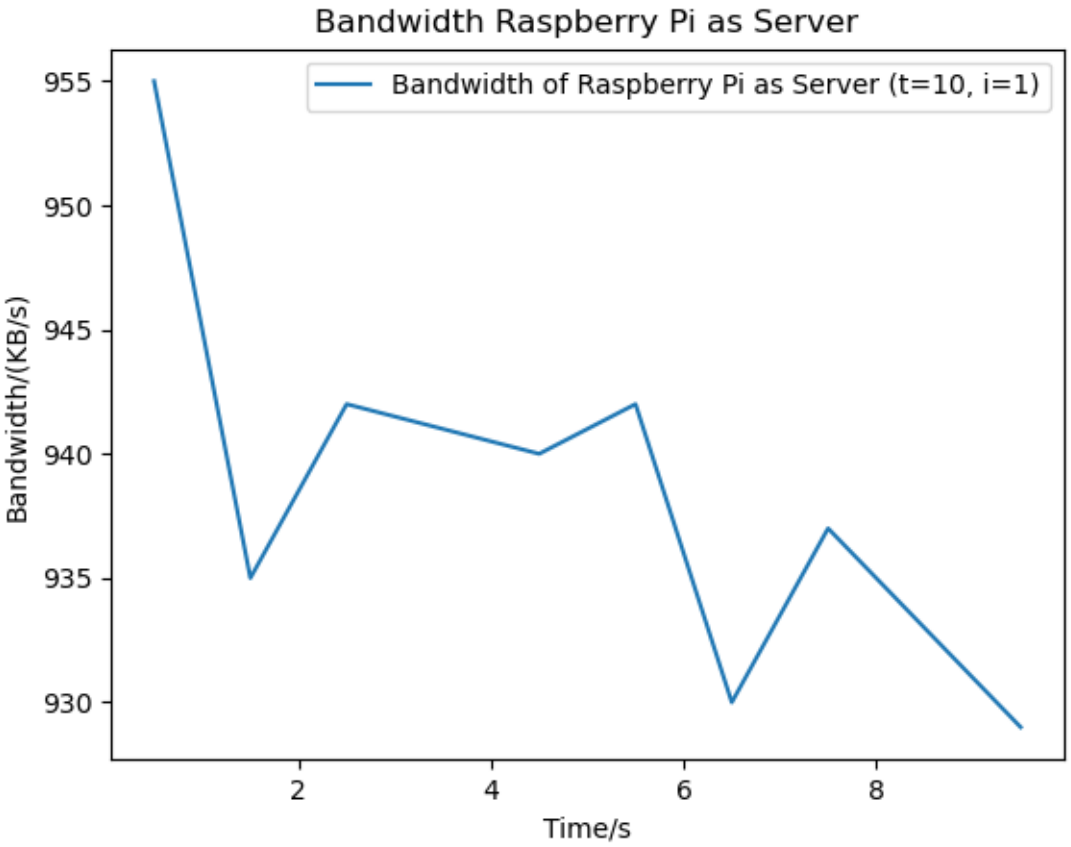
1)

```
pi@p4pi:~ $ iperf -c 192.168.10.1 -t 10
------------------------------------------------------------
Client connecting to 192.168.10.1, TCP port 5001
TCP window size: 85.0 KByte (default)
------------------------------------------------------------
[  3] local 192.168.10.2 port 49836 connected with 192.168.10.1 port 5001
[ ID] Interval       Transfer     Bandwidth
[  3] 0.0000-10.0060 sec  1.10 GBytes   941 Mbits/sec
```

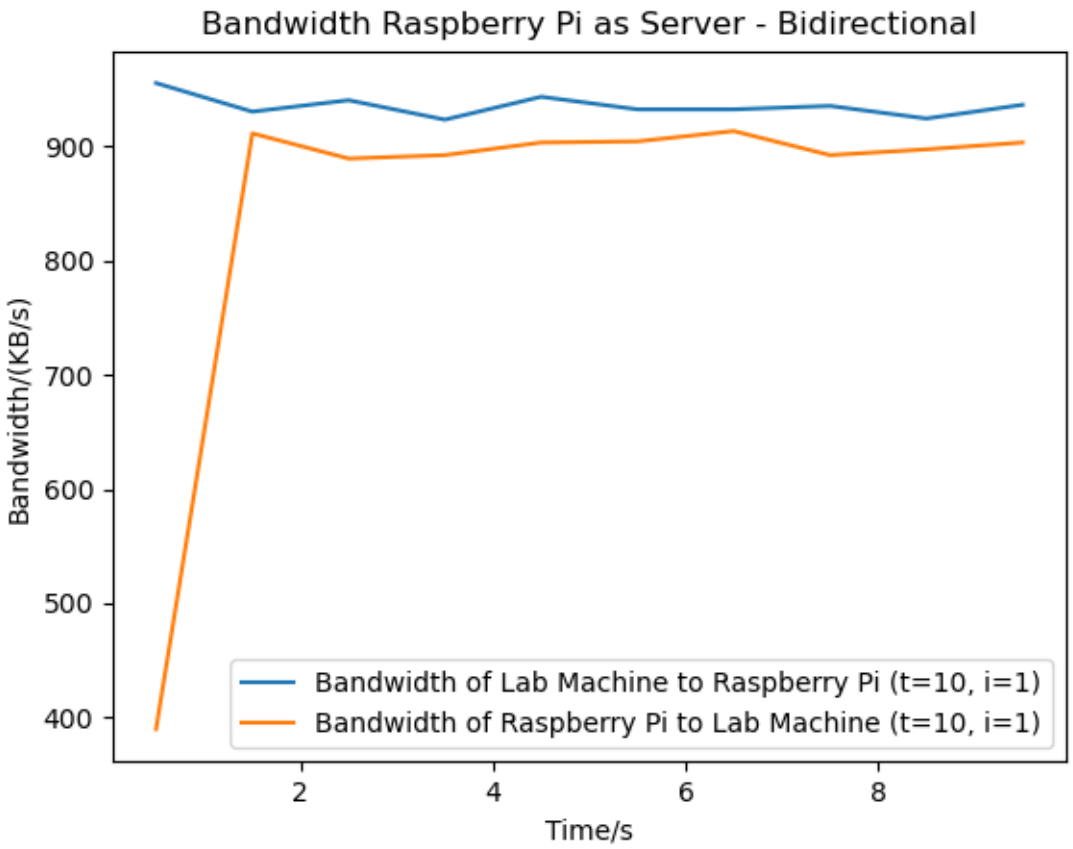
Effective Bandwidth is 941Mbits/s

2)

```
pi@p4pi:~ $ iperf -c 192.168.10.1 -t 10 -i 1
------------------------------------------------------------
Client connecting to 192.168.10.1, TCP port 5001
TCP window size:  162 KByte (default)
------------------------------------------------------------
[  3] local 192.168.10.2 port 49466 connected with 192.168.10.1 port 5001
[ ID] Interval       Transfer     Bandwidth
[  3] 0.0000-1.0000 sec   113 MBytes   951 Mbits/sec
[  3] 1.0000-2.0000 sec   113 MBytes   946 Mbits/sec
[  3] 2.0000-3.0000 sec   112 MBytes   943 Mbits/sec
[  3] 3.0000-4.0000 sec   112 MBytes   938 Mbits/sec
[  3] 4.0000-5.0000 sec   112 MBytes   941 Mbits/sec
[  3] 5.0000-6.0000 sec   112 MBytes   944 Mbits/sec
[  3] 6.0000-7.0000 sec   112 MBytes   941 Mbits/sec
[  3] 7.0000-8.0000 sec   112 MBytes   944 Mbits/sec
[  3] 8.0000-9.0000 sec   112 MBytes   940 Mbits/sec
[  3] 9.0000-10.0000 sec   112 MBytes   936 Mbits/sec
[  3] 10.0000-10.0033 sec   256 KBytes   634 Mbits/sec
[  3] 0.0000-10.0033 sec  1.10 GBytes   942 Mbits/sec
```



3)
The effective bandwidth of the lab machine to the raspberry pi is 932 Mbits/sec and the effective bandwidth of the raspberry pi to the lab machien is 850 Mbits/sec.


Bandwidth Raspberry Pi as Server - Bidirectional
Bandwidth/(KB/s)
900
800
700
600
500
400
2
4
6
8
Time/s
Bandwidth of Lab Machine to Raspberry Pi (t=10, i=1)
Bandwidth of Raspberry Pi to Lab Machine (t=10, i=1)

4)

```
ubuntu@ubuntu:~/CWM-ProgNets/assignment2$ iperf -s -B 192.168.10.1 -i 0.5 -t 5 -b 100k -u
------------------------------------------------------------
Server listening on UDP port 5001
UDP buffer size:  208 KByte (default)
------------------------------------------------------------
[  1] local 192.168.10.1 port 5001 connected with 192.168.10.2 port 39317
[ ID] Interval       Transfer     Bandwidth        Jitter   Lost/Total Datagrams
[  1] 0.0000-0.5000 sec  7.25 KBytes   119 Kbits/sec   0.098 ms 0/6 (0%)
[  1] 0.5000-1.0000 sec  5.74 KBytes  94.1 Kbits/sec   0.094 ms 0/4 (0%)
[  1] 1.0000-1.5000 sec  5.74 KBytes  94.1 Kbits/sec   0.089 ms 0/4 (0%)
[  1] 1.5000-2.0000 sec  7.18 KBytes   118 Kbits/sec   0.084 ms 0/5 (0%)
[  1] 2.0000-2.5000 sec  5.74 KBytes  94.1 Kbits/sec   0.084 ms 0/4 (0%)
[  1] 2.5000-3.0000 sec  5.74 KBytes  94.1 Kbits/sec   0.083 ms 0/4 (0%)
[  1] 3.0000-3.5000 sec  5.74 KBytes  94.1 Kbits/sec   0.079 ms 0/4 (0%)
[  1] 3.5000-4.0000 sec  7.18 KBytes   118 Kbits/sec   0.084 ms 0/5 (0%)
[  1] 4.0000-4.5000 sec  5.74 KBytes  94.1 Kbits/sec   0.094 ms 0/4 (0%)
[  1] 4.5000-5.0000 sec  5.74 KBytes  94.1 Kbits/sec   0.086 ms 0/4 (0%)
[  1] 0.0000-5.0565 sec  63.2 KBytes   102 Kbits/sec   0.090 ms 0/45 (0%)
```

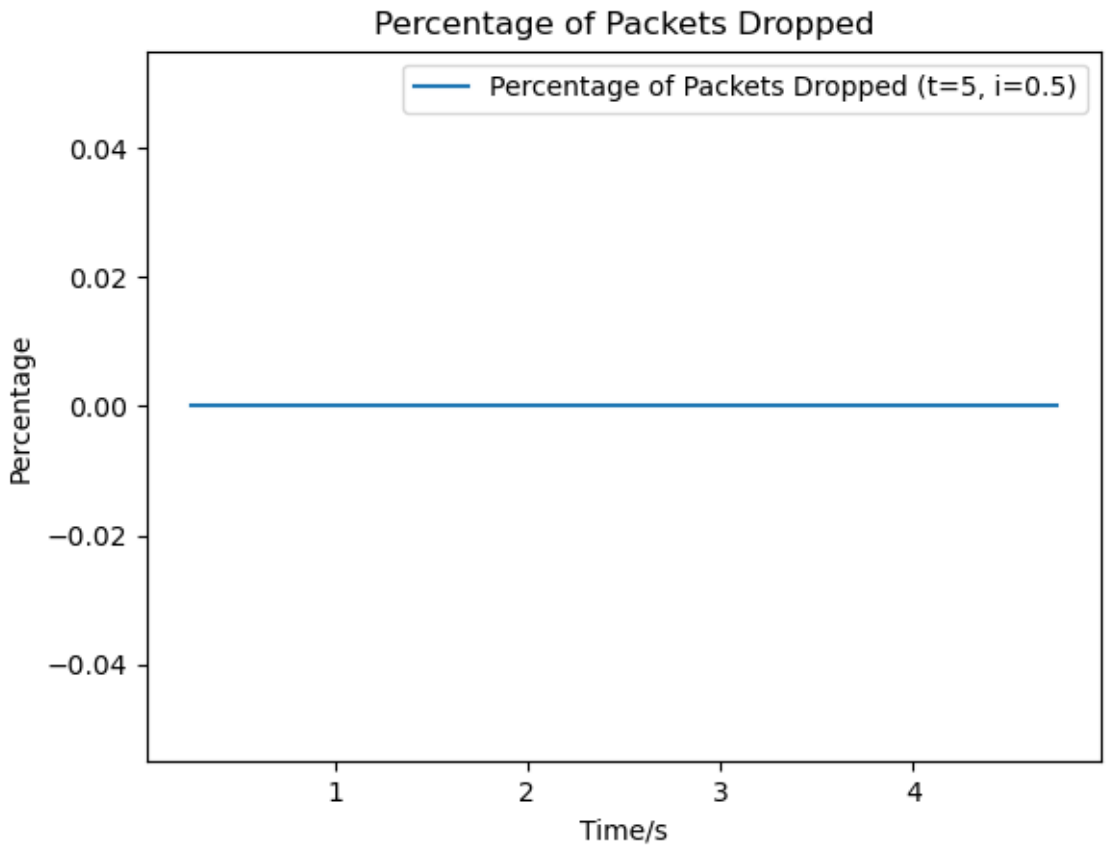
[1] 0.0000-5.0565 sec 63.2 KBytes 102 Kbits/sec 0.090 ms 0/45 (0%)

```
ubuntu@ubuntu:~/CWM-ProgNets/assignment2$ iperf -s -B 192.168.10.1 -i 0.5 -t 5 -b 1000k -u
------------------------------------------------------------
Server listening on UDP port 5001
UDP buffer size:  208 KByte (default)
------------------------------------------------------------
[  1] local 192.168.10.1 port 5001 connected with 192.168.10.2 port 51012
[ ID] Interval       Transfer     Bandwidth        Jitter   Lost/Total Datagrams
[  1] 0.0000-0.5000 sec  61.8 KBytes  1.01 Mbits/sec   0.064 ms 0/44 (0%)
[  1] 0.5000-1.0000 sec  61.7 KBytes  1.01 Mbits/sec   0.049 ms 0/43 (0%)
[  1] 1.0000-1.5000 sec  60.3 KBytes   988 Kbits/sec   0.056 ms 0/42 (0%)
[  1] 1.5000-2.0000 sec  61.7 KBytes  1.01 Mbits/sec   0.057 ms 0/43 (0%)
[  1] 2.0000-2.5000 sec  60.3 KBytes   988 Kbits/sec   0.058 ms 0/42 (0%)
[  1] 2.5000-3.0000 sec  61.7 KBytes  1.01 Mbits/sec   0.056 ms 0/43 (0%)
[  1] 3.0000-3.5000 sec  60.3 KBytes   988 Kbits/sec   0.088 ms 0/42 (0%)
[  1] 3.5000-4.0000 sec  61.7 KBytes  1.01 Mbits/sec   0.060 ms 0/43 (0%)
[  1] 4.0000-4.5000 sec  60.3 KBytes   988 Kbits/sec   0.058 ms 0/42 (0%)
[  1] 4.5000-5.0000 sec  61.7 KBytes  1.01 Mbits/sec   0.053 ms 0/43 (0%)
[  1] 0.0000-5.0098 sec   613 KBytes  1.00 Mbits/sec   0.051 ms 0/428 (0%)
```

[1] 0.0000-5.0098 sec 613 KBytes 1.00 Mbits/sec 0.051 ms 0/428 (0%)

```
ubuntu@ubuntu:~/CWM-ProgNets/assignment2$ iperf -s -B 192.168.10.1 -i 0.5 -t 5 -b 100000k -u
------------------------------------------------------------
Server listening on UDP port 5001
UDP buffer size:  208 KByte (default)
------------------------------------------------------------
[  1] local 192.168.10.1 port 5001 connected with 192.168.10.2 port 58836
[ ID] Interval       Transfer     Bandwidth        Jitter   Lost/Total Datagrams
[  1] 0.0000-0.5000 sec  5.96 MBytes   100 Mbits/sec   0.019 ms 0/4255 (0%)
[  1] 0.5000-1.0000 sec  5.96 MBytes   100 Mbits/sec   0.018 ms 0/4252 (0%)
[  1] 1.0000-1.5000 sec  5.96 MBytes   100 Mbits/sec   0.017 ms 0/4251 (0%)
[  1] 1.5000-2.0000 sec  5.96 MBytes   100 Mbits/sec   0.018 ms 0/4252 (0%)
[  1] 2.0000-2.5000 sec  5.96 MBytes   100 Mbits/sec   0.018 ms 0/4253 (0%)
[  1] 2.5000-3.0000 sec  5.96 MBytes   100 Mbits/sec   0.017 ms 0/4252 (0%)
[  1] 3.0000-3.5000 sec  5.96 MBytes   100 Mbits/sec   0.018 ms 0/4251 (0%)
[  1] 3.5000-4.0000 sec  5.96 MBytes   100 Mbits/sec   0.017 ms 0/4252 (0%)
[  1] 4.0000-4.5000 sec  5.96 MBytes   100 Mbits/sec   0.017 ms 0/4251 (0%)
[  1] 4.5000-4.9999 sec  5.96 MBytes   100 Mbits/sec   0.018 ms 0/4252 (0%)
[  1] 0.0000-4.9999 sec  59.6 MBytes   100 Mbits/sec   0.018 ms 0/42521 (0%)
```

[1] 0.0000-4.9999 sec 59.6 MBytes 100 Mbits/sec 0.018 ms 0/42521 (0%)

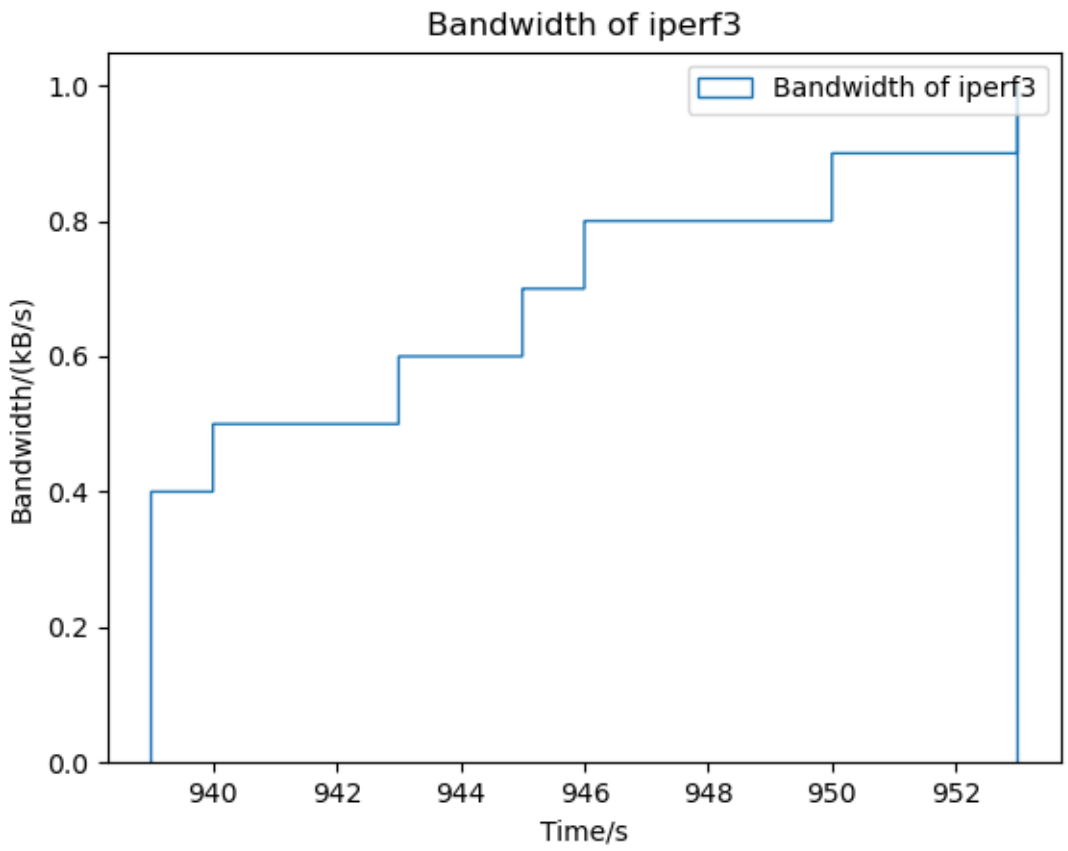


No packets are dropped so the line is flat.

iperf3)

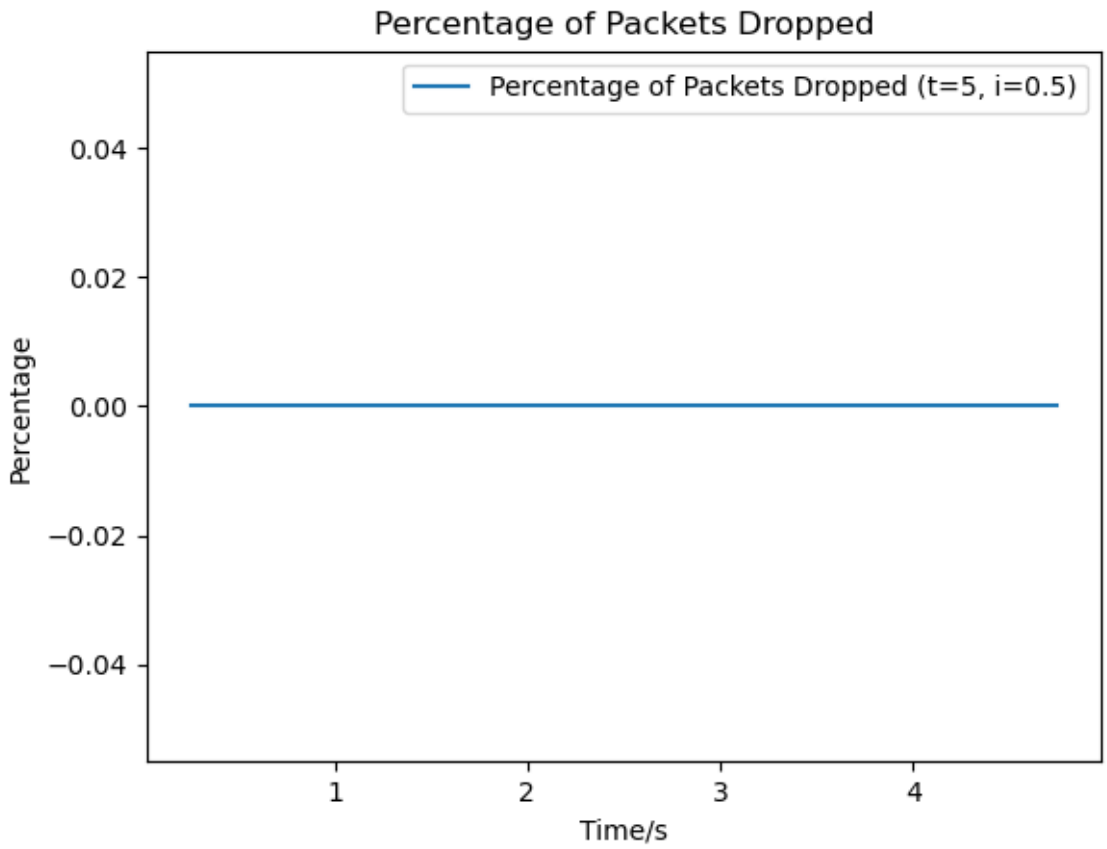
1)

Effective bandwidth of sender is 943 Mbits/sec.
Effective bandwidth of receiver is 937 Mbits/sec.



2)

```
Accepted connection from 192.168.10.2, port 44218
[  5] local 192.168.10.1 port 5201 connected to 192.168.10.2 port 37650
[ ID] Interval           Transfer     Bitrate         Jitter    Lost/Total Datagrams
[  5]   0.00-1.00   sec  12.7 KBytes   104 Kbits/sec  0.018 ms  0/9 (0%)
[  5]   1.00-2.00   sec  11.3 KBytes  92.7 Kbits/sec  0.046 ms  0/8 (0%)
[  5]   2.00-3.00   sec  12.7 KBytes   104 Kbits/sec  0.051 ms  0/9 (0%)
[  5]   3.00-4.00   sec  12.7 KBytes   104 Kbits/sec  0.046 ms  0/9 (0%)
[  5]   4.00-5.00   sec  11.3 KBytes  92.7 Kbits/sec  0.041 ms  0/8 (0%)
[  5]   5.00-5.04   sec  1.41 KBytes   291 Kbits/sec  0.052 ms  0/1 (0%)
- - - - - - - - - - - - - - - - - - - - - - - - -
[ ID] Interval           Transfer     Bitrate         Jitter    Lost/Total Datagrams
[  5]   0.00-5.04   sec  62.2 KBytes   101 Kbits/sec  0.052 ms  0/44 (0%)  receiver
-----------------------------------------------------------
Server listening on 5201
-----------------------------------------------------------
Accepted connection from 192.168.10.2, port 54596
[  5] local 192.168.10.1 port 5201 connected to 192.168.10.2 port 34285
[ ID] Interval           Transfer     Bitrate         Jitter    Lost/Total Datagrams
[  5]   0.00-1.00   sec   117 KBytes   961 Kbits/sec  0.048 ms  0/83 (0%)
[  5]   1.00-2.00   sec   122 KBytes   996 Kbits/sec  0.069 ms  0/86 (0%)
[  5]   2.00-3.00   sec   123 KBytes  1.01 Mbits/sec  0.056 ms  0/87 (0%)
[  5]   3.00-4.00   sec   122 KBytes   996 Kbits/sec  0.046 ms  0/86 (0%)
[  5]   4.00-5.00   sec   122 KBytes   996 Kbits/sec  0.082 ms  0/86 (0%)
[  5]   5.00-5.04   sec  5.66 KBytes  1.06 Mbits/sec  0.085 ms  0/4 (0%)
- - - - - - - - - - - - - - - - - - - - - - - - -
[ ID] Interval           Transfer     Bitrate         Jitter    Lost/Total Datagrams
[  5]   0.00-5.04   sec   611 KBytes   992 Kbits/sec  0.085 ms  0/432 (0%)  receiver
-----------------------------------------------------------
Server listening on 5201
-----------------------------------------------------------
Accepted connection from 192.168.10.2, port 47774
[  5] local 192.168.10.1 port 5201 connected to 192.168.10.2 port 57745
[ ID] Interval           Transfer     Bitrate         Jitter    Lost/Total Datagrams
[  5]   0.00-1.00   sec  11.4 MBytes  95.6 Mbits/sec  0.020 ms  0/8255 (0%)
[  5]   1.00-2.00   sec  11.9 MBytes   100 Mbits/sec  0.022 ms  0/8633 (0%)
[  5]   2.00-3.00   sec  11.9 MBytes   100 Mbits/sec  0.021 ms  0/8633 (0%)
[  5]   3.00-4.00   sec  11.9 MBytes   100 Mbits/sec  0.026 ms  0/8632 (0%)
[  5]   4.00-5.00   sec  11.9 MBytes   100 Mbits/sec  0.020 ms  0/8633 (0%)
[  5]   5.00-5.04   sec   525 KBytes  98.8 Mbits/sec  0.020 ms  0/371 (0%)
- - - - - - - - - - - - - - - - - - - - - - - - -
[ ID] Interval           Transfer     Bitrate         Jitter    Lost/Total Datagrams
[  5]   0.00-5.04   sec  59.6 MBytes  99.1 Mbits/sec  0.020 ms  0/43157 (0%)  receiver
-----------------------------------------------------------
Server listening on 5201
-----------------------------------------------------------
```



3) In both iperf and iperf3, there are no packets dropped so both graphs are identical. There is no noticeable difference due to there being no packets dropped on either.

Link to directory:
https://github.com/VKing15/CWM-ProgNets.git