Wireless Networks

Assignment 2

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Note: The references and the execution instructions can be found in `scripts/README.` I asked Prof. Arani and he allowed me to use the public iperf3 server iperf.worldstream.nl instead of running the server on a different machine. I found found about this server from https://www.reddit.com/r/homelab/comments/slojqr/any_good_public_iperf_servers/

Q1. Connect two computers over a wireless network. Then, utilize `iperf` to set up one of them as a server and the other as a client. Run it for 2 minutes using TCP-Cubic (Linux's default TCP) and plot the throughput reported throughout.

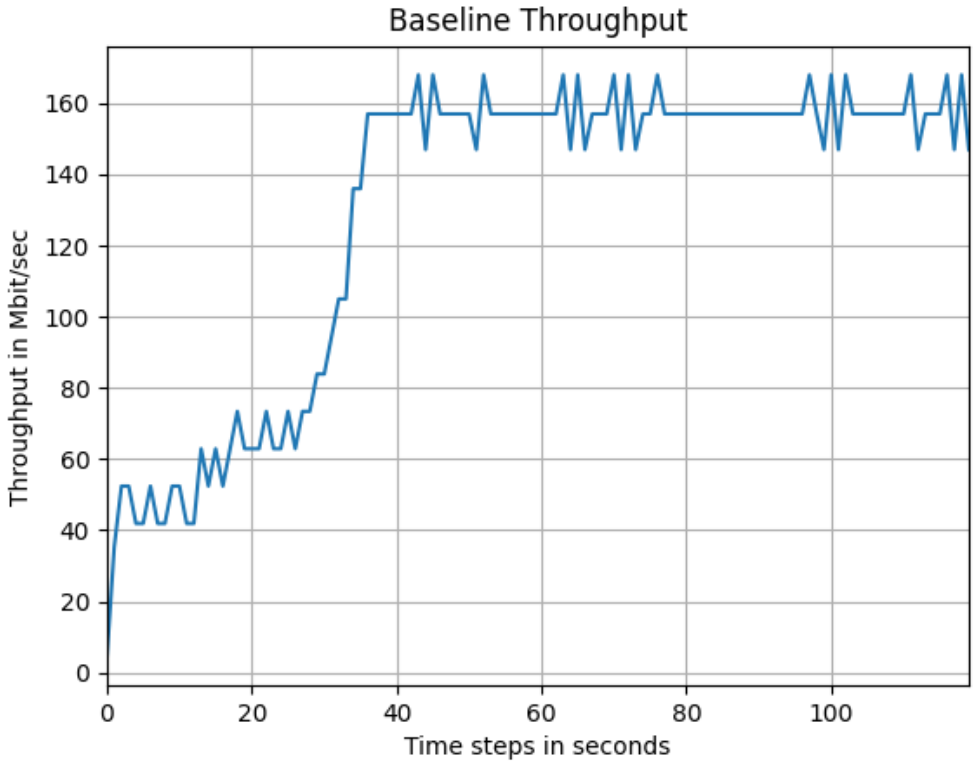
The command used to collect the trace:

```
~/IIITD-W/W/WN_Assignment-2/scripts main !2 ?1 ❯ ./client.sh iperf.worldstream.nl 5201 ../traces/q1
Starting the client. Talking to iperf.worldstream.nl:5201
~/IIITD-W/W/WN_Assignment-2/scripts main !2 ?1 ❯
```

The command used to plot the trace:

```
~/IIITD-W23/WN/WN_Assignment-2 main +5 ❯ python3 plotter.py traces/q1 plots/q1.png Baseline Throughput
```

The plot:



Q2. On one of the machines, run `tc` to add 100 ms of delay. Again, run `iperf` for 2 minutes
and plot the throughput reported. Repeat the above for 200 ms.

The command used to get the name of the NIC:

```
~/IIITD-W23/WN/WN_Assignment-2/traces main !2 ?1 ❯ ip addr
1: lo: <LOOPBACK,UP,LOWER_UP> mtu 65536 qdisc noqueue state UNKNOWN group default qlen 1000
    link/loopback 00:00:00:00:00:00 brd 00:00:00:00:00:00
    inet 127.0.0.1/8 scope host lo
       valid_lft forever preferred_lft forever
    inet6 ::1/128 scope host
       valid_lft forever preferred_lft forever
2: enp44s0: <NO-CARRIER,BROADCAST,MULTICAST,UP> mtu 1500 qdisc fq_codel state DOWN group default qlen 1000
    link/ether 08:8f:c3:2e:a4:56 brd ff:ff:ff:ff:ff:ff
3: wlp0s20f3: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc netem state UP group default qlen 1000
    link/ether f4:7b:09:50:b5:ea brd ff:ff:ff:ff:ff:ff
    inet 192.168.0.196/24 brd 192.168.0.255 scope global dynamic noprefixroute wlp0s20f3
       valid_lft 604015sec preferred_lft 604015sec
    inet6 fe80::4868:a3a4:8f5d:eff/64 scope link noprefixroute
       valid_lft forever preferred_lft forever
```

The commands used to collect the traces:

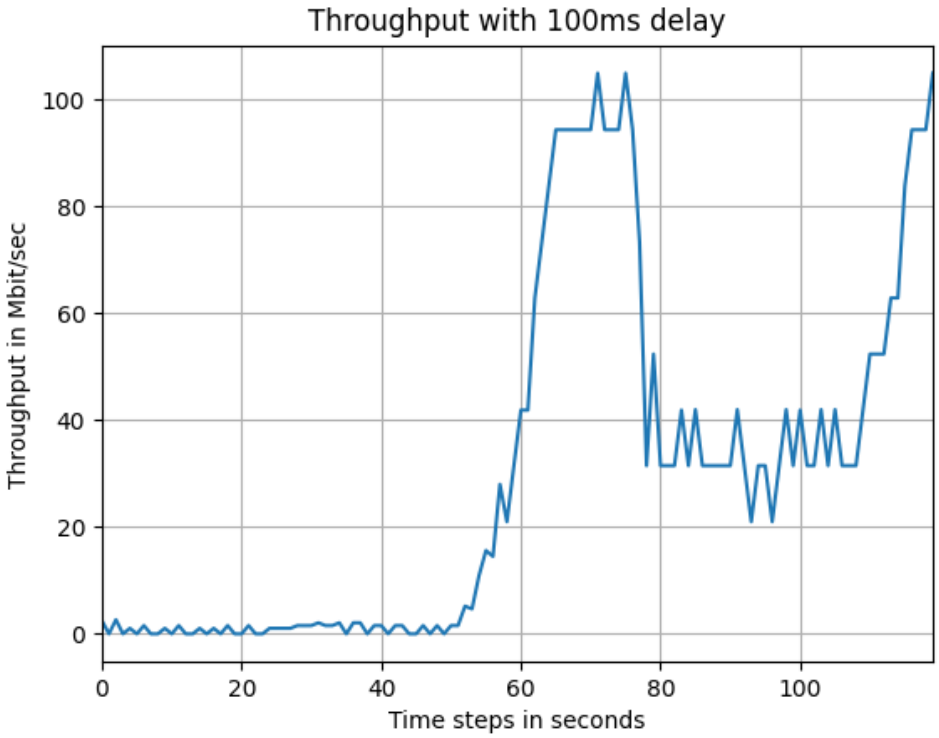
```
~/IIITD-W/W/WN_Assignment-2/scripts main +5 !1 ❯ ./q2a.sh wlp0s20f3 && ./client.sh iperf.worldstream.nl 5201 ../traces/q2a && ./cleanup.sh wlp0s20f3
qdisc netem 8005: root refcnt 2 limit 1000 delay 100ms
Starting the client. Talking to iperf.worldstream.nl:5201
qdisc noqueue 0: root refcnt 2
```

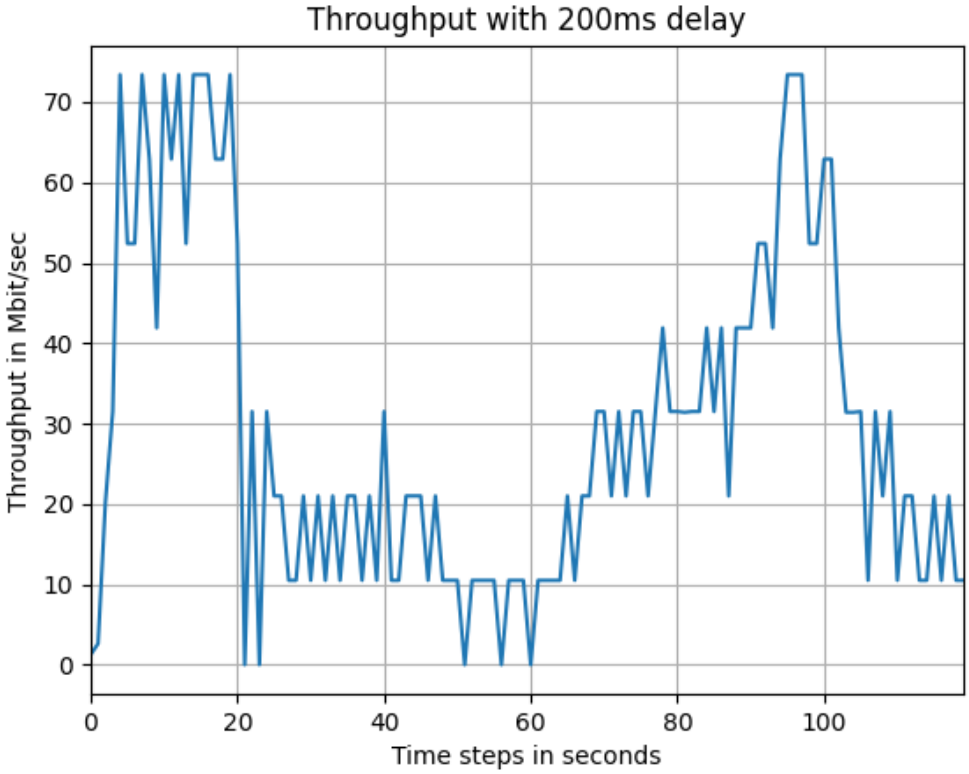
```
~/IIITD-W/W/WN_Assignment-2/scripts main +5 !1 ❯ ./q2b.sh wlp0s20f3 && ./client.sh iperf.worldstream.nl 5201 ../traces/q2b && ./cleanup.sh wlp0s20f3
qdisc netem 8006: root refcnt 2 limit 1000 delay 200ms
Starting the client. Talking to iperf.worldstream.nl:5201
qdisc noqueue 0: root refcnt 2
```

The commands used to plot the traces:

```
~/IIITD-W23/WN/WN_Assignment-2 main +6 ❯ python3 plotter.py traces/q2a plots/q2a.png Throughput with 100ms delay
~/IIITD-W23/WN/WN_Assignment-2 main +6 ?2 ❯ python3 plotter.py traces/q2b plots/q2b.png Throughput with 200ms delay
```

The plots:


Throughput with 100ms delay
Throughput in Mbit/sec
Time steps in seconds
0
20
40
60
80
100


Throughput with 200ms delay
Throughput in Mbit/sec
Time steps in seconds
0
10
20
30
40
50
60
70
0
20
40
60
80
100

Q3. Again run `tc` to restrict the bandwidth to 50 Kilobytes per second for the first 1 minute,
and remove the restriction for the next minute. Again plot the throughput reported.

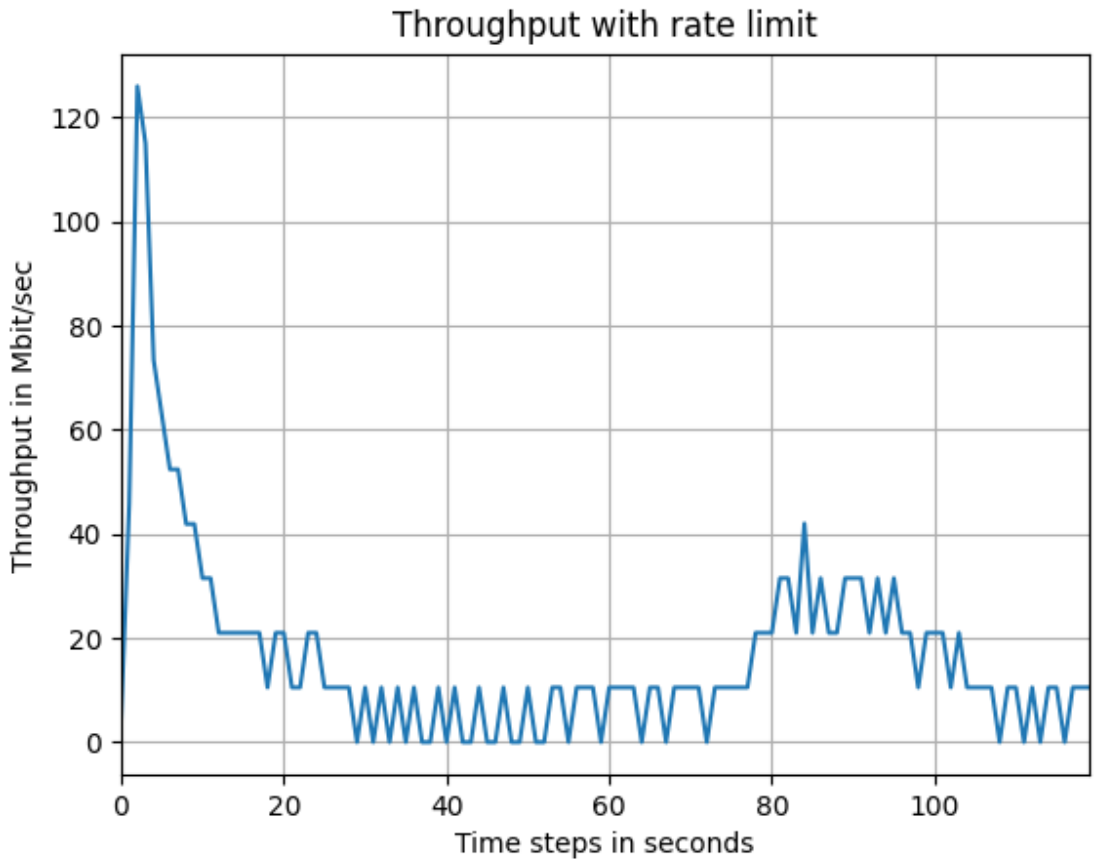
The command used to collect the trace:

```
~/IIITD-W/WN/WN_Assignment-2/scripts main !2 ?1 ❯ ./q3.sh wlp0s20f3 && ./client.sh iperf.worldstream.nl 5201 ../traces/q3 && ./cleanup.sh wlp0s20f3
[sudo] password for setu:
qdisc netem 8007: root refcnt 2 limit 1000 rate 400Kbit
qdisc noqueue 0: root refcnt 2
Starting the client. Talking to iperf.worldstream.nl:5201
Error: Cannot delete qdisc with handle of zero.
qdisc noqueue 0: root refcnt 2
```

The command used to plot the trace:

```
~/IIITD-W23/WN/WN_Assignment-2 main +6 ?3 ❯ python3 plotter.py traces/q3 plots/q3.png Throughput with rate limit
```

The plot:



Q4. Now, run `tc` to add 0.01%, 1% and 5% of packet losses. Run `iperf` to note the throughput
reported and plot it over 2 minutes.

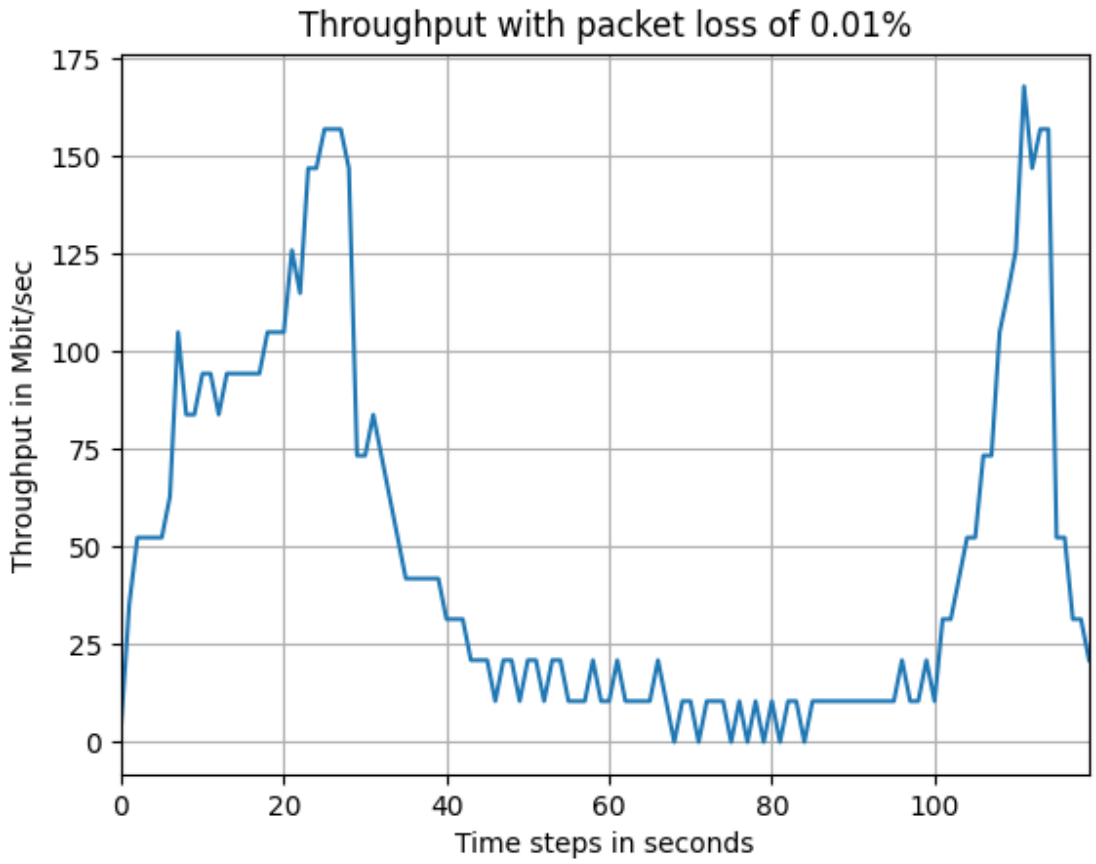
The commands used to collect the traces:

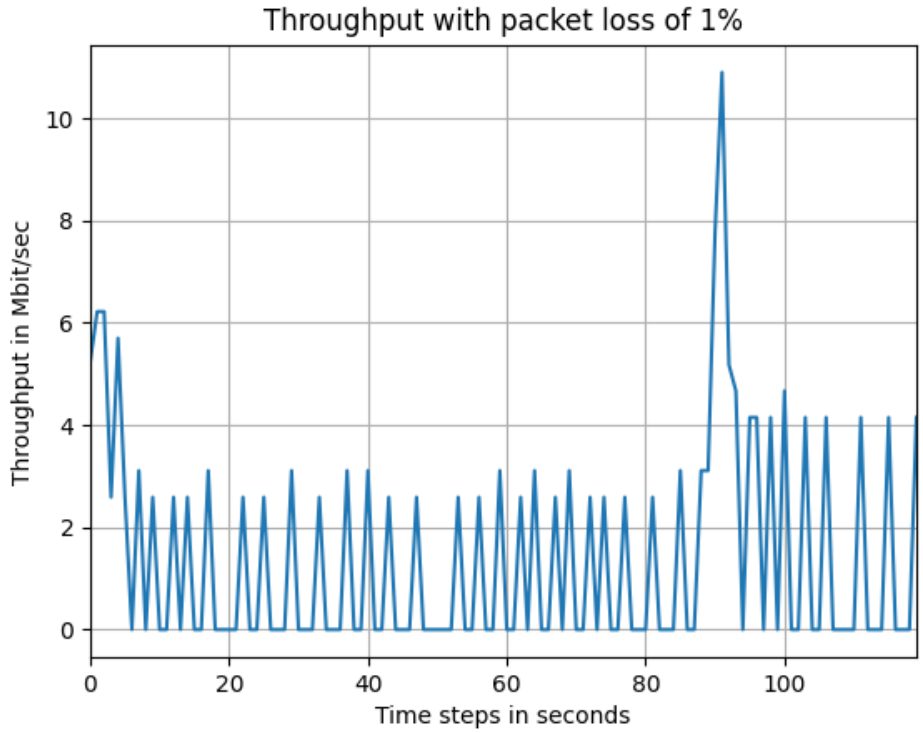
```
~/IIITD-W/WN/WN_Assignment-2/scripts main +11 !1 ❯ ./q4a.sh wlp0s20f3 && ./client.sh iperf.worldstream.nl 5201 ../traces/q4a && ./cleanup.sh wlp0s20f3
[sudo] password for setu:
qdisc netem 8009: root refcnt 2 limit 1000 loss 0.01%
Starting the client. Talking to iperf.worldstream.nl:5201
qdisc noqueue 0: root refcnt 2
~/IIITD-W/W/WN_Assignment-2/scripts main +11 !1 ❯ ./q4b.sh wlp0s20f3 && ./client.sh iperf.worldstream.nl 5201 ../traces/q4b && ./cleanup.sh wlp0s20f3
qdisc netem 800a: root refcnt 2 limit 1000 loss 1%
Starting the client. Talking to iperf.worldstream.nl:5201
qdisc noqueue 0: root refcnt 2
~/IIITD-W/W/WN_Assignment-2/scripts main +11 !1 ?2 ❯ ./q4c.sh wlp0s20f3 && ./client.sh iperf.worldstream.nl 5201 ../traces/q4c && ./cleanup.sh wlp0s20f
3
qdisc netem 800b: root refcnt 2 limit 1000 loss 5%
Starting the client. Talking to iperf.worldstream.nl:5201
qdisc noqueue 0: root refcnt 2
```

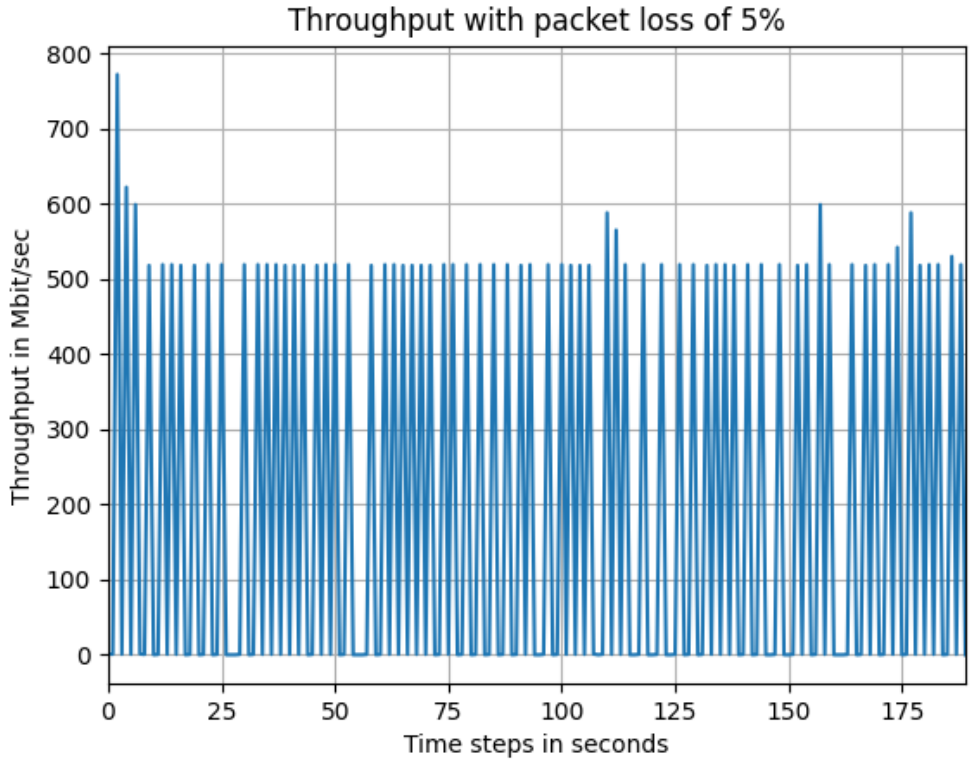
The commands used to plot the traces:

```
~/IIITD-W23/WN/WN_Assignment-2 main +11 ❯ python3 plotter.py traces/q4a plots/q4a.png Throughput with packet loss of 0.01%
~/IIITD-W23/WN/WN_Assignment-2 main +11 !1 ?2 ❯ python3 plotter.py traces/q4b plots/q4b.png Throughput with packet loss of 1%
~/IIITD-W23/WN/WN_Assignment-2 main +11 !1 ?4 ❯ python3 plotter.py traces/q4c plots/q4c.png Throughput with packet loss of 5%
```

The plots:




Throughput with packet loss of 1%
Throughput in Mbit/sec
Time steps in seconds
0
2
4
6
8
10
0
20
40
60
80
100


Throughput with packet loss of 5%
Throughput in Mbit/sec
Time steps in seconds
0
100
200
300
400
500
600
700
800
0
25
50
75
100
125
150
175

Q5. Ensure that 30% of the packets are duplicated, due to the assumption of lost packets. Run

`iperf` to note the throughput reported and plot it over 2 minutes.

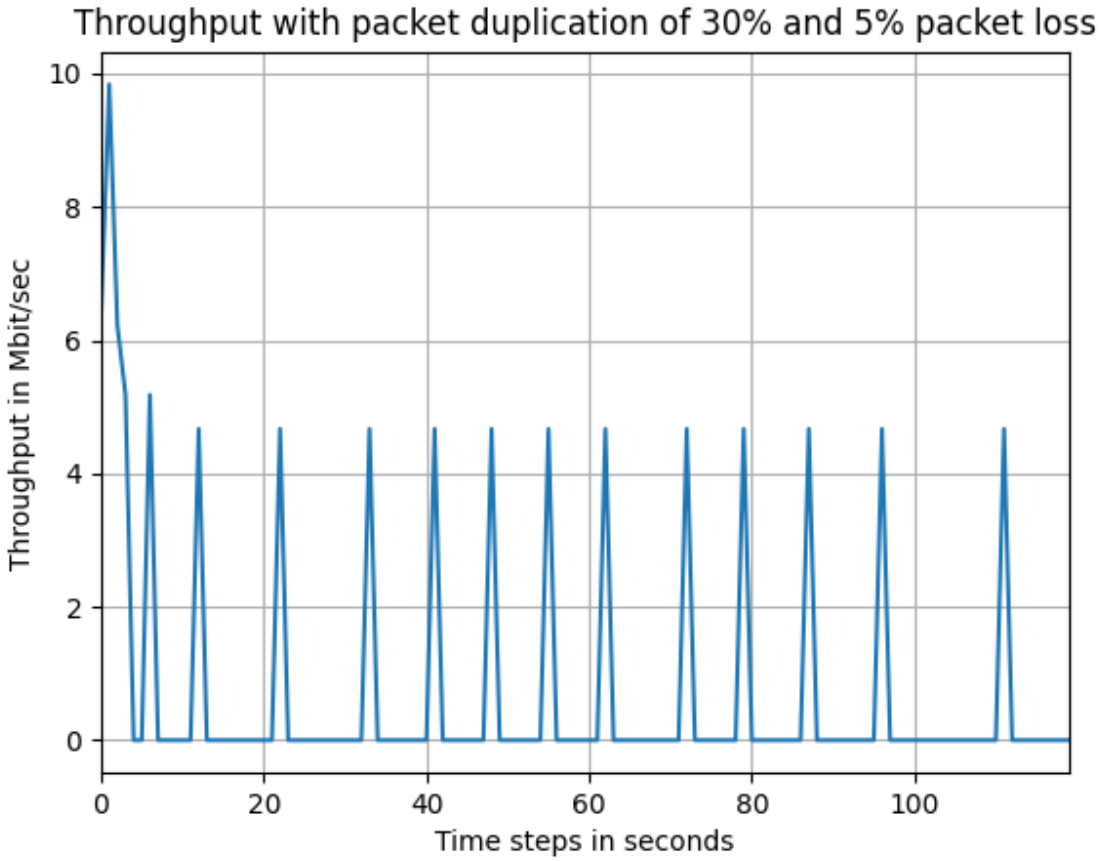
The command used to collect the trace:

```
~/IIITD-W23/WN/WN_Assignment-2/scripts main !2 ?1 ❯ ./q5.sh wlp0s20f3 && ./client.sh iperf.worldstream.nl 5201 ../traces/q5 && ./cleanup.sh wlp0s20f3
[sudo] password for setu:
qdisc netem 800c: root refcnt 2 limit 1000 loss 5% duplicate 30%
Starting the client. Talking to iperf.worldstream.nl:5201
qdisc noqueue 0: root refcnt 2
```

The command used to plot the trace:

```
~/IIITD-W23/WN/WN_Assignment-2 main +11 !1 ?7 ❯ python3 plotter.py traces/q5 plots/q5.png Throughput with packet duplication of 30% and 5% packet loss
```

The plot:



Q5. Same as above but this time without packet loss and with just 30% duplication.

The command used to collect the trace:

```
~/IIITD-W23/WN/WN_Assignment-2/scripts main +19 ❯ ./q5_noloss.sh wlp0s20f3 && ./client.sh iperf.worldstream.nl 5201 ../traces/q5_noloss && ./cleanup.sh
 wlp0s20f3
qdisc netem 800d: root refcnt 2 limit 1000 duplicate 30%
Starting the client. Talking to iperf.worldstream.nl:5201
qdisc noqueue 0: root refcnt 2
```

The command used to plot the trace:

```
~/IIITD-W23/WN/WN_Assignment-2 main +11 !1 ?7 ❯ python3 plotter.py traces/q5_noloss plots/q5_noloss.png Throughput with packet duplication of 30%
```

The plot: