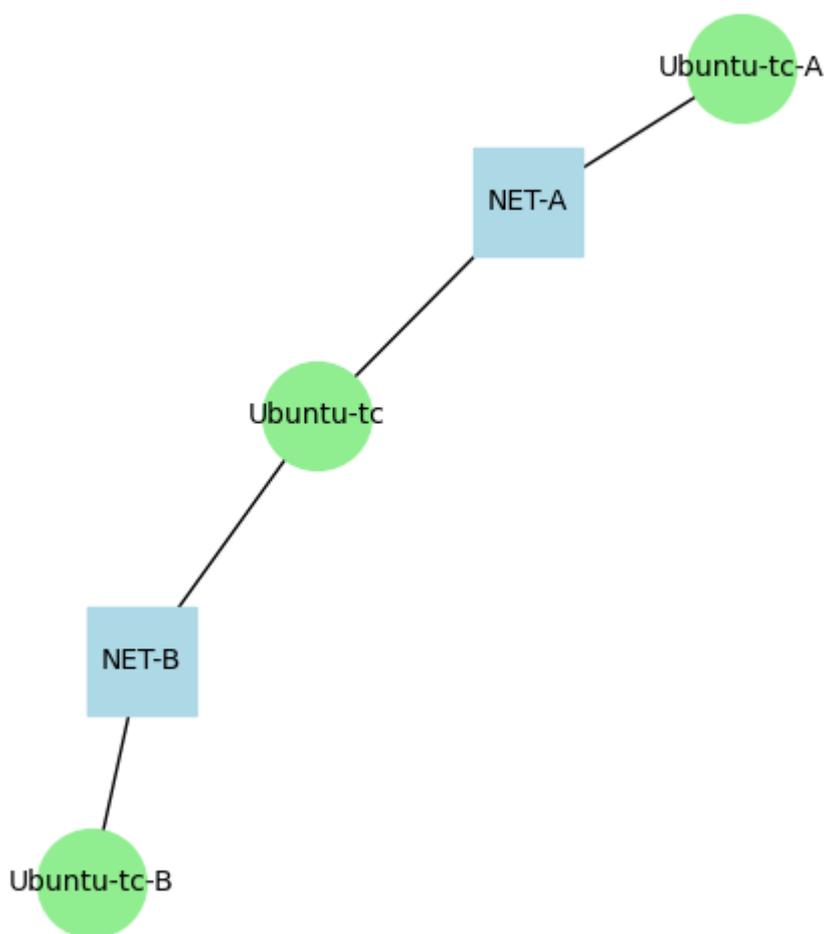


Linux: TC - ograniczanie pasma, indukowanie błędów w transmisji i opóźnienia

programy wykorzystane do zrobienia pomiarów:

- <https://man7.org/linux/man-pages/man8/tc.8.html>
- <https://github.com/tum-lkn/tcgui>

Schemat Połączeniowy



Schemat wygenerowany za pomocą [mojego skryptu](#)

| Nazwa maszyny | Karta sieciowa | Adres ip | brama | Switch wirtualny |
|---------------|----------------|-----------------|----------------|------------------|
| ubuntu-tc | eth0 | 192.168.1.1/24 | X | NET-A |
| | eth1 | 192.168.2.1/24 | X | NET-B |
| ubuntu-tc-A | eth0 | 192.168.1.10/24 | 192.168.1.1/24 | NET-A |
| ubuntu-tc-B | eth0 | 192.168.2.10/24 | 192.168.2.1/24 | NET-B |

Ustawienia na maszynie "Ubuntu-tc"

- włączenie forwardingu dla ipv4

```
echo "net.ipv4.ip_forward=1" | sudo tee -a /etc/sysctl.conf
```

- zrestartuj interfejsy sieciowe
- skopiowanie tc-gui na maszynę oraz uruchomienie

```
sudo apt install git
git clone https://github.com/tum-lkn/tcgui
cd tcgui
sudo python3 main.py --ip 127.0.0.1
```

- Otwieramy w przeglądarce firefox adres 127.0.0.1:5000

TCGUI - 4 Available Interfaces

eth0 (192.168.1.1)
eth1 (192.168.2.1)
eth2 (172.30.16.210)
lo (127.0.0.1)

eth0 (192.168.1.1)

| Name | Current Value | New Value | Variance / Correlation | New Value |
|-----------|---------------|---------------------------|------------------------|---------------------------|
| Rate | None | <input type="text"/> mbit | | |
| Delay | None | <input type="text"/> ms | ±None | ± <input type="text"/> ms |
| Loss | None | <input type="text"/> % | None | <input type="text"/> % |
| Duplicate | None | <input type="text"/> % | | |
| Reorder | None | <input type="text"/> % | None | <input type="text"/> % |
| Corrupt | None | <input type="text"/> % | | |
| Limit | None | <input type="text"/> | | |

[Apply eth0 \(192.168.1.1\) Rules](#)

[Remove eth0 \(192.168.1.1\) Rules](#)

Ustawienia na reszcie maszyn

```
sudo apt-get update
sudo apt-get install iperf3
```

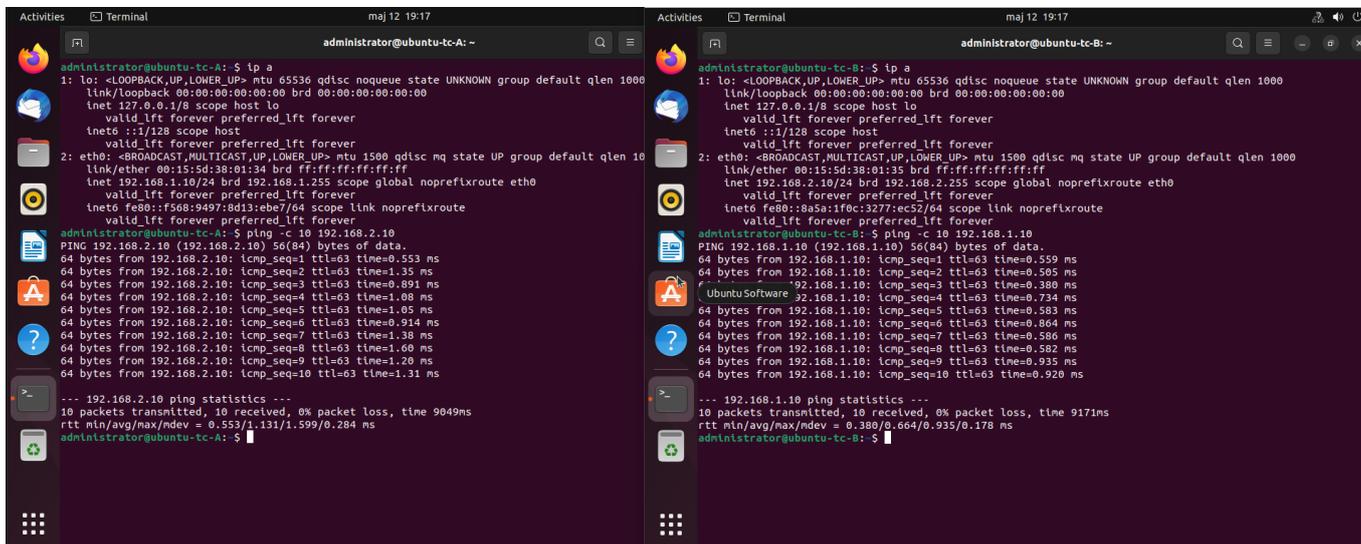
Musimy je jeszcze zaadresować statycznie za pomocą GUI albo za pomocą netplan

Tabela wyników testów

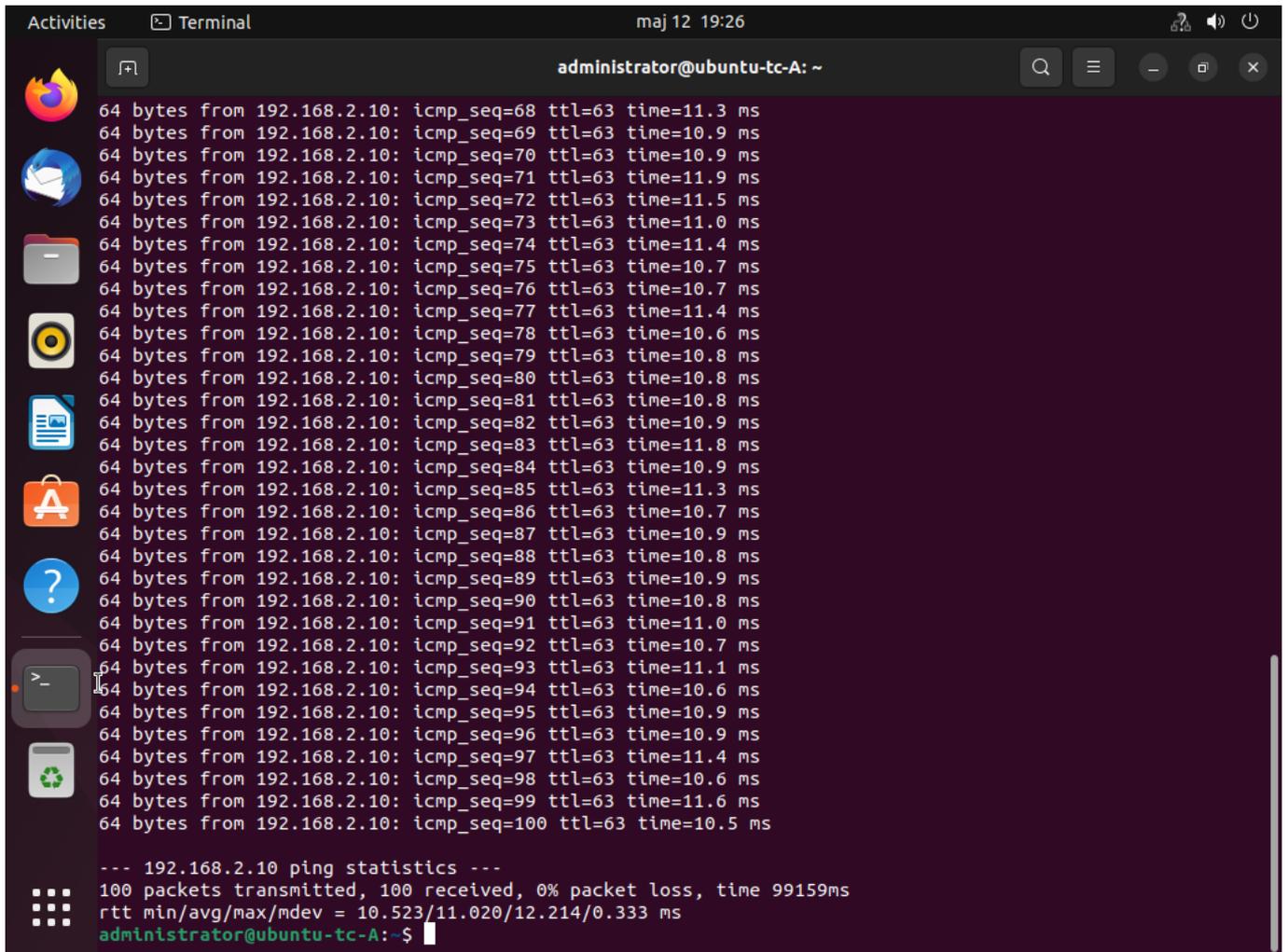
| Opis Testu | protokół | straty | pasmo | opóźnienie [ms] |
|--|----------|------------------|-----------|-----------------|
| Testy opóźnień | | | | |
| Test bez dodanego opóźnienia | icmp | 0% | — | 1,131 |
| Test z dodanym opóźnieniem 10ms wynik z 100 pomiarów | icmp | 0% | — | 11,020 |
| test z dodanym opóźnieniem 100ms wynik z 100 pomiarów | icmp | 0% | — | 101,071 |
| test z dodanym opóźnieniem 1000ms wynik z 100 pomiarów | icmp | 0% | — | 1000,911 |
| Testy pasma UDP | | | | |
| Opis Testu | protokół | Utracone/Wysłane | pasmo | opóźnienie [ms] |
| Test bez ograniczenia 30s (UDP iperf) | UDP | — | 998 Mbps | — |
| Ograniczenie pasma do 300Mbps 30s (UDP iperf) | UDP | 72% | 282 Mbps | — |
| Ograniczenie pasma do 100Mbps 30s (UDP iperf) | UDP | 91% | 94,3 Mbps | — |
| Ograniczenie pasma do 10Mbps 30s (UDP iperf) | UDP | 99% | 9,72 Mbps | — |
| Ograniczenie pasma do 1Mbps 30s (UDP iperf) | UDP | 1e+02% | 972 kbps | — |
| Testy pasma TCP | | | | |
| Opis Testu | protokół | retransmisje | pasmo | opóźnienie [ms] |
| Test bez ograniczenia 30s (TCP iperf) | TCP | 2 | 10,3 Gbps | — |
| Ograniczenie pasma do 300Mbps 30s (TCP iperf) | TCP | 0 | 282 Mbps | — |
| Ograniczenie pasma do 100Mbps 30s (TCP iperf) | TCP | 0 | 94,3 Mbps | — |
| Ograniczenie pasma do 10Mbps 30s (TCP iperf) | TCP | 152 | 9,72 Mbps | — |
| Ograniczenie pasma do 1Mbps 30s (TCP iperf) | TCP | 0 | 972 kbps | — |
| Inne Testy | | | | |
| Test łącza w obie strony 10Mbps, opóźnienie 2000ms, urata 3%, uszkodzone 10% (ping 100 pomiarów) | ICMP | 24% | — | 4001,69 |
| Test łącza w obie strony 10Mbps, opóźnienie 600ms, utrata 3%, uszkodzone 10% (TCP iperf) | TCP | 23 | 82 kbps | — |
| Test łącza w obie strony 10Mbps, opóźnienie 600ms, utrata 3%, uszkodzone 10% (UDP iperf) | UDP | 99% | 7,79 kbps | — |
| Test łącza w obie strony 60Mbps, opóźnienie 600ms, utrata 5% (UDP iperf) | UDP | 98% | 14,7 Mbps | — |

Testy opóźnień

Test bez dodanego opóźnienia



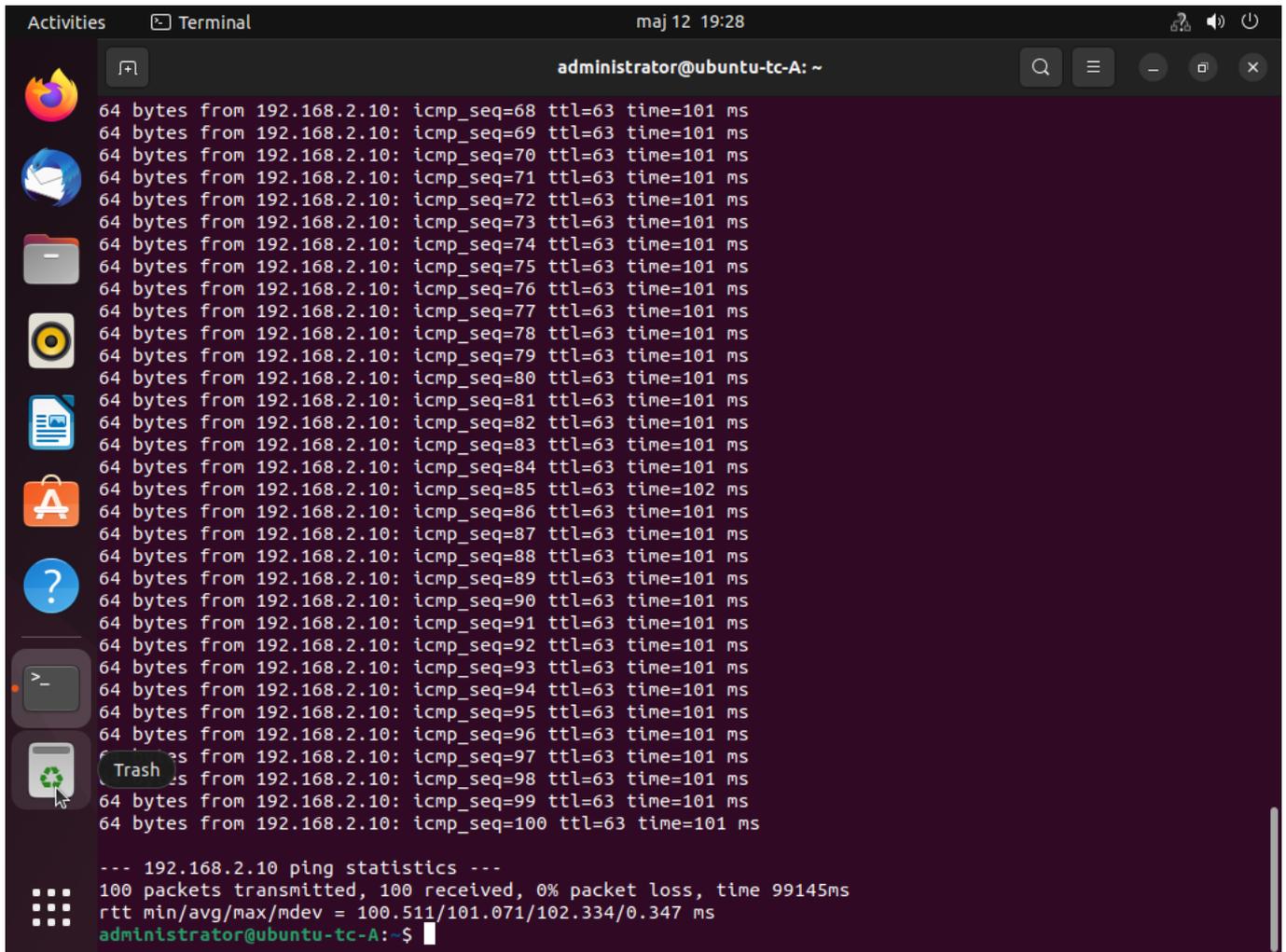
Test z dodanym opóźnieniem 10ms wynik z 100 pomiarów



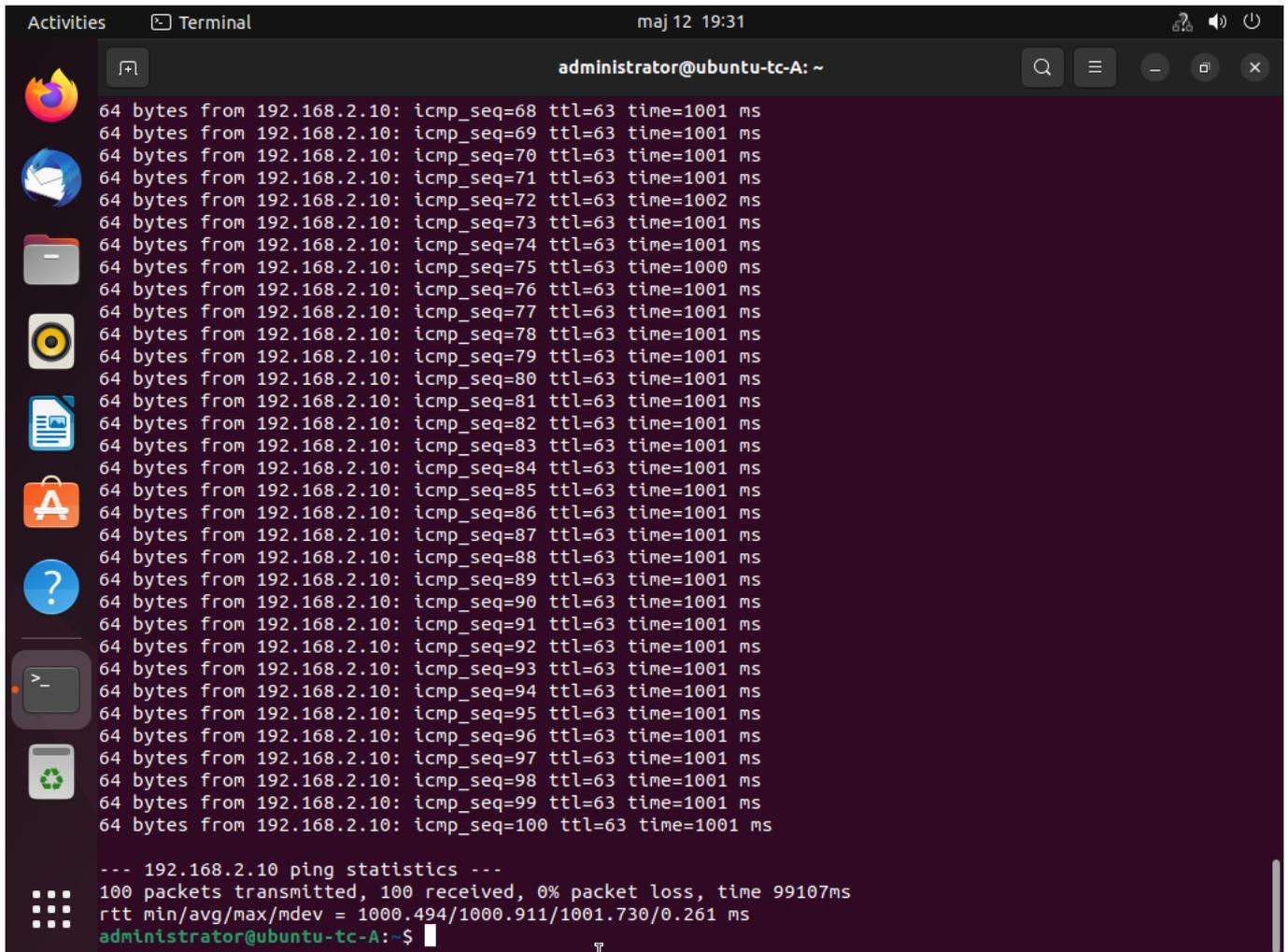
```
Activities Terminal maj 12 19:26 administrator@ubuntu-tc-A: ~
64 bytes from 192.168.2.10: icmp_seq=68 ttl=63 time=11.3 ms
64 bytes from 192.168.2.10: icmp_seq=69 ttl=63 time=10.9 ms
64 bytes from 192.168.2.10: icmp_seq=70 ttl=63 time=10.9 ms
64 bytes from 192.168.2.10: icmp_seq=71 ttl=63 time=11.9 ms
64 bytes from 192.168.2.10: icmp_seq=72 ttl=63 time=11.5 ms
64 bytes from 192.168.2.10: icmp_seq=73 ttl=63 time=11.0 ms
64 bytes from 192.168.2.10: icmp_seq=74 ttl=63 time=11.4 ms
64 bytes from 192.168.2.10: icmp_seq=75 ttl=63 time=10.7 ms
64 bytes from 192.168.2.10: icmp_seq=76 ttl=63 time=10.7 ms
64 bytes from 192.168.2.10: icmp_seq=77 ttl=63 time=11.4 ms
64 bytes from 192.168.2.10: icmp_seq=78 ttl=63 time=10.6 ms
64 bytes from 192.168.2.10: icmp_seq=79 ttl=63 time=10.8 ms
64 bytes from 192.168.2.10: icmp_seq=80 ttl=63 time=10.8 ms
64 bytes from 192.168.2.10: icmp_seq=81 ttl=63 time=10.8 ms
64 bytes from 192.168.2.10: icmp_seq=82 ttl=63 time=10.9 ms
64 bytes from 192.168.2.10: icmp_seq=83 ttl=63 time=11.8 ms
64 bytes from 192.168.2.10: icmp_seq=84 ttl=63 time=10.9 ms
64 bytes from 192.168.2.10: icmp_seq=85 ttl=63 time=11.3 ms
64 bytes from 192.168.2.10: icmp_seq=86 ttl=63 time=10.7 ms
64 bytes from 192.168.2.10: icmp_seq=87 ttl=63 time=10.9 ms
64 bytes from 192.168.2.10: icmp_seq=88 ttl=63 time=10.8 ms
64 bytes from 192.168.2.10: icmp_seq=89 ttl=63 time=10.9 ms
64 bytes from 192.168.2.10: icmp_seq=90 ttl=63 time=10.8 ms
64 bytes from 192.168.2.10: icmp_seq=91 ttl=63 time=11.0 ms
64 bytes from 192.168.2.10: icmp_seq=92 ttl=63 time=10.7 ms
64 bytes from 192.168.2.10: icmp_seq=93 ttl=63 time=11.1 ms
64 bytes from 192.168.2.10: icmp_seq=94 ttl=63 time=10.6 ms
64 bytes from 192.168.2.10: icmp_seq=95 ttl=63 time=10.9 ms
64 bytes from 192.168.2.10: icmp_seq=96 ttl=63 time=10.9 ms
64 bytes from 192.168.2.10: icmp_seq=97 ttl=63 time=11.4 ms
64 bytes from 192.168.2.10: icmp_seq=98 ttl=63 time=10.6 ms
64 bytes from 192.168.2.10: icmp_seq=99 ttl=63 time=11.6 ms
64 bytes from 192.168.2.10: icmp_seq=100 ttl=63 time=10.5 ms

--- 192.168.2.10 ping statistics ---
100 packets transmitted, 100 received, 0% packet loss, time 99159ms
rtt min/avg/max/mdev = 10.523/11.020/12.214/0.333 ms
administrator@ubuntu-tc-A:~$
```

test z dodanym opóźnieniem 100ms wynik z 100 pomiarów



test z dodanym opóźnieniem 1000ms wynik z 100 pomiarów



```
Activities Terminal maj 12 19:31 administrator@ubuntu-tc-A: ~
64 bytes from 192.168.2.10: icmp_seq=68 ttl=63 time=1001 ms
64 bytes from 192.168.2.10: icmp_seq=69 ttl=63 time=1001 ms
64 bytes from 192.168.2.10: icmp_seq=70 ttl=63 time=1001 ms
64 bytes from 192.168.2.10: icmp_seq=71 ttl=63 time=1001 ms
64 bytes from 192.168.2.10: icmp_seq=72 ttl=63 time=1002 ms
64 bytes from 192.168.2.10: icmp_seq=73 ttl=63 time=1001 ms
64 bytes from 192.168.2.10: icmp_seq=74 ttl=63 time=1001 ms
64 bytes from 192.168.2.10: icmp_seq=75 ttl=63 time=1000 ms
64 bytes from 192.168.2.10: icmp_seq=76 ttl=63 time=1001 ms
64 bytes from 192.168.2.10: icmp_seq=77 ttl=63 time=1001 ms
64 bytes from 192.168.2.10: icmp_seq=78 ttl=63 time=1001 ms
64 bytes from 192.168.2.10: icmp_seq=79 ttl=63 time=1001 ms
64 bytes from 192.168.2.10: icmp_seq=80 ttl=63 time=1001 ms
64 bytes from 192.168.2.10: icmp_seq=81 ttl=63 time=1001 ms
64 bytes from 192.168.2.10: icmp_seq=82 ttl=63 time=1001 ms
64 bytes from 192.168.2.10: icmp_seq=83 ttl=63 time=1001 ms
64 bytes from 192.168.2.10: icmp_seq=84 ttl=63 time=1001 ms
64 bytes from 192.168.2.10: icmp_seq=85 ttl=63 time=1001 ms
64 bytes from 192.168.2.10: icmp_seq=86 ttl=63 time=1001 ms
64 bytes from 192.168.2.10: icmp_seq=87 ttl=63 time=1001 ms
64 bytes from 192.168.2.10: icmp_seq=88 ttl=63 time=1001 ms
64 bytes from 192.168.2.10: icmp_seq=89 ttl=63 time=1001 ms
64 bytes from 192.168.2.10: icmp_seq=90 ttl=63 time=1001 ms
64 bytes from 192.168.2.10: icmp_seq=91 ttl=63 time=1001 ms
64 bytes from 192.168.2.10: icmp_seq=92 ttl=63 time=1001 ms
64 bytes from 192.168.2.10: icmp_seq=93 ttl=63 time=1001 ms
64 bytes from 192.168.2.10: icmp_seq=94 ttl=63 time=1001 ms
64 bytes from 192.168.2.10: icmp_seq=95 ttl=63 time=1001 ms
64 bytes from 192.168.2.10: icmp_seq=96 ttl=63 time=1001 ms
64 bytes from 192.168.2.10: icmp_seq=97 ttl=63 time=1001 ms
64 bytes from 192.168.2.10: icmp_seq=98 ttl=63 time=1001 ms
64 bytes from 192.168.2.10: icmp_seq=99 ttl=63 time=1001 ms
64 bytes from 192.168.2.10: icmp_seq=100 ttl=63 time=1001 ms

--- 192.168.2.10 ping statistics ---
100 packets transmitted, 100 received, 0% packet loss, time 99107ms
rtt min/avg/max/mdev = 1000.494/1000.911/1001.730/0.261 ms
administrator@ubuntu-tc-A:~$
```

test z dodanym opóźnieniem 5000ms wynik z 100 pomiarów

Test ograniczeń pasma

Test bez ograniczenia 30s (UDP 1Gbps iperf)

```

[ ID ] Interval      Transfer      Btrate      Total Datagrams
[ 5 ] 0.00-1.00 sec  119 MBytes  999 Mb/s/sec  86279
[ 5 ] 1.00-2.00 sec  119 MBytes  1000 Mb/s/sec  86325
[ 5 ] 2.00-3.00 sec  119 MBytes  1000 Mb/s/sec  86322
[ 5 ] 3.00-4.00 sec  119 MBytes  1000 Mb/s/sec  86323
[ 5 ] 4.00-5.00 sec  119 MBytes  1.00 Gb/s/sec  86327
[ 5 ] 5.00-6.00 sec  119 MBytes  1.00 Gb/s/sec  86327
[ 5 ] 6.00-7.00 sec  119 MBytes  1000 Mb/s/sec  86329
[ 5 ] 7.00-8.00 sec  119 MBytes  1000 Mb/s/sec  86323
[ 5 ] 8.00-9.00 sec  119 MBytes  1.00 Gb/s/sec  86328
[ 5 ] 9.00-10.00 sec 119 MBytes  1000 Mb/s/sec  86326
[ 5 ] 10.00-11.00 sec 119 MBytes  1000 Mb/s/sec  86324
[ 5 ] 11.00-12.00 sec 119 MBytes  1.00 Gb/s/sec  86333
[ 5 ] 12.00-13.00 sec 119 MBytes  1.00 Gb/s/sec  86331
[ 5 ] 13.00-14.00 sec 119 MBytes  1000 Mb/s/sec  86319
[ 5 ] 14.00-15.00 sec 119 MBytes  1000 Mb/s/sec  86324
[ 5 ] 15.00-16.00 sec 119 MBytes  1.00 Gb/s/sec  86330
[ 5 ] 16.00-17.00 sec 119 MBytes  1000 Mb/s/sec  86321
[ 5 ] 17.00-18.00 sec 119 MBytes  1000 Mb/s/sec  86313
[ 5 ] 18.00-19.00 sec 119 MBytes  1.00 Gb/s/sec  86339
[ 5 ] 19.00-20.00 sec 119 MBytes  1.00 Gb/s/sec  86327
[ 5 ] 20.00-21.00 sec 119 MBytes  1000 Mb/s/sec  86321
[ 5 ] 21.00-22.00 sec 119 MBytes  1.00 Gb/s/sec  86329
[ 5 ] 22.00-23.00 sec 119 MBytes  1.00 Gb/s/sec  86331
[ 5 ] 23.00-24.00 sec 119 MBytes  1000 Mb/s/sec  86328
[ 5 ] 24.00-25.00 sec 119 MBytes  1000 Mb/s/sec  86326
[ 5 ] 25.00-26.00 sec 119 MBytes  1.00 Gb/s/sec  86328
[ 5 ] 26.00-27.00 sec 119 MBytes  1.00 Gb/s/sec  86326
[ 5 ] 27.00-28.00 sec 119 MBytes  1000 Mb/s/sec  86325
[ 5 ] 28.00-29.00 sec 119 MBytes  1.00 Gb/s/sec  86327
[ 5 ] 29.00-30.00 sec 119 MBytes  1000 Mb/s/sec  86325

[ ID ] Interval      Transfer      Btrate      Jitter      Lost/Total Datagrams
[ 5 ] 0.00-30.00 sec  3.49 GBytes  998 Mb/s/sec  0.002 ms    0/2589728 (0%) sender
[ 5 ] 0.00-30.00 sec  3.49 GBytes  998 Mb/s/sec  0.002 ms    4048/2589728 (0.16%) receiver

iperf Done.
adminstrator@ubuntu-tc-A: ~$
  
```

Ograniczenie pasma do 300Mbps 30s (UDP iperf)

```

[ ID ] Interval      Transfer      Btrate      Total Datagrams
[ 5 ] 0.00-1.00 sec  119 MBytes  999 Mb/s/sec  86200
[ 5 ] 1.00-2.00 sec  119 MBytes  1.00 Gb/s/sec  86327
[ 5 ] 2.00-3.00 sec  119 MBytes  1000 Mb/s/sec  86324
[ 5 ] 3.00-4.00 sec  119 MBytes  1.00 Gb/s/sec  86328
[ 5 ] 4.00-5.00 sec  119 MBytes  1000 Mb/s/sec  86324
[ 5 ] 5.00-6.00 sec  119 MBytes  1000 Mb/s/sec  86325
[ 5 ] 6.00-7.00 sec  119 MBytes  1.00 Gb/s/sec  86341
[ 5 ] 7.00-8.00 sec  119 MBytes  1000 Mb/s/sec  86316
[ 5 ] 8.00-9.00 sec  119 MBytes  1.00 Gb/s/sec  86328
[ 5 ] 9.00-10.00 sec 119 MBytes  1000 Mb/s/sec  86321
[ 5 ] 10.00-11.00 sec 119 MBytes  1.00 Gb/s/sec  86332
[ 5 ] 11.00-12.00 sec 119 MBytes  1000 Mb/s/sec  86320
[ 5 ] 12.00-13.00 sec 119 MBytes  1.00 Gb/s/sec  86331
[ 5 ] 13.00-14.00 sec 119 MBytes  1.00 Gb/s/sec  86322
[ 5 ] 14.00-15.00 sec 119 MBytes  1000 Mb/s/sec  86327
[ 5 ] 15.00-16.00 sec 119 MBytes  1000 Mb/s/sec  86325
[ 5 ] 16.00-17.00 sec 119 MBytes  1.00 Gb/s/sec  86330
[ 5 ] 17.00-18.00 sec 119 MBytes  1000 Mb/s/sec  86321
[ 5 ] 18.00-19.00 sec 119 MBytes  1.00 Gb/s/sec  86327
[ 5 ] 19.00-20.00 sec 119 MBytes  1.00 Gb/s/sec  86327
[ 5 ] 20.00-21.00 sec 119 MBytes  1.00 Gb/s/sec  86327
[ 5 ] 21.00-22.00 sec 119 MBytes  1.00 Gb/s/sec  86327
[ 5 ] 22.00-23.00 sec 119 MBytes  1000 Mb/s/sec  86322
[ 5 ] 23.00-24.00 sec 119 MBytes  1.00 Gb/s/sec  86332
[ 5 ] 24.00-25.00 sec 119 MBytes  1.00 Gb/s/sec  86330
[ 5 ] 25.00-26.00 sec 119 MBytes  1000 Mb/s/sec  86304
[ 5 ] 26.00-27.00 sec 119 MBytes  1000 Mb/s/sec  86321
[ 5 ] 27.00-28.00 sec 119 MBytes  1.00 Gb/s/sec  86337
[ 5 ] 28.00-29.00 sec 119 MBytes  1000 Mb/s/sec  86312
[ 5 ] 29.00-30.00 sec 119 MBytes  1.00 Gb/s/sec  86331

[ ID ] Interval      Transfer      Btrate      Jitter      Lost/Total Datagrams
[ 5 ] 0.00-30.00 sec  3.49 GBytes  282 Mb/s/sec  0.000 ms    0/2589717 (0%) sender
[ 5 ] 0.00-30.04 sec  1010 MBytes  282 Mb/s/sec  0.048 ms    1858455/2589708 (72%) receiver

iperf Done.
adminstrator@ubuntu-tc-A: ~$
  
```

Ograniczenie pasma do 100Mbps 30s (UDP iperf)

```

[ ID ] Interval      Transfer      Btrate      Total Datagrams
[ 5 ] 0.00-1.00 sec  119 MBytes  1000 Mbits/sec  86324
[ 5 ] 1.00-2.00 sec  119 MBytes  999 Mbits/sec  86271
[ 5 ] 2.00-3.00 sec  119 MBytes  1000 Mbits/sec  86321
[ 5 ] 3.00-4.00 sec  119 MBytes  1.00 Gbits/sec  86326
[ 5 ] 4.00-5.00 sec  119 MBytes  1000 Mbits/sec  86322
[ 5 ] 5.00-6.00 sec  119 MBytes  1.00 Gbits/sec  86330
[ 5 ] 6.00-7.00 sec  119 MBytes  1.00 Gbits/sec  86333
[ 5 ] 7.00-8.00 sec  119 MBytes  1000 Mbits/sec  86316
[ 5 ] 8.00-9.00 sec  119 MBytes  1.00 Gbits/sec  86351
[ 5 ] 9.00-10.00 sec 119 MBytes  1000 Mbits/sec  86321
[ 5 ] 10.00-11.00 sec 119 MBytes  1000 Mbits/sec  86309
[ 5 ] 11.00-12.00 sec 119 MBytes  1.00 Gbits/sec  86338
[ 5 ] 12.00-13.00 sec 119 MBytes  1000 Mbits/sec  86322
[ 5 ] 13.00-14.00 sec 119 MBytes  1.00 Gbits/sec  86333
[ 5 ] 14.00-15.00 sec 119 MBytes  1000 Mbits/sec  86312
[ 5 ] 15.00-16.00 sec 119 MBytes  1.00 Gbits/sec  86334
[ 5 ] 16.00-17.00 sec 119 MBytes  1000 Mbits/sec  86322
[ 5 ] 17.00-18.00 sec 119 MBytes  1.00 Gbits/sec  86328
[ 5 ] 18.00-19.00 sec 119 MBytes  1000 Mbits/sec  86324
[ 5 ] 19.00-20.00 sec 119 MBytes  1000 Mbits/sec  86325
[ 5 ] 20.00-21.00 sec 119 MBytes  1000 Mbits/sec  86323
[ 5 ] 21.00-22.00 sec 119 MBytes  1.00 Gbits/sec  86331
[ 5 ] 22.00-23.00 sec 119 MBytes  1000 Mbits/sec  86323
[ 5 ] 23.00-24.00 sec 119 MBytes  1.00 Gbits/sec  86330
[ 5 ] 24.00-25.00 sec 119 MBytes  1.00 Gbits/sec  86331
[ 5 ] 25.00-26.00 sec 119 MBytes  1.00 Gbits/sec  86326
[ 5 ] 26.00-27.00 sec 119 MBytes  1000 Mbits/sec  86318
[ 5 ] 27.00-28.00 sec 119 MBytes  1.00 Gbits/sec  86342
[ 5 ] 28.00-29.00 sec 119 MBytes  1000 Mbits/sec  86308
[ 5 ] 29.00-30.00 sec 119 MBytes  1.00 Gbits/sec  86331

[ ID ] Interval      Transfer      Btrate      Jitter      Lost/Total Datagrams
[ 5 ] 0.00-30.00 sec  3.49 GBytes  94.3 Mbits/sec  0.000 ms  0/2589717 (0%) sender
[ 5 ] 0.00-30.12 sec  338 MBytes  94.3 Mbits/sec  0.171 ms  2344557/2589638 (91%) receiver

iperf Done.
administrator@ubuntu-tc-A: $
  
```

Ograniczenie pasma do 10Mbps 30s (UDP iperf)

```

[ ID ] Interval      Transfer      Btrate      Total Datagrams
[ 5 ] 0.00-1.00 sec  119 MBytes  999 Mbits/sec  86273
[ 5 ] 1.00-2.00 sec  119 MBytes  1000 Mbits/sec  86319
[ 5 ] 2.00-3.00 sec  119 MBytes  1.00 Gbits/sec  86335
[ 5 ] 3.00-4.00 sec  119 MBytes  1.00 Gbits/sec  86333
[ 5 ] 4.00-5.00 sec  119 MBytes  1000 Mbits/sec  86307
[ 5 ] 5.00-6.00 sec  119 MBytes  1.00 Gbits/sec  86344
[ 5 ] 6.00-7.00 sec  119 MBytes  1000 Mbits/sec  86318
[ 5 ] 7.00-8.00 sec  119 MBytes  1.00 Gbits/sec  86337
[ 5 ] 8.00-9.00 sec  119 MBytes  1000 Mbits/sec  86314
[ 5 ] 9.00-10.00 sec 119 MBytes  1.00 Gbits/sec  86366
[ 5 ] 10.00-11.00 sec 119 MBytes  1000 Mbits/sec  86296
[ 5 ] 11.00-12.00 sec 119 MBytes  1.00 Gbits/sec  86329
[ 5 ] 12.00-13.00 sec 119 MBytes  1000 Mbits/sec  86310
[ 5 ] 13.00-14.00 sec 119 MBytes  1000 Mbits/sec  86323
[ 5 ] 14.00-15.00 sec 119 MBytes  1000 Mbits/sec  86322
[ 5 ] 15.00-16.00 sec 119 MBytes  1.00 Gbits/sec  86332
[ 5 ] 16.00-17.00 sec 119 MBytes  1.00 Gbits/sec  86334
[ 5 ] 17.00-18.00 sec 119 MBytes  1.00 Gbits/sec  86342
[ 5 ] 18.00-19.00 sec 119 MBytes  1000 Mbits/sec  86319
[ 5 ] 19.00-20.00 sec 119 MBytes  1.00 Gbits/sec  86336
[ 5 ] 20.00-21.00 sec 119 MBytes  1000 Mbits/sec  86323
[ 5 ] 21.00-22.00 sec 119 MBytes  1000 Mbits/sec  86335
[ 5 ] 22.00-23.00 sec 119 MBytes  1.00 Gbits/sec  86335
[ 5 ] 23.00-24.00 sec 119 MBytes  1.00 Gbits/sec  86330
[ 5 ] 24.00-25.00 sec 119 MBytes  1000 Mbits/sec  86330
[ 5 ] 25.00-26.00 sec 119 MBytes  1.00 Gbits/sec  86338
[ 5 ] 26.00-27.00 sec 119 MBytes  1000 Mbits/sec  86328
[ 5 ] 27.00-28.00 sec 119 MBytes  1.00 Gbits/sec  86341
[ 5 ] 28.00-29.00 sec 119 MBytes  1.00 Gbits/sec  86341
[ 5 ] 29.00-30.00 sec 119 MBytes  1000 Mbits/sec  86304

[ ID ] Interval      Transfer      Btrate      Jitter      Lost/Total Datagrams
[ 5 ] 0.00-30.00 sec  3.49 GBytes  1000 Mbits/sec  0.000 ms  0/2589727 (0%) sender
[ 5 ] 0.00-31.19 sec  36.1 MBytes  9.72 Mbits/sec  0.289 ms  2563457/2589624 (99%) receiver

iperf Done.
administrator@ubuntu-tc-A: $
  
```

Ograniczenie pasma do 1Mbps 30s (UDP iperf)

```
adminstrator@ubuntu-tc-A:~$ iperf
[ ID] Interval      Transfer      Bitrate      Total  Datagrams
[ 5] 0.00-1.00 sec  119 MBytes    999 Mbts/sec 86272
[ 5] 1.00-2.00 sec  119 MBytes    1.00 gbts/sec 86345
[ 5] 2.00-3.00 sec  119 MBytes    1000 Mbts/sec 86309
[ 5] 3.00-4.00 sec  119 MBytes    1000 Mbts/sec 86314
[ 5] 4.00-5.00 sec  119 MBytes    1.00 gbts/sec 86338
[ 5] 5.00-6.00 sec  119 MBytes    1.00 gbts/sec 86346
[ 5] 6.00-7.00 sec  119 MBytes    1000 Mbts/sec 86305
[ 5] 7.00-8.00 sec  119 MBytes    1.00 gbts/sec 86336
[ 5] 8.00-9.00 sec  119 MBytes    1000 Mbts/sec 86322
[ 5] 9.00-10.00 sec 119 MBytes    1000 Mbts/sec 86321
[ 5] 10.00-11.00 sec 119 MBytes    1.00 gbts/sec 86335
[ 5] 11.00-12.00 sec 119 MBytes    1000 Mbts/sec 86316
[ 5] 12.00-13.00 sec 119 MBytes    1000 Mbts/sec 86326
[ 5] 13.00-14.00 sec 119 MBytes    1.00 gbts/sec 86326
[ 5] 14.00-15.00 sec 119 MBytes    1.00 gbts/sec 86327
[ 5] 15.00-16.00 sec 119 MBytes    1000 Mbts/sec 86326
[ 5] 16.00-17.00 sec 119 MBytes    1.00 gbts/sec 86361
[ 5] 17.00-18.00 sec 119 MBytes    1.00 gbts/sec 86336
[ 5] 18.00-19.00 sec 119 MBytes    1000 Mbts/sec 86289
[ 5] 19.00-20.00 sec 119 MBytes    1000 Mbts/sec 86325
[ 5] 20.00-21.00 sec 119 MBytes    1.00 gbts/sec 86317
[ 5] 21.00-22.00 sec 119 MBytes    1.00 gbts/sec 86328
[ 5] 22.00-23.00 sec 119 MBytes    1000 Mbts/sec 86323
[ 5] 23.00-24.00 sec 119 MBytes    1.00 gbts/sec 86328
[ 5] 24.00-25.00 sec 119 MBytes    1.00 gbts/sec 86336
[ 5] 25.00-26.00 sec 119 MBytes    1000 Mbts/sec 86320
[ 5] 26.00-27.00 sec 119 MBytes    1000 Mbts/sec 86301
[ 5] 27.00-28.00 sec 119 MBytes    1.00 gbts/sec 86368
[ 5] 28.00-29.00 sec 119 MBytes    1000 Mbts/sec 86302
[ 5] 29.00-30.00 sec 119 MBytes    1.00 gbts/sec 86340
-----
[ ID] Interval      Transfer      Bitrate      Jitter    Lost/Total Datagrams
[ 5] 0.00-30.00 sec  3.49 GBytes   1000 Mbts/sec 0.000 ms  0/2589738 (0%) sender
[ 5] 0.00-41.92 sec  4.86 MBytes   972 kbts/sec  0.147 ms 2585788/2589304 (1e+02%) receiver

iperf Done.
adminstrator@ubuntu-tc-A:~$
```

```
adminstrator@ubuntu-tc-B:~$ iperf
[ 5] 11.00-12.00 sec  119 KBytes    973 kbts/sec  8.644 ms 5244/5328 (98%)
[ 5] 12.00-13.00 sec  119 KBytes    973 kbts/sec  0.180 ms 86341/86425 (1e+02%)
[ 5] 13.00-14.00 sec  119 KBytes    973 kbts/sec  0.327 ms 86323/86407 (1e+02%)
[ 5] 14.00-15.00 sec  119 KBytes    973 kbts/sec  0.225 ms 86370/86454 (1e+02%)
[ 5] 15.00-16.00 sec  119 KBytes    973 kbts/sec  0.225 ms 86361/86445 (1e+02%)
[ 5] 16.00-17.00 sec  119 KBytes    973 kbts/sec  0.255 ms 86323/86407 (1e+02%)
[ 5] 17.00-18.00 sec  117 KBytes    973 kbts/sec  0.257 ms 85299/85382 (1e+02%)
[ 5] 18.00-19.00 sec  119 KBytes    973 kbts/sec  0.201 ms 86371/86455 (1e+02%)
[ 5] 19.00-20.00 sec  119 KBytes    973 kbts/sec  0.197 ms 86380/86464 (1e+02%)
[ 5] 20.00-21.00 sec  119 KBytes    973 kbts/sec  15.365 ms 1028905/1028989 (1e+02%)
[ 5] 21.00-22.00 sec  119 KBytes    973 kbts/sec  11.929 ms 0/84 (0%)
[ 5] 22.00-23.00 sec  119 KBytes    973 kbts/sec  11.918 ms 0/84 (0%)
[ 5] 23.00-24.00 sec  119 KBytes    973 kbts/sec  11.923 ms 0/84 (0%)
[ 5] 24.00-25.00 sec  117 KBytes    961 kbts/sec  11.922 ms 0/83 (0%)
[ 5] 25.00-26.00 sec  119 KBytes    973 kbts/sec  11.911 ms 0/84 (0%)
[ 5] 26.00-27.00 sec  119 KBytes    973 kbts/sec  11.905 ms 0/84 (0%)
[ 5] 27.00-28.00 sec  119 KBytes    973 kbts/sec  11.911 ms 0/84 (0%)
[ 5] 28.00-29.00 sec  119 KBytes    973 kbts/sec  11.910 ms 0/84 (0%)
[ 5] 29.00-30.00 sec  119 KBytes    973 kbts/sec  11.907 ms 0/84 (0%)
[ 5] 30.00-31.00 sec  119 KBytes    973 kbts/sec  11.898 ms 0/84 (0%)
[ 5] 31.00-32.00 sec  119 KBytes    973 kbts/sec  7.989 ms 6599/6683 (99%)
[ 5] 32.00-33.00 sec  119 KBytes    973 kbts/sec  0.267 ms 86331/86415 (1e+02%)
[ 5] 33.00-34.00 sec  117 KBytes    961 kbts/sec  0.183 ms 85295/85378 (1e+02%)
[ 5] 34.00-35.00 sec  119 KBytes    973 kbts/sec  0.140 ms 86411/86495 (1e+02%)
[ 5] 35.00-36.00 sec  119 KBytes    973 kbts/sec  0.175 ms 86330/86414 (1e+02%)
[ 5] 36.00-37.00 sec  119 KBytes    973 kbts/sec  0.312 ms 86322/86406 (1e+02%)
[ 5] 37.00-38.00 sec  119 KBytes    973 kbts/sec  0.353 ms 86351/86435 (1e+02%)
[ 5] 38.00-39.00 sec  119 KBytes    973 kbts/sec  0.159 ms 86388/86472 (1e+02%)
[ 5] 39.00-40.00 sec  119 KBytes    973 kbts/sec  0.164 ms 86338/86422 (1e+02%)
[ 5] 40.00-41.00 sec  119 KBytes    973 kbts/sec  0.214 ms 86307/86391 (1e+02%)
[ 5] 41.00-41.92 sec  109 KBytes    974 kbts/sec  0.147 ms 79199/79276 (1e+02%)
-----
[ ID] Interval      Transfer      Bitrate      Jitter    Lost/Total Datagrams
[ 5] 0.00-41.92 sec  4.86 MBytes   972 kbts/sec  0.147 ms 2585788/2589304 (1e+02%) receiver

Server listening on 5201
```

Test bez ograniczenia 30s (TCP iperf)

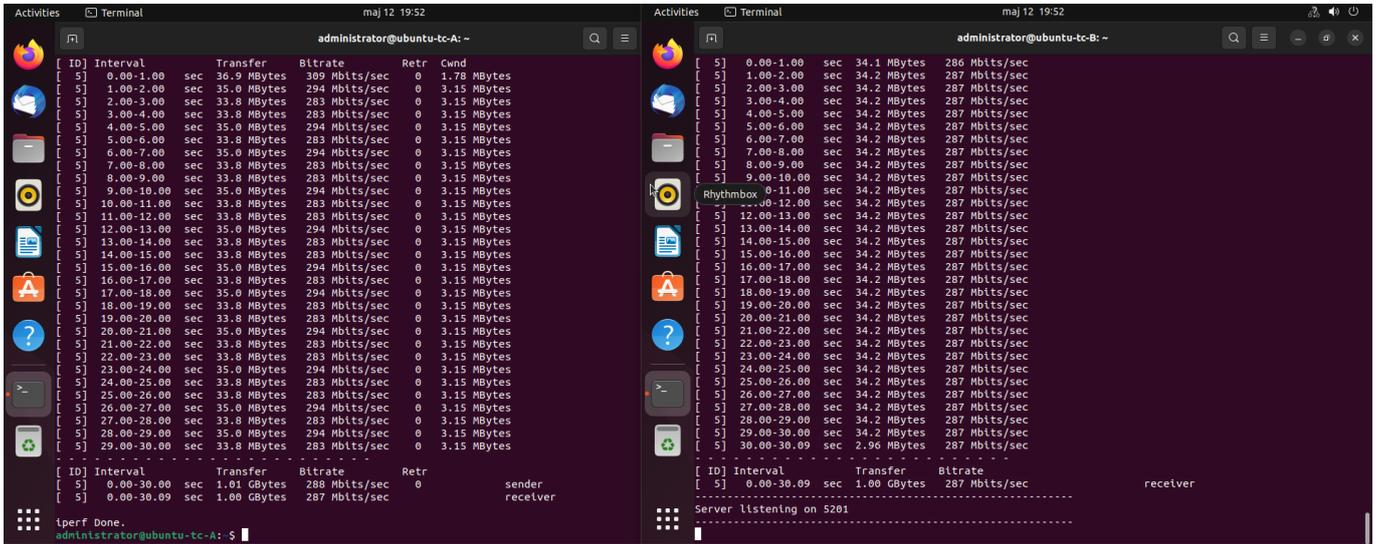
```
adminstrator@ubuntu-tc-A:~$ iperf
[ ID] Interval      Transfer      Bitrate      Retr  Cwnd
[ 5] 0.00-1.00 sec  1.17 GBytes   10.1 gbts/sec 0  3.16 MBytes
[ 5] 1.00-2.00 sec  1.25 GBytes   10.8 gbts/sec 0  3.16 MBytes
[ 5] 2.00-3.00 sec  1.29 GBytes   11.1 gbts/sec 0  3.16 MBytes
[ 5] 3.00-4.00 sec  1.27 GBytes   10.9 gbts/sec 0  3.16 MBytes
[ 5] 4.00-5.00 sec  1.26 GBytes   10.9 gbts/sec 0  3.16 MBytes
[ 5] 5.00-6.00 sec  1.26 GBytes   10.8 gbts/sec 0  3.16 MBytes
[ 5] 6.00-7.00 sec  1.27 GBytes   10.9 gbts/sec 0  3.16 MBytes
[ 5] 7.00-8.00 sec  1.25 GBytes   10.7 gbts/sec 0  3.16 MBytes
[ 5] 8.00-9.00 sec  1.24 GBytes   10.7 gbts/sec 0  3.16 MBytes
[ 5] 9.00-10.00 sec 1.26 GBytes   10.8 gbts/sec 0  3.16 MBytes
[ 5] 10.00-11.00 sec 1.23 GBytes   10.5 gbts/sec 0  3.16 MBytes
[ 5] 11.00-12.00 sec 1.22 GBytes   10.4 gbts/sec 0  3.16 MBytes
[ 5] 12.00-13.00 sec 1.25 GBytes   10.7 gbts/sec 0  3.16 MBytes
[ 5] 13.00-14.00 sec 1.20 GBytes   10.3 gbts/sec 0  3.16 MBytes
[ 5] 14.00-15.00 sec 1.05 GBytes   9.01 gbts/sec 0  3.16 MBytes
[ 5] 15.00-16.00 sec 1.17 GBytes   10.0 gbts/sec 0  3.16 MBytes
[ 5] 16.00-17.00 sec 1.19 GBytes   10.2 gbts/sec 0  3.16 MBytes
[ 5] 17.00-18.00 sec 1.18 GBytes   10.1 gbts/sec 0  3.16 MBytes
[ 5] 18.00-19.00 sec 1.18 GBytes   10.1 gbts/sec 0  3.16 MBytes
[ 5] 19.00-20.00 sec 1.18 GBytes   10.1 gbts/sec 0  3.16 MBytes
[ 5] 20.00-21.00 sec 1.18 GBytes   10.1 gbts/sec 0  3.16 MBytes
[ 5] 21.00-22.00 sec 1.21 GBytes   10.4 gbts/sec 0  3.16 MBytes
[ 5] 22.00-23.00 sec 1.13 GBytes   9.73 gbts/sec 1  3.16 MBytes
[ 5] 23.00-24.00 sec 1.13 GBytes   9.68 gbts/sec 0  3.16 MBytes
[ 5] 24.00-25.00 sec 1.06 GBytes   9.08 gbts/sec 1  3.16 MBytes
[ 5] 25.00-26.00 sec 1.25 GBytes   10.7 gbts/sec 0  3.16 MBytes
[ 5] 26.00-27.00 sec 1.19 GBytes   10.2 gbts/sec 0  3.16 MBytes
[ 5] 27.00-28.00 sec 1.17 GBytes   10.1 gbts/sec 0  3.16 MBytes
[ 5] 28.00-29.00 sec 1.21 GBytes   10.4 gbts/sec 0  3.16 MBytes
[ 5] 29.00-30.00 sec 1.24 GBytes   10.6 gbts/sec 0  3.16 MBytes
-----
[ ID] Interval      Transfer      Bitrate      Retr  Cwnd
[ 5] 0.00-30.00 sec  36.1 GBytes   10.3 gbts/sec 2
[ 5] 0.00-30.00 sec  36.1 GBytes   10.3 gbts/sec

iperf Done.
adminstrator@ubuntu-tc-A:~$
```

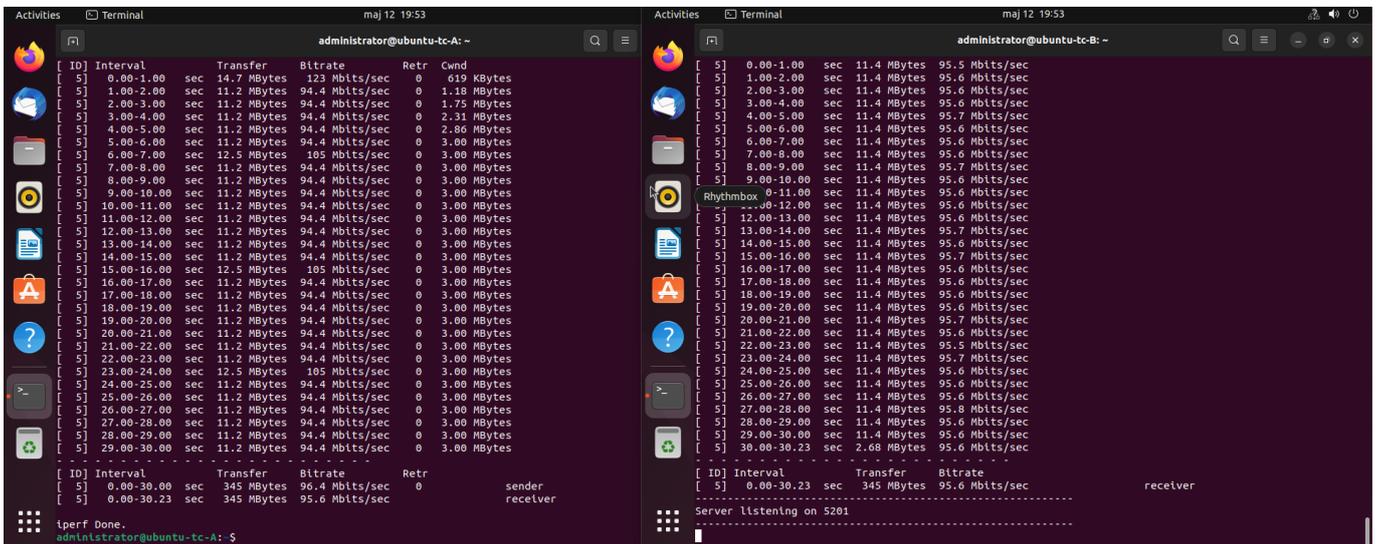
```
adminstrator@ubuntu-tc-B:~$ iperf
[ 5] 0.00-1.00 sec  1.17 GBytes   10.0 gbts/sec
[ 5] 1.00-2.00 sec  1.25 GBytes   10.8 gbts/sec
[ 5] 2.00-3.00 sec  1.29 GBytes   11.1 gbts/sec
[ 5] 3.00-4.00 sec  1.27 GBytes   10.9 gbts/sec
[ 5] 4.00-5.00 sec  1.26 GBytes   10.9 gbts/sec
[ 5] 5.00-6.00 sec  1.26 GBytes   10.8 gbts/sec
[ 5] 6.00-7.00 sec  1.27 GBytes   10.9 gbts/sec
[ 5] 7.00-8.00 sec  1.25 GBytes   10.7 gbts/sec
[ 5] 8.00-9.00 sec  1.24 GBytes   10.7 gbts/sec
[ 5] 9.00-10.00 sec 1.26 GBytes   10.8 gbts/sec
[ 5] 10.00-11.00 sec 1.23 GBytes   10.5 gbts/sec
[ 5] 11.00-12.00 sec 1.22 GBytes   10.4 gbts/sec
[ 5] 12.00-13.00 sec 1.25 GBytes   10.7 gbts/sec
[ 5] 13.00-14.00 sec 1.20 GBytes   10.3 gbts/sec
[ 5] 14.00-15.00 sec 1.05 GBytes   9.01 gbts/sec
[ 5] 15.00-16.00 sec 1.17 GBytes   10.0 gbts/sec
[ 5] 16.00-17.00 sec 1.19 GBytes   10.2 gbts/sec
[ 5] 17.00-18.00 sec 1.17 GBytes   10.1 gbts/sec
[ 5] 18.00-19.00 sec 1.18 GBytes   10.1 gbts/sec
[ 5] 19.00-20.00 sec 1.18 GBytes   10.1 gbts/sec
[ 5] 20.00-21.00 sec 1.18 GBytes   10.1 gbts/sec
[ 5] 21.00-22.00 sec 1.21 GBytes   10.4 gbts/sec
[ 5] 22.00-23.00 sec 1.13 GBytes   9.73 gbts/sec
[ 5] 23.00-24.00 sec 1.13 GBytes   9.68 gbts/sec
[ 5] 24.00-25.00 sec 1.06 GBytes   9.08 gbts/sec
[ 5] 25.00-26.00 sec 1.25 GBytes   10.7 gbts/sec
[ 5] 26.00-27.00 sec 1.19 GBytes   10.2 gbts/sec
[ 5] 27.00-28.00 sec 1.17 GBytes   10.1 gbts/sec
[ 5] 28.00-29.00 sec 1.21 GBytes   10.4 gbts/sec
[ 5] 29.00-30.00 sec 1.24 GBytes   10.6 gbts/sec
[ 5] 30.00-30.00 sec 506 KBytes  8.62 gbts/sec
-----
[ ID] Interval      Transfer      Bitrate
[ 5] 0.00-30.00 sec  36.1 GBytes   10.3 gbts/sec

Server listening on 5201
```

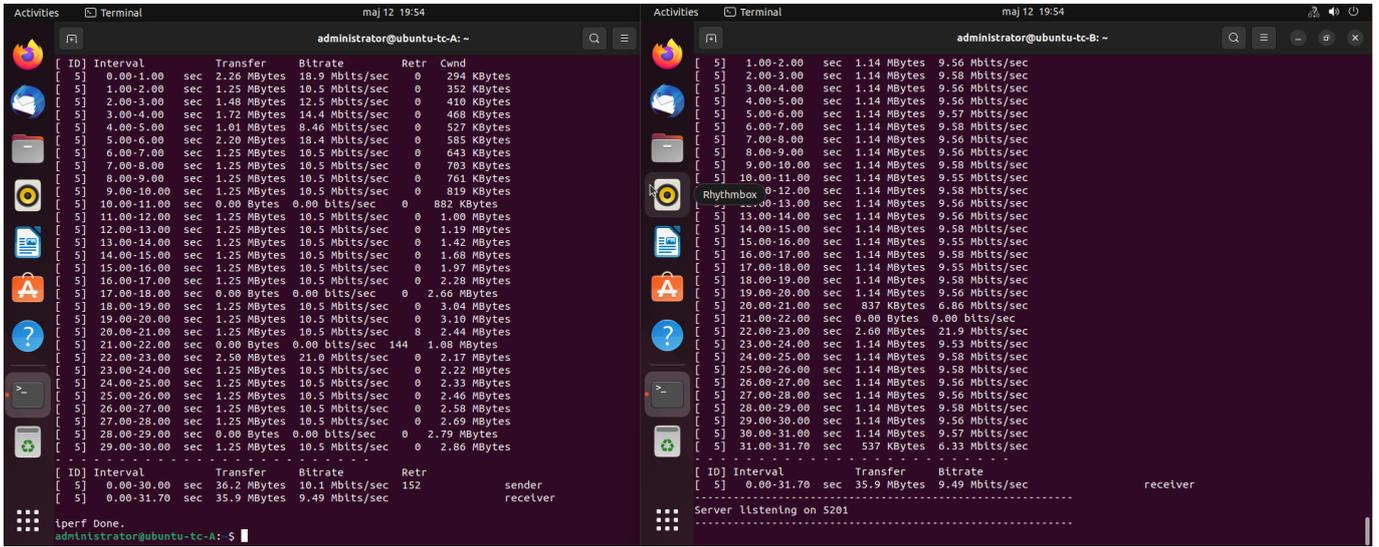
Ograniczenie pasma do 300Mbps 30s (TCP iperf)



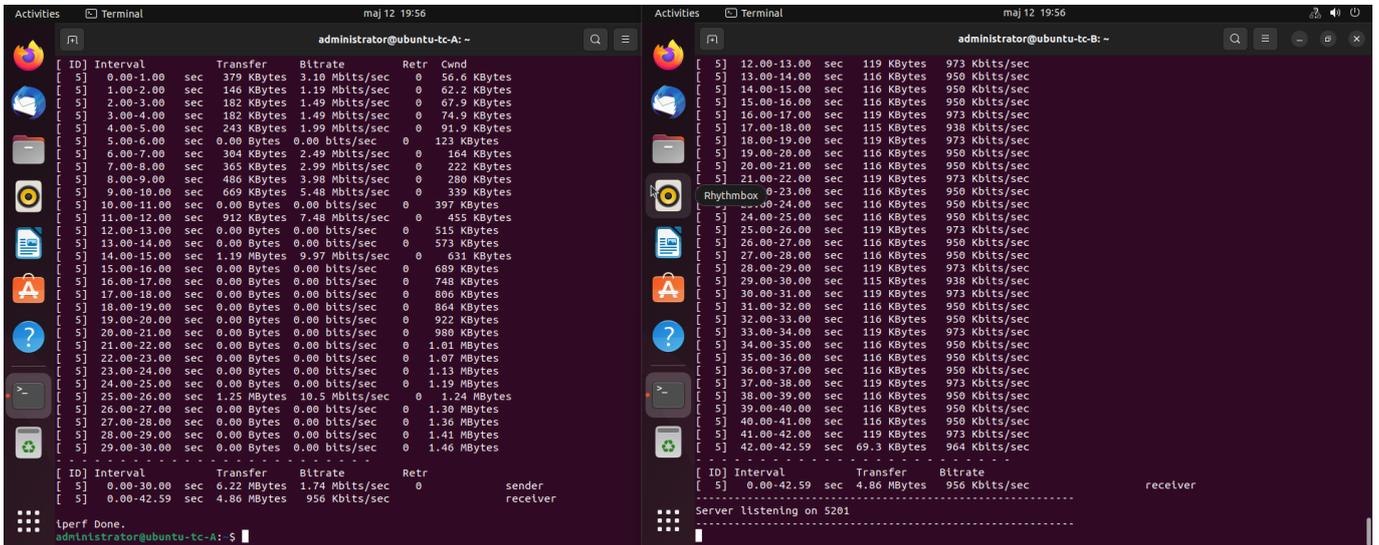
Ograniczenie pasma do 100Mbps 30s (TCP iperf)



Ograniczenie pasma do 10Mbps 30s (TCP iperf)



Ograniczenie pasma do 1Mbps 30s (TCP iperf)



Test łącza w obie strony 10Mbps, opóźnienie 2000ms, urata 3%, uszkodzone 10% (ping 100 pomiarów)

```

Activities Terminal maj 12 20:04 administrator@ubuntu-tc-A: ~
64 bytes from 192.168.2.10: icmp_seq=57 ttl=63 time=4002 ms
64 bytes from 192.168.2.10: icmp_seq=58 ttl=63 time=4002 ms
64 bytes from 192.168.2.10: icmp_seq=59 ttl=63 time=4003 ms
64 bytes from 192.168.2.10: icmp_seq=60 ttl=63 time=4001 ms
64 bytes from 192.168.2.10: icmp_seq=61 ttl=63 time=4001 ms
64 bytes from 192.168.2.10: icmp_seq=62 ttl=63 time=4001 ms
64 bytes from 192.168.2.10: icmp_seq=64 ttl=63 time=4001 ms
64 bytes from 192.168.2.10: icmp_seq=65 ttl=63 time=4001 ms
64 bytes from 192.168.2.10: icmp_seq=66 ttl=63 time=4001 ms
64 bytes from 192.168.2.10: icmp_seq=67 ttl=63 time=4001 ms
64 bytes from 192.168.2.10: icmp_seq=68 ttl=63 time=4001 ms
64 bytes from 192.168.2.10: icmp_seq=70 ttl=63 time=4001 ms
64 bytes from 192.168.2.10: icmp_seq=71 ttl=63 time=4001 ms
64 bytes from 192.168.2.10: icmp_seq=72 ttl=63 time=4001 ms
64 bytes from 192.168.2.10: icmp_seq=73 ttl=63 time=4001 ms
64 bytes from 192.168.2.10: icmp_seq=74 ttl=63 time=4001 ms
64 bytes from 192.168.2.10: icmp_seq=76 ttl=63 time=4001 ms
64 bytes from 192.168.2.10: icmp_seq=78 ttl=63 time=4001 ms
64 bytes from 192.168.2.10: icmp_seq=82 ttl=63 time=4001 ms
64 bytes from 192.168.2.10: icmp_seq=84 ttl=63 time=4001 ms
64 bytes from 192.168.2.10: icmp_seq=85 ttl=63 time=4002 ms
64 bytes from 192.168.2.10: icmp_seq=86 ttl=63 time=4001 ms
64 bytes from 192.168.2.10: icmp_seq=87 ttl=63 time=4001 ms
64 bytes from 192.168.2.10: icmp_seq=88 ttl=63 time=4001 ms
64 bytes from 192.168.2.10: icmp_seq=89 ttl=63 time=4001 ms
64 bytes from 192.168.2.10: icmp_seq=90 ttl=63 time=4002 ms
64 bytes from 192.168.2.10: icmp_seq=91 ttl=63 time=4001 ms
64 bytes from 192.168.2.10: icmp_seq=93 ttl=63 time=4001 ms
64 bytes from 192.168.2.10: icmp_seq=94 ttl=63 time=4001 ms
64 bytes from 192.168.2.10: icmp_seq=97 ttl=63 time=4001 ms
64 bytes from 192.168.2.10: icmp_seq=98 ttl=63 time=4001 ms
64 bytes from 192.168.2.10: icmp_seq=99 ttl=63 time=4001 ms
64 bytes from 192.168.2.10: icmp_seq=100 ttl=63 time=4001 ms

--- 192.168.2.10 ping statistics ---
100 packets transmitted, 76 received, 24% packet loss, time 99542ms
rtt min/avg/max/mdev = 4000.690/4001.120/4002.574/0.383 ms, pipe 5
administrator@ubuntu-tc-A:~$

```

Test łącza w obie strony 10Mbps, opóźnienie 600ms, utrata 3%, uszkodzone 10% (TCP iperf)

```

Activities Terminal maj 12 20:06 administrator@ubuntu-tc-A: ~
[ ID] Interval      Transfer     Bitrate      Retr  Cwnd
[ 5] 0.00-1.20    sec  102 KBytes  695 Kbits/sec  0  14.1 KBytes
[ 5] 1.20-2.00    sec  0.00 Bytes  0.00 bbits/sec  0  14.1 KBytes
[ 5] 2.00-3.00    sec  93.3 KBytes  765 Kbits/sec  0  28.3 KBytes
[ 5] 3.00-4.00    sec  0.00 Bytes  0.00 bbits/sec  3  32.5 KBytes
[ 5] 4.00-5.00    sec  0.00 Bytes  0.00 bbits/sec  1  22.6 KBytes
[ 5] 5.00-6.00    sec  0.00 Bytes  0.00 bbits/sec  0  22.6 KBytes
[ 5] 6.00-7.00    sec  0.00 Bytes  0.00 bbits/sec  1  28.3 KBytes
[ 5] 7.00-8.00    sec  0.00 Bytes  0.00 bbits/sec  2  21.2 KBytes
[ 5] 8.00-9.00    sec  90.5 KBytes  742 Kbits/sec  1  17.0 KBytes
[ 5] 9.00-10.00   sec  0.00 Bytes  0.00 bbits/sec  0  15.6 KBytes
[ 5] 10.00-11.00  sec  0.00 Bytes  0.00 bbits/sec  1  12.7 KBytes
[ 5] 11.00-12.00  sec  0.00 Bytes  0.00 bbits/sec  0  12.7 KBytes
[ 5] 12.00-13.00  sec  0.00 Bytes  0.00 bbits/sec  3  9.90 KBytes
[ 5] 13.00-14.00  sec  122 KBytes  997 Kbits/sec  1  8.48 KBytes
[ 5] 14.00-15.00  sec  0.00 Bytes  0.00 bbits/sec  0  5.66 KBytes
[ 5] 15.00-16.00  sec  0.00 Bytes  0.00 bbits/sec  0  7.07 KBytes
[ 5] 16.00-17.00  sec  0.00 Bytes  0.00 bbits/sec  0  11.3 KBytes
[ 5] 17.00-18.00  sec  0.00 Bytes  0.00 bbits/sec  0  11.3 KBytes
[ 5] 18.00-19.00  sec  0.00 Bytes  0.00 bbits/sec  0  17.0 KBytes
[ 5] 19.00-20.00  sec  0.00 Bytes  0.00 bbits/sec  2  12.7 KBytes
[ 5] 20.00-21.00  sec  0.00 Bytes  0.00 bbits/sec  0  14.1 KBytes
[ 5] 21.00-22.00  sec  0.00 Bytes  0.00 bbits/sec  0  18.4 KBytes
[ 5] 22.00-23.00  sec  0.00 Bytes  0.00 bbits/sec  1  12.7 KBytes
[ 5] 23.00-24.00  sec  0.00 Bytes  0.00 bbits/sec  0  12.7 KBytes
[ 5] 24.00-25.00  sec  0.00 Bytes  0.00 bbits/sec  1  7.07 KBytes
[ 5] 25.00-26.00  sec  0.00 Bytes  0.00 bbits/sec  3  7.07 KBytes
[ 5] 26.00-27.00  sec  0.00 Bytes  0.00 bbits/sec  1  5.66 KBytes
[ 5] 27.00-28.00  sec  122 KBytes  996 Kbits/sec  0  12.7 KBytes
[ 5] 28.00-29.00  sec  0.00 Bytes  0.00 bbits/sec  1  8.48 KBytes
[ 5] 29.00-30.00  sec  0.00 Bytes  0.00 bbits/sec  0  8.48 KBytes

iperf Done.
administrator@ubuntu-tc-A:~$

Activities Terminal maj 12 20:06 administrator@ubuntu-tc-B: ~
[ 5] 1.00-2.00    sec  0.00 Bytes  0.00 bbits/sec
[ 5] 2.00-3.00    sec  14.1 KBytes  116 Kbits/sec
[ 5] 3.00-4.00    sec  11.3 KBytes  92.7 Kbits/sec
[ 5] 4.00-5.00    sec  2.83 KBytes  23.2 Kbits/sec
[ 5] 5.00-6.00    sec  0.00 Bytes  0.00 bbits/sec
[ 5] 6.00-7.00    sec  56.0 KBytes  463 Kbits/sec
[ 5] 7.00-8.00    sec  1.41 KBytes  11.6 Kbits/sec
[ 5] 8.00-9.00    sec  33.9 KBytes  278 Kbits/sec
[ 5] 9.00-10.00   sec  32.5 KBytes  267 Kbits/sec
[ 5] 10.00-11.00  sec  7.07 KBytes  57.9 Kbits/sec
[ 5] 11.00-12.00  sec  0.00 Bytes  0.00 bbits/sec
[ 5] 12.00-13.00  sec  4.24 KBytes  34.8 Kbits/sec
[ 5] 13.00-14.00  sec  14.1 KBytes  116 Kbits/sec
[ 5] 14.00-15.00  sec  12.7 KBytes  104 Kbits/sec
[ 5] 15.00-16.00  sec  5.66 KBytes  46.4 Kbits/sec
[ 5] 16.00-17.00  sec  7.07 KBytes  57.9 Kbits/sec
[ 5] 17.00-18.00  sec  0.00 Bytes  0.00 bbits/sec
[ 5] 18.00-19.00  sec  11.3 KBytes  92.7 Kbits/sec
[ 5] 19.00-20.00  sec  2.83 KBytes  23.2 Kbits/sec
[ 5] 20.00-21.00  sec  24.0 KBytes  197 Kbits/sec
[ 5] 21.00-22.00  sec  14.1 KBytes  116 Kbits/sec
[ 5] 22.00-23.00  sec  0.00 Bytes  0.00 bbits/sec
[ 5] 23.00-24.00  sec  0.00 Bytes  0.00 bbits/sec
[ 5] 24.00-25.00  sec  18.4 KBytes  151 Kbits/sec
[ 5] 25.00-26.00  sec  0.00 Bytes  0.00 bbits/sec
[ 5] 26.00-27.00  sec  0.00 Bytes  0.00 bbits/sec
[ 5] 27.00-28.00  sec  19.4 KBytes  151 Kbits/sec
[ 5] 28.00-29.00  sec  0.00 Bytes  0.00 bbits/sec
[ 5] 29.00-30.00  sec  0.00 Bytes  0.00 bbits/sec
[ 5] 30.00-31.00  sec  19.8 KBytes  162 Kbits/sec
[ 5] 31.00-31.20  sec  0.00 Bytes  0.00 bbits/sec

iperf Done.
Server listening on 5201

```

Test łącza w obie strony 10Mbps, opóźnienie 600ms, utrata 3%, uszkodzone 10% (UDP iperf)

The image shows two terminal windows side-by-side. The left window is the sender's terminal, and the right window is the receiver's terminal. Both show the output of an iperf UDP test. The sender's output shows a total transfer of approximately 29.5 Mbytes and a total datagram count of 258924. The receiver's output shows a total transfer of 29.5 Mbytes and a total datagram count of 258910, with a 0.9% loss. The test duration is 31.79 seconds.

```
[ID] Interval      Transfer      Bitrate      Total Datagrams
[ 5] 0.00-1.20 sec  1.41 Kbytes  9.65 Kbits/sec  1
[ 5] 1.20-2.00 sec  238 Mbytes  2.50 Gbits/sec  172598
[ 5] 2.00-3.00 sec  119 Mbytes  1.00 Gbits/sec  86329
[ 5] 3.00-4.00 sec  119 Mbytes  1.00 Gbits/sec  86319
[ 5] 4.00-5.00 sec  119 Mbytes  1.00 Gbits/sec  86351
[ 5] 5.00-6.00 sec  119 Mbytes  1.00 Gbits/sec  86297
[ 5] 6.00-7.00 sec  119 Mbytes  1.00 Gbits/sec  86321
[ 5] 7.00-8.00 sec  119 Mbytes  1.00 Gbits/sec  86328
[ 5] 8.00-9.00 sec  119 Mbytes  1.00 Gbits/sec  86337
[ 5] 9.00-10.00 sec 119 Mbytes  1.00 Gbits/sec  86324
[ 5] 10.00-11.00 sec 119 Mbytes  1.00 Gbits/sec  86321
[ 5] 11.00-12.00 sec 119 Mbytes  1.00 Gbits/sec  86343
[ 5] 12.00-13.00 sec 119 Mbytes  1.00 Gbits/sec  86310
[ 5] 13.00-14.00 sec 119 Mbytes  1.00 Gbits/sec  86328
[ 5] 14.00-15.00 sec 119 Mbytes  1.00 Gbits/sec  86322
[ 5] 15.00-16.00 sec 119 Mbytes  1.00 Gbits/sec  86331
[ 5] 16.00-17.00 sec 119 Mbytes  1.00 Gbits/sec  86331
[ 5] 17.00-18.00 sec 119 Mbytes  1.00 Gbits/sec  86331
[ 5] 18.00-19.00 sec 119 Mbytes  1.00 Gbits/sec  86324
[ 5] 19.00-20.00 sec 119 Mbytes  1.00 Gbits/sec  86321
[ 5] 20.00-21.00 sec 119 Mbytes  1.00 Gbits/sec  86322
[ 5] 21.00-22.00 sec 119 Mbytes  1.00 Gbits/sec  86331
[ 5] 22.00-23.00 sec 119 Mbytes  1.00 Gbits/sec  86326
[ 5] 23.00-24.00 sec 119 Mbytes  1.00 Gbits/sec  86334
[ 5] 24.00-25.00 sec 119 Mbytes  1.00 Gbits/sec  86328
[ 5] 25.00-26.00 sec 119 Mbytes  1.00 Gbits/sec  86333
[ 5] 26.00-27.00 sec 119 Mbytes  1.00 Gbits/sec  86306
[ 5] 27.00-28.00 sec 119 Mbytes  1.00 Gbits/sec  86342
[ 5] 28.00-29.00 sec 119 Mbytes  1.00 Gbits/sec  86321
[ 5] 29.00-30.00 sec 119 Mbytes  1.00 Gbits/sec  86325
[ 5] 30.00-31.79 sec 3.49 Gbytes 1000 Mbits/sec 0.000 ms 0/258924 (0%) sender
[ 5] 0.00-31.79 sec 29.5 Mbytes 7.79 Mbits/sec 0.240 ms 258923/258910 (99%) receiver

iperf Done.
administrator@ubuntu-tc-A:~$
```

```
[ 5] 1.00-2.00 sec  0.00 Bytes  0.00 bits/sec  0.000 ms 0/0 (0%)
[ 5] 2.00-3.00 sec  635 Kbytes  5.21 Mbits/sec  1.320 ms 69/518 (13%)
[ 5] 3.00-4.00 sec  1.04 Mbytes  8.73 Mbits/sec  0.262 ms 189195/189949 (1e+02%)
[ 5] 4.00-5.00 sec  1.05 Mbytes  8.80 Mbits/sec  0.243 ms 85629/86380 (99%)
[ 5] 5.00-6.00 sec  1.04 Mbytes  8.72 Mbits/sec  0.249 ms 85598/86351 (99%)
[ 5] 6.00-7.00 sec  1.06 Mbytes  8.87 Mbits/sec  0.301 ms 85578/86341 (99%)
[ 5] 7.00-8.00 sec  1.05 Mbytes  8.82 Mbits/sec  0.271 ms 85428/86189 (99%)
[ 5] 8.00-9.00 sec  1.05 Mbytes  8.78 Mbits/sec  0.247 ms 85583/86341 (99%)
[ 5] 9.00-10.00 sec  1.02 Mbytes  8.56 Mbits/sec  0.314 ms 85617/86356 (99%)
[ 5] 10.00-11.00 sec  1.04 Mbytes  8.74 Mbits/sec  0.248 ms 85572/86326 (99%)
[ 5] 11.00-12.00 sec  1.04 Mbytes  8.70 Mbits/sec  0.330 ms 85380/86331 (99%)
[ 5] 12.00-13.00 sec  1.03 Mbytes  8.68 Mbits/sec  0.300 ms 85370/86327 (99%)
[ 5] 13.00-14.00 sec  1.04 Mbytes  8.70 Mbits/sec  0.272 ms 85571/86322 (99%)
[ 5] 14.00-15.00 sec  1.04 Mbytes  8.71 Mbits/sec  0.301 ms 85579/86331 (99%)
[ 5] 15.00-16.00 sec  1.03 Mbytes  8.62 Mbits/sec  0.294 ms 85558/86319 (99%)
[ 5] 16.00-17.00 sec  1.03 Mbytes  8.64 Mbits/sec  0.287 ms 85591/86337 (99%)
[ 5] 17.00-18.00 sec  1.04 Mbytes  8.70 Mbits/sec  0.291 ms 85545/86286 (99%)
[ 5] 18.00-19.00 sec  1.04 Mbytes  8.76 Mbits/sec  0.266 ms 85577/86333 (99%)
[ 5] 19.00-20.00 sec  1.06 Mbytes  8.86 Mbits/sec  0.243 ms 85577/86342 (99%)
[ 5] 20.00-21.00 sec  1.01 Mbytes  8.44 Mbits/sec  0.277 ms 85578/86307 (99%)
[ 5] 21.00-22.00 sec  1.05 Mbytes  8.77 Mbits/sec  0.265 ms 85598/86355 (99%)
[ 5] 22.00-23.00 sec  1.05 Mbytes  8.70 Mbits/sec  0.291 ms 85548/86380 (99%)
[ 5] 23.00-24.00 sec  1.04 Mbytes  8.70 Mbits/sec  0.267 ms 85640/86391 (99%)
[ 5] 24.00-25.00 sec  1.07 Mbytes  8.94 Mbits/sec  0.265 ms 85581/86353 (99%)
[ 5] 25.00-26.00 sec  332 Kbytes  2.72 Mbits/sec  0.246 ms 25828/26063 (99%)
[ 5] 26.00-27.00 sec  693 Kbytes  5.68 Mbits/sec  1.250 ms 148269/148758 (1e+02%)
[ 5] 27.00-28.00 sec  1.02 Mbytes  8.55 Mbits/sec  0.265 ms 91330/92074 (99%)
[ 5] 28.00-29.00 sec  1.05 Mbytes  8.77 Mbits/sec  0.265 ms 85565/86322 (99%)
[ 5] 29.00-30.00 sec  1.05 Mbytes  8.84 Mbits/sec  0.280 ms 85565/86328 (99%)
[ 5] 30.00-31.00 sec  1.05 Mbytes  8.78 Mbits/sec  0.279 ms 85573/86331 (99%)
[ 5] 31.00-31.79 sec  853 Kbytes  6.83 Mbits/sec  0.240 ms 67730/68333 (99%)

Server listening on 5201
```

Test łącza w obie strony 60Mbps, opóźnienie 600ms, utrata 5% (UDP iperf)

The image shows two terminal windows side-by-side. The left window is the sender's terminal, and the right window is the receiver's terminal. Both show the output of an iperf UDP test. The sender's output shows a total transfer of 66.3 Mbytes and a total datagram count of 2515137. The receiver's output shows a total transfer of 66.2 Mbytes and a total datagram count of 2515137, with a 0.9% loss. The test duration is 37.81 seconds.

```
[ID] Interval      Transfer      Bitrate      Total Datagrams
[ 5] 0.00-1.00 sec  119 Mbytes  999 Mbits/sec  86263
[ 5] 1.00-2.00 sec  119 Mbytes  1.00 Gbits/sec  86329
[ 5] 2.00-3.00 sec  119 Mbytes  1.00 Gbits/sec  86321
[ 5] 3.00-4.00 sec  119 Mbytes  1.00 Gbits/sec  86338
[ 5] 4.00-5.00 sec  119 Mbytes  1.00 Gbits/sec  86314
[ 5] 5.00-6.00 sec  119 Mbytes  1.00 Gbits/sec  86334
[ 5] 6.00-7.00 sec  119 Mbytes  1.00 Gbits/sec  86326
[ 5] 7.00-8.00 sec  119 Mbytes  1.00 Gbits/sec  86318
[ 5] 8.00-9.00 sec  119 Mbytes  1.00 Gbits/sec  86337
[ 5] 9.00-10.00 sec  119 Mbytes  1.00 Gbits/sec  86328
[ 5] 10.00-11.00 sec  119 Mbytes  1.00 Gbits/sec  86310
[ 5] 11.00-12.00 sec  119 Mbytes  1.00 Gbits/sec  86342
[ 5] 12.00-13.00 sec  119 Mbytes  1.00 Gbits/sec  86332
[ 5] 13.00-14.00 sec  119 Mbytes  1.00 Gbits/sec  86313
[ 5] 14.00-15.00 sec  119 Mbytes  1.00 Gbits/sec  86327
[ 5] 15.00-16.00 sec  119 Mbytes  1.00 Gbits/sec  86334
[ 5] 16.00-17.00 sec  119 Mbytes  1.00 Gbits/sec  86314
[ 5] 17.00-18.00 sec  119 Mbytes  1.00 Gbits/sec  86337
[ 5] 18.00-19.00 sec  119 Mbytes  1.00 Gbits/sec  86323
[ 5] 19.00-20.00 sec  119 Mbytes  1.00 Gbits/sec  86312
[ 5] 20.00-21.00 sec  119 Mbytes  1.00 Gbits/sec  86341
[ 5] 21.00-22.00 sec  119 Mbytes  1.00 Gbits/sec  86326
[ 5] 22.00-23.00 sec  119 Mbytes  1.00 Gbits/sec  86319
[ 5] 23.00-24.00 sec  119 Mbytes  1.00 Gbits/sec  86331
[ 5] 24.00-25.00 sec  119 Mbytes  1.00 Gbits/sec  86326
[ 5] 25.00-26.00 sec  119 Mbytes  1.00 Gbits/sec  86316
[ 5] 26.00-27.00 sec  119 Mbytes  1.00 Gbits/sec  86377
[ 5] 27.00-28.00 sec  119 Mbytes  1.00 Gbits/sec  86304
[ 5] 28.00-29.00 sec  119 Mbytes  1.00 Gbits/sec  86294
[ 5] 29.00-30.00 sec  119 Mbytes  1.00 Gbits/sec  86334
[ 5] 30.00-30.00 sec  3.49 Gbytes 1000 Mbits/sec 0.000 ms 0/258920 (0%) sender
[ 5] 0.00-37.81 sec 66.3 Mbytes 14.7 Mbits/sec 0.266 ms 2515137/2563136 (98%) receiver

iperf Done.
administrator@ubuntu-tc-A:~$
```

```
[ 6] 7.00-8.00 sec  1.68 Mbytes  14.1 Mbits/sec  0.281 ms 54372/55591 (98%)
[ 6] 8.00-9.00 sec  1.38 Mbytes  11.6 Mbits/sec  0.232 ms 50950/51950 (98%)
[ 6] 9.00-10.00 sec  785 Kbytes  6.43 Mbits/sec  0.188 ms 141495/142520 (1e+02%)
[ 6] 10.00-11.00 sec  2.08 Mbytes  16.7 Mbits/sec  0.256 ms 66953/68398 (98%)
[ 6] 11.00-12.00 sec  2.76 Mbytes  23.2 Mbits/sec  0.290 ms 101843/103842 (98%)
[ 6] 12.00-13.00 sec  2.11 Mbytes  17.7 Mbits/sec  0.273 ms 94130/95658 (98%)
[ 6] 13.00-14.00 sec  2.03 Mbytes  17.0 Mbits/sec  0.278 ms 58569/60041 (98%)
[ 6] 14.00-15.00 sec  2.76 Mbytes  23.2 Mbits/sec  0.252 ms 181795/183795 (98%)
[ 6] 15.00-16.00 sec  2.07 Mbytes  17.4 Mbits/sec  0.292 ms 93689/95140 (98%)
[ 6] 16.00-17.00 sec  2.07 Mbytes  17.4 Mbits/sec  0.294 ms 59915/60514 (98%)
[ 6] 17.00-18.00 sec  2.76 Mbytes  23.2 Mbits/sec  0.285 ms 101766/103766 (98%)
[ 6] 18.00-19.00 sec  2.76 Mbytes  23.2 Mbits/sec  0.307 ms 93224/94699 (98%)
[ 6] 19.00-20.00 sec  2.11 Mbytes  17.7 Mbits/sec  0.309 ms 59587/61032 (98%)
[ 6] 20.00-21.00 sec  2.76 Mbytes  23.2 Mbits/sec  0.270 ms 181764/183764 (98%)
[ 6] 21.00-22.00 sec  2.00 Mbytes  16.8 Mbits/sec  0.270 ms 92737/94186 (98%)
[ 6] 22.00-23.00 sec  2.14 Mbytes  18.0 Mbits/sec  0.260 ms 59964/61515 (98%)
[ 6] 23.00-24.00 sec  2.70 Mbytes  23.2 Mbits/sec  0.272 ms 101792/103792 (97%)
[ 6] 24.00-25.00 sec  1.97 Mbytes  16.5 Mbits/sec  0.292 ms 92249/93665 (98%)
[ 6] 25.00-26.00 sec  2.15 Mbytes  18.3 Mbits/sec  0.284 ms 66489/61986 (97%)
[ 6] 26.00-27.00 sec  2.76 Mbytes  23.2 Mbits/sec  0.290 ms 101755/103755 (98%)
[ 6] 27.00-28.00 sec  1.93 Mbytes  16.2 Mbits/sec  0.265 ms 91839/93236 (99%)
[ 6] 28.00-29.00 sec  2.21 Mbytes  18.6 Mbits/sec  0.301 ms 60817/62420 (97%)
[ 6] 29.00-30.00 sec  2.76 Mbytes  23.2 Mbits/sec  0.285 ms 181754/183754 (98%)
[ 6] 30.00-31.00 sec  1.98 Mbytes  15.9 Mbits/sec  0.283 ms 91483/92804 (99%)
[ 6] 31.00-32.00 sec  2.25 Mbytes  18.8 Mbits/sec  0.268 ms 61223/62850 (97%)
[ 6] 32.00-33.00 sec  2.76 Mbytes  23.2 Mbits/sec  0.282 ms 101762/103762 (98%)
[ 6] 33.00-34.00 sec  1.88 Mbytes  15.6 Mbits/sec  0.294 ms 91027/92373 (99%)
[ 6] 34.00-35.00 sec  2.28 Mbytes  19.2 Mbits/sec  0.266 ms 61620/63274 (99%)
[ 6] 35.00-36.00 sec  0.00 Bytes  0.00 bits/sec  0.260 ms 0/0 (0%)
[ 6] 36.00-37.00 sec  0.00 Bytes  0.00 bits/sec  0.260 ms 0/0 (0%)
[ 6] 37.00-37.81 sec  0.00 Bytes  0.00 bits/sec  0.266 ms 0/0 (0%)

Server listening on 5201
```