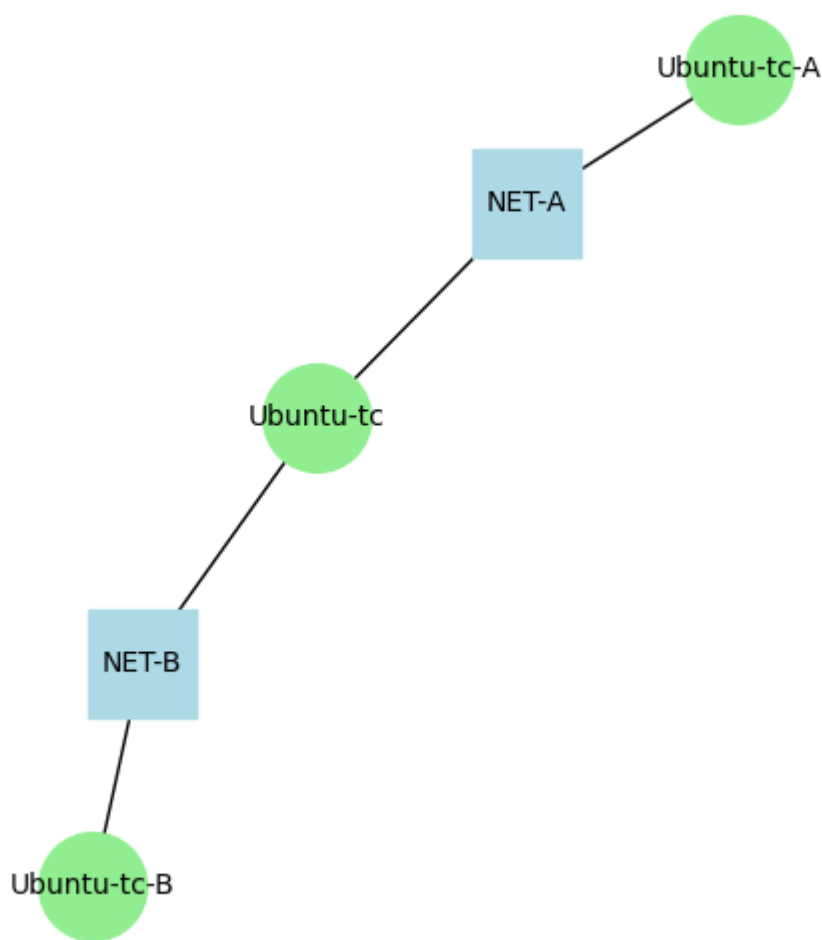


TC linux - ograniczanie pasma, indukowanie błędów w transmisji i opóźnienia

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	mbit		
Delay	None	ms	±None	± ms
Loss	None	%	None	%
Duplicate	None	%		
Reorder	None	%	None	%
Corrupt	None	%		
Limit	None			

Apply eth0 (192.168.1.1) Rules

Remove eth0 (192.168.1.1) Rules

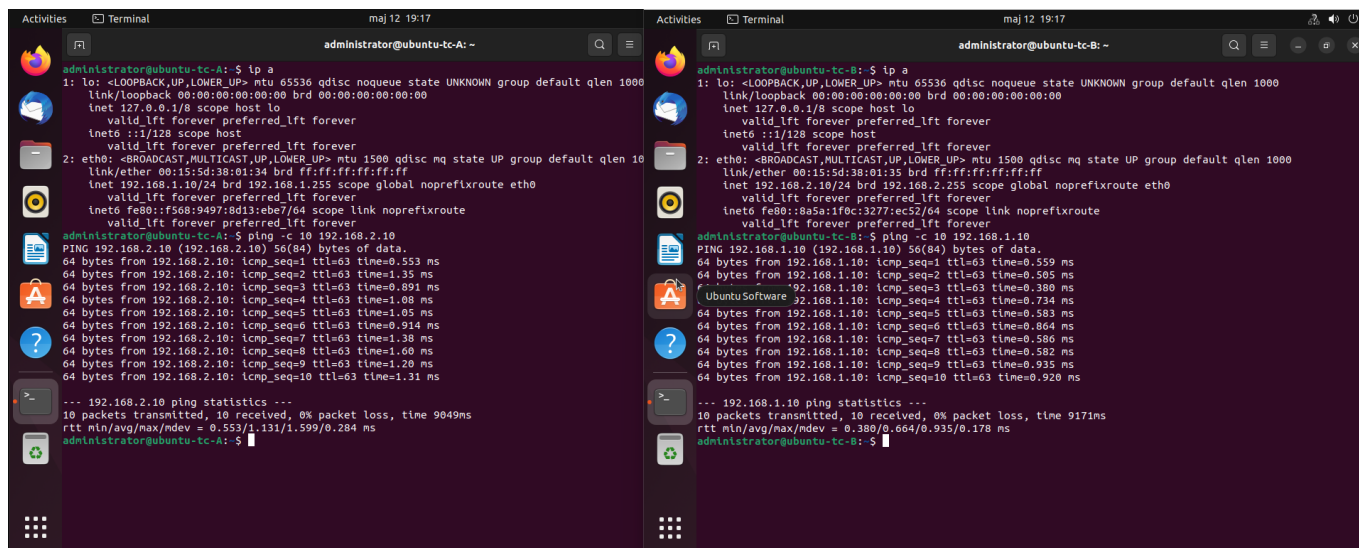
Ustawienia na reszcie maszyn

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

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

Testy opóźnień

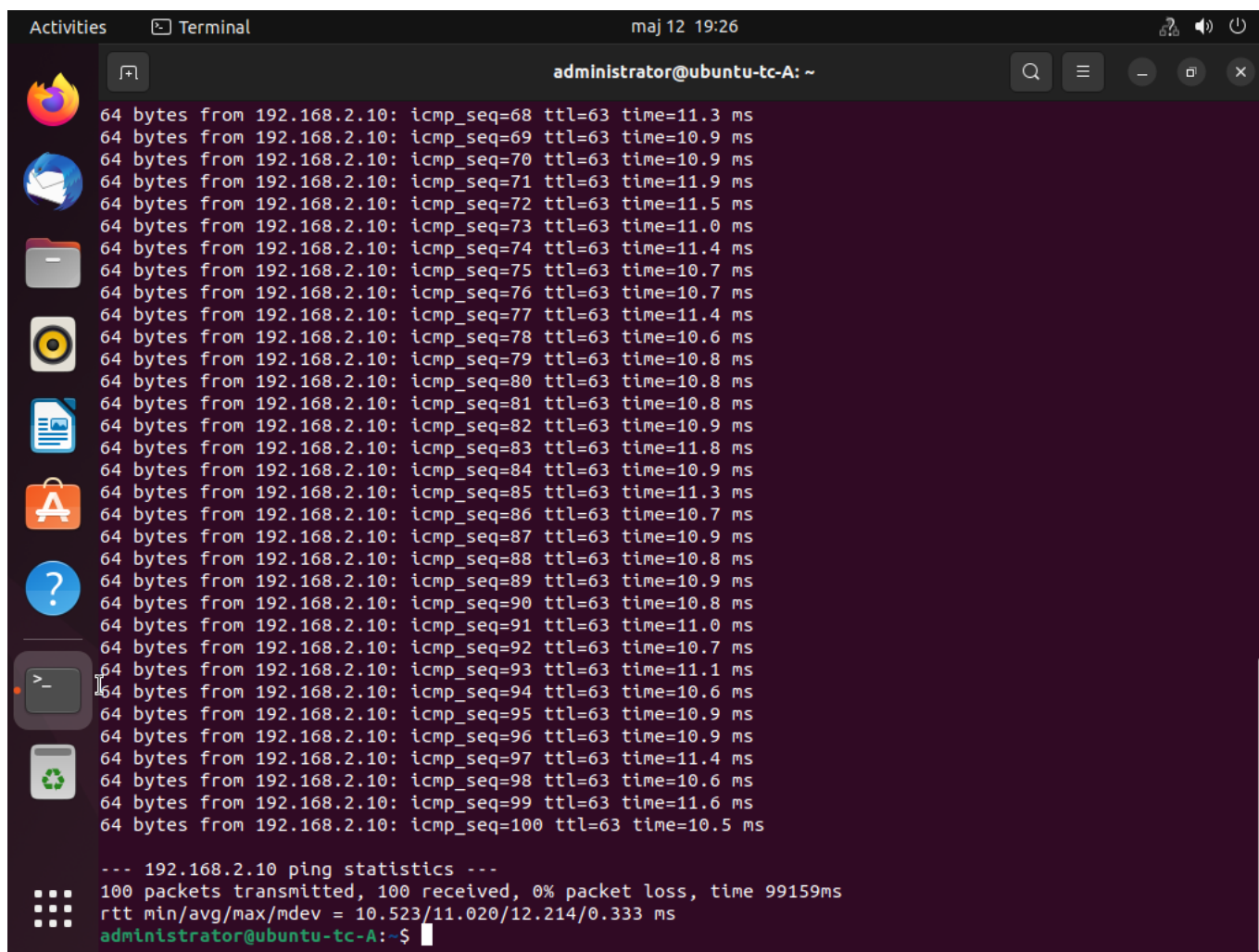
Test bez dodanego opóźnienia



The image shows two terminal windows side-by-side, both running on Ubuntu. The left window is titled 'administrator@ubuntu-tc-a: ~' and the right window is titled 'administrator@ubuntu-tc-b: ~'. Both windows show the same network configuration commands: `ip a` to show interface details for `lo` and `eth0`, and `ping -c 10 192.168.2.10` to test connectivity. The ping results show a round-trip time of approximately 0.553 ms for the left window and 0.559 ms for the right window. The ping statistics at the bottom of each window show 10 packets transmitted, 10 received, 0% packet loss, and a time of 9049ms for the left window and 9171ms for the right window.

```
administrator@ubuntu-tc-a: ~  
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: eth0: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc mq state UP group default qlen 10  
    link/ether 00:15:5d:38:01:34 brd ff:ff:ff:ff:ff:ff  
    inet 192.168.1.10/24 brd 192.168.1.255 scope global noprefixroute eth0  
        valid_lft forever preferred_lft forever  
    inet6 fe80::f508:9497:bd13:eb67/64 scope link noprefixroute  
        valid_lft forever preferred_lft forever  
administrator@ubuntu-tc-a: ~  
$ ping -c 10 192.168.2.10  
PING 192.168.2.10 (192.168.2.10) 56(84) bytes of data:  
64 bytes from 192.168.2.10: icmp_seq=1 ttl=63 time=0.553 ms  
64 bytes from 192.168.2.10: icmp_seq=2 ttl=63 time=1.35 ms  
64 bytes from 192.168.2.10: icmp_seq=3 ttl=63 time=0.891 ms  
64 bytes from 192.168.2.10: icmp_seq=4 ttl=63 time=1.08 ms  
64 bytes from 192.168.2.10: icmp_seq=5 ttl=63 time=1.05 ms  
64 bytes from 192.168.2.10: icmp_seq=6 ttl=63 time=0.914 ms  
64 bytes from 192.168.2.10: icmp_seq=7 ttl=63 time=1.38 ms  
64 bytes from 192.168.2.10: icmp_seq=8 ttl=63 time=1.68 ms  
64 bytes from 192.168.2.10: icmp_seq=9 ttl=63 time=1.20 ms  
64 bytes from 192.168.2.10: icmp_seq=10 ttl=63 time=1.31 ms  
--- 192.168.2.10 ping statistics ---  
10 packets transmitted, 10 received, 0% packet loss, time 9049ms  
rtt min/avg/max/ndev = 0.553/1.131/1.599/0.284 ms  
administrator@ubuntu-tc-a: ~  
$  
administrator@ubuntu-tc-b: ~  
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: eth0: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc mq state UP group default qlen 1000  
    link/ether 00:15:5d:38:01:35 brd ff:ff:ff:ff:ff:ff  
    inet 192.168.2.10/24 brd 192.168.2.255 scope global noprefixroute eth0  
        valid_lft forever preferred_lft forever  
    inet6 fe80::8a5a:1f0c:3277:ec52/64 scope link noprefixroute  
        valid_lft forever preferred_lft forever  
administrator@ubuntu-tc-b: ~  
$ ping -c 10 192.168.1.10  
PING 192.168.1.10 (192.168.1.10) 56(84) bytes of data:  
64 bytes from 192.168.1.10: icmp_seq=1 ttl=63 time=0.559 ms  
64 bytes from 192.168.1.10: icmp_seq=2 ttl=63 time=0.505 ms  
64 bytes from 192.168.1.10: icmp_seq=3 ttl=63 time=0.380 ms  
64 bytes from 192.168.1.10: icmp_seq=4 ttl=63 time=0.734 ms  
64 bytes from 192.168.1.10: icmp_seq=5 ttl=63 time=0.583 ms  
64 bytes from 192.168.1.10: icmp_seq=6 ttl=63 time=0.864 ms  
64 bytes from 192.168.1.10: icmp_seq=7 ttl=63 time=0.580 ms  
64 bytes from 192.168.1.10: icmp_seq=8 ttl=63 time=0.582 ms  
64 bytes from 192.168.1.10: icmp_seq=9 ttl=63 time=0.935 ms  
64 bytes from 192.168.1.10: icmp_seq=10 ttl=63 time=0.920 ms  
--- 192.168.1.10 ping statistics ---  
10 packets transmitted, 10 received, 0% packet loss, time 9171ms  
rtt min/avg/max/ndev = 0.380/0.664/0.935/0.178 ms  
administrator@ubuntu-tc-b: ~  
$
```

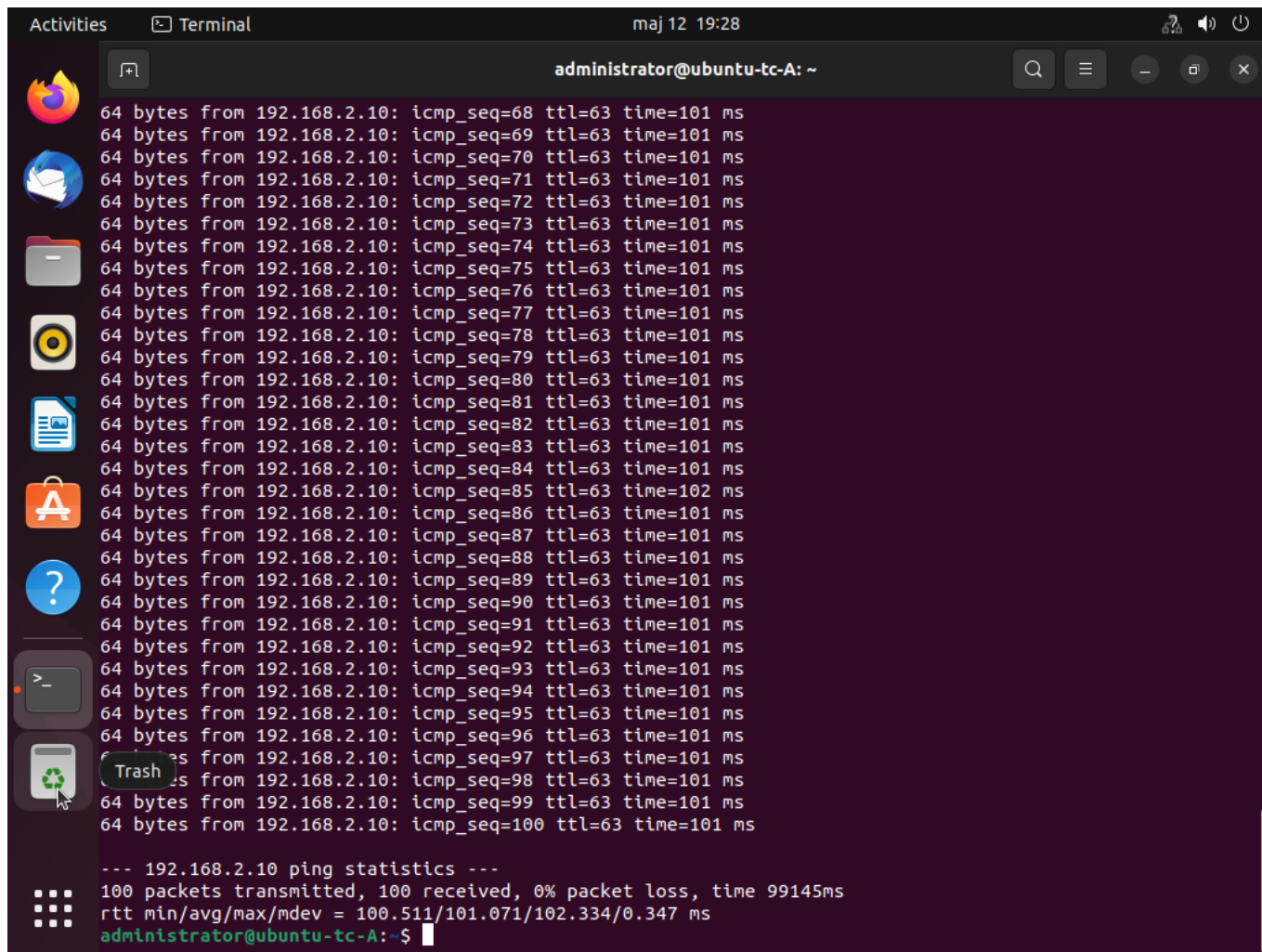
Test z dodanym opóźnieniem 10ms wynik z 100 pomiarów



```
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

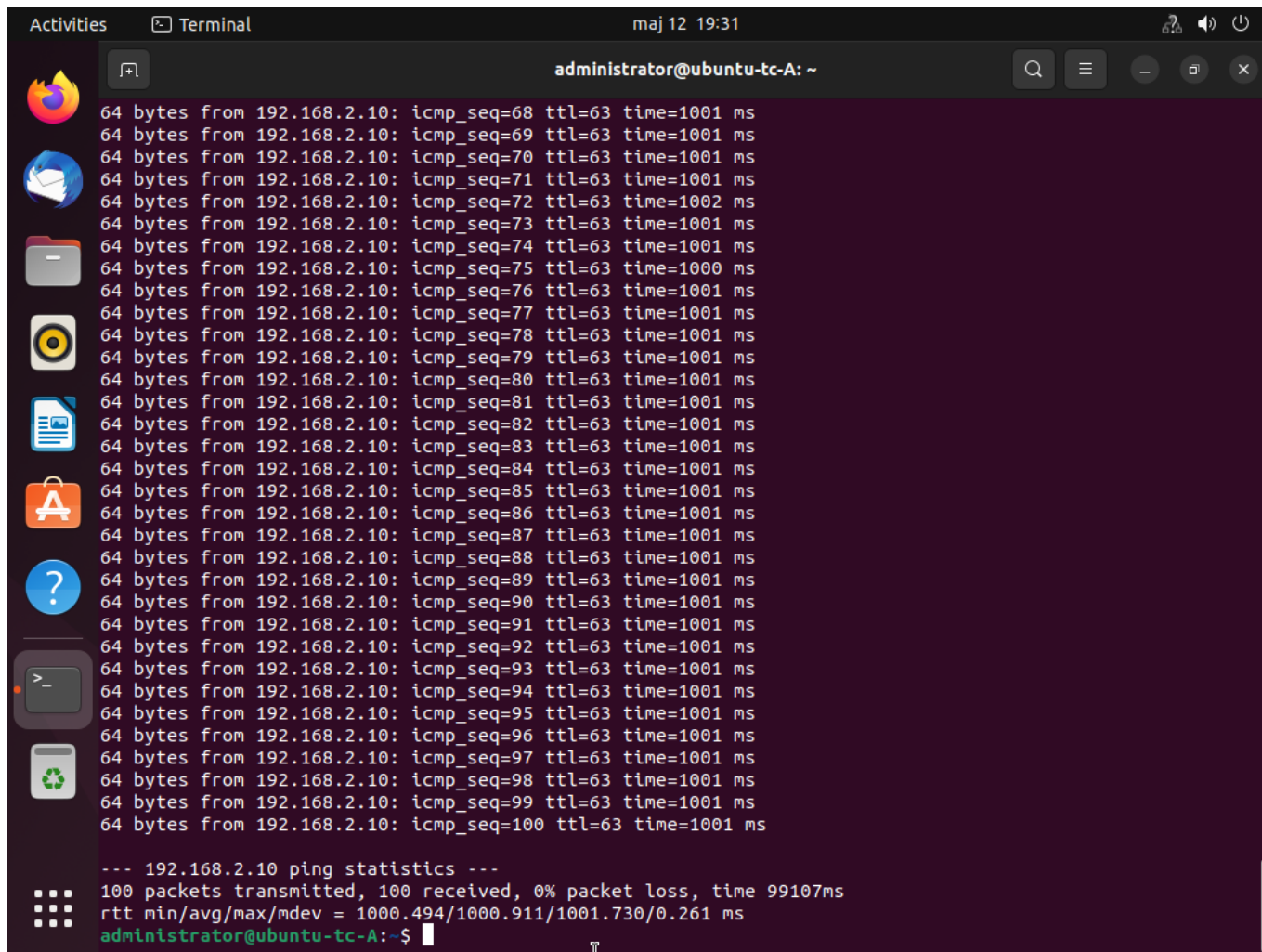


The screenshot shows a terminal window titled "administrator@ubuntu-tc-A: ~" with a dark purple background. The terminal displays the output of a ping command to 192.168.2.10. Each line shows "64 bytes from 192.168.2.10: icmp_seq=X ttl=63 time=Y ms", where X ranges from 68 to 100 and Y is consistently 101 ms, except for sequence 85 which is 102 ms. At the bottom, a summary line reads: "100 packets transmitted, 100 received, 0% packet loss, time 99145ms rtt min/avg/max/mdev = 100.511/101.071/102.334/0.347 ms". The terminal is part of a desktop environment with a sidebar on the left containing icons for various applications like Firefox, Mail, Files, and a Trash icon. The top of the window shows system status: "maj 12 19:28".

```
64 bytes from 192.168.2.10: icmp_seq=68 ttl=63 time=101 ms
64 bytes from 192.168.2.10: icmp_seq=69 ttl=63 time=101 ms
64 bytes from 192.168.2.10: icmp_seq=70 ttl=63 time=101 ms
64 bytes from 192.168.2.10: icmp_seq=71 ttl=63 time=101 ms
64 bytes from 192.168.2.10: icmp_seq=72 ttl=63 time=101 ms
64 bytes from 192.168.2.10: icmp_seq=73 ttl=63 time=101 ms
64 bytes from 192.168.2.10: icmp_seq=74 ttl=63 time=101 ms
64 bytes from 192.168.2.10: icmp_seq=75 ttl=63 time=101 ms
64 bytes from 192.168.2.10: icmp_seq=76 ttl=63 time=101 ms
64 bytes from 192.168.2.10: icmp_seq=77 ttl=63 time=101 ms
64 bytes from 192.168.2.10: icmp_seq=78 ttl=63 time=101 ms
64 bytes from 192.168.2.10: icmp_seq=79 ttl=63 time=101 ms
64 bytes from 192.168.2.10: icmp_seq=80 ttl=63 time=101 ms
64 bytes from 192.168.2.10: icmp_seq=81 ttl=63 time=101 ms
64 bytes from 192.168.2.10: icmp_seq=82 ttl=63 time=101 ms
64 bytes from 192.168.2.10: icmp_seq=83 ttl=63 time=101 ms
64 bytes from 192.168.2.10: icmp_seq=84 ttl=63 time=101 ms
64 bytes from 192.168.2.10: icmp_seq=85 ttl=63 time=102 ms
64 bytes from 192.168.2.10: icmp_seq=86 ttl=63 time=101 ms
64 bytes from 192.168.2.10: icmp_seq=87 ttl=63 time=101 ms
64 bytes from 192.168.2.10: icmp_seq=88 ttl=63 time=101 ms
64 bytes from 192.168.2.10: icmp_seq=89 ttl=63 time=101 ms
64 bytes from 192.168.2.10: icmp_seq=90 ttl=63 time=101 ms
64 bytes from 192.168.2.10: icmp_seq=91 ttl=63 time=101 ms
64 bytes from 192.168.2.10: icmp_seq=92 ttl=63 time=101 ms
64 bytes from 192.168.2.10: icmp_seq=93 ttl=63 time=101 ms
64 bytes from 192.168.2.10: icmp_seq=94 ttl=63 time=101 ms
64 bytes from 192.168.2.10: icmp_seq=95 ttl=63 time=101 ms
64 bytes from 192.168.2.10: icmp_seq=96 ttl=63 time=101 ms
64 bytes from 192.168.2.10: icmp_seq=97 ttl=63 time=101 ms
64 bytes from 192.168.2.10: icmp_seq=98 ttl=63 time=101 ms
64 bytes from 192.168.2.10: icmp_seq=99 ttl=63 time=101 ms
64 bytes from 192.168.2.10: icmp_seq=100 ttl=63 time=101 ms

--- 192.168.2.10 ping statistics ---
100 packets transmitted, 100 received, 0% packet loss, time 99145ms
rtt min/avg/max/mdev = 100.511/101.071/102.334/0.347 ms
administrator@ubuntu-tc-A:~$
```

test z dodanym opóźnieniem 1000ms wynik z 100 pomiarów



The screenshot shows a terminal window titled "Terminal" with the user "administrator@ubuntu-tc-A: ~". The terminal displays the output of a series of ping commands to the IP address 192.168.2.10. Each line shows "64 bytes from 192.168.2.10: icmp_seq=X ttl=63 time=1001 ms", where X ranges from 68 to 100. Below the ping results, there is a section titled "--- 192.168.2.10 ping statistics ---" which reports "100 packets transmitted, 100 received, 0% packet loss, time 99107ms" and "rtt min/avg/max/mdev = 1000.494/1000.911/1001.730/0.261 ms". The prompt "administrator@ubuntu-tc-A:~\$" is visible at the bottom.

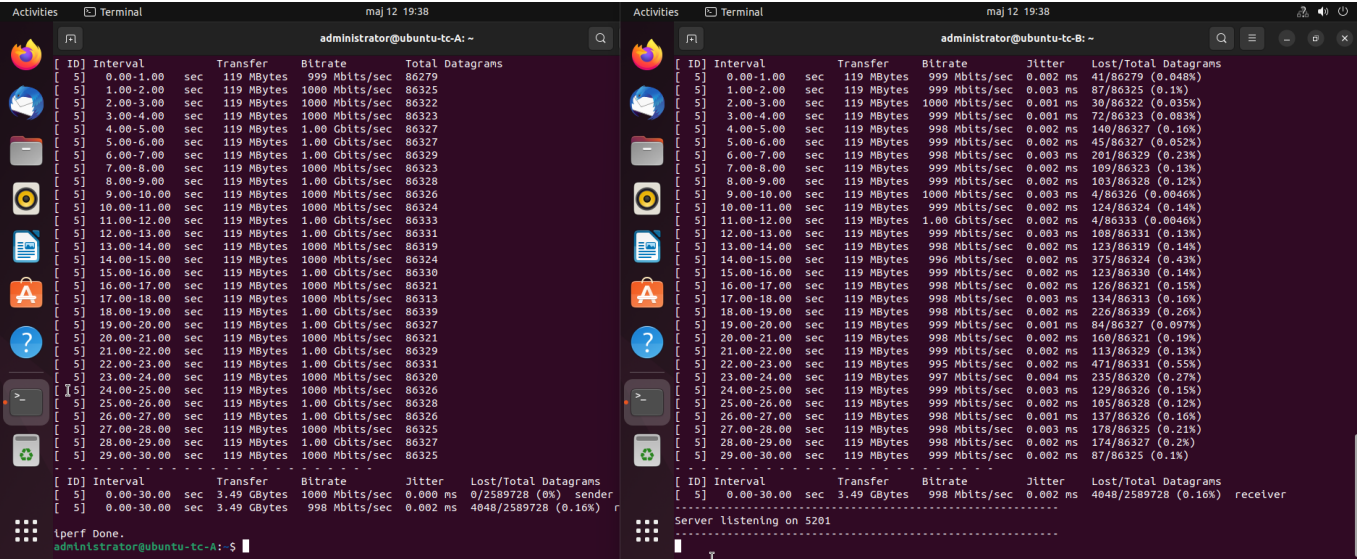
```
64 bytes from 192.168.2.10: icmp_seq=68 ttl=63 time=1001 ms
64 bytes from 192.168.2.10: icmp_seq=69 ttl=63 time=1001 ms
64 bytes from 192.168.2.10: icmp_seq=70 ttl=63 time=1001 ms
64 bytes from 192.168.2.10: icmp_seq=71 ttl=63 time=1001 ms
64 bytes from 192.168.2.10: icmp_seq=72 ttl=63 time=1002 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:~$
```

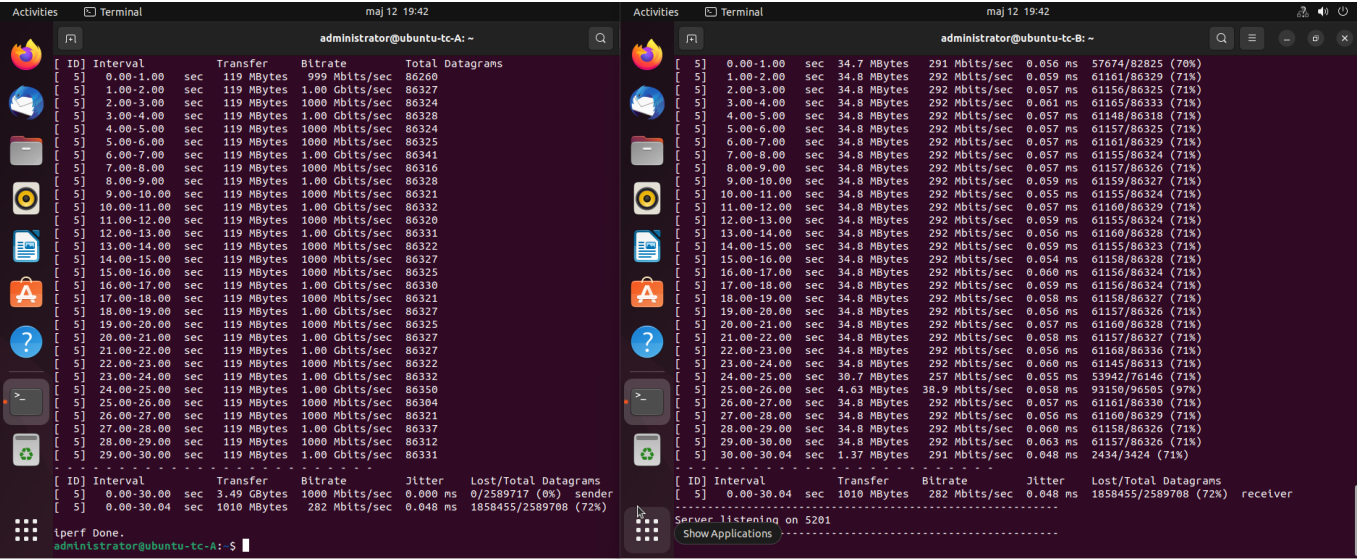
test z dodanym opóźnieniem 5000ms wynik z 100 pomiarów

Test ograniczeń pasma

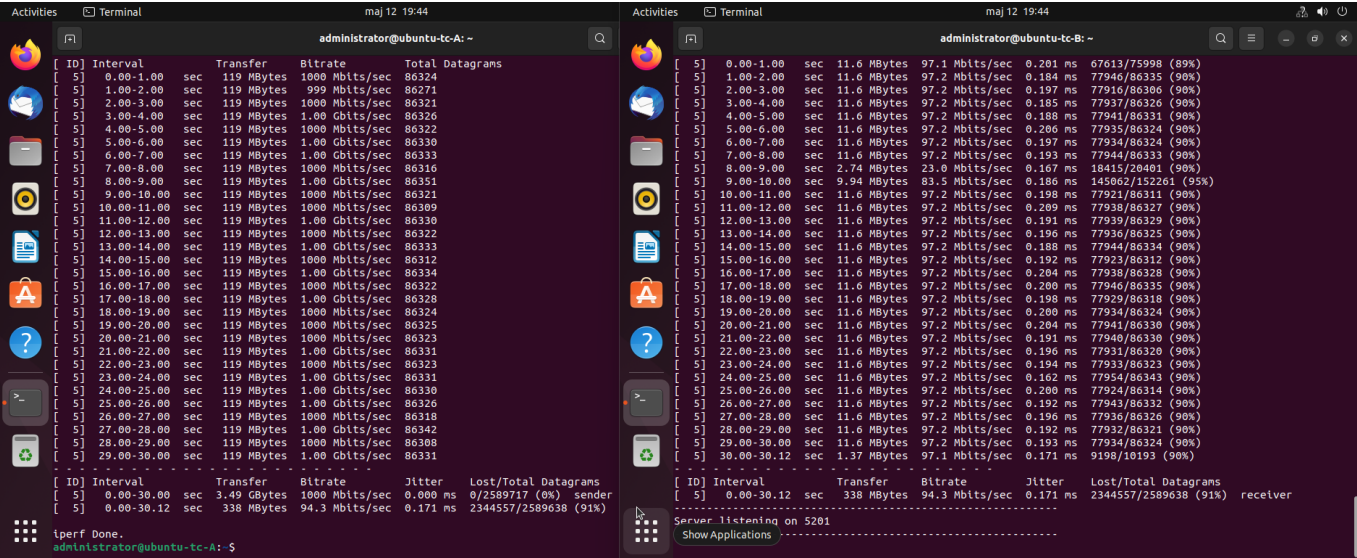
Test bez ograniczenia 30s (UDP 1Gbps iperf)



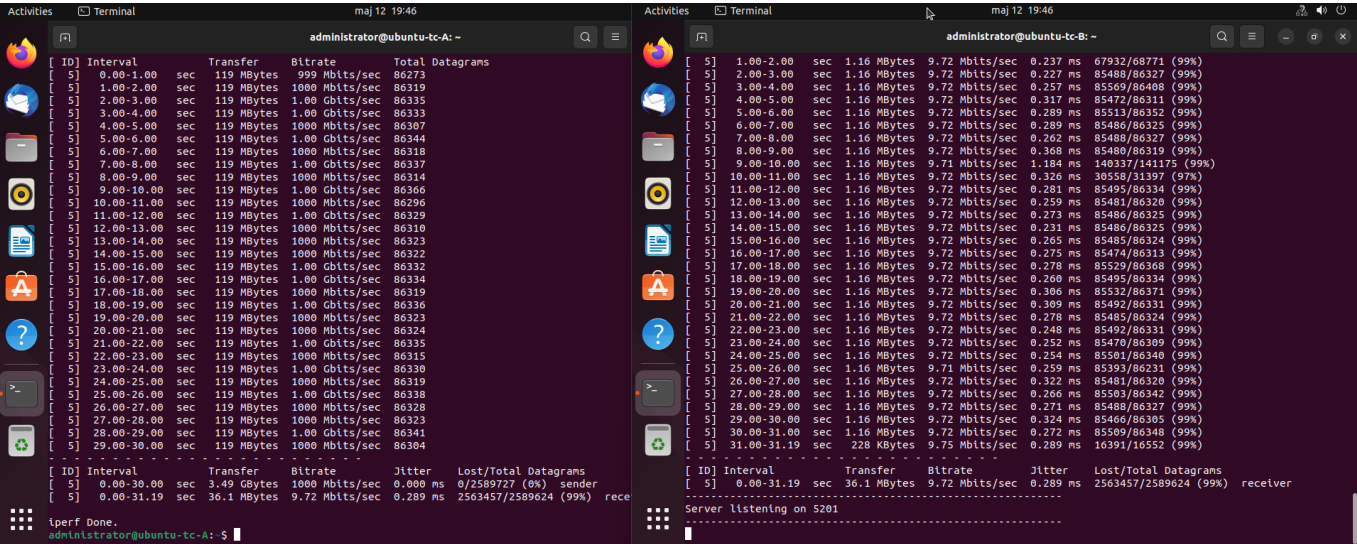
Ograniczenie pasma do 300Mbps 30s (UDP iperf)



Ograniczenie pasma do 100Mbps 30s (UDP iperf)



Ograniczenie pasma do 10Mbps 30s (UDP iperf)



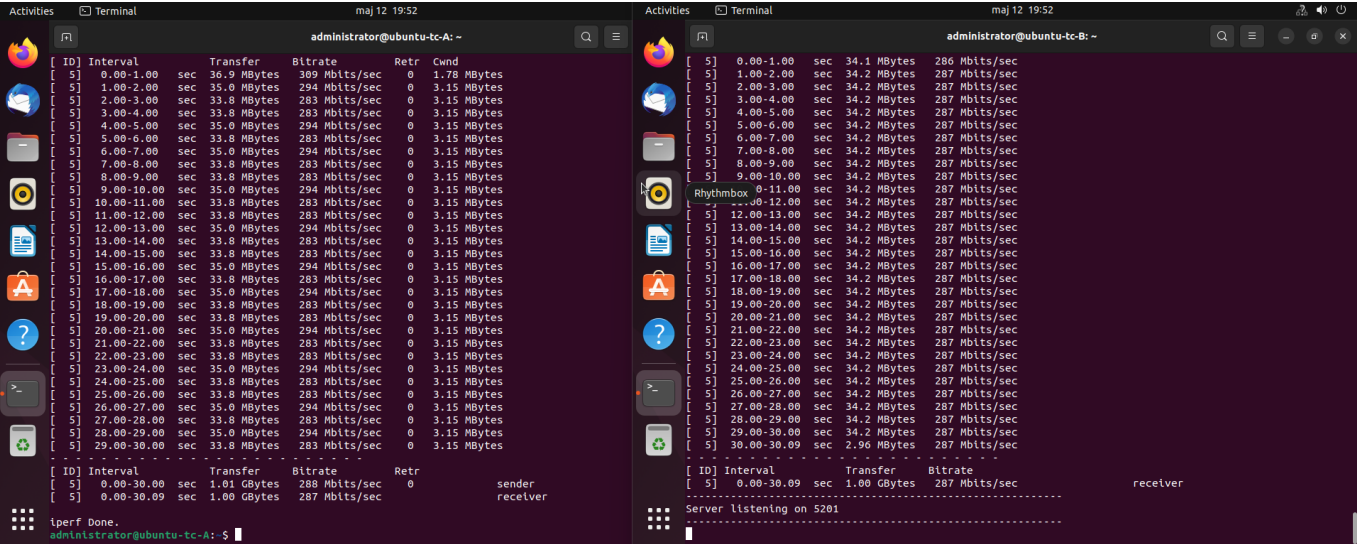
Ograniczenie pasma do 1Mbps 30s (UDP iperf)

```
adminstrator@ubuntu-tc-A: ~  
[ 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    1.00 Gbts/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  86320  
[ 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  86328  
[ 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 Kbits/sec  0.147 ms    2585788/2589304 (1e+02%) receiver  
iperf Done.  
adminstrator@ubuntu-tc-A: ~  
[ ID] Interval      Transfer      Bitrate      Total      Datagrams  
[ 5] 11.00-12.00 sec  119 KBytes     973 kbits/sec  8.644 ms    5244/5338 (98%)  
[ 5] 12.00-13.00 sec  119 KBytes     973 kbits/sec  0.180 ms    86341/86425 (1e+02%)  
[ 5] 13.00-14.00 sec  119 KBytes     973 kbits/sec  0.327 ms    86323/86407 (1e+02%)  
[ 5] 14.00-15.00 sec  119 KBytes     973 kbits/sec  0.163 ms    86370/86454 (1e+02%)  
[ 5] 15.00-16.00 sec  119 KBytes     973 kbits/sec  0.225 ms    86361/86445 (1e+02%)  
[ 5] 16.00-17.00 sec  119 KBytes     973 kbits/sec  0.255 ms    86323/86407 (1e+02%)  
[ 5] 17.00-18.00 sec  117 KBytes     961 kbits/sec  0.257 ms    85299/85302 (1e+02%)  
[ 5] 18.00-19.00 sec  119 KBytes     973 kbits/sec  0.201 ms    86371/86455 (1e+02%)  
[ 5] 19.00-20.00 sec  119 KBytes     973 kbits/sec  0.197 ms    86380/86464 (1e+02%)  
[ 5] 20.00-21.00 sec  119 KBytes     973 kbits/sec  15.365 ms   1028905/1028989 (1e+02%)  
[ 5] 21.00-22.00 sec  119 KBytes     973 kbits/sec  11.929 ms    0/84 (0%)  
[ 5] 22.00-23.00 sec  119 KBytes     973 kbits/sec  11.918 ms    0/84 (0%)  
[ 5] 23.00-24.00 sec  119 KBytes     973 kbits/sec  11.923 ms    0/84 (0%)  
[ 5] 24.00-25.00 sec  117 KBytes     961 kbits/sec  11.922 ms    0/83 (0%)  
[ 5] 25.00-26.00 sec  119 KBytes     973 kbits/sec  11.911 ms    0/84 (0%)  
[ 5] 26.00-27.00 sec  119 KBytes     973 kbits/sec  11.905 ms    0/84 (0%)  
[ 5] 27.00-28.00 sec  119 KBytes     973 kbits/sec  11.911 ms    0/84 (0%)  
[ 5] 28.00-29.00 sec  119 KBytes     973 kbits/sec  11.910 ms    0/84 (0%)  
[ 5] 29.00-30.00 sec  119 KBytes     973 kbits/sec  11.907 ms    0/84 (0%)  
[ 5] 30.00-31.00 sec  119 KBytes     973 kbits/sec  11.898 ms    0/84 (0%)  
[ 5] 31.00-32.00 sec  119 KBytes     973 kbits/sec  7.989 ms    6599/6683 (99%)  
[ 5] 32.00-33.00 sec  119 KBytes     973 kbits/sec  0.267 ms    86331/86415 (1e+02%)  
[ 5] 33.00-34.00 sec  117 KBytes     961 kbits/sec  0.183 ms    85295/85378 (1e+02%)  
[ 5] 34.00-35.00 sec  119 KBytes     973 kbits/sec  0.140 ms    86411/86495 (1e+02%)  
[ 5] 35.00-36.00 sec  119 KBytes     973 kbits/sec  0.175 ms    86330/86414 (1e+02%)  
[ 5] 36.00-37.00 sec  119 KBytes     973 kbits/sec  0.312 ms    86322/86406 (1e+02%)  
[ 5] 37.00-38.00 sec  119 KBytes     973 kbits/sec  0.353 ms    86351/86435 (1e+02%)  
[ 5] 38.00-39.00 sec  119 KBytes     973 kbits/sec  0.159 ms    86388/86472 (1e+02%)  
[ 5] 39.00-40.00 sec  119 KBytes     973 kbits/sec  0.164 ms    86338/86422 (1e+02%)  
[ 5] 40.00-41.00 sec  119 KBytes     973 kbits/sec  0.214 ms    86307/86391 (1e+02%)  
[ 5] 41.00-41.92 sec  109 KBytes     974 kbits/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 kbits/sec  0.147 ms    2585788/2589304 (1e+02%) receiver  
Server listening on 5201
```

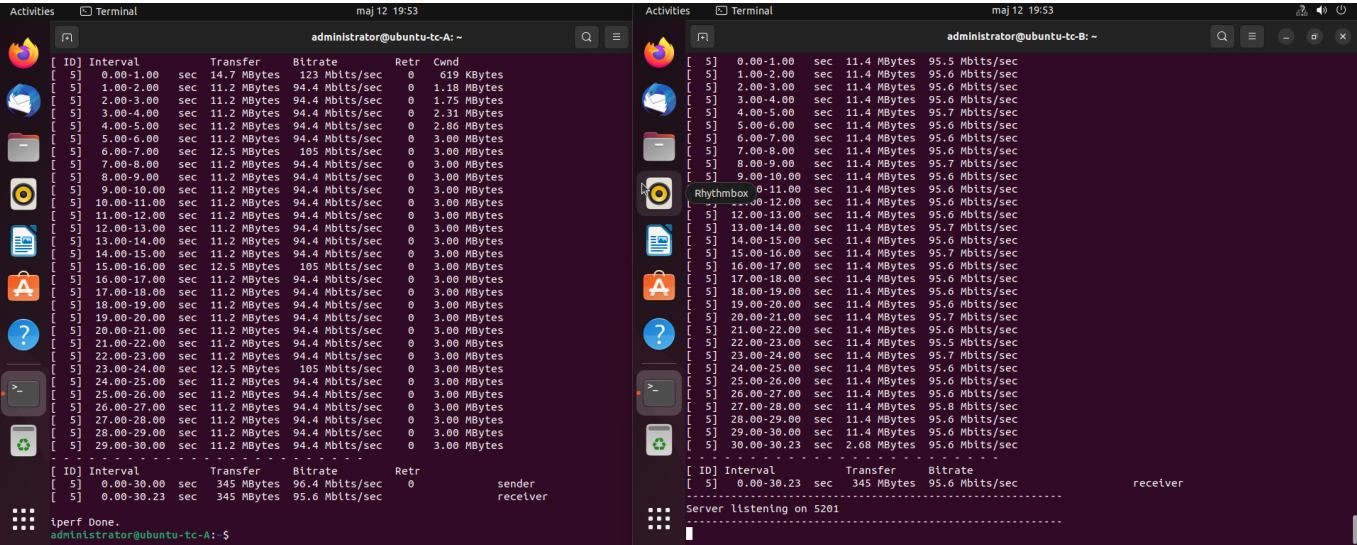
Test bez ograniczenia 30s (TCP iperf)

```
adminstrator@ubuntu-tc-A: ~  
[ 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      sender receiver  
[ 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: ~  
[ ID] Interval      Transfer      Bitrate      Retr      Cwnd  
[ 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  
[ 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)

```
administorator@ubuntu-tc-A: ~  
[ ID] Interval      Transfer      Bitrate      Retr      Cwnd  
[ 5] 0.00-1.00 sec  2.26 MBytes  18.9 Mbits/sec  0      294 KBytes  
[ 5] 1.00-2.00 sec  1.25 MBytes  10.5 Mbits/sec  0      352 KBytes  
[ 5] 2.00-3.00 sec  1.48 MBytes  12.5 Mbits/sec  0      410 KBytes  
[ 5] 3.00-4.00 sec  1.72 MBytes  14.4 Mbits/sec  0      468 KBytes  
[ 5] 4.00-5.00 sec  1.01 MBytes  8.46 Mbits/sec  0      527 KBytes  
[ 5] 5.00-6.00 sec  2.20 MBytes  18.4 Mbits/sec  0      585 KBytes  
[ 5] 6.00-7.00 sec  1.25 MBytes  10.5 Mbits/sec  0      643 KBytes  
[ 5] 7.00-8.00 sec  1.25 MBytes  10.5 Mbits/sec  0      703 KBytes  
[ 5] 8.00-9.00 sec  1.25 MBytes  10.5 Mbits/sec  0      761 KBytes  
[ 5] 9.00-10.00 sec  1.25 MBytes  10.5 Mbits/sec  0      819 KBytes  
[ 5] 10.00-11.00 sec  0.00 Bytes  0.00 bits/sec  0      882 KBytes  
[ 5] 11.00-12.00 sec  1.25 MBytes  10.5 Mbits/sec  0      1.00 MBytes  
[ 5] 12.00-13.00 sec  1.25 MBytes  10.5 Mbits/sec  0      1.19 MBytes  
[ 5] 13.00-14.00 sec  1.25 MBytes  10.5 Mbits/sec  0      1.42 MBytes  
[ 5] 14.00-15.00 sec  1.25 MBytes  10.5 Mbits/sec  0      1.68 MBytes  
[ 5] 15.00-16.00 sec  1.25 MBytes  10.5 Mbits/sec  0      1.97 MBytes  
[ 5] 16.00-17.00 sec  1.25 MBytes  10.5 Mbits/sec  0      2.28 MBytes  
[ 5] 17.00-18.00 sec  0.00 Bytes  0.00 bits/sec  0      2.66 MBytes  
[ 5] 18.00-19.00 sec  1.25 MBytes  10.5 Mbits/sec  0      3.04 MBytes  
[ 5] 19.00-20.00 sec  1.25 MBytes  10.5 Mbits/sec  0      3.18 MBytes  
[ 5] 20.00-21.00 sec  1.25 MBytes  10.5 Mbits/sec  0      2.44 MBytes  
[ 5] 21.00-22.00 sec  0.00 Bytes  0.00 bits/sec  144    1.08 MBytes  
[ 5] 22.00-23.00 sec  2.50 MBytes  21.0 Mbits/sec  0      2.17 MBytes  
[ 5] 23.00-24.00 sec  1.25 MBytes  10.5 Mbits/sec  0      2.22 MBytes  
[ 5] 24.00-25.00 sec  1.25 MBytes  10.5 Mbits/sec  0      2.33 MBytes  
[ 5] 25.00-26.00 sec  1.25 MBytes  10.5 Mbits/sec  0      2.40 MBytes  
[ 5] 26.00-27.00 sec  1.25 MBytes  10.5 Mbits/sec  0      2.58 MBytes  
[ 5] 27.00-28.00 sec  1.25 MBytes  10.5 Mbits/sec  0      2.69 MBytes  
[ 5] 28.00-29.00 sec  0.00 Bytes  0.00 bits/sec  0      2.79 MBytes  
[ 5] 29.00-30.00 sec  1.25 MBytes  10.5 Mbits/sec  0      2.86 MBytes  
[ ID] Interval      Transfer      Bitrate      Retr      Cwnd  
[ 5] 0.00-30.00 sec  36.2 MBytes  10.1 Mbits/sec  152    sender  
[ 5] 0.00-31.70 sec  35.9 MBytes  9.49 Mbits/sec  receiver  
iperf Done.  
administorator@ubuntu-tc-A: ~  
[ ID] Interval      Transfer      Bitrate      Retr      Cwnd  
[ 5] 1.00-2.00 sec  1.14 MBytes  9.56 Mbits/sec  
[ 5] 2.00-3.00 sec  1.14 MBytes  9.58 Mbits/sec  
[ 5] 3.00-4.00 sec  1.14 MBytes  9.56 Mbits/sec  
[ 5] 4.00-5.00 sec  1.14 MBytes  9.56 Mbits/sec  
[ 5] 5.00-6.00 sec  1.14 MBytes  9.57 Mbits/sec  
[ 5] 6.00-7.00 sec  1.14 MBytes  9.58 Mbits/sec  
[ 5] 7.00-8.00 sec  1.14 MBytes  9.56 Mbits/sec  
[ 5] 8.00-9.00 sec  1.14 MBytes  9.56 Mbits/sec  
[ 5] 9.00-10.00 sec  1.14 MBytes  9.58 Mbits/sec  
[ 5] 10.00-11.00 sec  1.14 MBytes  9.55 Mbits/sec  
[ 5] 11.00-12.00 sec  1.14 MBytes  9.58 Mbits/sec  
[ 5] 12.00-13.00 sec  1.14 MBytes  9.56 Mbits/sec  
[ 5] 13.00-14.00 sec  1.14 MBytes  9.56 Mbits/sec  
[ 5] 14.00-15.00 sec  1.14 MBytes  9.58 Mbits/sec  
[ 5] 15.00-16.00 sec  1.14 MBytes  9.55 Mbits/sec  
[ 5] 16.00-17.00 sec  1.14 MBytes  9.58 Mbits/sec  
[ 5] 17.00-18.00 sec  1.14 MBytes  9.55 Mbits/sec  
[ 5] 18.00-19.00 sec  1.14 MBytes  9.58 Mbits/sec  
[ 5] 19.00-20.00 sec  1.14 MBytes  9.56 Mbits/sec  
[ 5] 20.00-21.00 sec  837 KBytes  6.86 Mbits/sec  
[ 5] 21.00-22.00 sec  0.00 Bytes  0.00 bits/sec  
[ 5] 22.00-23.00 sec  2.60 MBytes  21.9 Mbits/sec  
[ 5] 23.00-24.00 sec  1.14 MBytes  9.53 Mbits/sec  
[ 5] 24.00-25.00 sec  1.14 MBytes  9.58 Mbits/sec  
[ 5] 25.00-26.00 sec  1.14 MBytes  9.58 Mbits/sec  
[ 5] 26.00-27.00 sec  1.14 MBytes  9.56 Mbits/sec  
[ 5] 27.00-28.00 sec  1.14 MBytes  9.56 Mbits/sec  
[ 5] 28.00-29.00 sec  1.14 MBytes  9.58 Mbits/sec  
[ 5] 29.00-30.00 sec  1.14 MBytes  9.56 Mbits/sec  
[ 5] 30.00-31.00 sec  1.14 MBytes  9.57 Mbits/sec  
[ 5] 31.00-31.70 sec  537 KBytes  6.33 Mbits/sec  
[ ID] Interval      Transfer      Bitrate  
[ 5] 0.00-31.70 sec  35.9 MBytes  9.49 Mbits/sec  
Server listening on 5201
```

Ograniczenie pasma do 1Mbps 30s (TCP iperf)

```
administorator@ubuntu-tc-A: ~  
[ ID] Interval      Transfer      Bitrate      Retr      Cwnd  
[ 5] 0.00-1.00 sec  379 KBytes  3.10 Mbits/sec  0      56.8 KBytes  
[ 5] 1.00-2.00 sec  146 KBytes  1.19 Mbits/sec  0      62.2 KBytes  
[ 5] 2.00-3.00 sec  182 KBytes  1.49 Mbits/sec  0      67.9 KBytes  
[ 5] 3.00-4.00 sec  182 KBytes  1.49 Mbits/sec  0      74.9 KBytes  
[ 5] 4.00-5.00 sec  243 KBytes  1.99 Mbits/sec  0      91.9 KBytes  
[ 5] 5.00-6.00 sec  0.00 Bytes  0.00 bits/sec  0      123 KBytes  
[ 5] 6.00-7.00 sec  304 KBytes  2.49 Mbits/sec  0      164 KBytes  
[ 5] 7.00-8.00 sec  365 KBytes  2.99 Mbits/sec  0      222 KBytes  
[ 5] 8.00-9.00 sec  406 KBytes  3.98 Mbits/sec  0      280 KBytes  
[ 5] 9.00-10.00 sec  609 KBytes  5.48 Mbits/sec  0      339 KBytes  
[ 5] 10.00-11.00 sec  0.00 Bytes  0.00 bits/sec  0      397 KBytes  
[ 5] 11.00-12.00 sec  912 KBytes  7.48 Mbits/sec  0      455 KBytes  
[ 5] 12.00-13.00 sec  0.00 Bytes  0.00 bits/sec  0      515 KBytes  
[ 5] 13.00-14.00 sec  0.00 Bytes  0.00 bits/sec  0      573 KBytes  
[ 5] 14.00-15.00 sec  1.19 MBytes  9.97 Mbits/sec  0      631 KBytes  
[ 5] 15.00-16.00 sec  0.00 Bytes  0.00 bits/sec  0      689 KBytes  
[ 5] 16.00-17.00 sec  0.00 Bytes  0.00 bits/sec  0      748 KBytes  
[ 5] 17.00-18.00 sec  0.00 Bytes  0.00 bits/sec  0      806 KBytes  
[ 5] 18.00-19.00 sec  0.00 Bytes  0.00 bits/sec  0      864 KBytes  
[ 5] 19.00-20.00 sec  0.00 Bytes  0.00 bits/sec  0      922 KBytes  
[ 5] 20.00-21.00 sec  0.00 Bytes  0.00 bits/sec  0      980 KBytes  
[ 5] 21.00-22.00 sec  0.00 Bytes  0.00 bits/sec  0      1.01 MBytes  
[ 5] 22.00-23.00 sec  0.00 Bytes  0.00 bits/sec  0      1.07 MBytes  
[ 5] 23.00-24.00 sec  0.00 Bytes  0.00 bits/sec  0      1.13 MBytes  
[ 5] 24.00-25.00 sec  0.00 Bytes  0.00 bits/sec  0      1.19 MBytes  
[ 5] 25.00-26.00 sec  1.25 MBytes  10.5 Mbits/sec  0      1.24 MBytes  
[ 5] 26.00-27.00 sec  0.00 Bytes  0.00 bits/sec  0      1.30 MBytes  
[ 5] 27.00-28.00 sec  0.00 Bytes  0.00 bits/sec  0      1.36 MBytes  
[ 5] 28.00-29.00 sec  0.00 Bytes  0.00 bits/sec  0      1.41 MBytes  
[ 5] 29.00-30.00 sec  0.00 Bytes  0.00 bits/sec  0      1.46 MBytes  
[ ID] Interval      Transfer      Bitrate      Retr      Cwnd  
[ 5] 0.00-30.00 sec  6.22 MBytes  1.74 Mbits/sec  0      sender  
[ 5] 0.00-42.59 sec  4.86 MBytes  956 Kbits/sec  receiver  
iperf Done.  
administorator@ubuntu-tc-A: ~  
[ ID] Interval      Transfer      Bitrate      Retr      Cwnd  
[ 5] 12.00-13.00 sec  119 KBytes  973 kbits/sec  
[ 5] 13.00-14.00 sec  116 KBytes  950 kbits/sec  
[ 5] 14.00-15.00 sec  116 KBytes  950 kbits/sec  
[ 5] 15.00-16.00 sec  116 KBytes  950 kbits/sec  
[ 5] 16.00-17.00 sec  119 KBytes  973 kbits/sec  
[ 5] 17.00-18.00 sec  115 KBytes  938 kbits/sec  
[ 5] 18.00-19.00 sec  119 KBytes  973 kbits/sec  
[ 5] 19.00-20.00 sec  116 KBytes  950 kbits/sec  
[ 5] 20.00-21.00 sec  116 KBytes  973 kbits/sec  
[ 5] 21.00-22.00 sec  119 KBytes  973 kbits/sec  
[ 5] 22.00-23.00 sec  116 KBytes  950 kbits/sec  
[ 5] 23.00-24.00 sec  116 KBytes  950 kbits/sec  
[ 5] 24.00-25.00 sec  116 KBytes  950 kbits/sec  
[ 5] 25.00-26.00 sec  119 KBytes  973 kbits/sec  
[ 5] 26.00-27.00 sec  116 KBytes  950 kbits/sec  
[ 5] 27.00-28.00 sec  116 KBytes  950 kbits/sec  
[ 5] 28.00-29.00 sec  119 KBytes  973 kbits/sec  
[ 5] 29.00-30.00 sec  115 KBytes  938 kbits/sec  
[ 5] 30.00-31.00 sec  119 KBytes  973 kbits/sec  
[ 5] 31.00-32.00 sec  116 KBytes  950 kbits/sec  
[ 5] 32.00-33.00 sec  116 KBytes  950 kbits/sec  
[ 5] 33.00-34.00 sec  119 KBytes  973 kbits/sec  
[ 5] 34.00-35.00 sec  116 KBytes  950 kbits/sec  
[ 5] 35.00-36.00 sec  116 KBytes  950 kbits/sec  
[ 5] 36.00-37.00 sec  116 KBytes  950 kbits/sec  
[ 5] 37.00-38.00 sec  119 KBytes  973 kbits/sec  
[ 5] 38.00-39.00 sec  116 KBytes  950 kbits/sec  
[ 5] 39.00-40.00 sec  116 KBytes  950 kbits/sec  
[ 5] 40.00-41.00 sec  116 KBytes  950 kbits/sec  
[ 5] 41.00-42.00 sec  119 KBytes  973 kbits/sec  
[ 5] 42.00-42.59 sec  69.3 KBytes  964 kbits/sec  
[ ID] Interval      Transfer      Bitrate  
[ 5] 0.00-42.59 sec  4.86 MBytes  956 Kbits/sec  
Server listening on 5201
```

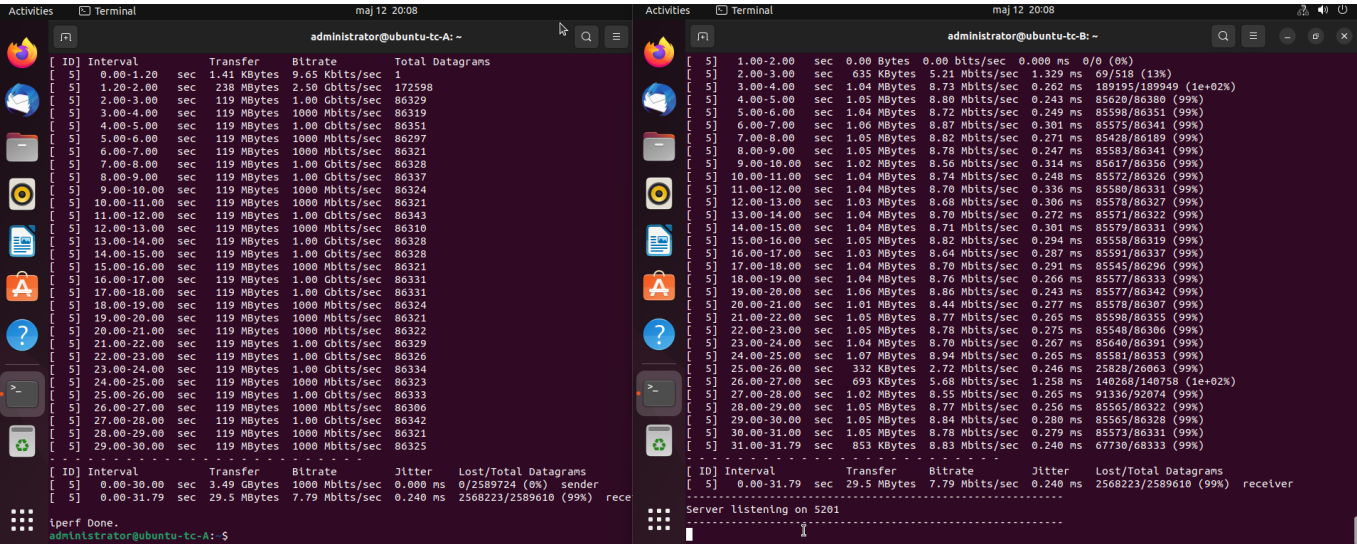
Test łączy w obie strony 10Mbps, opóźnienie 2000ms, urata 3%, uszkodzone 10% (ping 100 pomiarów)

```
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 1 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 20.3 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 10.4 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  
[ ID] Interval Transfer Bitrate Retr sender receiver  
[ 5] 0.00-30.00 sec 529 KBytes 144 Kbits/sec 23  
[ 5] 0.00-31.20 sec 313 KBytes 82.0 Kbits/sec  
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 18.4 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  
[ ID] Interval Transfer Bitrate  
[ 5] 0.00-31.20 sec 313 KBytes 82.0 Kbits/sec  
Server listening on 5201
```

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



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

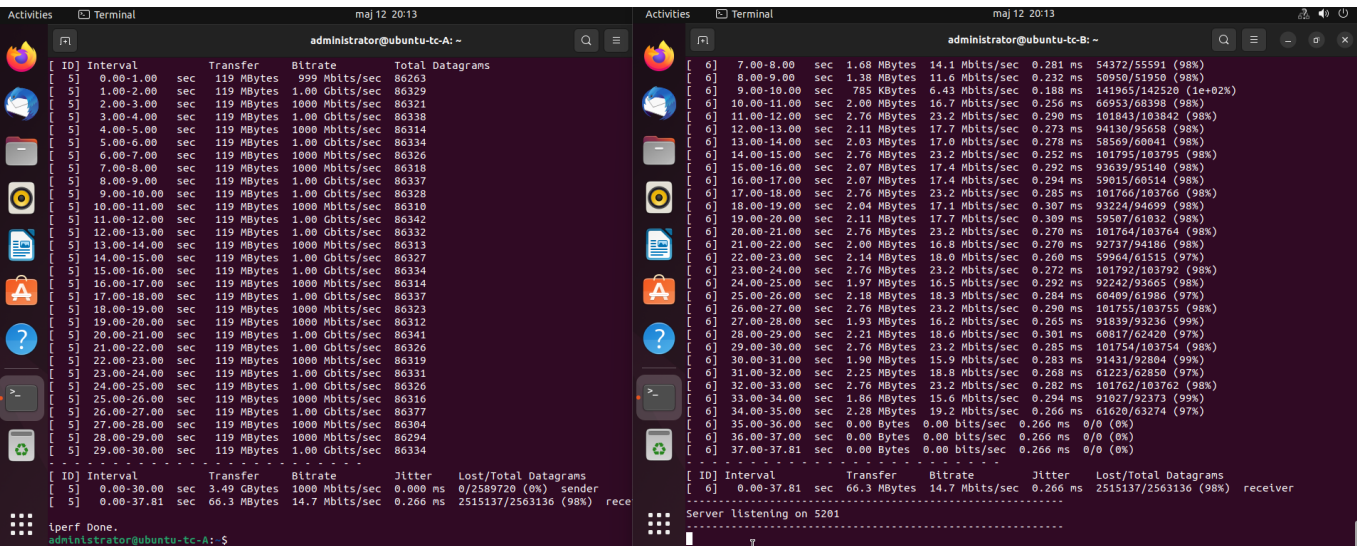


Tabela wyników testów

Opis Testu	protokół	straty	pasma	opóźnienie [ms]
Testy opóźnień				

Opis Testu	protokół	straty	pasma	opóźnienie [ms]
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	protokół	Utracone/Wysłane	pasma	opóźnienie [ms]
Test bez ograniczenia 30s (UDP 1Gbps 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	protokół	retransmisje	pasma	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	—
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	—