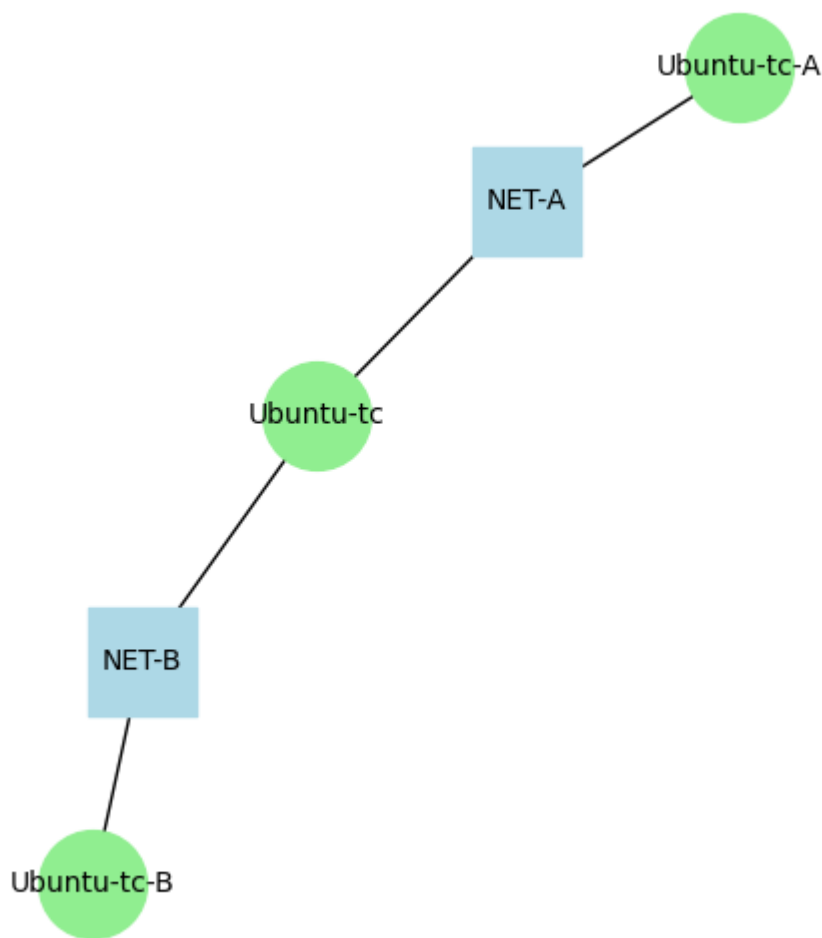


TC linux - ograniczanie pasma, indukowanie błędów w transmisji i opóźnienia

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

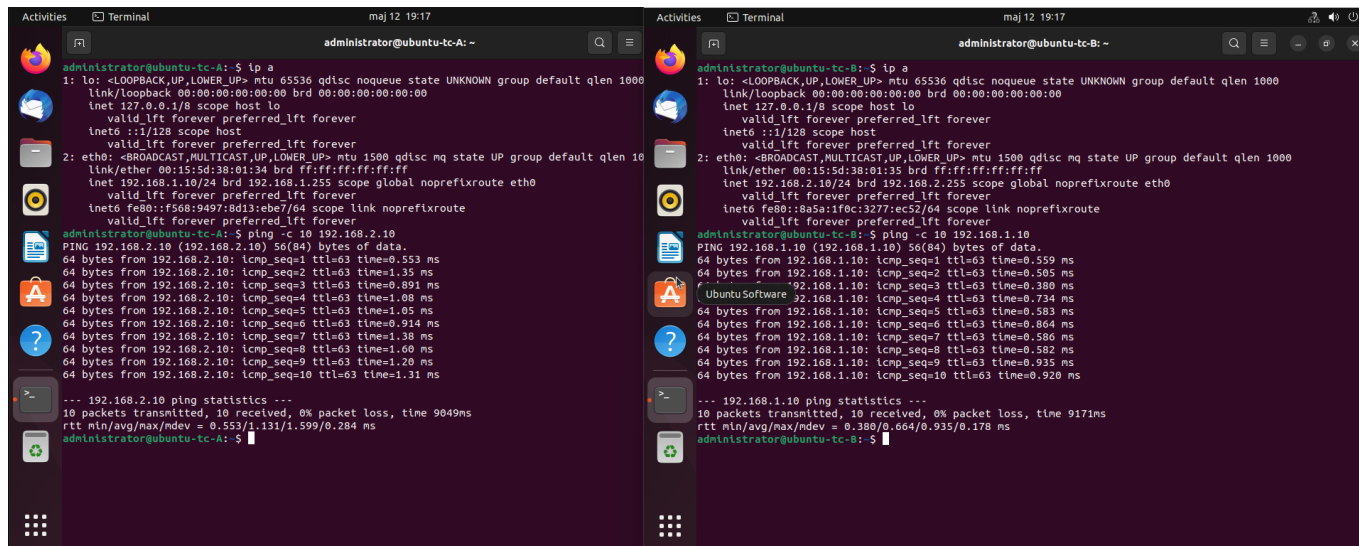
Ustawienia na reszcie maszyn

```
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

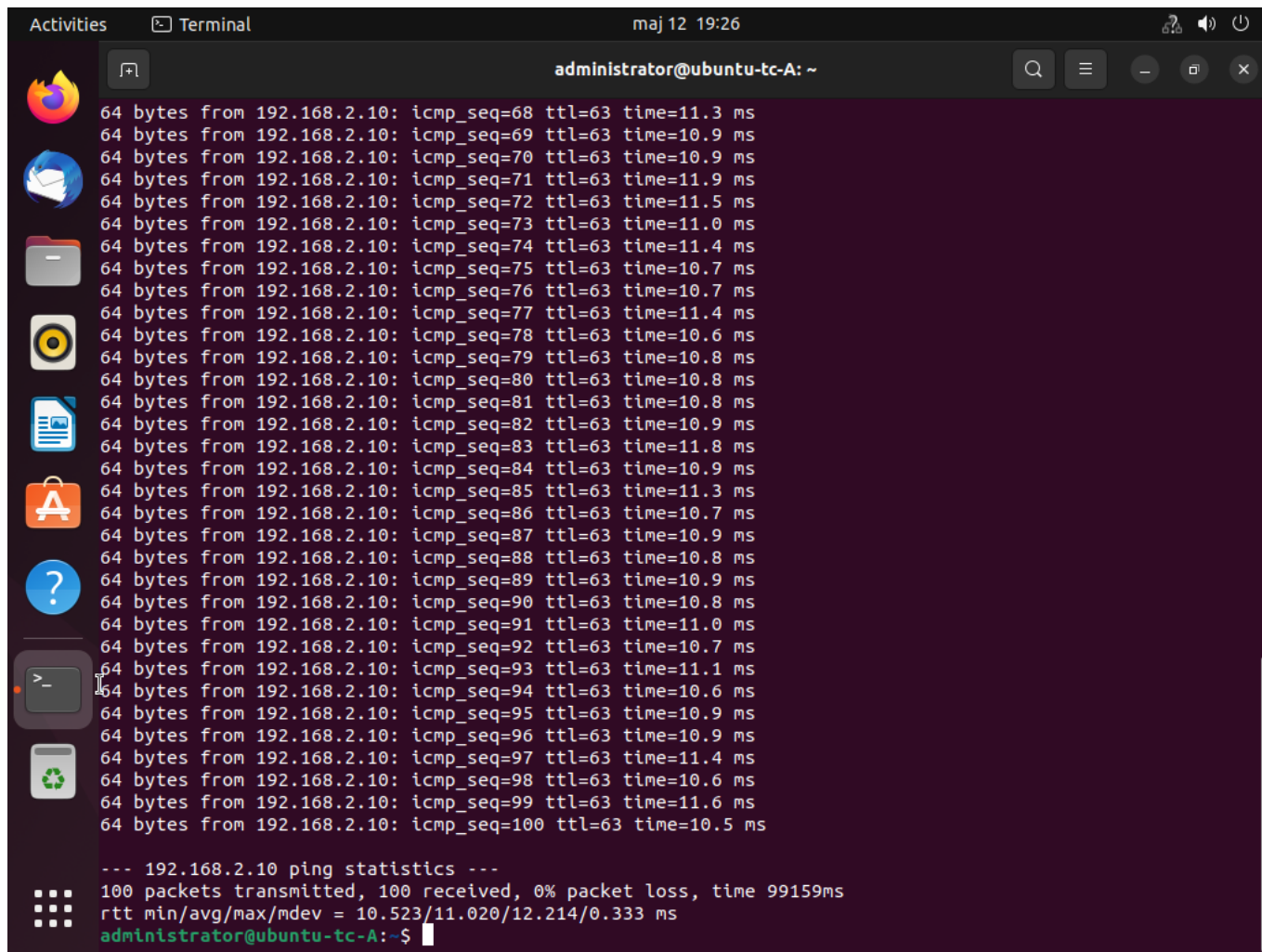


The image shows two terminal windows side-by-side, both running on Ubuntu machines. The left window is titled 'administrator@ubuntu-tc-A: ~' and the right window is titled 'administrator@ubuntu-tc-B: ~'. Both windows show the same network configuration commands: `ip a` to show interface details, `ip netns exec ns1 ip a` to show the IP address in the namespace, `ip netns exec ns1 ping -c 10 192.168.2.10` to perform a ping test, and `ping -c 10 192.168.2.10` to perform a standard ping test. The ping results show a round-trip time of approximately 0.553 ms for the first packet and 0.553 ms for the last packet, with a total of 10 packets transmitted and 10 received, 0% packet loss, and a time of 9049 ns.

```
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 1000  
    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

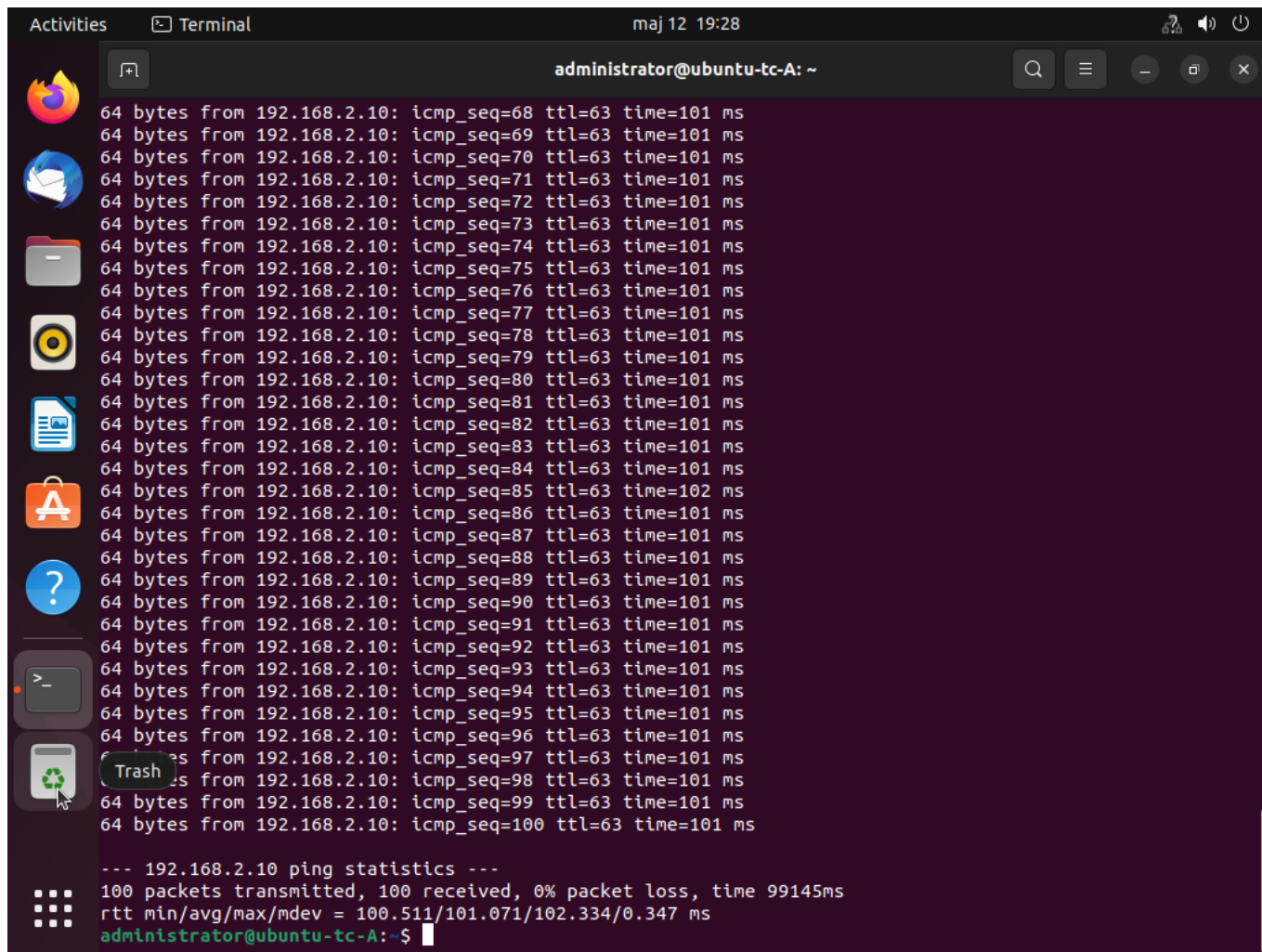


The screenshot shows a terminal window titled "Terminal" with the user "administrator@ubuntu-tc-A: ~". The terminal displays the output of a ping command to the IP address 192.168.2.10. The output consists of 100 lines, each showing a successful ping with 64 bytes, a TTL of 63, and a response time. The response times range from 10.5 ms to 11.9 ms. At the bottom, the terminal shows the "ping statistics" for 192.168.2.10, indicating 100 packets transmitted and received with 0% packet loss and a total time of 99159ms. The round-trip time (rtt) statistics are: min/avg/max/mdev = 10.523/11.020/12.214/0.333 ms.

```
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

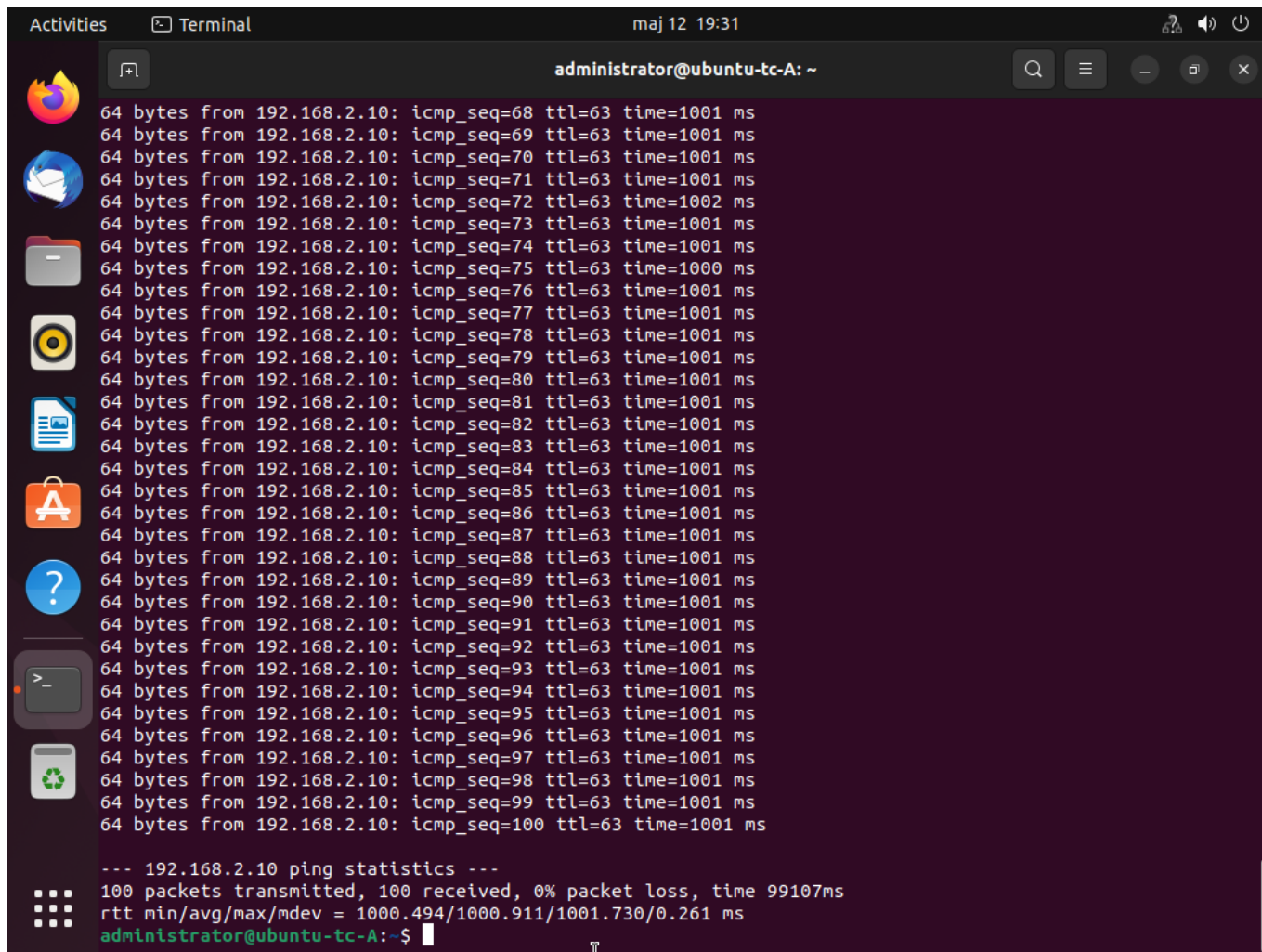


The screenshot shows a terminal window titled "administrator@ubuntu-tc-A: ~" with a dark purple background. The terminal displays the output of a ping command to 192.168.2.10. Each line shows "64 bytes from 192.168.2.10: icmp_seq=X ttl=63 time=Y ms", where X ranges from 68 to 100 and Y is consistently 101 ms. 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 window 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 the system clock as "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



```
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

Ograniczenie pasma do 100mbps

Ograniczenie pasma do 10mbps

Ograniczenie pasma do 1mbps

Inne testy