

## **Лабораторная работа № 5**

**Эмуляция и измерение потерь пакетов в глобальных сетях**

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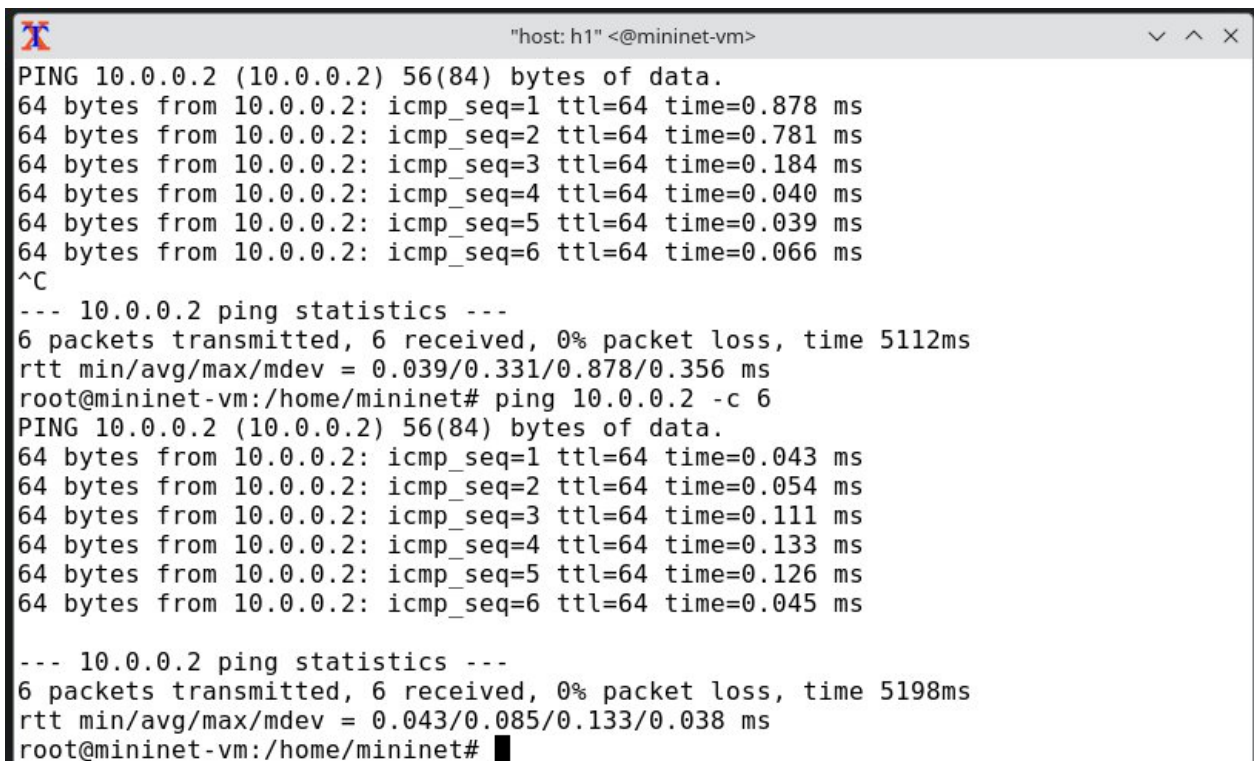
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# 1 . Цель работы

Основной целью работы является получение навыков проведения интерактивных экспериментов в среде Mininet по исследованию параметров сети, связанных с потерей, дублированием, изменением порядка и повреждением пакетов при передаче данных. Эти параметры влияют на производительность протоколов и сетей.

## 2 . Выполнение лабораторной работы



```
"host: h1" <@mininet-vm>
PING 10.0.0.2 (10.0.0.2) 56(84) bytes of data.
64 bytes from 10.0.0.2: icmp_seq=1 ttl=64 time=0.878 ms
64 bytes from 10.0.0.2: icmp_seq=2 ttl=64 time=0.781 ms
64 bytes from 10.0.0.2: icmp_seq=3 ttl=64 time=0.184 ms
64 bytes from 10.0.0.2: icmp_seq=4 ttl=64 time=0.040 ms
64 bytes from 10.0.0.2: icmp_seq=5 ttl=64 time=0.039 ms
64 bytes from 10.0.0.2: icmp_seq=6 ttl=64 time=0.066 ms
^C
--- 10.0.0.2 ping statistics ---
6 packets transmitted, 6 received, 0% packet loss, time 5112ms
rtt min/avg/max/mdev = 0.039/0.331/0.878/0.356 ms
root@mininet-vm:/home/mininet# ping 10.0.0.2 -c 6
PING 10.0.0.2 (10.0.0.2) 56(84) bytes of data.
64 bytes from 10.0.0.2: icmp_seq=1 ttl=64 time=0.043 ms
64 bytes from 10.0.0.2: icmp_seq=2 ttl=64 time=0.054 ms
64 bytes from 10.0.0.2: icmp_seq=3 ttl=64 time=0.111 ms
64 bytes from 10.0.0.2: icmp_seq=4 ttl=64 time=0.133 ms
64 bytes from 10.0.0.2: icmp_seq=5 ttl=64 time=0.126 ms
64 bytes from 10.0.0.2: icmp_seq=6 ttl=64 time=0.045 ms

--- 10.0.0.2 ping statistics ---
6 packets transmitted, 6 received, 0% packet loss, time 5198ms
rtt min/avg/max/mdev = 0.043/0.085/0.133/0.038 ms
root@mininet-vm:/home/mininet#
```

Фигура № 1

```
64 bytes from 10.0.0.2: icmp_seq=27 ttl=64 time=0.000 ms
64 bytes from 10.0.0.2: icmp_seq=28 ttl=64 time=0.059 ms
64 bytes from 10.0.0.2: icmp_seq=29 ttl=64 time=0.042 ms
64 bytes from 10.0.0.2: icmp_seq=30 ttl=64 time=0.047 ms
^C
--- 10.0.0.2 ping statistics ---
30 packets transmitted, 27 received, 10% packet loss, time 29621ms
rtt min/avg/max/mdev = 0.036/0.133/1.204/0.273 ms
root@mininet-vm:/home/mininet#
```

Фигура № 2



"host: h1" <@mininet-vm>

```
root@mininet-vm:/home/mininet# ping 10.0.0.2 -c 100
PING 10.0.0.2 (10.0.0.2) 56(84) bytes of data.
64 bytes from 10.0.0.2: icmp_seq=1 ttl=64 time=1.20 ms
64 bytes from 10.0.0.2: icmp_seq=3 ttl=64 time=0.979 ms
64 bytes from 10.0.0.2: icmp_seq=4 ttl=64 time=0.142 ms
64 bytes from 10.0.0.2: icmp_seq=5 ttl=64 time=0.058 ms
64 bytes from 10.0.0.2: icmp_seq=6 ttl=64 time=0.065 ms
64 bytes from 10.0.0.2: icmp_seq=7 ttl=64 time=0.051 ms
64 bytes from 10.0.0.2: icmp_seq=8 ttl=64 time=0.075 ms
64 bytes from 10.0.0.2: icmp_seq=10 ttl=64 time=0.042 ms
64 bytes from 10.0.0.2: icmp_seq=11 ttl=64 time=0.042 ms
64 bytes from 10.0.0.2: icmp_seq=13 ttl=64 time=0.036 ms
64 bytes from 10.0.0.2: icmp_seq=14 ttl=64 time=0.041 ms
64 bytes from 10.0.0.2: icmp_seq=15 ttl=64 time=0.064 ms
64 bytes from 10.0.0.2: icmp_seq=16 ttl=64 time=0.047 ms
64 bytes from 10.0.0.2: icmp_seq=17 ttl=64 time=0.040 ms
64 bytes from 10.0.0.2: icmp_seq=18 ttl=64 time=0.045 ms
64 bytes from 10.0.0.2: icmp_seq=19 ttl=64 time=0.096 ms
64 bytes from 10.0.0.2: icmp_seq=20 ttl=64 time=0.046 ms
64 bytes from 10.0.0.2: icmp_seq=21 ttl=64 time=0.043 ms
64 bytes from 10.0.0.2: icmp_seq=22 ttl=64 time=0.059 ms
64 bytes from 10.0.0.2: icmp_seq=23 ttl=64 time=0.051 ms
64 bytes from 10.0.0.2: icmp_seq=24 ttl=64 time=0.042 ms
64 bytes from 10.0.0.2: icmp_seq=25 ttl=64 time=0.073 ms
```

Фигура № 3



"host: h1" <@mininet-vm>

```
root@mininet-vm:/home/mininet# ping 10.0.0.2 -c 100
PING 10.0.0.2 (10.0.0.2) 56(84) bytes of data.
64 bytes from 10.0.0.2: icmp_seq=1 ttl=64 time=1.20 ms
64 bytes from 10.0.0.2: icmp_seq=3 ttl=64 time=0.979 ms
64 bytes from 10.0.0.2: icmp_seq=4 ttl=64 time=0.142 ms
64 bytes from 10.0.0.2: icmp_seq=5 ttl=64 time=0.058 ms
64 bytes from 10.0.0.2: icmp_seq=6 ttl=64 time=0.065 ms
64 bytes from 10.0.0.2: icmp_seq=7 ttl=64 time=0.051 ms
64 bytes from 10.0.0.2: icmp_seq=8 ttl=64 time=0.075 ms
64 bytes from 10.0.0.2: icmp_seq=10 ttl=64 time=0.042 ms
64 bytes from 10.0.0.2: icmp_seq=11 ttl=64 time=0.042 ms
64 bytes from 10.0.0.2: icmp_seq=13 ttl=64 time=0.036 ms
64 bytes from 10.0.0.2: icmp_seq=14 ttl=64 time=0.041 ms
64 bytes from 10.0.0.2: icmp_seq=15 ttl=64 time=0.064 ms
64 bytes from 10.0.0.2: icmp_seq=16 ttl=64 time=0.047 ms
64 bytes from 10.0.0.2: icmp_seq=17 ttl=64 time=0.040 ms
64 bytes from 10.0.0.2: icmp_seq=18 ttl=64 time=0.045 ms
64 bytes from 10.0.0.2: icmp_seq=19 ttl=64 time=0.096 ms
64 bytes from 10.0.0.2: icmp_seq=20 ttl=64 time=0.046 ms
64 bytes from 10.0.0.2: icmp_seq=21 ttl=64 time=0.043 ms
64 bytes from 10.0.0.2: icmp_seq=22 ttl=64 time=0.059 ms
64 bytes from 10.0.0.2: icmp_seq=23 ttl=64 time=0.051 ms
64 bytes from 10.0.0.2: icmp_seq=24 ttl=64 time=0.042 ms
64 bytes from 10.0.0.2: icmp_seq=25 ttl=64 time=0.073 ms
```

Фигура № 4

```
64 bytes from 10.0.0.2: icmp_seq=91 ttl=64 time=0.112 ms
64 bytes from 10.0.0.2: icmp_seq=92 ttl=64 time=0.048 ms
64 bytes from 10.0.0.2: icmp_seq=93 ttl=64 time=0.041 ms
64 bytes from 10.0.0.2: icmp_seq=94 ttl=64 time=0.153 ms
64 bytes from 10.0.0.2: icmp_seq=96 ttl=64 time=0.045 ms
64 bytes from 10.0.0.2: icmp_seq=97 ttl=64 time=0.094 ms
64 bytes from 10.0.0.2: icmp_seq=99 ttl=64 time=0.049 ms

--- 10.0.0.2 ping statistics ---
100 packets transmitted, 76 received, 24% packet loss, time 101512ms
rtt min/avg/max/mdev = 0.034/0.076/0.554/0.065 ms
root@mininet-vm:/home/mininet# █
```

Фигура № 5

```
64 bytes from 10.0.0.2: icmp_seq=22 ttl=64 time=0.057 ms
64 bytes from 10.0.0.2: icmp_seq=23 ttl=64 time=0.100 ms
64 bytes from 10.0.0.2: icmp_seq=24 ttl=64 time=0.036 ms
64 bytes from 10.0.0.2: icmp_seq=25 ttl=64 time=0.091 ms
64 bytes from 10.0.0.2: icmp_seq=26 ttl=64 time=0.034 ms
64 bytes from 10.0.0.2: icmp_seq=27 ttl=64 time=0.039 ms
64 bytes from 10.0.0.2: icmp_seq=28 ttl=64 time=0.044 ms
64 bytes from 10.0.0.2: icmp_seq=29 ttl=64 time=0.123 ms
64 bytes from 10.0.0.2: icmp_seq=30 ttl=64 time=0.085 ms
^C
--- 10.0.0.2 ping statistics ---
30 packets transmitted, 30 received, 0% packet loss, time 30244ms
rtt min/avg/max/mdev = 0.032/0.074/0.213/0.043 ms
root@mininet-vm:/home/mininet# █
```

---

Фигура № 6

```
"host: h1" <@mininet-vm>
30 packets transmitted, 30 received, 0% packet loss, time 30244ms
rtt min/avg/max/mdev = 0.032/0.074/0.213/0.043 ms
root@mininet-vm:/home/mininet# sudo tc qdisc add dev h1-eth0 root netem corrupt 0.01%
root@mininet-vm:/home/mininet# iperf3 -c 10.0.0.2
Connecting to host 10.0.0.2, port 5201
[ 7] local 10.0.0.1 port 48630 connected to 10.0.0.2 port 5201
[ ID] Interval            Transfer          Bitrate          Retr  Cwnd
[ 7]  0.00-1.00      sec  4.55 GBytes      39.1 Gbits/sec    14   296 KBytes
[ 7]  1.00-2.00      sec  3.94 GBytes      33.8 Gbits/sec     8   467 KBytes
[ 7]  2.00-3.00      sec  4.56 GBytes      39.2 Gbits/sec    14   631 KBytes
[ 7]  3.00-4.00      sec  3.93 GBytes      33.8 Gbits/sec     7   274 KBytes
[ 7]  4.00-5.00      sec  3.42 GBytes      29.4 Gbits/sec     7   561 KBytes
[ 7]  5.00-6.00      sec  4.15 GBytes      35.7 Gbits/sec    11   486 KBytes
[ 7]  6.00-7.00      sec  3.82 GBytes      32.9 Gbits/sec    14   484 KBytes
[ 7]  7.00-8.00      sec  4.24 GBytes      36.4 Gbits/sec   199   819 KBytes
[ 7]  8.00-9.00      sec  4.37 GBytes      37.5 Gbits/sec     5   776 KBytes
[ 7]  9.00-10.00     sec  3.81 GBytes      32.8 Gbits/sec    17   897 KBytes
- - - - -
[ ID] Interval            Transfer          Bitrate          Retr
[ 7]  0.00-10.00     sec  40.8 GBytes      35.1 Gbits/sec   296
[ 7]  0.00-10.00     sec  40.8 GBytes      35.0 Gbits/sec
sender
receiver

iperf Done.
root@mininet-vm:/home/mininet#
```

Фигура № 7

```
mininet@mininet-vm:~/work/lab_netem_ii/simple-drop$ nvim lab_netem_ii.py
mininet@mininet-vm:~/work/lab_netem_ii/simple-drop$ nvim Makefile
mininet@mininet-vm:~/work/lab_netem_ii/simple-drop$ make
sudo python lab_netem_ii.py
*** Adding controller
*** Adding hosts
*** Adding switch
*** Creating links
*** Starting network
*** Configuring hosts
h1 h2
*** Starting controller
c0
*** Starting 1 switches
s1 ...
*** Waiting for switches to connect
s1
*** Set delay
*** h1 : ('tc qdisc add dev h1-eth0 root netem loss 10%',)
*** h2 : ('tc qdisc add dev h2-eth0 root netem loss 10%',)
*** Ping
*** h1 : ('ping -c 100', '10.0.0.2', '| grep "time=" | awk \'{print $5, $7}\'' | sed -e \'s/time=//g\' -e \'
ping.dat')
*** Stopping network*** Stopping 1 controllers
c0
*** Stopping 2 links
..
*** Stopping 1 switches
s1
*** Stopping 2 hosts
h1 h2
*** Done
sudo chown mininet:mininet ping.dat
```

Фигура № 8



```
mininet@mininet-vm:~/work/lab_netem_11/simple-drop$ cat ping.dat
1 1.54
2 0.271
4 0.051
5 0.086
6 0.095
7 0.041
8 0.042
9 0.042
10 0.045
11 0.034
12 0.121
13 0.068
14 0.048
15 0.100
16 0.065
17 0.049
18 0.042
20 0.104
21 0.117
```

Фигура № 9

### ***3. Вывод***

Я приобрел навыки проведения интерактивных экспериментов в среде Mininet по изучению сетевых параметров, связанных с потерей, дублированием, переупорядочением и повреждением пакетов при передаче данных. Эти параметры влияют на производительность протоколов и сетей.