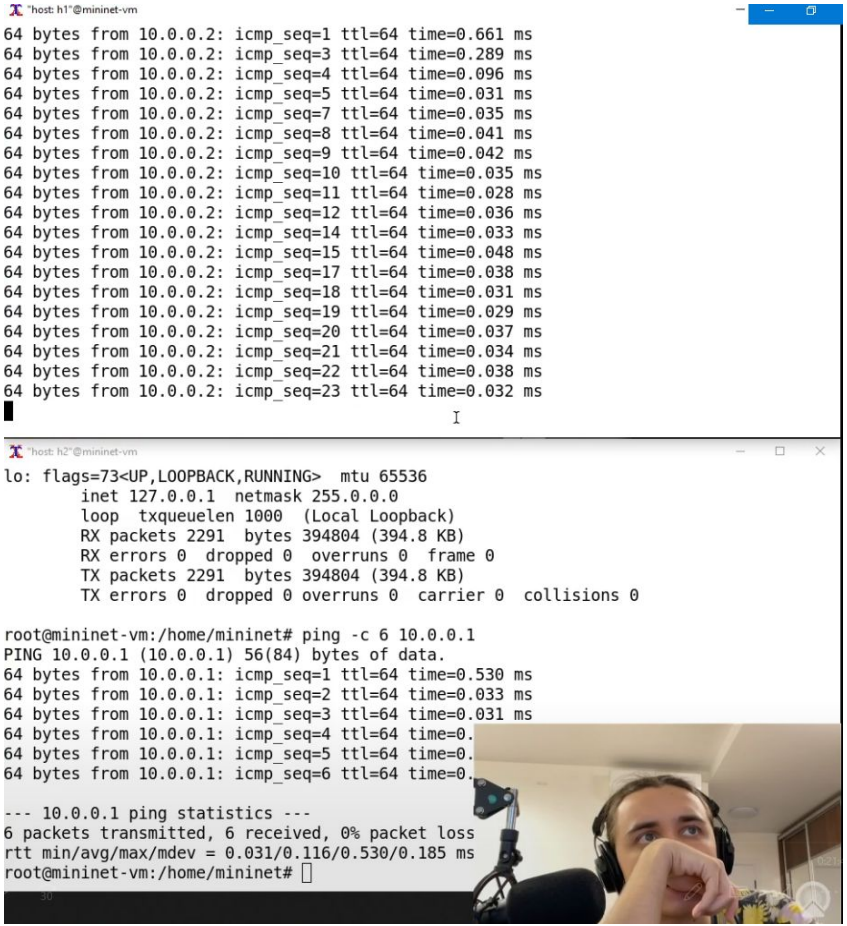
Лабораторная работа №5

по дисциплине Моделирование сетей передачи данных

Ход работы


mininet@mininet-vm: ~
login as: mininet
mininet@192.168.56.101's password:
Welcome to Ubuntu 20.04.1 LTS (GNU/Linux 5.4.0-42-generic x86_64)
* Documentation: https://help.ubuntu.com
* Management: https://landscape.canonical.com
* Support: https://ubuntu.com/advantage
Last login: Fri Dec 6 11:54:37 2024 from 192.168.56.1
mininet@mininet-vm:~$ xauth list $DISPLAY
mininet-vm/unix:10 MIT-MAGIC-COOKIE-1 ffb9645fce3a9afb636f676ffcd66df5
mininet@mininet-vm:~$ sudo -i
root@mininet-vm:~# xauth add mininet-vm/unix:10 MIT-MAGIC-COOKIE-1 ffb96
root@mininet-vm:~# xauth list $DISPLAY
mininet-vm/unix:10 MIT-MAGIC-COOKIE-1 ffb9645fce3a9afb636f676ffcd66df5
root@mininet-vm:~# logout
mininet@mininet-vm:~$ sudo mn --topo=single,2 -x
*** Creating network
*** Adding controller
*** Adding hosts:
h1 h2
*** Adding switches:
s1
*** Adding links:
(h1, s1) (h2, s1)
*** Configuring hosts
h1 h2
*** Running terms on localhost:10.0
*** Starting controller
c0
*** Starting 1 switches
s1 ...
*** Starting CLI:
mininet>
"host: h1"@mininet-vm
root@mininet-vm:/home/mininet# ifconfig
h1-eth0: flags=4163<UP,BROADCAST,RUNNING,MULTICAST> mtu 1500
inet 10.0.0.1 netmask 255.0.0.0 broadcast 10.255.255.255
ether 26:45:ae:08:ba:d6 txqueuelen 1000 (Ethernet)
RX packets 0 bytes 0 (0.0 B)
RX errors 0 dropped 0 overruns 0 frame 0
TX packets 0 bytes 0 (0.0 B)
TX errors 0 dropped 0 overruns 0 carrier 0 collisions 0
lo: flags=73<UP,LOOPBACK,RUNNING> mtu 65536
inet 127.0.0.1 netmask 255.0.0.0
loop txqueuelen 1000 (Local Loopback)
RX packets 1815 bytes 355444 (355.4 KB)
RX errors 0 dropped 0 overruns 0 frame 0
TX packets 1815 bytes 355444 (355.4 KB)
TX errors 0 dropped 0 overruns 0 carrier 0 collisions 0
root@mininet-vm:/home/mininet#
"host: h2"@mininet-vm
root@mininet-vm:/home/mininet# ifconfig
h2-eth0: flags=4163<UP,BROADCAST,RUNNING,MULTICAST> mtu 1500
inet 10.0.0.2 netmask 255.0.0.0 broadcast 10.255.255.255
ether ea:8a:31:06:e9:9c txqueuelen 1000 (Ethernet)
RX packets 0 bytes 0 (0.0 B)
RX errors 0 dropped 0 overruns 0 frame 0
TX packets 0 bytes 0 (0.0 B)
TX errors 0 dropped 0 overruns 0 carrier 0 collisions 0
lo: flags=73<UP,LOOPBACK,RUNNING> mtu 65536
inet 127.0.0.1 netmask 255.0.0.0
loop txqueuelen 1000 (Local Loopback)
RX packets 2291 bytes 394804 (394.8 KB)
RX errors 0 dropped 0 overruns 0 frame
TX packets 2291 bytes 394804 (394.8 KB)
TX errors 0 dropped 0 overruns 0 carrie
root@mininet-vm:/home/mininet#
МСПД
Notepad++
Rockstar Games ...
AIDA64 Extreme
Корзина

Ход работы


"host: h1"@mininet-vm
64 bytes from 10.0.0.2: icmp_seq=1 ttl=64 time=0.661 ms
64 bytes from 10.0.0.2: icmp_seq=3 ttl=64 time=0.289 ms
64 bytes from 10.0.0.2: icmp_seq=4 ttl=64 time=0.096 ms
64 bytes from 10.0.0.2: icmp_seq=5 ttl=64 time=0.031 ms
64 bytes from 10.0.0.2: icmp_seq=7 ttl=64 time=0.035 ms
64 bytes from 10.0.0.2: icmp_seq=8 ttl=64 time=0.041 ms
64 bytes from 10.0.0.2: icmp_seq=9 ttl=64 time=0.042 ms
64 bytes from 10.0.0.2: icmp_seq=10 ttl=64 time=0.035 ms
64 bytes from 10.0.0.2: icmp_seq=11 ttl=64 time=0.028 ms
64 bytes from 10.0.0.2: icmp_seq=12 ttl=64 time=0.036 ms
64 bytes from 10.0.0.2: icmp_seq=14 ttl=64 time=0.033 ms
64 bytes from 10.0.0.2: icmp_seq=15 ttl=64 time=0.048 ms
64 bytes from 10.0.0.2: icmp_seq=17 ttl=64 time=0.038 ms
64 bytes from 10.0.0.2: icmp_seq=18 ttl=64 time=0.031 ms
64 bytes from 10.0.0.2: icmp_seq=19 ttl=64 time=0.029 ms
64 bytes from 10.0.0.2: icmp_seq=20 ttl=64 time=0.037 ms
64 bytes from 10.0.0.2: icmp_seq=21 ttl=64 time=0.034 ms
64 bytes from 10.0.0.2: icmp_seq=22 ttl=64 time=0.038 ms
64 bytes from 10.0.0.2: icmp_seq=23 ttl=64 time=0.032 ms
"host: h2"@mininet-vm
lo: flags=73<UP,LOOPBACK,RUNNING> mtu 65536
inet 127.0.0.1 netmask 255.0.0.0
loop txqueuelen 1000 (Local Loopback)
RX packets 2291 bytes 394804 (394.8 KB)
RX errors 0 dropped 0 overruns 0 frame 0
TX packets 2291 bytes 394804 (394.8 KB)
TX errors 0 dropped 0 overruns 0 carrier 0 collisions 0
root@mininet-vm:/home/mininet# ping -c 6 10.0.0.1
PING 10.0.0.1 (10.0.0.1) 56(84) bytes of data.
64 bytes from 10.0.0.1: icmp_seq=1 ttl=64 time=0.530 ms
64 bytes from 10.0.0.1: icmp_seq=2 ttl=64 time=0.033 ms
64 bytes from 10.0.0.1: icmp_seq=3 ttl=64 time=0.031 ms
64 bytes from 10.0.0.1: icmp_seq=4 ttl=64 time=0.
64 bytes from 10.0.0.1: icmp_seq=5 ttl=64 time=0.
64 bytes from 10.0.0.1: icmp_seq=6 ttl=64 time=0.
--- 10.0.0.1 ping statistics ---
6 packets transmitted, 6 received, 0% packet loss
rtt min/avg/max/mdev = 0.031/0.116/0.530/0.185 ms
root@mininet-vm:/home/mininet#

Ход работы

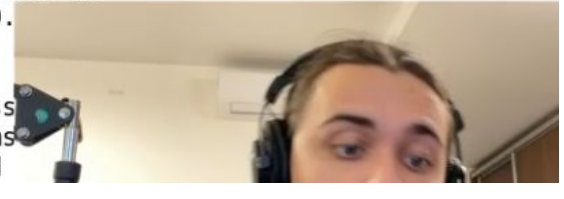
```
64 bytes from 10.0.0.2: icmp_seq=38 ttl=64 time=0.039 ms
64 bytes from 10.0.0.2: icmp_seq=39 ttl=64 time=0.038 ms
64 bytes from 10.0.0.2: icmp_seq=41 ttl=64 time=0.032 ms
64 bytes from 10.0.0.2: icmp_seq=42 ttl=64 time=0.031 ms
64 bytes from 10.0.0.2: icmp_seq=43 ttl=64 time=0.032 ms

--- 10.0.0.2 ping statistics ---
45 packets transmitted, 35 received, 22.2222% packet loss, time 45043ms
rtt min/avg/max/mdev = 0.024/0.043/0.284/0.042 ms
root@mininet-vm:/home/mininet# sudo tc qdisc del dev h1-eth0 root netem
root@mininet-vm:/home/mininet# sudo tc qdisc add dev h1-eth0 root netem loss 50% 50%
root@mininet-vm:/home/mininet#
root@mininet-vm:/home/mininet#
```

Ход работы

```
64 bytes from 10.0.0.2: icmp_seq=49 ttl=64 time=0.036 ms

--- 10.0.0.2 ping statistics ---
50 packets transmitted, 24 received, 52% packet loss, time 50160ms
rtt min/avg/max/mdev = 0.028/0.069/0.637/0.124 ms
root@mininet-vm:/home/mininet# sudo tc qdisc del dev h1-eth0 root netem
root@mininet-vm:/home/mininet#
```

"host: h2"@mininet-vm

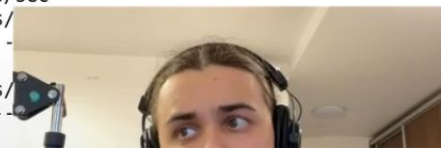
```
        loop  txqueuelen 1000  (Local Loopback)
        RX packets 2291  bytes 394804 (394.8 KB)
        RX errors 0  dropped 0  overruns 0  frame 0
        TX packets 2291  bytes 394804 (394.8 KB)
        TX errors 0  dropped 0 overruns 0  carrier 0  collisions 0

root@mininet-vm:/home/mininet# ping -c 6 10.0.0.1
PING 10.0.0.1 (10.0.0.1) 56(84) bytes of data.
64 bytes from 10.0.0.1: icmp_seq=1 ttl=64 time=0.530 ms
64 bytes from 10.0.0.1: icmp_seq=2 ttl=64 time=0.033 ms
64 bytes from 10.0.0.1: icmp_seq=3 ttl=64 time=0.031 ms
64 bytes from 10.0.0.1: icmp_seq=4 ttl=64 time=0.037 ms
64 bytes from 10.0.0.1: icmp_seq=5 ttl=64 time=0.035 ms
64 bytes from 10.0.0.1: icmp_seq=6 ttl=64 time=0.

--- 10.0.0.1 ping statistics ---
6 packets transmitted, 6 received, 0% packet loss
rtt min/avg/max/mdev = 0.031/0.116/0.530/0.185 ms
root@mininet-vm:/home/mininet# sudo tc qdisc add
```



Ход работы

```
[ ID] Interval           Transfer     Bitrate         Retr  Cwnd
[  7]   0.00-1.00   sec  6.22 GBytes  53.3 Gbits/sec    7   1.73 MBytes
[  7]   1.00-2.00   sec  6.52 GBytes  56.1 Gbits/sec   15   3.02 MBytes
[  7]   2.00-3.00   sec  6.99 GBytes  60.1 Gbits/sec    8   1.66 MBytes
[  7]   3.00-4.00   sec  7.35 GBytes  63.2 Gbits/sec   11   1.62 MBytes
[  7]   4.00-5.00   sec  7.23 GBytes  62.1 Gbits/sec   18   1.94 MBytes
[  7]   5.00-6.00   sec  7.08 GBytes  60.7 Gbits/sec   13   1.48 MBytes
[  7]   6.00-7.00   sec  7.40 GBytes  63.7 Gbits/sec   13   2.53 MBytes
[  7]   7.00-8.00   sec  7.02 GBytes  60.3 Gbits/sec   20   1.09 MBytes
[  7]   8.00-9.00   sec  6.65 GBytes  57.0 Gbits/sec    6   2.37 MBytes
[  7]   9.00-10.00  sec  6.85 GBytes  58.9 Gbits/sec   15   1.54 MBytes
- - - - - - - - - - - - - - - - - - - - - - - - -
[ ID] Interval           Transfer     Bitrate         Retr
[  7]   0.00-10.00  sec  69.3 GBytes  59.5 Gbits/sec  126             sender
[  7]   0.00-10.00  sec  69.3 GBytes  59.5 Gbits/sec                  receiver

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

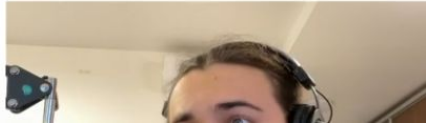
```
"host: h2"@mininet-vm
Accepted connection from 10.0.0.1, port 35814
[  7] local 10.0.0.2 port 5201 connected to 10.0.0.1 port 35816
[ ID] Interval           Transfer     Bitrate
[  7]   0.00-1.00   sec  6.20 GBytes  53.3 Gbits/sec
[  7]   1.00-2.00   sec  6.52 GBytes  56.0 Gbits/sec
[  7]   2.00-3.00   sec  6.99 GBytes  60.1 Gbits/sec
[  7]   3.00-4.00   sec  7.35 GBytes  63.2 Gbits/sec
[  7]   4.00-5.00   sec  7.24 GBytes  62.2 Gbits/sec
[  7]   5.00-6.00   sec  7.07 GBytes  60.7 Gbits/sec
[  7]   6.00-7.00   sec  7.41 GBytes  63.7 Gbits/sec
[  7]   7.00-8.00   sec  7.01 GBytes  60.2 Gbits/sec
[  7]   8.00-9.00   sec  6.65 GBytes  57.1 Gbits/sec
[  7]   9.00-10.00  sec  6.85 GBytes  58.9 Gbits/sec
[  7]  10.00-10.00  sec  10.8 MBytes  67.0 Gbits/
- - - - - - - - - - - - - - - - - - - - - - - - -
[ ID] Interval           Transfer     Bitrate
[  7]   0.00-10.00  sec  69.3 GBytes  59.5 Gbits/
-----------------------------------------------------
Server listening on 5201
```



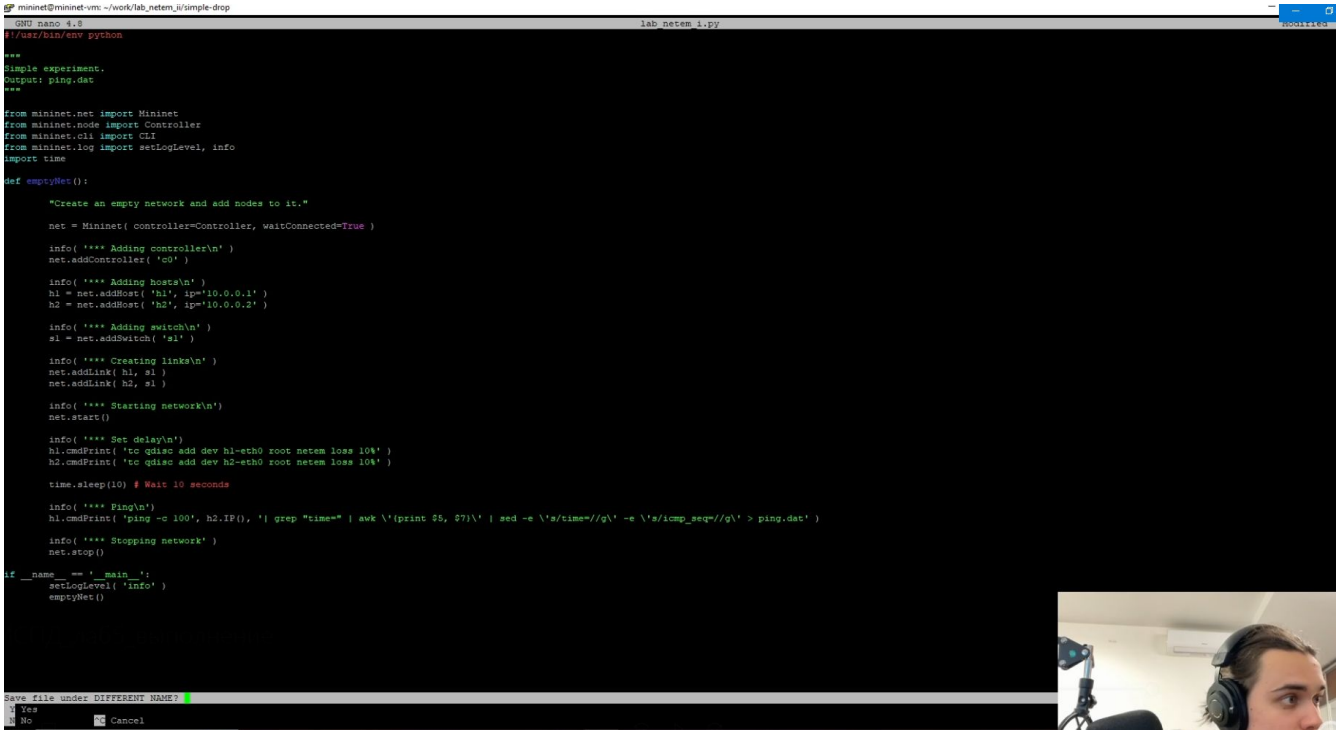
Ход работы

```
64 bytes from 10.0.0.2: icmp_seq=6 ttl=64 time=10.3 ms
64 bytes from 10.0.0.2: icmp_seq=7 ttl=64 time=10.2 ms
64 bytes from 10.0.0.2: icmp_seq=8 ttl=64 time=10.1 ms
64 bytes from 10.0.0.2: icmp_seq=9 ttl=64 time=10.2 ms
64 bytes from 10.0.0.2: icmp_seq=10 ttl=64 time=10.0 ms
64 bytes from 10.0.0.2: icmp_seq=11 ttl=64 time=0.030 ms
64 bytes from 10.0.0.2: icmp_seq=12 ttl=64 time=10.4 ms
64 bytes from 10.0.0.2: icmp_seq=13 ttl=64 time=10.2 ms
64 bytes from 10.0.0.2: icmp_seq=14 ttl=64 time=10.2 ms
64 bytes from 10.0.0.2: icmp_seq=15 ttl=64 time=10.2 ms
64 bytes from 10.0.0.2: icmp_seq=16 ttl=64 time=10.2 ms
64 bytes from 10.0.0.2: icmp_seq=17 ttl=64 time=10.2 ms
64 bytes from 10.0.0.2: icmp_seq=18 ttl=64 time=0.027 ms
64 bytes from 10.0.0.2: icmp_seq=19 ttl=64 time=10.2 ms
64 bytes from 10.0.0.2: icmp_seq=20 ttl=64 time=10.2 ms

--- 10.0.0.2 ping statistics ---
20 packets transmitted, 20 received, 0% packet loss, time 19077ms
rtt min/avg/max/mdev = 0.027/9.193/10.379/3.055 ms
root@mininet-vm:/home/mininet# sudo tc qdisc del dev h1-eth0 root netem
root@mininet-vm:/home/mininet#
```

```
"host: h2"@mininet-vm
root@mininet-vm:/home/mininet#
```



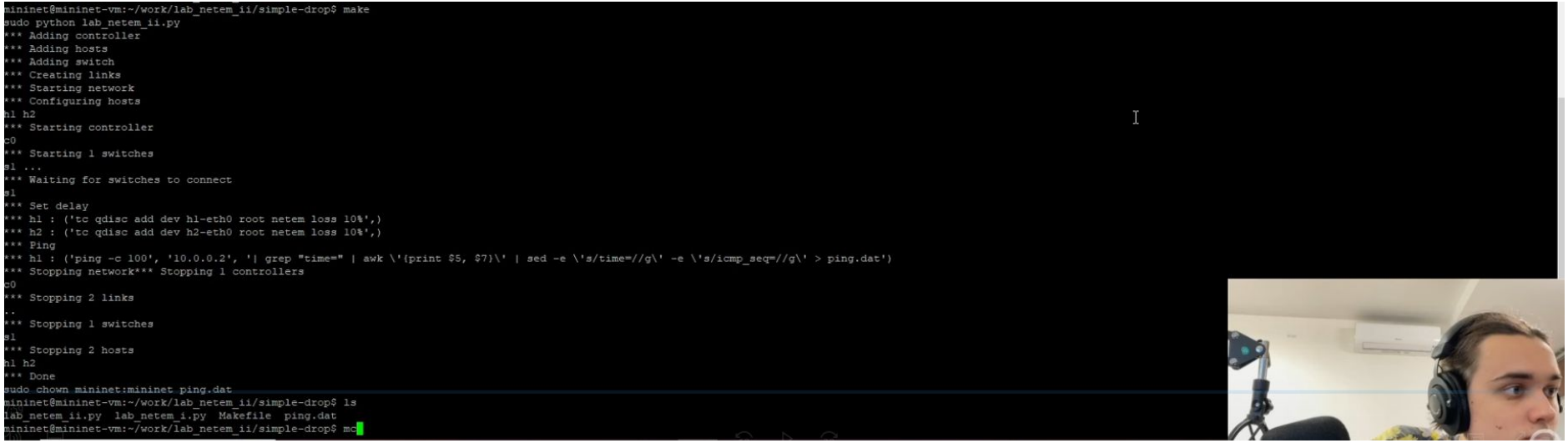
Ход работы


mininet@mininet-vm: ~/work/lab_netem_ii/simple-drop
GNU nano 4.8
lab_netem_i.py
Modified
#!/usr/bin/env python
"""
Simple experiment.
Output: ping.dat
"""
from mininet.net import Mininet
from mininet.node import Controller
from mininet.cli import CLI
from mininet.log import setLogLevel, info
import time
def emptyNet():
"Create an empty network and add nodes to it."
net = Mininet(controller=Controller, waitConnected=True)
info('*** Adding controller\n')
net.addController('c0')
info('*** Adding hosts\n')
h1 = net.addHost('h1', ip='10.0.0.1')
h2 = net.addHost('h2', ip='10.0.0.2')
info('*** Adding switch\n')
s1 = net.addSwitch('s1')
info('*** Creating links\n')
net.addLink(h1, s1)
net.addLink(h2, s1)
info('*** Starting network\n')
net.start()
info('*** Set delay\n')
h1.cmdPrint('tc qdisc add dev h1-eth0 root netem loss 10%')
h2.cmdPrint('tc qdisc add dev h2-eth0 root netem loss 10%')
time.sleep(10) # Wait 10 seconds
info('*** Ping\n')
h1.cmdPrint('ping -c 100', h2.IP(), '| grep "time=" | awk \'{print $5, $7}\' | sed -e \'s/time=//g\' -e \'s/icmp_seq=//g\' > ping.dat')
info('*** Stopping network')
net.stop()
if __name__ == '__main__':
setLogLevel('info')
emptyNet()
Save file under DIFFERENT NAME?
Y Yes
N No
^C Cancel

Ход работы


GNU nano 4.8
Makefile
all: ping.dat
ping.dat:
sudo python lab_netem_ii.py
sudo chown mininet:mininet ping.dat
clean:
-rm -f *.dat
Save modified buffer?
Yes
No
Cancel

Ход работы


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, $7}\' | sed -e \'s/time=//g\' -e \'s/icmp_seq=//g\' > ping.dat')
*** Stopping network*** Stopping 1 controllers
c0
*** Stopping 2 links
..
*** Stopping 1 switches
s1
*** Stopping 2 hosts
h1 h2
*** Done
sudo chown mininet:mininet ping.dat
mininet@mininet-vm:~/work/lab_netem_ii/simple-drop$ ls
lab_netem_ii.py lab_netem_i.py Makefile ping.dat
mininet@mininet-vm:~/work/lab_netem_ii/simple-drop$ mc

Ход работы


sudo chown mininet:mininet ping.dat
mininet@mininet-vm:~/work/lab_netem_ii/simple-drop$ ls
lab_netem_ii.py lab_netem_i.py Makefile ping.dat
mininet@mininet-vm:~/work/lab_netem_ii/simple-drop$ nano ping.dat
mininet@mininet-vm:~/work/lab_netem_ii/simple-drop$ make clean
Поиск

Вывод

Я получил навыки проведения интерактивных экспериментов в среде **Mininet** по исследованию параметров сети, связанных с потерей, дублированием, изменением порядка и повреждением пакетов при передаче данных.