Российский университет дружбы народов

Факультет физико-математических и естественных наук

Отчёт по лабораторной работе №4

Москва 2023

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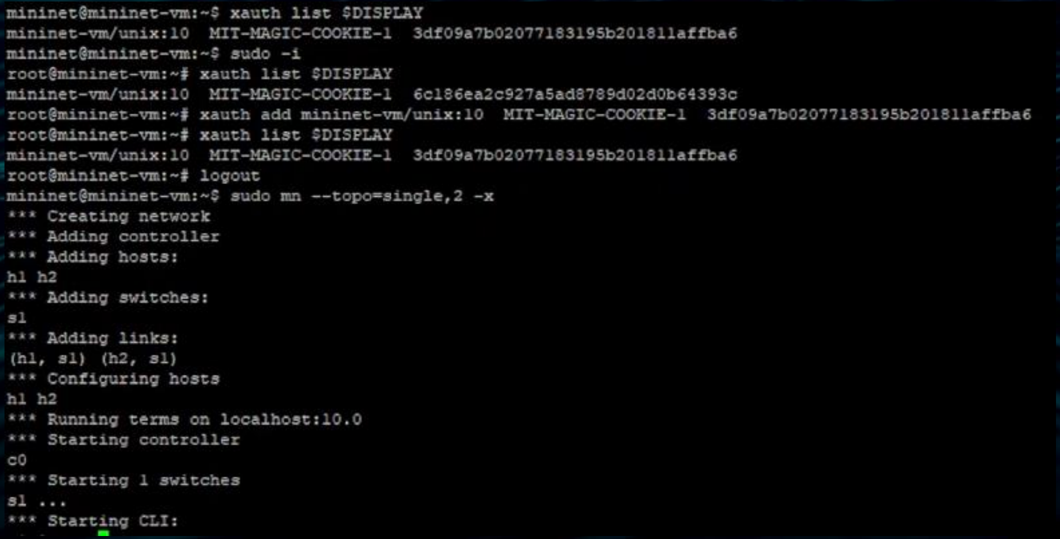
Цель работы (задание)

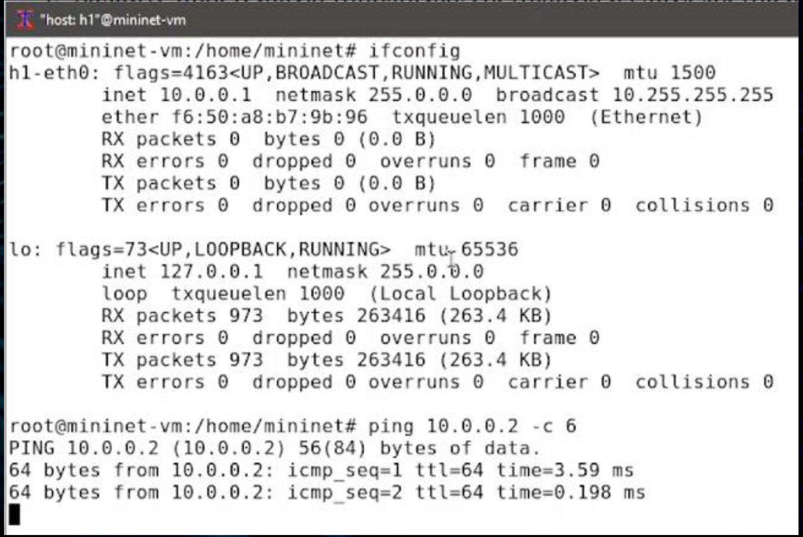
- Знакомство с NETEM — инструментом для тестирования производительности приложений в виртуальной сети
- Получение навыков проведения интерактивного и воспроизводимого экспериментов по измерению задержки и её дрожания (jitter) в моделируемой сети в среде Mininet.

Задачи (метод выполнения)

- Запуск лабораторной топологии



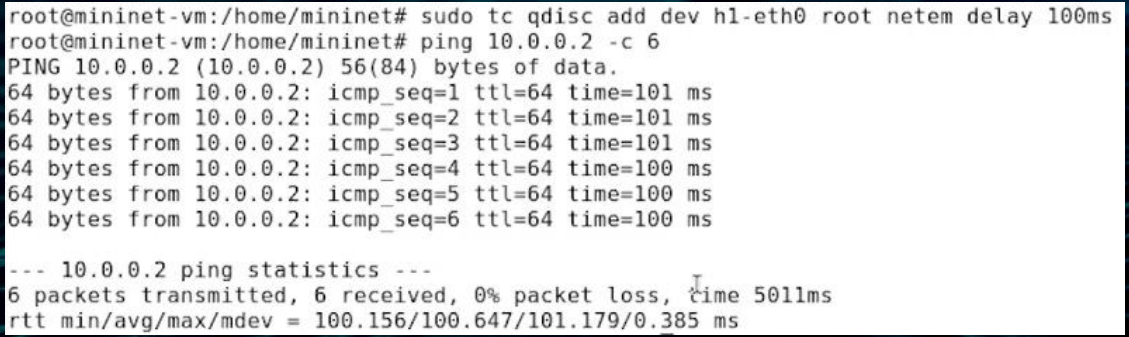
```
mininet@mininet-vm:~$ xauth list $DISPLAY
mininet-vm/unix:10  MIT-MAGIC-COOKIE-1  3df09a7b02077183195b20181laffba6
mininet@mininet-vm:~$ sudo -i
root@mininet-vm:~# xauth list $DISPLAY
mininet-vm/unix:10  MIT-MAGIC-COOKIE-1  6c186ea2c927a5ad8789d02d0b64393c
root@mininet-vm:~# xauth add mininet-vm/unix:10  MIT-MAGIC-COOKIE-1  3df09a7b02077183195b20181laffba6
root@mininet-vm:~# xauth list $DISPLAY
mininet-vm/unix:10  MIT-MAGIC-COOKIE-1  3df09a7b02077183195b20181laffba6
root@mininet-vm:~# logout
mininet@mininet-vm:~$ 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:
```



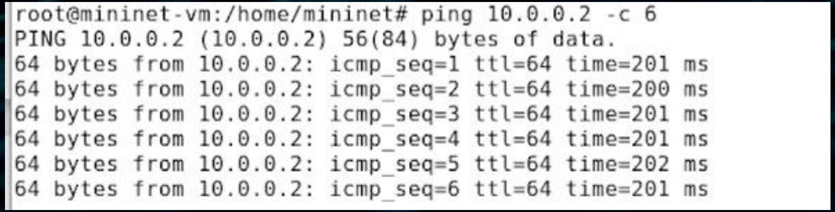
```
root@mininet-vm:/home/mininet# ifconfig
h1-eth0: flags=4163<UP,BROADCAST,RUNNING,MULTICAST>  mtu 1500
        inet 10.0.0.1  netmask 255.0.0.0  broadcast 10.255.255.255
        ether f6:50:a8:b7:9b:96  txqueuelen 1000  (Ethernet)
        RX packets 0  bytes 0 (0.0 B)
        RX errors 0  dropped 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 973  bytes 263416 (263.4 KB)
        RX errors 0  dropped 0  overruns 0  frame 0
        TX packets 973  bytes 263416 (263.4 KB)
        TX errors 0  dropped 0 overruns 0  carrier 0  collisions 0

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=3.59 ms
64 bytes from 10.0.0.2: icmp_seq=2 ttl=64 time=0.198 ms
```

Задачи (метод выполнения)

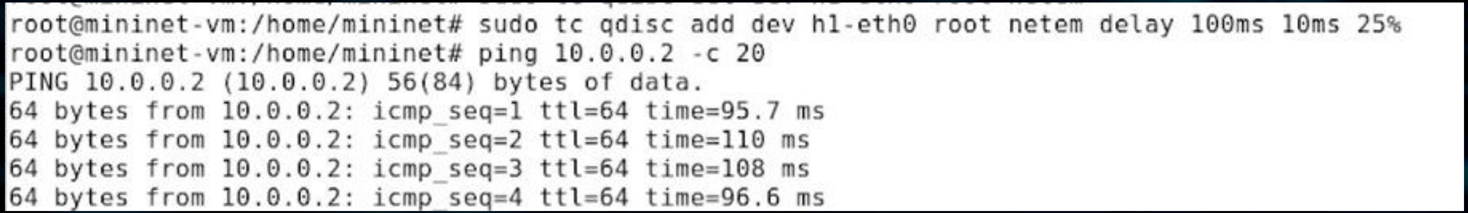
- Интерактивные эксперименты



```
root@mininet-vm:/home/mininet# sudo tc qdisc add dev h1-eth0 root netem delay 100ms
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=101 ms
64 bytes from 10.0.0.2: icmp_seq=2 ttl=64 time=101 ms
64 bytes from 10.0.0.2: icmp_seq=3 ttl=64 time=101 ms
64 bytes from 10.0.0.2: icmp_seq=4 ttl=64 time=100 ms
64 bytes from 10.0.0.2: icmp_seq=5 ttl=64 time=100 ms
64 bytes from 10.0.0.2: icmp_seq=6 ttl=64 time=100 ms

--- 10.0.0.2 ping statistics ---
6 packets transmitted, 6 received, 0% packet loss, time 5011ms
rtt min/avg/max/mdev = 100.156/100.647/101.179/0.385 ms
```



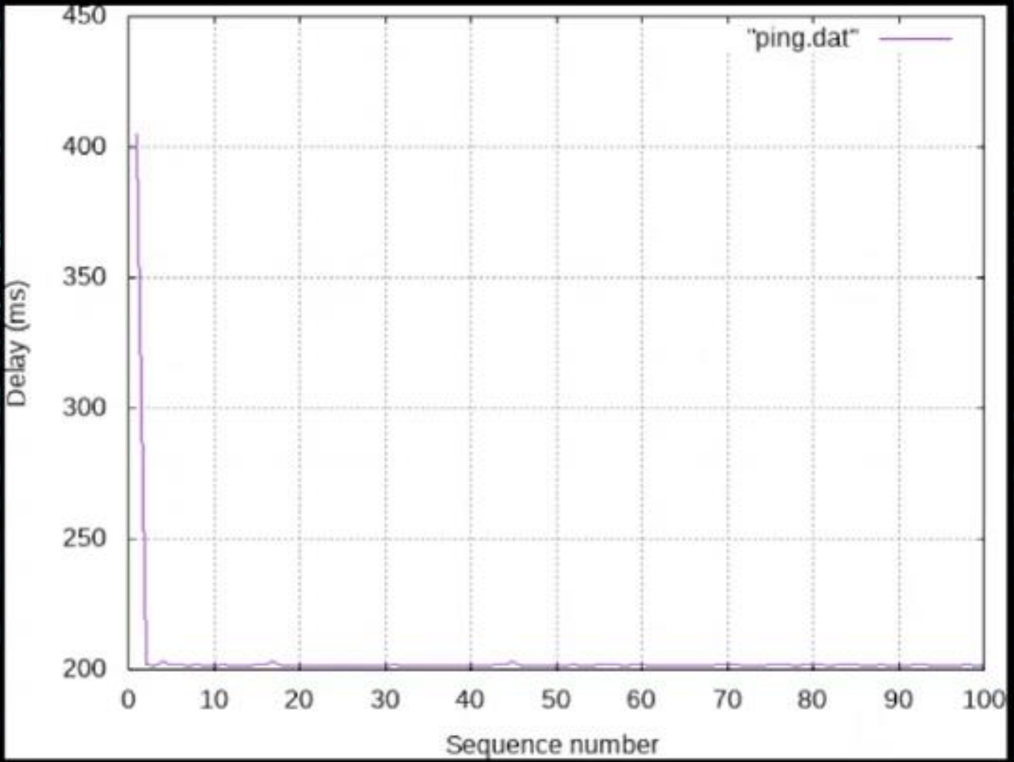
```
root@mininet-vm:/home/mininet# ping 10.0.0.2 -c 6
PING 10.0.0.2 (10.0.0.2) 56(84) bytes of data.
64 bytes from 10.0.0.2: icmp_seq=1 ttl=64 time=201 ms
64 bytes from 10.0.0.2: icmp_seq=2 ttl=64 time=200 ms
64 bytes from 10.0.0.2: icmp_seq=3 ttl=64 time=201 ms
64 bytes from 10.0.0.2: icmp_seq=4 ttl=64 time=201 ms
64 bytes from 10.0.0.2: icmp_seq=5 ttl=64 time=202 ms
64 bytes from 10.0.0.2: icmp_seq=6 ttl=64 time=201 ms
```

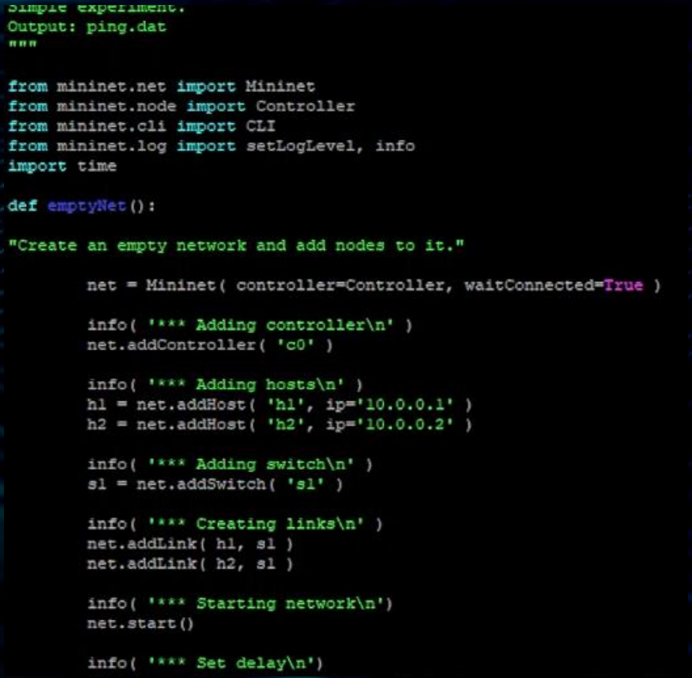


```
root@mininet-vm:/home/mininet# sudo tc qdisc add dev h1-eth0 root netem delay 100ms 10ms 25%
root@mininet-vm:/home/mininet# ping 10.0.0.2 -c 20
PING 10.0.0.2 (10.0.0.2) 56(84) bytes of data.
64 bytes from 10.0.0.2: icmp_seq=1 ttl=64 time=95.7 ms
64 bytes from 10.0.0.2: icmp_seq=2 ttl=64 time=110 ms
64 bytes from 10.0.0.2: icmp_seq=3 ttl=64 time=108 ms
64 bytes from 10.0.0.2: icmp_seq=4 ttl=64 time=96.6 ms
```

Задачи (метод выполнения)

- Воспроизведение экспериментов

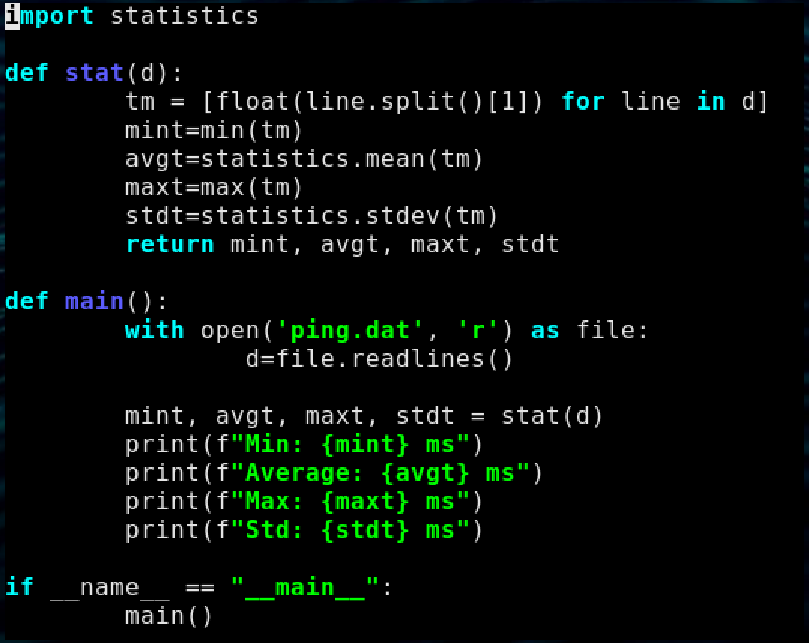




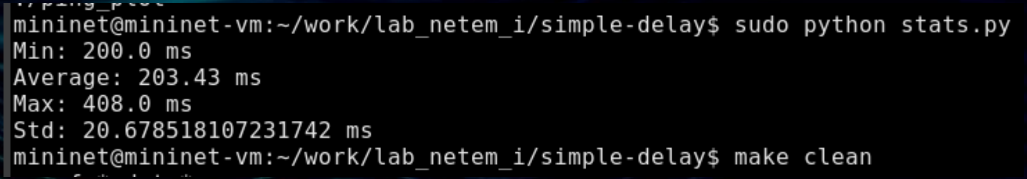
```
Simple experiment.
Output: ping.dat
"""

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')
```

Задачи (метод выполнения)

- Воспроизведение экспериментов



```python
import statistics

def stat(d):
        tm = [float(line.split()[1]) for line in d]
        mint=min(tm)
        avgt=statistics.mean(tm)
        maxt=max(tm)
        stdt=statistics.stdev(tm)
        return mint, avgt, maxt, stdt

def main():
        with open('ping.dat', 'r') as file:
                d=file.readlines()

        mint, avgt, maxt, stdt = stat(d)
        print(f"Min: {mint} ms")
        print(f"Average: {avgt} ms")
        print(f"Max: {maxt} ms")
        print(f"Std: {stdt} ms")

if __name__ == "__main__":
        main()
```



```
mininet@mininet-vm:~/work/lab_netem_i/simple-delay$ sudo python stats.py
Min: 200.0 ms
Average: 203.43 ms
Max: 408.0 ms
Std: 20.678518107231742 ms
mininet@mininet-vm:~/work/lab_netem_i/simple-delay$ make clean
```

Результаты и их анализ

- Познакомился с NETEM — инструментом для тестирования производительности приложений в виртуальной сети.
- Получил навыки проведения интерактивного и воспроизводимого экспериментов в среде Mininet.

Благодарю за внимание