

Лабораторная работа № 2

Измерение и тестирование пропускной способности сети. Интерактивный эксперимент

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Информация

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Цель работы

Основной целью работы является знакомство с инструментом для измерения пропускной способности сети в режиме реального времени —iPerf3, а также получение навыков проведения интерактивного эксперимента по измерению пропускной способности моделируемой сети в среде Mininet.

Задание

1. Установить на виртуальную машину mininet iPerf3 и дополнительное программное обеспечение для визуализации и обработки данных.
2. Провести ряд интерактивных экспериментов по измерению пропускной способности с помощью iPerf3 с построением графиков.

Выполнение лабораторной работы

Установка необходимого программного обеспечения

```
esdobershteyjn@fedora:~$ ssh -Y mininet@192.168.48.5
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

Failed to connect to https://changelogs.ubuntu.com/meta-release-lts. Check your I

Last login: Tue Sep  9 07:57:33 2025 from 192.168.48.1
mininet@mininet-vm:~$ ifconfig
eth0: flags=4163<UP,BROADCAST,RUNNING,MULTICAST>  mtu 1500
      inet 192.168.48.5  netmask 255.255.255.0  broadcast 192.168.48.255
          ether 08:00:27:eb:bd:44  txqueuelen 1000  (Ethernet)
            RX packets 14892  bytes 2811235 (2.8 MB)
            RX errors 0  dropped 0  overruns 0  frame 0
            TX packets 13846  bytes 3001249 (3.0 MB)
            TX errors 0  dropped 0  overruns 0  carrier 0  collisions 0

eth1: flags=4163<UP,BROADCAST,RUNNING,MULTICAST>  mtu 1500
      inet 10.0.2.15  netmask 255.255.255.0  broadcast 10.0.2.255
          ether 08:00:27:1a:a8:cb  txqueuelen 1000  (Ethernet)
            RX packets 2746  bytes 2183995 (2.1 MB)
            RX errors 0  dropped 0  overruns 0  frame 0
            TX packets 1989  bytes 158779 (158.7 KB)
            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 34736  bytes 4807938 (4.8 MB)
```

Установка необходимого программного обеспечения

```
mininet@mininet-vm:~$ sudo apt-get update
Get:1 http://security.ubuntu.com/ubuntu focal-security InRelease [128 kB]
Get:2 http://security.ubuntu.com/ubuntu focal-security/main i386 Packages [881 kB]
Hit:3 http://us.archive.ubuntu.com/ubuntu focal InRelease
Get:4 http://us.archive.ubuntu.com/ubuntu focal-updates InRelease [128 kB]
Get:5 http://us.archive.ubuntu.com/ubuntu focal-security/main amd64 Packages [3,564 kB]
Get:6 http://us.archive.ubuntu.com/ubuntu focal-backports InRelease [128 kB]
Get:7 http://security.ubuntu.com/ubuntu focal-security/main Translation-en [518 kB]
Get:8 http://security.ubuntu.com/ubuntu focal-security/main amd64 c-n-f Metadata [14.4 kB]
Get:9 http://security.ubuntu.com/ubuntu focal-security/restricted i386 Packages [42.5 kB]
Get:10 http://security.ubuntu.com/ubuntu focal-security/restricted amd64 Packages [3,768 kB]
Get:11 http://us.archive.ubuntu.com/ubuntu focal-updates/main amd64 Packages [3,955 kB]
Get:12 http://security.ubuntu.com/ubuntu focal-security/restricted Translation-en [527 kB]
```

Рис. 2: Обновление репозиториев

Установка необходимого программного обеспечения

```
mininet@mininet-vm:/tmp$ git clone https://github.com/ekfouri/iperf3_plotter.git
Cloning into 'iperf3_plotter'...
remote: Enumerating objects: 74, done.
remote: Total 74 (delta 0), reused 0 (delta 0), pack-reused 74 (from 1)
Unpacking objects: 100% (74/74), 100.09 KiB | 632.00 KiB/s, done.
mininet@mininet-vm:/tmp$ cd /iperf3_plotter
-bash: cd: /iperf3_plotter: No such file or directory
mininet@mininet-vm:/tmp$ cd /tmp/iperf3_plotter
mininet@mininet-vm:/tmp/iperf3_plotter$ sudo cp plot * /usr/bin
mininet@mininet-vm:/tmp/iperf3_plotter$ sudo cp *.sh /usr/bin
```

Рис. 3: Установка iperf3

Интерактивные эксперименты

Запустила простейшую топологию с двумя хостами и коммутатором.

```
root@mininet-vm:~# xauth list $DISPLAY
mininet-vm/unix:10  MIT-MAGIC-COOKIE-1  1fdfcc9f067189a8b51d46db6194252e
root@mininet-vm:~# logout
mininet@mininet-vm:/tmp/iperf3_plotter$ sudo mn --topo=single,2 -x
*** Creating network
```

Рис. 4: Запуск простейшей топологии

Интерактивные эксперименты

Посмотрела параметры запущенной в интерактивном режиме топологии.

```
mininet> net
h1 h1-eth0:s1-eth1
h2 h2-eth0:s1-eth2
s1 lo:  s1-eth1:h1-eth0 s1-eth2:h2-eth0
c0
```

Рис. 5: Параметры топологии

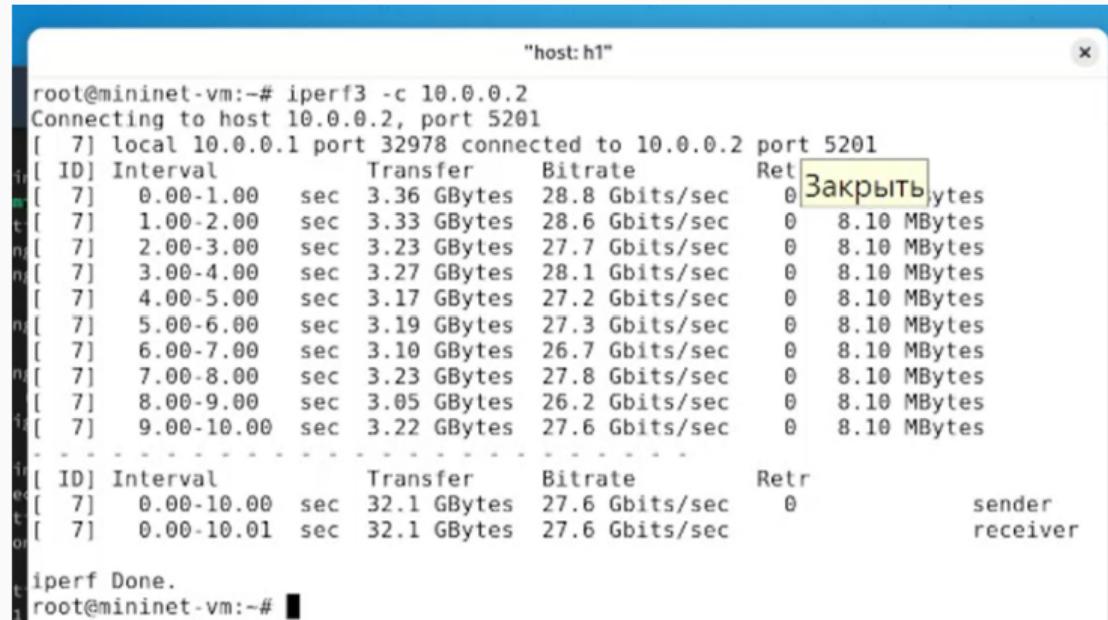
Интерактивные эксперименты

```
mininet> link
invalid number of args: link end1 end2 [up down]
mininet> links
h1-eth0<->s1-eth1 (OK OK)
h2-eth0<->s1-eth2 (OK OK)
```

Рис. 6: Параметры топологии

Интерактивные эксперименты

В терминале h2 запустила сервер iperf3, после запуска в терминале хоста h1 запустила клиент iperf3.



"host: h1"

```
root@mininet-vm:~# iperf3 -c 10.0.0.2
Connecting to host 10.0.0.2, port 5201
[ 7] local 10.0.0.1 port 32978 connected to 10.0.0.2 port 5201
[ ID] Interval      Transfer     Bitrate    Retr
[ 7]  0.00-1.00  sec  3.36 GBytes  28.8 Gbits/sec  0  8.10 MBytes
[ 7]  1.00-2.00  sec  3.33 GBytes  28.6 Gbits/sec  0  8.10 MBytes
[ 7]  2.00-3.00  sec  3.23 GBytes  27.7 Gbits/sec  0  8.10 MBytes
[ 7]  3.00-4.00  sec  3.27 GBytes  28.1 Gbits/sec  0  8.10 MBytes
[ 7]  4.00-5.00  sec  3.17 GBytes  27.2 Gbits/sec  0  8.10 MBytes
[ 7]  5.00-6.00  sec  3.19 GBytes  27.3 Gbits/sec  0  8.10 MBytes
[ 7]  6.00-7.00  sec  3.10 GBytes  26.7 Gbits/sec  0  8.10 MBytes
[ 7]  7.00-8.00  sec  3.23 GBytes  27.8 Gbits/sec  0  8.10 MBytes
[ 7]  8.00-9.00  sec  3.05 GBytes  26.2 Gbits/sec  0  8.10 MBytes
[ 7]  9.00-10.00 sec  3.22 GBytes  27.6 Gbits/sec  0  8.10 MBytes
-
[ ID] Interval      Transfer     Bitrate    Retr
[ 7]  0.00-10.00 sec 32.1 GBytes  27.6 Gbits/sec  0
[ 7]  0.00-10.01 sec 32.1 GBytes  27.6 Gbits/sec
sender
receiver

iperf Done.
root@mininet-vm:~#
```

Рис. 7: Терминал хоста h1

Интерактивные эксперименты

```
"host: h2"

-----
Server listening on 5201

-----
Accepted connection from 10.0.0.1, port 32976
[ 7] local 10.0.0.2 port 5201 connected to 10.0.0.1
[ ID] Interval          Transfer     Bitrate
[ 7]  0.00-1.00    sec  3.36 GBytes  28.8 Gbits/sec
[ 7]  1.00-2.00    sec  3.32 GBytes  28.5 Gbits/sec
[ 7]  2.00-3.00    sec  3.23 GBytes  27.7 Gbits/sec
[ 7]  3.00-4.00    sec  3.27 GBytes  28.1 Gbits/sec
[ 7]  4.00-5.00    sec  3.16 GBytes  27.1 Gbits/sec
[ 7]  5.00-6.00    sec  3.19 GBytes  27.3 Gbits/sec
[ 7]  6.00-7.00    sec  3.11 GBytes  26.8 Gbits/sec
[ 7]  7.00-8.00    sec  3.23 GBytes  27.7 Gbits/sec
[ 7]  8.00-9.00    sec  3.06 GBytes  26.2 Gbits/sec
[ 7]  9.00-10.00   sec  3.21 GBytes  27.6 Gbits/sec
[ 7] 10.00-10.01   sec 12.0 MBytes  19.5 Gbits/sec
[ 7]
```

Интерактивные эксперименты

Провела аналогичный эксперимент в интерфейсе iperf3.

```
*** Starting CLI:  
mininet> h2 iperf3 -s &  
mininet> h1 iperf3 -c h2  
Connecting to host 10.0.0.2, port 5201  
[ 5] local 10.0.0.1 port 32982 connected to 10.0.0.2 port 5201  
[ ID] Interval Transfer Bitrate Retr Cwnd  
[ 5] 0.00-1.00 sec 3.04 GBytes 26.1 Gbits/sec 14 3.76 MBytes  
[ 5] 1.00-2.00 sec 3.35 GBytes 28.8 Gbits/sec 0 3.77 MBytes  
[ 5] 2.00-3.00 sec 3.48 GBytes 29.9 Gbits/sec 0 3.77 MBytes  
[ 5] 3.00-4.00 sec 3.38 GBytes 29.8 Gbits/sec 0 3.78 MBytes  
[ 5] 4.00-5.00 sec 3.10 GBytes 26.7 Gbits/sec 0 3.78 MBytes  
[ 5] 5.00-6.00 sec 3.22 GBytes 27.6 Gbits/sec 0 3.79 MBytes  
[ 5] 6.00-7.00 sec 3.37 GBytes 28.9 Gbits/sec 0 3.79 MBytes  
[ 5] 7.00-8.00 sec 3.31 GBytes 28.5 Gbits/sec 0 3.79 MBytes  
[ 5] 8.00-9.00 sec 3.17 GBytes 27.2 Gbits/sec 0 3.80 MBytes  
[ 5] 9.00-10.00 sec 3.35 GBytes 28.8 Gbits/sec 0 3.80 MBytes  
-----  
[ ID] Interval Transfer Bitrate Retr  
[ 5] 0.00-10.00 sec 32.8 GBytes 28.2 Gbits/sec 14 sender  
[ 5] 0.00-10.00 sec 32.8 GBytes 28.1 Gbits/sec receiver  
  
iperf Done.  
mininet> h2 killall iperf3
```

Рис. 9: Интерактивный эксперимент в интерфейсе iperf3

Интерактивные эксперименты

```
mininet> h2 killall iperf3
warning: this system does not seem to support IPv6 - trying IPv4
-----
Server listening on 5201

Accepted connection from 10.0.0.1, port 32980
[ 5] local 10.0.0.2 port 5201 connected to 10.0.0.1 port 32982
[ ID] Interval      Transfer     Bitrate
[ 5]  0.00-1.00   sec  3.03 GBytes  26.1 Gbits/sec
[ 5]  1.00-2.00   sec  3.35 GBytes  28.8 Gbits/sec
[ 5]  2.00-3.00   sec  3.48 GBytes  29.9 Gbits/sec
[ 5]  3.00-4.00   sec  3.38 GBytes  29.8 Gbits/sec
[ 5]  4.00-5.00   sec  3.11 GBytes  26.7 Gbits/sec
[ 5]  5.00-6.00   sec  3.21 GBytes  27.6 Gbits/sec
[ 5]  6.00-7.00   sec  3.37 GBytes  28.9 Gbits/sec
[ 5]  7.00-8.00   sec  3.31 GBytes  28.5 Gbits/sec
[ 5]  8.00-9.00   sec  3.17 GBytes  27.2 Gbits/sec
[ 5]  9.00-10.00  sec  3.36 GBytes  28.8 Gbits/sec
[ 5] 10.00-10.00  sec 11.7 MBytes  55.0 Gbits/sec
-----
[ ID] Interval      Transfer     Bitrate
[ 5]  0.00-10.00  sec 32.8 GBytes  28.1 Gbits/sec
-----                                         receiver
Server listening on 5201
-----
iperf3: interrupt - the server has terminated
mininet>
```

Рис. 10: Остановка серверного процесса

Интерактивные эксперименты

Далее провела интерактивный эксперимент с измененным временем передачи (по умолчанию - 10 секунд, параметр **-t**).

```
"host: h1"
root@mininet-vm:~# iperf3 -c 10.0.0.2 -t 5
Connecting to host 10.0.0.2, port 5201
[ 7] local 10.0.0.1 port 33082 connected to 10.0.0.2 port 5201
[ ID] Interval      Transfer     Bitrate      Retr Cwnd
[ 7]  0.00-1.00  sec  3.18 GBytes   27.3 Gbits/sec  0  8.33 MBytes
[ 7]  1.00-2.00  sec  3.39 GBytes   29.1 Gbits/sec  0  8.33 MBytes
[ 7]  2.00-3.00  sec  3.06 GBytes   26.3 Gbits/sec  0  8.33 MBytes
[ 7]  3.00-4.00  sec  3.02 GBytes   26.0 Gbits/sec  0  8.33 MBytes
[ 7]  4.00-5.00  sec  3.04 GBytes   26.1 Gbits/sec  0  8.33 MBytes
[ ID] Interval      Transfer     Bitrate      Retr
[ 7]  0.00-5.00  sec  15.7 GBytes   27.8 Gbits/sec  0           sender
[ 7]  0.00-5.01  sec  15.7 GBytes   26.9 Gbits/sec  0           receive
iperf Done.
root@mininet-vm:~#
```

```
"host: h2"
root@mininet-vm:~# iperf3 -s
[ 7] Interval      Transfer     Bitrate
[ 7]  0.00-1.00  sec  3.03 GBytes   26.1 Gbits/sec
[ 7]  1.00-2.00  sec  3.35 GBytes   28.8 Gbits/sec
[ 7]  2.00-3.00  sec  3.48 GBytes   29.9 Gbits/sec
[ 7]  3.00-4.00  sec  3.38 GBytes   29.0 Gbits/sec
[ 7]  4.00-5.00  sec  3.11 GBytes   26.7 Gbits/sec
[ 7]  5.00-6.00  sec  3.21 GBytes   27.6 Gbits/sec
[ 7]  6.00-7.00  sec  3.37 GBytes   28.9 Gbits/sec
[ 7]  7.00-8.00  sec  3.31 GBytes   28.5 Gbits/sec
[ 7]  8.00-9.00  sec  3.17 GBytes   27.2 Gbits/sec
[ 7]  9.00-10.00  sec  3.26 GBytes   28.1 Gbits/sec
[ 7]  10.00-11.00 sec  3.32 GBytes   28.3 Gbits/sec
root@mininet-vm:~# iperf3 -s
[ 7] warning: this system does not seem to support IPv6 - trying IPv4
[ 7] Server listening on 5201
[ 7] Accepted connection from 10.0.0.1, port 33080
[ 7] [ ID] Interval      Transfer     Bitrate
[ 7] [ 7]  0.00-1.00  sec  3.17 GBytes   27.2 Gbits/sec
[ 7] [ 7]  1.00-2.00  sec  3.20 GBytes   28.1 Gbits/sec
```

Интерактивные эксперименты

Далее провела интерактивный эксперимент с 2-секундным интервалом времени отсчёта как на клиенте, так и на сервере.

Интерактивные эксперименты

Далее провела интерактивный эксперимент с изменением объема отправляемых данных(Transfer, 16 Гбайт).

```

iperf Done.
root@mininet-vm:~# iperf3 -c 10.0.0.2 -n 16G
Connecting to host 10.0.0.2, port 5201
[ 7] local 10.0.0.1 port 33010 connected to 10.0.0.2 port 5201
[ ID] Interval           Transfer     Bitrate      Retr  Cwnd
[ 7]  0.00-1.00  sec   3.22 GBytes   27.6 Gbits/sec  0  8.10 MBytes
[ 7]  1.00-2.00  sec   3.26 GBytes   28.0 Gbits/sec  0  8.10 MBytes
[ 7]  2.00-3.00  sec   3.21 GBytes   27.5 Gbits/sec  0  8.10 MBytes
[ 7]  3.00-4.00  sec   3.28 GBytes   28.2 Gbits/sec  0  8.10 MBytes
[ 7]  4.00-4.97  sec   3.03 GBytes   26.9 Gbits/sec  0  8.10 MBytes

[ ID] Interval           Transfer     Bitrate      Retr
[ 7]  0.00-4.97  sec   16.0 GBytes  27.7 Gbits/sec  0
[ 7]  0.00-4.97  sec   16.0 GBytes  27.6 Gbits/sec  sende

spted connection from 10.0.0.1, port 32980
[ 7] local 10.0.0.2 port 5201 connected to 10.0.0.1 port 32982
[ 0] Interval           Transfer     Bitrate
[ 0]  0.00-1.00  sec   3.03 GBytes  26.1 Gbits/sec
[ 1]  0.00-2.00  sec   3.35 GBytes  28.8 Gbytes/sec
[ 2]  0.00-3.00  sec   3.48 GBytes  29.9 Gbits/sec
[ 3]  0.00-4.00  sec   3.38 GBytes  29.0 Gbits/sec
[ 4]  0.00-5.00  sec   3.11 GBytes  26.7 Gbits/sec
[ 5]  0.00-6.00  sec   3.21 GBytes  27.6 Gbits/sec
[ 6]  0.00-7.00  sec   3.37 GBytes  28.9 Gbits/sec
[ 7]  0.00-8.00  sec   3.31 GBytes  28.5 Gbits/sec
[ 8]  0.00-9.00  sec   3.17 GBytes  27.2 Gbits/sec
[ 9]  0.00-10.00  sec   3.35 GBytes  28.6 Gbits/sec
[ 0]  10.00-10.00  sec   0.00 GBytes  0.00 Gbits/sec
                                         "host: h2"

[ 0] Interval           Transfer     Bitrate
[ 0]  0. Server listening on 5201
[ 0]  0. Server listening on 5201

ver list
`Ciperf3: interrupt - the server has terminated
root@mininet-vm:~# iperf3 -s
rf3: warning: this system does not seem to support IPv6 - trying IPv4
inet>
Stoppp! Server listening on 5201

Stoppp! Accepted connection from 10.0.0.1, port 33008
Stoppp! [ 7] local 10.0.0.2 port 5201 connected to 10.0.0.1 port 33010
[ ID] Interval           Transfer     Bitrate
```

Интерактивные эксперименты

Далее провела интерактивный эксперимент с изменением протокола передачи данных с TCP на UDP.

Интерактивные эксперименты

Далее провела интерактивный эксперимент с изменением порта для отправки и получения пакетов или датаграмм.

```
root@mininet-vm:~# iperf3 -c 10.0.0.2 -p 3250
Connecting to host 10.0.0.2, port 3250
[ 7] local 10.0.0.1 port 35980 connected to 10.0.0.2 port 3250
[ ID] Interval      Transfer     Bitrate    Retr
[ 7]  0.00-1.00  sec  3.25 GBytes   27.9 Gbits/sec  0  8.37 MBytes
[ 7]  1.00-2.00  sec  3.23 GBytes   27.7 Gbits/sec  0  8.37 MBytes
[ 7]  2.00-3.00  sec  3.31 GBytes   28.5 Gbits/sec  1  8.37 MBytes
[ 7]  3.00-4.00  sec  3.23 GBytes   27.7 Gbits/sec  0  8.37 MBytes
[ 7]  4.00-5.00  sec  3.18 GBytes   27.4 Gbits/sec  0  8.37 MBytes
[ 7]  5.00-6.00  sec  3.29 GBytes   28.3 Gbits/sec  0  8.37 MBytes
[ 7]  6.00-7.00  sec  3.24 GBytes   27.8 Gbits/sec  0  8.37 MBytes
[ 7]  7.00-8.00  sec  3.29 GBytes   28.3 Gbits/sec  0  8.37 MBytes
[ 7]  8.00-9.00  sec  3.47 GBytes   29.8 Gbits/sec  0  8.37 MBytes
[ 7]  9.00-10.00 sec  3.08 GBytes   26.4 Gbits/sec  0  8.37 MBytes
-----
[ ID] Interval      Transfer     Bitrate    Retr
[ 7]  0.00-10.00 sec 32.6 GBytes  28.0 Gbits/sec  1          sender
[ 7]  0.00-10.00 sec 32.6 GBytes  28.0 Gbits/sec          receive
iperf Done.
root@mininet-vm:~# []
```

```
opted connection from 10.0.0.1, port 32980
[ 5] local 10.0.0.2 port 5201 connected to 10.0.0.1 port 32982
[ 0] Interval      Transfer     Bitrate
[ 5]  0.00-1.00  sec  3.03 GBytes   26.1 Gbits/sec
[ 5]  1.00-2.00  sec  3.35 GBytes   28.8 Gbits/sec
[ 5]  2.00-3.00  sec  3.48 GBytes   29.9 Gbits/sec
[ 5]  3.00-4.00  sec  3.38 GBytes   29.0 Gbits/sec
[ 5]  4.00-5.00  sec  3.11 GBytes   26.7 Gbits/sec
[ 5]  5.00-6.00  sec  3.21 GBytes   27.6 Gbits/sec
[ 5]  6.00-7.00  sec  3.37 GBytes   28.9 Gbits/sec
[ 5]  7.00-8.00  sec  3.31 GBytes   28.5 Gbits/sec
[ 5]  8.00-9.00  sec  3.17 GBytes   27.2 Gbits/sec
[ 5]  9.00-10.00 sec  3.00 GBytes   26.4 Gbits/sec
[ 6] 10.00-10.00 sec 32.6 GBytes  28.0 Gbits/sec
                                         "host: h2"
-----
```

```
[ 0] Interval      Transfer     Bitrate
-----[ 0]  0.00-1.00  sec  3.25 GBytes   27.8 Gbits/sec
-----[ 1] local 10.0.0.2 port 3250 connected to 10.0.0.1 port 35980
[ 1]  0.00-1.01  sec  3.25 GBytes   27.8 Gbits/sec
[ 1]  1.01-2.00  sec  3.22 GBytes   27.8 Gbits/sec
[ 1]  2.00-3.00  sec  3.32 GBytes   28.6 Gbits/sec
[ 1]  3.00-4.00  sec  3.23 GBytes   27.7 Gbits/sec
[ 1]  4.00-5.00  sec  3.18 GBytes   27.4 Gbits/sec
[ 1]  5.00-6.00  sec  3.29 GBytes   28.3 Gbits/sec
[ 1]  6.00-7.00  sec  3.24 GBytes   27.8 Gbits/sec
```

Интерактивные эксперименты

Далее провела интерактивный эксперимент с изменением параметра обработки данных (только от одного клиента с остановкой сервера по завершении теста).

```
root@mininet-vm:~# iperf3 -c 10.0.0.2
Connecting to host 10.0.0.2, port 5201
[ 7] local 10.0.0.1 port 33020 connected to 10.0.0.2 port 5201
[ ID] Interval           Transfer     Bitrate      Retr  [Закрыть]
[ 7]  0.00-1.00  sec   3.09 GBytes   26.5 Gbits/sec  0  8.10 MBytes
[ 7]  1.00-2.00  sec   2.88 GBytes   24.7 Gbits/sec  0  8.10 MBytes
[ 7]  2.00-3.00  sec   3.06 GBytes   26.3 Gbits/sec  0  8.10 MBytes
[ 7]  3.00-4.00  sec   2.90 GBytes   24.9 Gbits/sec  0  8.10 MBytes
[ 7]  4.00-5.00  sec   3.20 GBytes   27.4 Gbits/sec  0  8.10 MBytes
[ 7]  5.00-6.00  sec   3.18 GBytes   27.3 Gbits/sec  0  8.10 MBytes
[ 7]  6.00-7.00  sec   3.34 GBytes   28.8 Gbits/sec  0  8.10 MBytes
[ 7]  7.00-8.00  sec   3.15 GBytes   27.0 Gbits/sec  0  8.10 MBytes
[ 7]  8.00-9.00  sec   3.29 GBytes   28.3 Gbits/sec  0  8.10 MBytes
[ 7]  9.00-10.00 sec   3.37 GBytes   28.9 Gbits/sec  0  8.10 MBytes
[ -- -- -- -- --]
[ ID] Interval           Transfer     Bitrate      Retr
[ 7]  0.00-10.00 sec  31.5 GBytes   27.0 Gbits/sec  0          sender
[ 7]  0.00-10.01 sec  31.5 GBytes   27.0 Gbits/sec  0          receive
iperf Done.
root@mininet-vm:~# []
eped connection from 10.0.0.1, port 32988
$) local 10.0.0.2 port 5201 connected to 10.0.0.1 port 32982
$) Interval           Transfer     Bitrate      Retr
$)  0.00-1.00  sec   3.03 GBytes   26.1 Gbytes/sec
$)  1.00-2.00  sec   3.35 GBytes   28.8 Gbytes/sec
$)  2.00-3.00  sec   3.48 GBytes   29.9 Gbytes/sec
$)  3.00-4.00  sec   3.38 GBytes   29.8 Gbytes/sec
$)  4.00-5.00  sec   3.11 GBytes   26.7 Gbytes/sec
$)  5.00-6.00  sec   3.21 GBytes   27.6 Gbytes/sec
$)  6.00-7.00  sec   3.37 GBytes   28.9 Gbytes/sec
$)  7.00-8.00  sec   3.31 GBytes   28.5 Gbytes/sec
$)  8.00-9.00  sec   3.17 GBytes   27.2 Gbytes/sec
$)  9.00-10.00 sec   3.20 GBytes   28.1 Gbytes/sec
$) 10.00-10.01 sec   3.17 GBytes   28.1 Gbytes/sec
                               "host: h2"
[ -- -- -- -- --]
$) Interval           Transfer     Bitrate      Retr
$)  0.00-1.00  sec   3.09 GBytes   26.5 Gbytes/sec
root@mininet-vm:~# iperf3 -s -1
ver 1.1.0 warning: this system does not seem to support IPv6 - trying IPv4
-----[Server listening on 5201
inet>
Stoppid: Accepted connection from 10.0.0.1, port 33018
Stoppid: 7] local 10.0.0.2 port 5201 connected to 10.0.0.1 port 33020
Stoppid: [ ID] Interval           Transfer     Bitrate
Stoppid: [ 7]  0.00-1.00  sec   3.09 GBytes   26.5 Gbytes/sec
Stoppid: [ 7]  1.00-2.00  sec   2.88 GBytes   24.7 Gbytes/sec
Stoppid: [ 7]  2.00-3.00  sec   3.06 GBytes   26.3 Gbytes/sec
```

Интерактивные эксперименты

Экспортировала вывод результатов теста в формате JSON в файл, перенаправив стандартный вывод в файл.

```
root@mininet-vm:~# iperf3 -c 10.0.0.2 -J > /home/mininet/work/lab_iperf3/iperf_
results.json
root@mininet-vm:~# cd /home/mininet/
```

Рис. 17: Экспорт результатов теста

Интерактивные эксперименты

Перешла в каталог для работы над проектом и скорректировала права доступа к файлу JSON.

```
mininet@mininet-vm:~/work/lab_iperf3
mininet@mininet-vm:~/work/lab_iperf3$ cd ~/work/lab_iperf3
mininet@mininet-vm:~/work/lab_iperf3$ ls -l
total 8
-rw-r--r-- 1 root root 7775 Sep  9 10:28 iperf_results.json
mininet@mininet-vm:~/work/lab_iperf3$ sudo chown -R mininet:mininet ~/work
mininet@mininet-vm:~/work/lab_iperf3$ ls -l
total 8
-rw-r--r-- 1 mininet mininet 7775 Sep  9 10:28 iperf_results.json
mininet@mininet-vm:~/work/lab_iperf3$ _
```

Рис. 18: Корректировка прав доступа

Интерактивные эксперименты

Сгенерировала выходные данные для файла JSON, выполнив команду `plot_iperf.sh iperf3_results.json`. Убедилась, что файлы с данными и графиками сформировались.

[~ /work/lab_iperf3/results]			
.	Name	Size	Modify time
/..		UP--DTR	Sep 9 10:33
	1.dat	472	Sep 9 10:33
	HTU.pdf	9636	Sep 9 10:33
	RTT.pdf	9636	Sep 9 10:33
	RTT_Var.pdf	9132	Sep 9 10:33
	bytes.pdf	9785	Sep 9 10:33
	cwnd.pdf	9619	Sep 9 10:33
	retransmits.pdf	8978	Sep 9 10:33
	throughput.pdf	9525	Sep 9 10:33

Рис. 19: Результаты

Выводы

В ходе выполнения лабораторной работы я познакомилась с инструментом для измерения пропускной способности сети в режиме реального времени —iPerf3, а также получила навыки проведения интерактивного эксперимента по измерению пропускной способности моделируемой сети в среде Mininet.