

Лаб №2 по дисциплине Моделирование сетей передачи данных

Измерение и тестирование пропускной способности сети. Интерактивный эксперимент

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Вводная часть

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.

Выполнение лабораторной работы

1. Установка необходимого программного обеспечения

```
mininet@mininet-vm: ~  
  
mininet@mininet-vm:~$ sudo mcedit /etc/netplan/01-netcfg.yaml  
Could not find ':' in DISPLAY: needs-to-be-defined  
  
mininet@mininet-vm:~$ sudo mcedit /etc/netplan/01-netcfg.yaml  
Could not find ':' in DISPLAY: needs-to-be-defined  
  
mininet@mininet-vm:~$ sudo apt-get update  
Hit:1 http://us.archive.ubuntu.com/ubuntu focal InRelease  
Get:2 http://security.ubuntu.com/ubuntu focal-security InRelease [128 kB]  
Get:3 http://us.archive.ubuntu.com/ubuntu focal-updates InRelease [128 kB]  
Get:4 http://us.archive.ubuntu.com/ubuntu focal-backports InRelease [128 kB]  
Get:5 http://us.archive.ubuntu.com/ubuntu focal-updates/main i386 Packages [1,054 kB]  
Get:6 http://security.ubuntu.com/ubuntu focal-security/main i386 Packages [834 kB]  
Get:7 http://security.ubuntu.com/ubuntu focal-security/main amd64 Packages [3,303 kB]  
Get:8 http://us.archive.ubuntu.com/ubuntu focal-updates/main amd64 Packages [3,676 kB]  
Get:9 http://us.archive.ubuntu.com/ubuntu focal-updates/main Translation-en [563 kB]  
Get:10 http://us.archive.ubuntu.com/ubuntu focal-updates/main amd64 c-n-f Metadata [17.8 kB]  
Get:11 http://us.archive.ubuntu.com/ubuntu focal-updates/restricted amd64 Packages [3,375 kB]  
Get:12 http://security.ubuntu.com/ubuntu focal-security/main Translation-en [484 kB]  
Get:13 http://security.ubuntu.com/ubuntu focal-security/main amd64 c-n-f Metadata [14.3 kB]  
Get:14 http://security.ubuntu.com/ubuntu focal-security/restricted amd64 Packages [3,247 kB]  
52% [8 Packages store 0 B] [11 Packages 562 kB/3,375 kB 17%] [14 Packages 0 B/3,247 kB 0%]
```

1. Установка необходимого программного обеспечения

```
mininet@mininet-v
mininet@mininet-vm:~$ cd /tmp
mininet@mininet-vm:/tmp$ git clone https://github.com/ekfoury/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 | 453.00 KiB/s, done.
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
mininet@mininet-vm:/tmp/iperf3_plotter$
```

Рис. 2: Устанавливаем iperf3

2. Интерактивные эксперименты

The image shows two terminal windows from a Mininet VM. The left window, titled "host: h2"@mininet-vm, shows the server output of an iperf3 test. The right window, titled "host: h1"@mininet-vm, shows the client output of the same test. Both windows display a table of results for 10 intervals, followed by a summary table and the message "iperf Done".

Host h2 (Server) Output:

ID	Interval	sec	Transfer	Bitrate
7	1.00-2.00	sec	1.81 GBytes	15.6 Gbits/sec
7	2.00-3.00	sec	2.08 GBytes	17.9 Gbits/sec
7	3.00-4.00	sec	1.83 GBytes	15.7 Gbits/sec
7	4.00-5.00	sec	1.81 GBytes	15.5 Gbits/sec
7	5.00-6.00	sec	1.69 GBytes	14.5 Gbits/sec
7	6.00-7.00	sec	2.04 GBytes	17.5 Gbits/sec
7	7.00-8.00	sec	2.06 GBytes	17.7 Gbits/sec
7	8.00-9.00	sec	1.85 GBytes	15.9 Gbits/sec
7	9.00-10.00	sec	1.74 GBytes	14.9 Gbits/sec
7	10.00-10.00	sec	256 KBytes	2.13 Gbits/sec

Summary:

ID	Interval	sec	Transfer	Bitrate
7	0.00-10.00	sec	18.8 GBytes	16.1 Gbits/sec

Server listening on 5201

Host h1 (Client) Output:

ID	Interval	sec	Transfer	Bitrate
7	3.00-4.00	sec	1.81 GBytes	15.5 Gbits/sec
7	4.00-5.00	sec	1.83 GBytes	15.7 Gbits/sec
7	5.00-6.00	sec	1.69 GBytes	14.5 Gbits/sec
7	6.00-7.00	sec	2.04 GBytes	17.5 Gbits/sec
7	7.00-8.00	sec	2.04 GBytes	17.5 Gbits/sec
7	8.00-9.00	sec	1.85 GBytes	15.9 Gbits/sec
7	9.00-10.00	sec	1.73 GBytes	14.9 Gbits/sec

Summary:

ID	Interval	sec	Transfer	Bitrate
7	0.00-10.00	sec	18.8 GBytes	16.1 Gbits/sec

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

Рис. 3: Интерактивный эксперимент по измерению пропускной способности

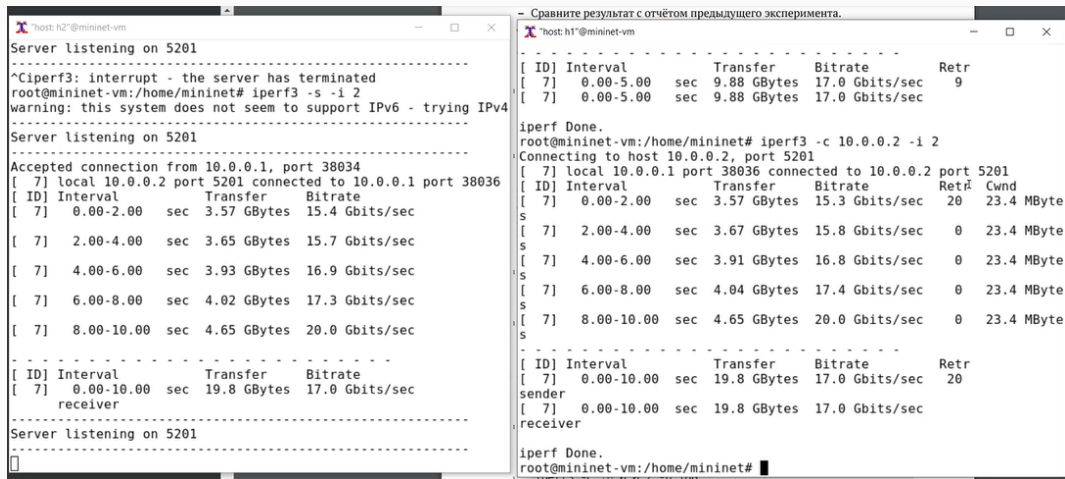
2. Интерактивные эксперименты

```
mininet@mininet-vm: ~  
iperf3 homepage at: https://software.es.net/iperf/  
Report bugs to: https://github.com/esnet/iperf  
Connecting to host 10.0.0.2, port 5201  
[ 5] local 10.0.0.1 port 38026 connected to 10.0.0.2 port 5201  
[ ID] Interval      Transfer    Bitrate      Retr  Cwnd  
[ 5]  0.00-1.00    sec  1.86 GBytes  15.9 Gbits/sec    9   18.0 MBytes  
[ 5]  1.00-2.00    sec  1.83 GBytes  15.8 Gbits/sec    0   18.0 MBytes  
[ 5]  2.00-3.01    sec  1.86 GBytes  15.8 Gbits/sec    0   18.0 MBytes  
[ 5]  3.01-4.00    sec  1.86 GBytes  16.1 Gbits/sec    0   18.0 MBytes  
[ 5]  4.00-5.00    sec  1.37 GBytes  11.7 Gbits/sec    0   18.0 MBytes  
[ 5]  5.00-6.00    sec  1.90 GBytes  16.3 Gbits/sec    0   18.0 MBytes  
[ 5]  6.00-7.00    sec  1.90 GBytes  16.3 Gbits/sec    0   18.0 MBytes  
[ 5]  7.00-8.00    sec  1.92 GBytes  16.5 Gbits/sec    0   18.0 MBytes  
[ 5]  8.00-9.00    sec  1.93 GBytes  16.6 Gbits/sec    0   18.0 MBytes  
[ 5]  9.00-10.00   sec  1.78 GBytes  15.3 Gbits/sec    0   18.0 MBytes  
  
- - - - -  
[ ID] Interval      Transfer    Bitrate      Retr  
[ 5]  0.00-10.00   sec  18.2 GBytes  15.6 Gbits/sec    9  
[ 5]  0.00-10.00   sec  18.2 GBytes  15.6 Gbits/sec    0  
er  
  
iperf Done.  
mininet> h2 k
```


2. Интерактивные эксперименты

Запускаем клиент iPerf3 с параметром -t

2. Интерактивные эксперименты



The image shows two terminal windows from a mininet environment. The left window, titled 'host: h2@mininet-vm', shows a server listening on port 5201. It receives a connection from 10.0.0.1 on port 38034. The output shows a table of performance metrics over five 2-second intervals, with a total transfer of 19.8 GBytes and a bitrate of 17.0 Gbits/sec. The right window, titled 'host: h1@mininet-vm', shows a client connecting to the server on port 5201. It also displays a table of performance metrics over five 2-second intervals, with a total transfer of 19.8 GBytes and a bitrate of 17.0 Gbits/sec. Both windows show the command 'iperf3 Done.' and the prompt 'root@mininet-vm:/home/mininet#'.

```
host: h2@mininet-vm
Server listening on 5201
-----
^Ciperf3: interrupt - the server has terminated
root@mininet-vm:/home/mininet# iperf3 -s -i 2
warning: this system does not seem to support IPv6 - trying IPv4
-----
Server listening on 5201
-----
Accepted connection from 10.0.0.1, port 38034
[ 7] local 10.0.0.2 port 5201 connected to 10.0.0.1 port 38036
[ ID] Interval      Transfer    Bitrate
[ 7] 0.00-2.00 sec  3.57 GBytes 15.4 Gbits/sec
[ 7] 2.00-4.00 sec  3.65 GBytes 15.7 Gbits/sec
[ 7] 4.00-6.00 sec  3.93 GBytes 16.9 Gbits/sec
[ 7] 6.00-8.00 sec  4.02 GBytes 17.3 Gbits/sec
[ 7] 8.00-10.00 sec 4.65 GBytes 20.0 Gbits/sec
-----
[ ID] Interval      Transfer    Bitrate
[ 7] 0.00-10.00 sec 19.8 GBytes 17.0 Gbits/sec
receiver
-----
Server listening on 5201
-----

host: h1@mininet-vm
Сравните результат с отчётом предыдущего эксперимента.
-----
[ ID] Interval      Transfer    Bitrate    Retr
[ 7] 0.00-5.00 sec  9.88 GBytes 17.0 Gbits/sec    9
[ 7] 0.00-5.00 sec  9.88 GBytes 17.0 Gbits/sec
-----
iperf Done.
root@mininet-vm:/home/mininet# iperf3 -c 10.0.0.2 -i 2
Connecting to host 10.0.0.2, port 5201
[ 7] local 10.0.0.1 port 38036 connected to 10.0.0.2 port 5201
[ ID] Interval      Transfer    Bitrate    Retr  Cwnd
[ 7] 0.00-2.00 sec  3.57 GBytes 15.3 Gbits/sec    20   23.4 MByte
s
[ 7] 2.00-4.00 sec  3.67 GBytes 15.8 Gbits/sec    0   23.4 MByte
s
[ 7] 4.00-6.00 sec  3.91 GBytes 16.8 Gbits/sec    0   23.4 MByte
s
[ 7] 6.00-8.00 sec  4.04 GBytes 17.4 Gbits/sec    0   23.4 MByte
s
[ 7] 8.00-10.00 sec 4.65 GBytes 20.0 Gbits/sec    0   23.4 MByte
s
-----
[ ID] Interval      Transfer    Bitrate    Retr
[ 7] 0.00-10.00 sec 19.8 GBytes 17.0 Gbits/sec    20
sender
[ 7] 0.00-10.00 sec 19.8 GBytes 17.0 Gbits/sec
receiver
-----
iperf Done.
root@mininet-vm:/home/mininet#
```

Рис. 5: Запускаем клиент iPerf3 с 2-секундным интервалом времени отсчёта

2. Интерактивные эксперименты

```
host: h2@mininet-vm
Server listening on 5201
-----
Accepted connection from 10.0.0.1, port 38038
[ 7] local 10.0.0.2 port 5201 connected to 10.0.0.1 port 38040
[ ID] Interval            Transfer          Bitrate
[ 7]  0.00-1.00      sec  2.09 GBytes    18.0 Gbits/sec
[ 7]  1.00-2.00      sec  1.90 GBytes    16.3 Gbits/sec
[ 7]  2.00-3.00      sec  1.82 GBytes    15.6 Gbits/sec
[ 7]  3.00-4.00      sec  2.27 GBytes    19.5 Gbits/sec
[ 7]  4.00-5.00      sec  2.29 GBytes    19.6 Gbits/sec
[ 7]  5.00-6.00      sec  2.33 GBytes    20.0 Gbits/sec
[ 7]  6.00-7.00      sec  2.22 GBytes    19.1 Gbits/sec
[ 7]  7.00-7.48      sec  1.09 GBytes    19.3 Gbits/sec
-----
[ ID] Interval            Transfer          Bitrate
[ 7]  0.00-7.48      sec  16.0 GBytes    18.4 Gbits/sec
sender
receiver
-----
Server listening on 5201
-----

host: h1@mininet-vm
root@mininet-vm:/home/mininet# iperf3 -c 10.0.0.2 -n 16G
Connecting to host 10.0.0.2, port 5201
[ 7] local 10.0.0.1 port 38040 connected to 10.0.0.2 port 5201
[ ID] Interval            Transfer          Bitrate      Retr  Cwnd
[ 7]  0.00-1.00      sec  2.12 GBytes    18.2 Gbits/sec      9   21.4 MByte
s
[ 7]  1.00-2.00      sec  1.89 GBytes    16.1 Gbits/sec      0   21.4 MByte
s
[ 7]  2.00-3.00      sec  1.83 GBytes    15.8 Gbits/sec      0   21.4 MByte
s
[ 7]  3.00-4.00      sec  2.27 GBytes    19.5 Gbits/sec      0   21.4 MByte
s
[ 7]  4.00-5.00      sec  2.29 GBytes    19.6 Gbits/sec      0   21.4 MByte
s
[ 7]  5.00-6.00      sec  2.33 GBytes    20.0 Gbits/sec      0   21.4 MByte
s
[ 7]  6.00-7.00      sec  2.22 GBytes    19.1 Gbits/sec      0   21.4 MByte
s
[ 7]  7.00-7.48      sec  1.06 GBytes    18.9 Gbits/sec      0   21.4 MByte
s
-----
[ ID] Interval            Transfer          Bitrate      Retr
[ 7]  0.00-7.48      sec  16.0 GBytes    18.4 Gbits/sec      9
sender
[ 7]  0.00-7.48      sec  16.0 GBytes    18.4 Gbits/sec
receiver
iperf Done.
root@mininet-vm:/home/mininet#
```

Рис. 6: Задаем на клиенте iPerf3 отправку определённого объёма данных

2. Интерактивные эксперименты

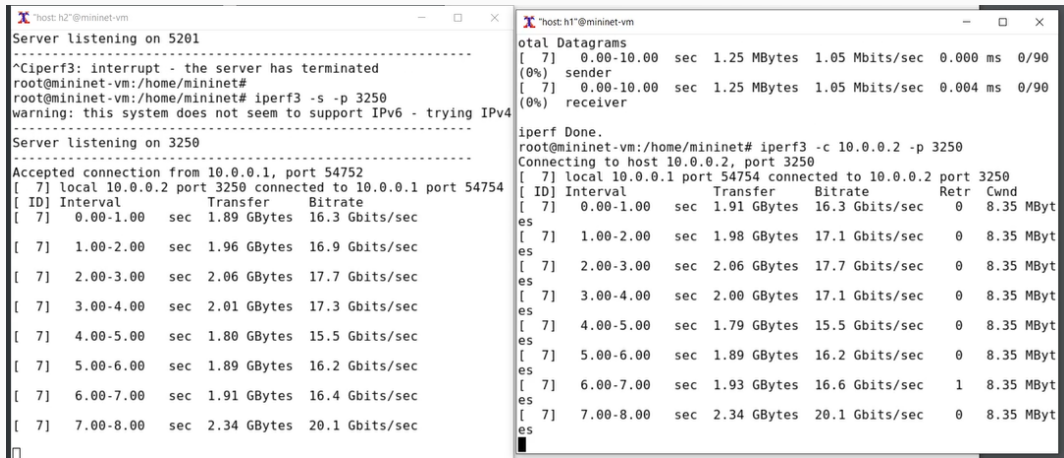
```
host: h2@mininet-vm
[ 7] 0.00-1.00 sec 129 KBytes 1.05 Mbits/sec 0.027 ms
0/91 (0%)
[ 7] 1.00-2.03 sec 127 KBytes 1.01 Mbits/sec 0.028 ms
0/90 (0%)
[ 7] 2.03-3.00 sec 129 KBytes 1.09 Mbits/sec 0.010 ms
0/91 (0%)
[ 7] 3.00-4.00 sec 127 KBytes 1.04 Mbits/sec 0.009 ms
0/90 (0%)
[ 7] 4.00-5.00 sec 129 KBytes 1.05 Mbits/sec 0.014 ms
0/91 (0%)
[ 7] 5.00-6.00 sec 127 KBytes 1.04 Mbits/sec 0.010 ms
0/90 (0%)
[ 7] 6.00-7.00 sec 129 KBytes 1.05 Mbits/sec 0.008 ms
0/91 (0%)
[ 7] 7.00-8.00 sec 127 KBytes 1.04 Mbits/sec 0.010 ms
0/90 (0%)
[ 7] 8.00-9.00 sec 129 KBytes 1.05 Mbits/sec 0.009 ms
0/91 (0%)
[ 7] 9.00-10.00 sec 129 KBytes 1.05 Mbits/sec 0.004 ms
0/91 (0%)
-----
[ ID] Interval      Transfer      Bitrate      Jitter
Lost/Total Datagrams
[ 7] 0.00-10.00 sec 1.25 MBytes 1.05 Mbits/sec 0.004 ms
0/906 (0%) receiver
-----
Server listening on 5201
-----

host: h1@mininet-vm
sender
[ 7] 0.00-7.48 sec 16.0 GBytes 18.4 Gbits/sec
receiver
iperf Done.
root@mininet-vm:/home/mininet# iperf3 -c 10.0.0.2 -u
Connecting to host 10.0.0.2, port 5201
[ 7] local 10.0.0.1 port 34736 connected to 10.0.0.2 port 5201
[ ID] Interval      Transfer      Bitrate      Total Datagrams
[ 7] 0.00-1.00 sec 129 KBytes 1.05 Mbits/sec 91
[ 7] 1.00-2.04 sec 127 KBytes 1.01 Mbits/sec 90
[ 7] 2.04-3.00 sec 129 KBytes 1.09 Mbits/sec 91
[ 7] 3.00-4.00 sec 129 KBytes 1.05 Mbits/sec 91
[ 7] 4.00-5.00 sec 127 KBytes 1.04 Mbits/sec 90
[ 7] 5.00-6.00 sec 129 KBytes 1.05 Mbits/sec 91
[ 7] 6.00-7.00 sec 127 KBytes 1.04 Mbits/sec 90
[ 7] 7.00-8.00 sec 129 KBytes 1.05 Mbits/sec 91
[ 7] 8.00-9.00 sec 127 KBytes 1.04 Mbits/sec 90
[ 7] 9.00-10.00 sec 129 KBytes 1.05 Mbits/sec 91
-----
[ ID] Interval      Transfer      Bitrate      Jitter      Lost/T
otal Datagrams
[ 7] 0.00-10.00 sec 1.25 MBytes 1.05 Mbits/sec 0.000 ms 0/906
(0%) sender
[ 7] 0.00-10.00 sec 1.25 MBytes 1.05 Mbits/sec 0.004 ms 0/906
(0%) receiver
iperf Done.
root@mininet-vm:/home/mininet#
```

с общим количеством отправленных на сервере (и процентное соотношение)

Рис. 7: Меняем протокол передачи данных с TCP на UDP

2. Интерактивные эксперименты



The image shows two terminal windows from a Mininet VM. The left window, titled "host: h2", shows a server listening on port 5201, which is then interrupted. It then starts listening on port 3250 and accepts a connection from 10.0.0.1. The right window, titled "host: h1", shows the output of an iperf3 client command, displaying a table of performance metrics for the connection to 10.0.0.2 on port 3250.

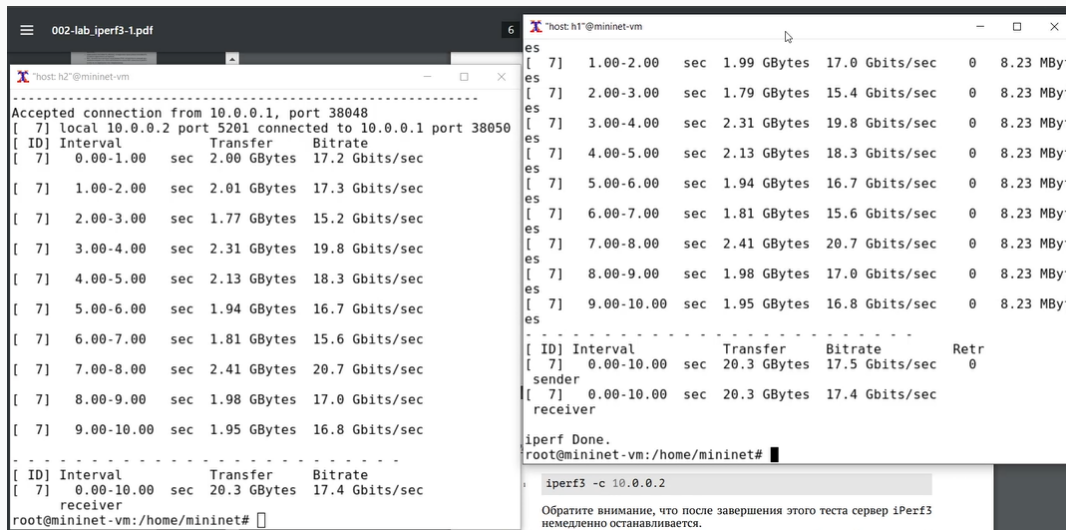
```
host: h2@mininet-vm
Server listening on 5201
-----
^Ciperf3: interrupt - the server has terminated
root@mininet-vm:/home/mininet# iperf3 -s -p 3250
warning: this system does not seem to support IPv6 - trying IPv4
-----
Server listening on 3250
-----
Accepted connection from 10.0.0.1, port 54752
[ 7] local 10.0.0.2 port 3250 connected to 10.0.0.1 port 54754
[ ID] Interval      Transfer    Bitrate
[ 7]  0.00-1.00    sec  1.89 GBytes  16.3 Gbits/sec
[ 7]  1.00-2.00    sec  1.96 GBytes  16.9 Gbits/sec
[ 7]  2.00-3.00    sec  2.06 GBytes  17.7 Gbits/sec
[ 7]  3.00-4.00    sec  2.01 GBytes  17.3 Gbits/sec
[ 7]  4.00-5.00    sec  1.80 GBytes  15.5 Gbits/sec
[ 7]  5.00-6.00    sec  1.89 GBytes  16.2 Gbits/sec
[ 7]  6.00-7.00    sec  1.91 GBytes  16.4 Gbits/sec
[ 7]  7.00-8.00    sec  2.34 GBytes  20.1 Gbits/sec

host: h1@mininet-vm
total Datagrams
[ 7]  0.00-10.00  sec  1.25 MBytes  1.05 Mbits/sec  0.000 ms  0/90
(0%) sender
[ 7]  0.00-10.00  sec  1.25 MBytes  1.05 Mbits/sec  0.004 ms  0/90
(0%) receiver

iperf Done.
root@mininet-vm:/home/mininet# iperf3 -c 10.0.0.2 -p 3250
Connecting to host 10.0.0.2, port 3250
[ 7] local 10.0.0.1 port 54754 connected to 10.0.0.2 port 3250
[ ID] Interval      Transfer    Bitrate      Retr  Cwnd
[ 7]  0.00-1.00    sec  1.91 GBytes  16.3 Gbits/sec    0   8.35 MByt
es
[ 7]  1.00-2.00    sec  1.98 GBytes  17.1 Gbits/sec    0   8.35 MByt
es
[ 7]  2.00-3.00    sec  2.06 GBytes  17.7 Gbits/sec    0   8.35 MByt
es
[ 7]  3.00-4.00    sec  2.00 GBytes  17.1 Gbits/sec    0   8.35 MByt
es
[ 7]  4.00-5.00    sec  1.79 GBytes  15.5 Gbits/sec    0   8.35 MByt
es
[ 7]  5.00-6.00    sec  1.89 GBytes  16.2 Gbits/sec    0   8.35 MByt
es
[ 7]  6.00-7.00    sec  1.93 GBytes  16.6 Gbits/sec    1   8.35 MByt
es
[ 7]  7.00-8.00    sec  2.34 GBytes  20.1 Gbits/sec    0   8.35 MByt
es
```

Рис. 8: Меняем номер порта для отправки/получения пакетов

2. Интерактивные эксперименты



002-lab_iperf3-1.pdf

host: h2@mininet-vm

```
Accepted connection from 10.0.0.1, port 38048
[ 7] local 10.0.0.2 port 5201 connected to 10.0.0.1 port 38050
[ ID] Interval      Transfer    Bitrate
[ 7]  0.00-1.00    sec  2.00 GBytes  17.2 Gbits/sec
[ 7]  1.00-2.00    sec  2.01 GBytes  17.3 Gbits/sec
[ 7]  2.00-3.00    sec  1.77 GBytes  15.2 Gbits/sec
[ 7]  3.00-4.00    sec  2.31 GBytes  19.8 Gbits/sec
[ 7]  4.00-5.00    sec  2.13 GBytes  18.3 Gbits/sec
[ 7]  5.00-6.00    sec  1.94 GBytes  16.7 Gbits/sec
[ 7]  6.00-7.00    sec  1.81 GBytes  15.6 Gbits/sec
[ 7]  7.00-8.00    sec  2.41 GBytes  20.7 Gbits/sec
[ 7]  8.00-9.00    sec  1.98 GBytes  17.0 Gbits/sec
[ 7]  9.00-10.00   sec  1.95 GBytes  16.8 Gbits/sec
[ ID] Interval      Transfer    Bitrate
[ 7]  0.00-10.00   sec  20.3 GBytes  17.4 Gbits/sec
receiver
root@mininet-vm:/home/mininet#
```

host: h1@mininet-vm

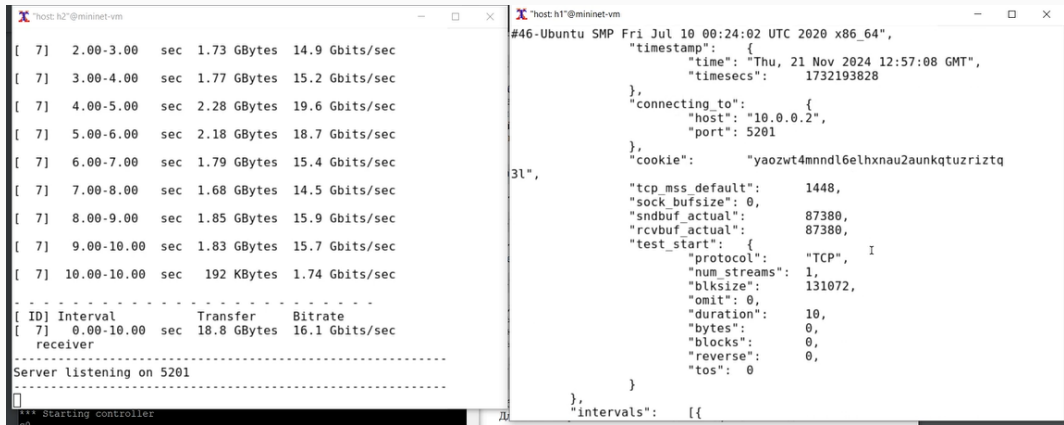
```
es
[ 7]  1.00-2.00    sec  1.99 GBytes  17.0 Gbits/sec  0  8.23 MByt
es
[ 7]  2.00-3.00    sec  1.79 GBytes  15.4 Gbits/sec  0  8.23 MByt
es
[ 7]  3.00-4.00    sec  2.31 GBytes  19.8 Gbits/sec  0  8.23 MByt
es
[ 7]  4.00-5.00    sec  2.13 GBytes  18.3 Gbits/sec  0  8.23 MByt
es
[ 7]  5.00-6.00    sec  1.94 GBytes  16.7 Gbits/sec  0  8.23 MByt
es
[ 7]  6.00-7.00    sec  1.81 GBytes  15.6 Gbits/sec  0  8.23 MByt
es
[ 7]  7.00-8.00    sec  2.41 GBytes  20.7 Gbits/sec  0  8.23 MByt
es
[ 7]  8.00-9.00    sec  1.98 GBytes  17.0 Gbits/sec  0  8.23 MByt
es
[ 7]  9.00-10.00   sec  1.95 GBytes  16.8 Gbits/sec  0  8.23 MByt
es
[ ID] Interval      Transfer    Bitrate      Retr
[ 7]  0.00-10.00   sec  20.3 GBytes  17.5 Gbits/sec  0
sender
[ 7]  0.00-10.00   sec  20.3 GBytes  17.4 Gbits/sec
receiver
iperf Done.
root@mininet-vm:/home/mininet#
```

iperf3 -c 10.0.0.2

Обратите внимание, что после завершения этого теста сервер iPerf3 немедленно останавливается.

Рис. 9: Используем параметр -1, чтобы принять только одного клиента:

2. Интерактивные эксперименты



The image shows two terminal windows from a Mininet VM. The left window, titled "host: h2", displays a table of network test results for intervals from 2.00-3.00 sec to 10.00-10.00 sec. The right window, titled "host: h1", shows a JSON output for a test_start event, including details like timestamp, host, port, and test parameters.

```
host: h2@mininet-vm
[ 7] 2.00-3.00 sec 1.73 GBytes 14.9 Gbits/sec
[ 7] 3.00-4.00 sec 1.77 GBytes 15.2 Gbits/sec
[ 7] 4.00-5.00 sec 2.28 GBytes 19.6 Gbits/sec
[ 7] 5.00-6.00 sec 2.18 GBytes 18.7 Gbits/sec
[ 7] 6.00-7.00 sec 1.79 GBytes 15.4 Gbits/sec
[ 7] 7.00-8.00 sec 1.68 GBytes 14.5 Gbits/sec
[ 7] 8.00-9.00 sec 1.85 GBytes 15.9 Gbits/sec
[ 7] 9.00-10.00 sec 1.83 GBytes 15.7 Gbits/sec
[ 7] 10.00-10.00 sec 192 KBytes 1.74 Gbits/sec

-----
[ ID] Interval      Transfer    Bitrate
[ 7] 0.00-10.00 sec 18.8 GBytes 16.1 Gbits/sec
receiver
-----
Server listening on 5201
*** Starting controller
(c0)
```

```
host: h1@mininet-vm
#46-Ubuntu SMP Fri Jul 10 00:24:02 UTC 2020 x86_64",
"timestamp": {
  "time": "Thu, 21 Nov 2024 12:57:08 GMT",
  "timesecs": 1732193828
},
"connecting_to": {
  "host": "10.0.0.2",
  "port": 5201
},
"cookie": "yaozwt4mnndl6elhxnu2aunkqtuzriztq
3l",
"tcp_mss_default": 1448,
"sock_bufsize": 0,
"sndbuf_actual": 87380,
"rcvbuf_actual": 87380,
"test_start": {
  "protocol": "TCP",
  "num_streams": 1,
  "blksize": 131072,
  "omit": 0,
  "duration": 10,
  "bytes": 0,
  "blocks": 0,
  "reverse": 0,
  "tos": 0
},
"intervals": [{
```

Рис. 10: Указываем параметр -J для отображения вывода результатов в формате JSON:

2. Интерактивные эксперименты

```
root@mininet-vm:~# logout
mininet@mininet-vm:~$ cd ~/work/lab_iperf3
mininet@mininet-vm:~/work/lab_iperf3$ ls -l
total 8
-rw-r--r-- 1 root root 7787 Nov 21 04:58 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 7787 Nov 21 04:58 iperf_results.json
mininet@mininet-vm:~/work/lab_iperf3$
```

Рис. 11: Генерируем выходные данные для файла JSON iPerf3:

2. Интерактивные эксперименты

```
mininet@mininet-vm:~/work/lab_iperf3$ plot_iperf.sh iperf_results.json
mininet@mininet-vm:~/work/lab_iperf3$ cd ~/work/lab_iperf3
mininet@mininet-vm:~/work/lab_iperf3$ ls -l
total 16
-rw-rw-r-- 1 mininet mininet  947 Nov 21 05:03 iperf.csv
-rw-r--r-- 1 mininet mininet 7787 Nov 21 04:58 iperf_results.json
drwxrwxr-x 2 mininet mininet 4096 Nov 21 05:03 results
mininet@mininet-vm:~/work/lab_iperf3$ cd ~/work/lab_iperf3/results
mininet@mininet-vm:~/work/lab_iperf3/results$ ls -l
total 88
-rw-rw-r-- 1 mininet mininet  482 Nov 21 05:03 1.dat
-rw-rw-r-- 1 mininet mininet 9725 Nov 21 05:03 bytes.pdf
-rw-rw-r-- 1 mininet mininet 9618 Nov 21 05:03 cwnd.pdf
-rw-rw-r-- 1 mininet mininet 9036 Nov 21 05:03 MTU.pdf
-rw-rw-r-- 1 mininet mininet 8978 Nov 21 05:03 retransmits.pdf
-rw-rw-r-- 1 mininet mininet 9001 Nov 21 05:03 RTT.pdf
-rw-rw-r-- 1 mininet mininet 9102 Nov 21 05:03 RTT_Var.pdf
-rw-rw-r-- 1 mininet mininet 9656 Nov 21 05:03 throughput.pdf
mininet@mininet-vm:~/work/lab_iperf3/results$
```

Выводы

Мы познакомились с инструментом для измерения пропускной способности сети в режиме реального времени — iPerf3, а также получили навыки проведения интерактивного эксперимента по измерению пропускной способности моделируемой сети в среде Mininet.