

Лабораторная работа №2.

Измерение и тестирование пропускной способности сети. Интерактивный эксперимент

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Цели и задачи 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.

```
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 [834 k
B]
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://security.ubuntu.com/ubuntu focal-security/main amd64 Packages [3,30
2 kB]
Get:6 http://security.ubuntu.com/ubuntu focal-security/main Translation-en [484
kB]
Get:7 http://security.ubuntu.com/ubuntu focal-security/main amd64 c-n-f Metadata
[14.3 kB]
Get:8 http://security.ubuntu.com/ubuntu focal-security/restricted amd64 Packages
[3,247 kB]
Get:9 http://us.archive.ubuntu.com/ubuntu focal-backports InRelease [128 kB]
Get:10 http://security.ubuntu.com/ubuntu focal-security/restricted i386 Packages
[38.6 kB]
Get:11 http://security.ubuntu.com/ubuntu focal-security/restricted Translation-e
```

Рис. 1: Обновление репозитория ПО

Установка необходимого программного обеспечения

```
mininet@mininet-vm:~$ sudo apt-get install iperf3
Reading package lists... Done
Building dependency tree
Reading state information... Done
The following additional packages will be installed:
  libiperf0 libsctp1
Suggested packages:
  lksctp-tools
The following NEW packages will be installed:
  iperf3 libiperf0 libsctp1
0 upgraded, 3 newly installed, 0 to remove and 391 not upgraded.
Need to get 94.1 kB of archives.
After this operation, 331 kB of additional disk space will be used.
Do you want to continue? [Y/n]
Get:1 http://us.archive.ubuntu.com/ubuntu focal/main amd64 libsctp1 amd64 1.0.18+dfsg-1 [7,876 B]
Get:2 http://us.archive.ubuntu.com/ubuntu focal/universe amd64 libiperf0 amd64 3.7-3 [72.0 kB]
Get:3 http://us.archive.ubuntu.com/ubuntu focal/universe amd64 iperf3 amd64 3.7-3 [14.2 kB]
Fetched 94.1 kB in 1s (125 kB/s)
Selecting previously unselected package libsctp1:amd64.
(Reading database ... 102146 files and directories currently installed.)
Preparing to unpack .../libsctp1_1.0.18+dfsg-1_amd64.deb ...
Unpacking libsctp1:amd64 (1.0.18+dfsg-1) ...
Selecting previously unselected package libiperf0:amd64.
Preparing to unpack .../libiperf0_3.7-3_amd64.deb ...
Unpacking libiperf0:amd64 (3.7-3) ...
Selecting previously unselected package iperf3.
Preparing to unpack .../iperf3_3.7-3_amd64.deb ...
Unpacking iperf3 (3.7-3) ...
Setting up libsctp1:amd64 (1.0.18+dfsg-1) ...
Setting up libiperf0:amd64 (3.7-3) ...
Setting up iperf3 (3.7-3) ...
Processing triggers for man-db (2.9.1-1) ...
Processing triggers for libc-bin (2.31-0ubuntu9)
```

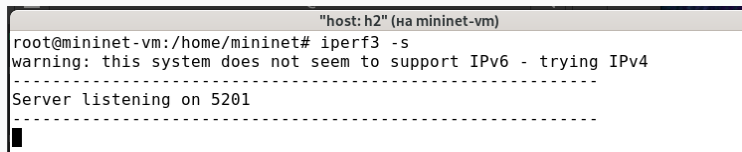
```
mininet@mininet-vm:~$ cd /tmp/  
mininet@mininet-vm:/tmp$ git clone https://github.com/ekfoury/iperf3_plotter.git  
Cloning into 'iperf3_plotter'...  
remote: Enumerating objects: 74, done.  
remote: Total 74 (delta 0), reused 0 (delta 0), pack-reused 74 (from 1)  
Unpacking objects: 100% (74/74), 100.09 KiB | 1.01 MiB/s, done.
```

Рис. 3: Установка iperf3_plotter. git clone

```
mininet@mininet-vm:/tmp$ cd iperf3_plotter/  
mininet@mininet-vm:/tmp/iperf3_plotter$ sudo cp plot_* /usr/bin  
mininet@mininet-vm:/tmp/iperf3_plotter$ sudo *.sh /usr/bin  
sudo: fairness.sh: command not found  
mininet@mininet-vm:/tmp/iperf3_plotter$ sudo cp *.sh /usr/bin
```

Рис. 4: Установка iperf3_plotter. перенос файлов

```
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: h2" (на mininet-vm)
root@mininet-vm:/home/mininet# iperf3 -s
warning: this system does not seem to support IPv6 - trying IPv4
-----
Server listening on 5201
-----
█
```

Рис. 6: Запуск сервера iperf3

```
"host: h1" (на mininet-vm) x
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 50700 connected to 10.0.0.2 port 5201
[ ID] Interval            Transfer          Bitrate          Retr  Cwnd
[ 7]  0.00-1.00      sec  4.21 GBytes     36.1 Gbits/sec    9   22.3 MBytes
[ 7]  1.00-2.00      sec  4.29 GBytes     36.9 Gbits/sec    0   22.3 MBytes
[ 7]  2.00-3.00      sec  3.92 GBytes     33.6 Gbits/sec    0   22.3 MBytes
[ 7]  3.00-4.00      sec  3.97 GBytes     34.2 Gbits/sec    0   22.3 MBytes
[ 7]  4.00-5.00      sec  3.84 GBytes     33.0 Gbits/sec    0   22.3 MBytes
[ 7]  5.00-6.00      sec  3.91 GBytes     33.5 Gbits/sec    0   22.3 MBytes
[ 7]  6.00-7.00      sec  3.92 GBytes     33.7 Gbits/sec    0   22.3 MBytes
[ 7]  7.00-8.00      sec  3.91 GBytes     33.6 Gbits/sec    0   22.3 MBytes
[ 7]  8.00-9.00      sec  4.24 GBytes     36.4 Gbits/sec    0   22.3 MBytes
[ 7]  9.00-10.00     sec  4.42 GBytes     37.9 Gbits/sec    0   22.3 MBytes
- - - - -
[ ID] Interval            Transfer          Bitrate          Retr
[ 7]  0.00-10.00     sec  40.6 GBytes     34.9 Gbits/sec    9
[ 7]  0.00-10.00     sec  40.6 GBytes     34.9 Gbits/sec    0
                                     sender
                                     receiver

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

Рис. 7: Запуск клиента iperf3

```
root@mininet-vm:/home/mininet# iperf3 -c 10.0.0.2 -t 5
Connecting to host 10.0.0.2, port 5201
[ 7] local 10.0.0.1 port 50708 connected to 10.0.0.2 port 5201
[ ID] Interval          Transfer      Bitrate      Retr  Cwnd
[ 7]  0.00-1.00    sec  4.30 GBytes  37.0 Gbits/sec    0   8.01 MBytes
[ 7]  1.00-2.00    sec  4.22 GBytes  36.3 Gbits/sec    0   8.01 MBytes
[ 7]  2.00-3.00    sec  4.19 GBytes  36.0 Gbits/sec    0   8.01 MBytes
[ 7]  3.00-4.00    sec  4.25 GBytes  36.5 Gbits/sec    0   8.01 MBytes
[ 7]  4.00-5.00    sec  4.35 GBytes  37.4 Gbits/sec    0   8.01 MBytes
- - - - -
[ ID] Interval          Transfer      Bitrate      Retr
[ 7]  0.00-5.00    sec  21.3 GBytes  36.6 Gbits/sec    0
[ 7]  0.00-5.00    sec  21.3 GBytes  36.6 Gbits/sec    0
I
sender
receiver

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

Рис. 8: Измерение пропускной способности. Опция -t

```
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 50712 connected to 10.0.0.2 port 5201
[ ID] Interval            Transfer      Bitrate      Retr  Cwnd
[ 7]  0.00-2.00      sec   8.75 GBytes  37.5 Gbits/sec    11   4.16 MBytes
[ 7]  2.00-4.00      sec   8.97 GBytes  38.5 Gbits/sec     0   4.17 MBytes
[ 7]  4.00-6.00      sec   8.92 GBytes  38.3 Gbits/sec     0   4.18 MBytes
[ 7]  6.00-8.00      sec   9.13 GBytes  39.3 Gbits/sec     0   4.19 MBytes
[ 7]  8.00-10.00     sec   9.16 GBytes  39.3 Gbits/sec     0   4.20 MBytes
- - - - -
[ ID] Interval            Transfer      Bitrate      Retr
[ 7]  0.00-10.00     sec  44.9 GBytes  38.6 Gbits/sec    11
[ 7]  0.00-10.00     sec  44.9 GBytes  38.6 Gbits/sec
                                     sender
                                     receiver

iperf Done.
```

Рис. 9: Измерение пропускной способности. Опция -i. Запуск клиента

```
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 50716 connected to 10.0.0.2 port 5201
[ ID] Interval          Transfer      Bitrate      Retr  Cwnd
[ 7]  0.00-1.00      sec  4.20 GBytes  36.0 Gbits/sec    19   4.15 MBytes
[ 7]  1.00-2.00      sec  4.15 GBytes  35.7 Gbits/sec     0   4.16 MBytes
[ 7]  2.00-3.00      sec  4.10 GBytes  35.2 Gbits/sec     0   4.16 MBytes
[ 7]  3.00-3.83      sec  3.55 GBytes  36.7 Gbits/sec     0   4.16 MBytes
- - - - -
[ ID] Interval          Transfer      Bitrate      Retr
[ 7]  0.00-3.83      sec  16.0 GBytes  35.9 Gbits/sec    19
[ 7]  0.00-3.83      sec  16.0 GBytes  35.8 Gbits/sec
                                     sender
                                     receiver

iperf Done.
```

Рис. 10: Измерение пропускной способности. Опция -n. Запуск клиента

```
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 34130 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] 1.00-2.00 sec      127 KBytes   1.04 Mbits/sec  90
[ 7] 2.00-3.00 sec      129 KBytes   1.05 Mbits/sec  91
[ 7] 3.00-4.00 sec      127 KBytes   1.04 Mbits/sec  90
[ 7] 4.00-5.00 sec      129 KBytes   1.05 Mbits/sec  91
[ 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/Total Datag
rams
[ 7] 0.00-10.00 sec     1.25 MBytes   1.05 Mbits/sec  0.000 ms    0/906 (0%) send
er
[ 7] 0.00-10.00 sec     1.25 MBytes   1.05 Mbits/sec  0.013 ms    0/906 (0%) rece
iver

iperf Done.
```

*разница в
записи*

*кол-во потерянных
даграмм не связано с ошиб
кой в работе*

Рис. 11: Измерение пропускной способности. Опция -u. Запуск клиента

```
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 46254 connected to 10.0.0.2 port 3250
[ ID] Interval            Transfer          Bitrate          Retr  Cwnd
[ 7]  0.00-1.00    sec   4.38 GBytes    37.7 Gbits/sec     0   8.18 MBytes
[ 7]  1.00-2.00    sec   4.36 GBytes    37.4 Gbits/sec     0   8.18 MBytes
[ 7]  2.00-3.00    sec   4.41 GBytes    37.9 Gbits/sec     0   8.18 MBytes
[ 7]  3.00-4.00    sec   4.42 GBytes    37.9 Gbits/sec     0   8.18 MBytes
[ 7]  4.00-5.00    sec   4.37 GBytes    37.5 Gbits/sec     0   8.18 MBytes
[ 7]  5.00-6.00    sec   4.35 GBytes    37.4 Gbits/sec     0   8.18 MBytes
[ 7]  6.00-7.00    sec   4.45 GBytes    38.2 Gbits/sec     0   8.18 MBytes
[ 7]  7.00-8.00    sec   4.44 GBytes    38.1 Gbits/sec     0   8.18 MBytes
[ 7]  8.00-9.00    sec   4.33 GBytes    37.1 Gbits/sec     0   8.18 MBytes
[ 7]  9.00-10.00   sec   4.39 GBytes    37.7 Gbits/sec     0   8.18 MBytes
- - - - -
[ ID] Interval            Transfer          Bitrate          Retr
[ 7]  0.00-10.00   sec  43.9 GBytes    37.7 Gbits/sec     0
[ 7]  0.00-10.00   sec  43.9 GBytes    37.7 Gbits/sec     0
sender
receiver

iperf Done.
```

Рис. 12: Измерение пропускной способности. Опция -p. Запуск клиента

```
root@mininet-vm:/home/mininet# iperf3 -s -1
warning: this system does not seem to support IPv6 - trying IPv4
-----
Server listening on 5201
-----
Accepted connection from 10.0.0.1, port 50724
[ 7] local 10.0.0.2 port 5201 connected to 10.0.0.1 port 50726
[ ID] Interval            Transfer        Bitrate
[ 7] 0.00-1.00      sec  4.36 GBytes    37.4 Gbits/sec
[ 7] 1.00-2.00      sec  4.40 GBytes    37.8 Gbits/sec
[ 7] 2.00-3.00      sec  4.34 GBytes    37.2 Gbits/sec
[ 7] 3.00-4.00      sec  4.33 GBytes    37.2 Gbits/sec
[ 7] 4.00-5.00      sec  4.39 GBytes    37.7 Gbits/sec
[ 7] 5.00-6.00      sec  4.38 GBytes    37.6 Gbits/sec
[ 7] 6.00-7.00      sec  4.46 GBytes    38.3 Gbits/sec
[ 7] 7.00-8.00      sec  4.33 GBytes    37.2 Gbits/sec
[ 7] 8.00-9.00      sec  4.42 GBytes    38.0 Gbits/sec
[ 7] 9.00-10.00     sec  4.39 GBytes    37.6 Gbits/sec
-----
[ ID] Interval            Transfer        Bitrate
[ 7] 0.00-10.00     sec  43.8 GBytes    37.6 Gbits/sec
receiver
```

Рис. 13: Измерение пропускной способности. Опция -1. Запуск сервера


```
root@mininet-vm:/home/mininet# iperf3 -c 10.0.0.2 -J
{
  "start": {
    "connected": [{
      "socket": 7,
      "local_host": "10.0.0.1",
      "local_port": 50730,
      "remote_host": "10.0.0.2",
      "remote_port": 5201
    }],
    "version": "iperf 3.7",
    "system_info": "Linux mininet-vm 5.4.0-42-generic #46-Ubuntu SMP Fri Jul 10 00:24:02 UTC 2020 x86_64",
    "timestamp": {
      "time": "Wed, 20 Nov 2024 14:28:51 GMT",
      "timesecs": 1732112931
    },
    "connecting_to": {
      "host": "10.0.0.2"
    }
  }
}
```

Рис. 14: Измерение пропускной способности. Опция -J. Запуск клиента.

```
root@mininet-vm:/home/mininet# iperf3 -c 10.0.0.2 -J > /home/mininet/work/lab_iperf3/i  
perf_results.json
```

Рис. 15: Перенаправление вывода в файл

```
mininet@mininet-vm:~/work/lab_iperf3$ plot_iperf.sh iperf_results.json
mininet@mininet-vm:~/work/lab_iperf3$ l
iperf.csv iperf_results.json results/
```

Рис. 16: Генерация выходных данных для файла JSON

```
mininet@mininet-vm:~/work/lab_iperf3$ cd results/  
mininet@mininet-vm:~/work/lab_iperf3/results$ ls -l  
total 88  
-rw-rw-r-- 1 mininet mininet 471 Nov 20 06:35 1.dat  
-rw-rw-r-- 1 mininet mininet 9871 Nov 20 06:35 bytes.pdf  
-rw-rw-r-- 1 mininet mininet 9617 Nov 20 06:35 cwnd.pdf  
-rw-rw-r-- 1 mininet mininet 9036 Nov 20 06:35 MTU.pdf  
-rw-rw-r-- 1 mininet mininet 8978 Nov 20 06:35 retransmits.pdf  
-rw-rw-r-- 1 mininet mininet 8996 Nov 20 06:35 RTT.pdf  
-rw-rw-r-- 1 mininet mininet 9253 Nov 20 06:35 RTT_Var.pdf  
-rw-rw-r-- 1 mininet mininet 9569 Nov 20 06:35 throughput.pdf
```

Рис. 17: Файлы с графиками

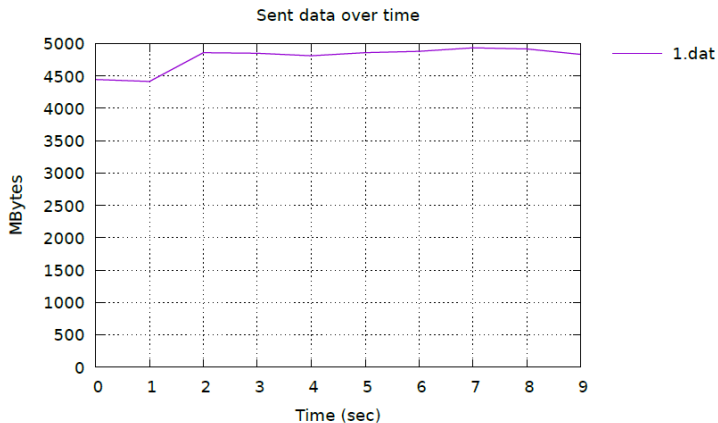


Рис. 18: bytes.pdf

Выводы по проделанной работе

В ходе 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.