

Лаб №6 по дисциплине Моделирование сетей передачи данных

Настройка пропускной способности глобальной сети с помощью Token Bucket Filter

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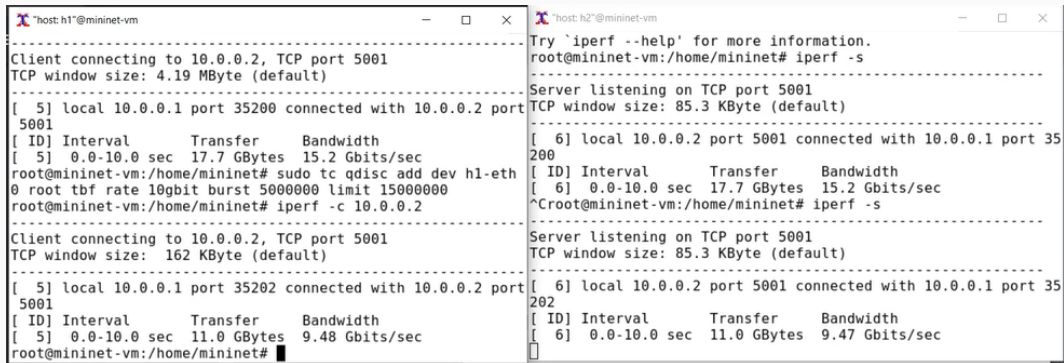
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Вводная часть

Основной целью работы является знакомство с принципами работы дисциплины очереди Token Bucket Filter, которая формирует входящий/исходящий трафик для ограничения пропускной способности, а также получение навыков моделирования и исследования поведения трафика посредством проведения интерактивного и воспроизводимого экспериментов в Mininet.

Выполнение работы

Интерактивные эксперименты. Ограничение скорости на конечных хостах



The image shows two terminal windows side-by-side, both titled "host: h1" and "host: h2" at "mininet-vm".

Left Window (host: h1):

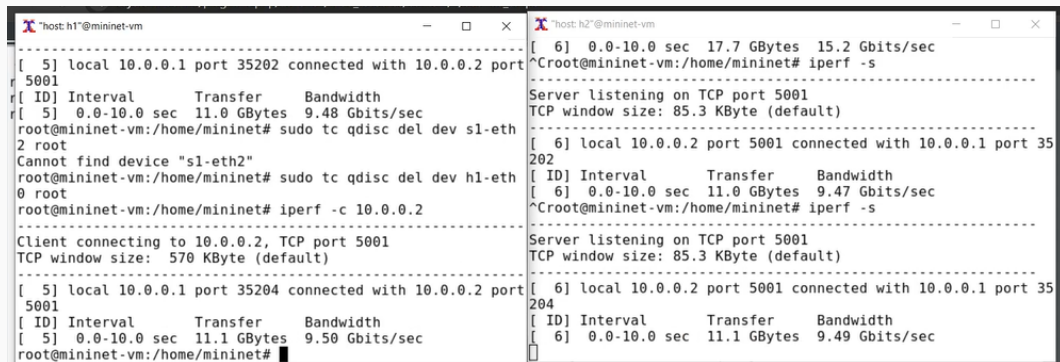
- Client connecting to 10.0.0.2, TCP port 5001. TCP window size: 4.19 MByte (default).
- Connection established: [5] local 10.0.0.1 port 35200 connected with 10.0.0.2 port 5001.
- iperf output: [ID] Interval Transfer Bandwidth [5] 0.0-10.0 sec 17.7 GBytes 15.2 Gbits/sec.
- Command: `root@mininet-vm:/home/mininet# sudo tc qdisc add dev h1-eth 0 root tbf rate 10gbit burst 5000000 limit 15000000`
- iperf output: [ID] Interval Transfer Bandwidth [5] 0.0-10.0 sec 11.0 GBytes 9.48 Gbits/sec.

Right Window (host: h2):

- Try `iperf --help` for more information.
- Server listening on TCP port 5001. TCP window size: 85.3 KByte (default).
- Connection established: [6] local 10.0.0.2 port 5001 connected with 10.0.0.1 port 35200.
- iperf output: [ID] Interval Transfer Bandwidth [6] 0.0-10.0 sec 17.7 GBytes 15.2 Gbits/sec.
- iperf output: [ID] Interval Transfer Bandwidth [6] 0.0-10.0 sec 11.0 GBytes 9.47 Gbits/sec.

Рис. 1: Ограничение скорости на конечных хостах

Ограничение скорости на коммутаторах



The image shows two terminal windows from a Mininet VM. The left window, titled "host: h1", shows a user running a series of commands to test network connectivity and speed. It includes a connection to 10.0.0.2 port 5001, a table of test results showing 11.0 GBytes transfer at 9.48 Gbits/sec, an attempt to delete a queue discipline on s1-eth2 (failing), and another test on h1-eth0 showing 11.1 GBytes transfer at 9.50 Gbits/sec. The right window, titled "host: h2", shows a user running 'iperf -s' to act as a server. It receives two connections from 10.0.0.1, with test results showing 17.7 GBytes transfer at 15.2 Gbits/sec and 11.0 GBytes transfer at 9.47 Gbits/sec.

```
-----
[ 5] local 10.0.0.1 port 35202 connected with 10.0.0.2 port 5001
[ ID] Interval      Transfer    Bandwidth
[ 5]  0.0-10.0 sec  11.0 GBytes 9.48 Gbits/sec
root@mininet-vm:/home/mininet# sudo tc qdisc del dev s1-eth2 root
Cannot find device "s1-eth2"
root@mininet-vm:/home/mininet# sudo tc qdisc del dev h1-eth0 root
root@mininet-vm:/home/mininet# iperf -c 10.0.0.2
-----
Client connecting to 10.0.0.2, TCP port 5001
TCP window size: 570 KByte (default)
-----
[ 5] local 10.0.0.1 port 35204 connected with 10.0.0.2 port 5001
[ ID] Interval      Transfer    Bandwidth
[ 5]  0.0-10.0 sec  11.1 GBytes 9.50 Gbits/sec
root@mininet-vm:/home/mininet#
```

```
-----
[ 6]  0.0-10.0 sec  17.7 GBytes 15.2 Gbits/sec
^Croot@mininet-vm:/home/mininet# iperf -s
-----
Server listening on TCP port 5001
TCP window size: 85.3 KByte (default)
-----
[ 6] local 10.0.0.2 port 5001 connected with 10.0.0.1 port 35202
[ ID] Interval      Transfer    Bandwidth
[ 6]  0.0-10.0 sec  11.0 GBytes 9.47 Gbits/sec
^Croot@mininet-vm:/home/mininet# iperf -s
-----
Server listening on TCP port 5001
TCP window size: 85.3 KByte (default)
-----
[ 6] local 10.0.0.2 port 5001 connected with 10.0.0.1 port 35204
[ ID] Interval      Transfer    Bandwidth
[ 6]  0.0-10.0 sec  11.1 GBytes 9.49 Gbits/sec
[ 6]  0.0-10.0 sec  11.1 GBytes 9.49 Gbits/sec
```

Рис. 2: Ограничение скорости на коммутаторах

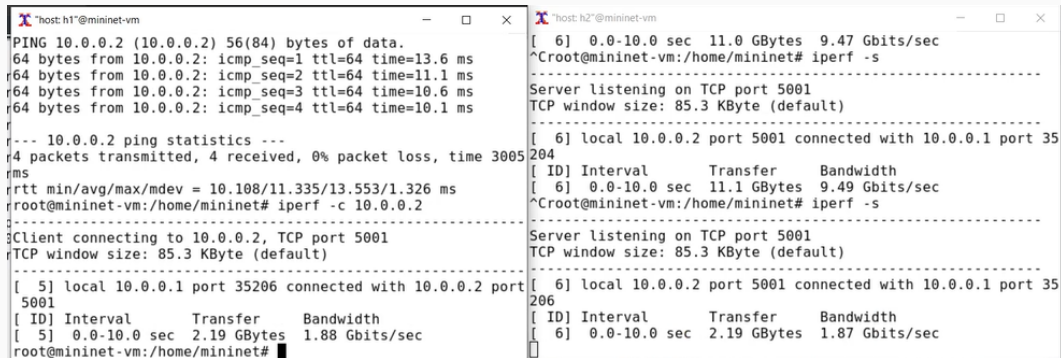
```
host: h1" @mininet-vm

-----
Client connecting to 10.0.0.2, TCP port 5001
TCP window size: 570 KByte (default)
-----

[ 5] local 10.0.0.1 port 35204 connected with 10.0.0.2 port
5001
[ ID] Interval      Transfer      Bandwidth
[ 5]  0.0-10.0 sec  11.1 GBytes  9.50 Gbits/sec
root@mininet-vm:/home/mininet# ping 10.0.0.2 -c 4
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=13.6 ms
64 bytes from 10.0.0.2: icmp_seq=2 ttl=64 time=11.1 ms
64 bytes from 10.0.0.2: icmp_seq=3 ttl=64 time=10.6 ms
64 bytes from 10.0.0.2: icmp_seq=4 ttl=64 time=10.1 ms

--- 10.0.0.2 ping statistics ---
4 packets transmitted, 4 received, 0% packet loss, time 3005
ms
rtt min/avg/max/mdev = 10.108/11.335/13.553/1.326 ms
root@mininet-vm:/home/mininet#
```

Объединение NETEM и TBF



```
host: h1@mininet-vm
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=13.6 ms
64 bytes from 10.0.0.2: icmp_seq=2 ttl=64 time=11.1 ms
64 bytes from 10.0.0.2: icmp_seq=3 ttl=64 time=10.6 ms
64 bytes from 10.0.0.2: icmp_seq=4 ttl=64 time=10.1 ms

--- 10.0.0.2 ping statistics ---
4 packets transmitted, 4 received, 0% packet loss, time 3005 ms
rtt min/avg/max/mdev = 10.108/11.335/13.553/1.326 ms
root@mininet-vm:/home/mininet# iperf -c 10.0.0.2

Client connecting to 10.0.0.2, TCP port 5001
TCP window size: 85.3 KByte (default)

[ 5] local 10.0.0.1 port 35206 connected with 10.0.0.2 port 5001
[ ID] Interval      Transfer    Bandwidth
[ 5] 0.0-10.0 sec  2.19 GBytes  1.88 Gbits/sec
root@mininet-vm:/home/mininet#
```

```
host: h2@mininet-vm
[ 6] 0.0-10.0 sec  11.0 GBytes  9.47 Gbits/sec
^Croot@mininet-vm:/home/mininet# iperf -s

Server listening on TCP port 5001
TCP window size: 85.3 KByte (default)

[ 6] local 10.0.0.2 port 5001 connected with 10.0.0.1 port 35206
[ ID] Interval      Transfer    Bandwidth
[ 6] 0.0-10.0 sec  11.1 GBytes  9.49 Gbits/sec
^Croot@mininet-vm:/home/mininet# iperf -s

Server listening on TCP port 5001
TCP window size: 85.3 KByte (default)

[ 6] local 10.0.0.2 port 5001 connected with 10.0.0.1 port 35206
[ ID] Interval      Transfer    Bandwidth
[ 6] 0.0-10.0 sec  2.19 GBytes  1.87 Gbits/sec
```

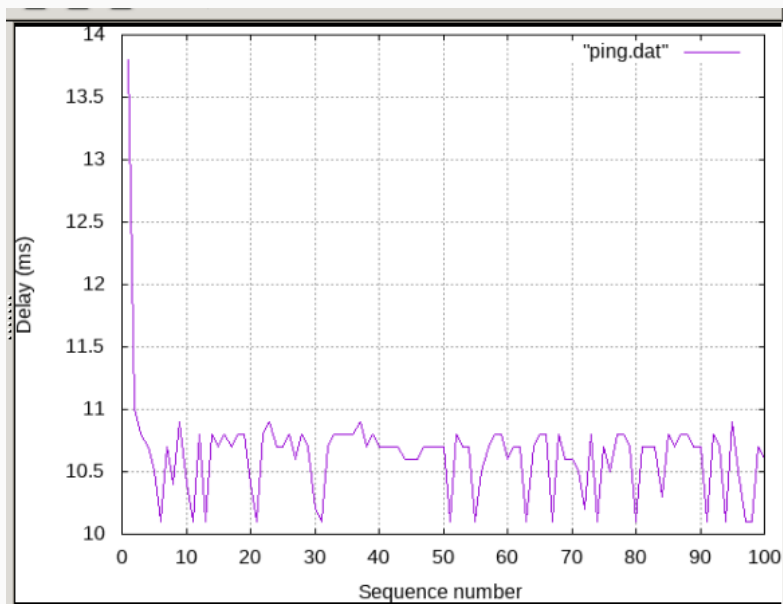
Рис. 4: Объединение NETEM и TBF


```
lab1.mn lab_iperf3 lab_iperf3_topo lab_n
mininet@mininet-vm:~/work$ mkdir exp1
mininet@mininet-vm:~/work$ mkdir exp2
mininet@mininet-vm:~/work$ ls
exp1 exp2 lab1.mn lab_iperf3 lab_iperf3
mininet@mininet-vm:~/work$ cd lab_iperf3
```

Рис. 5: Каталоги для экспериментов

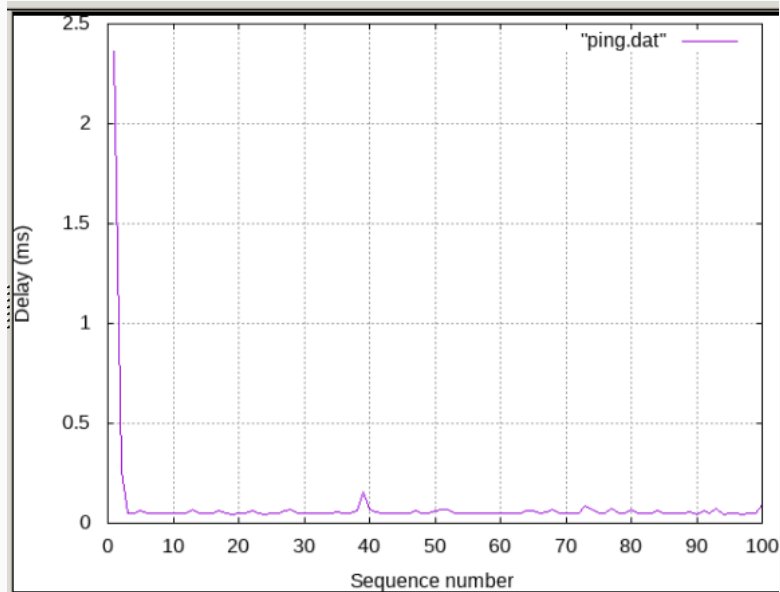
Воспроизводимые эксперименты

```
*** Starting network
*** Configuring hosts
h1 h2
*** Starting controller
c0
*** Starting 2 switches
s1 s2 ...
*** Waiting for switches to connect
s1 s2
*** Set delay
*** s1 : ('tc qdisc add dev s1-eth2 root handle 1: netem delay 10ms',)
*** s1 : ('tc qdisc add dev s1-eth2 parent 1: handle 2: tbf rate 2gbit burst 1000000 limit 2
000000',)
*** Traffic generation
*** h2 : ('iperf3 -s -D -1',)
*** h1 : ('iperf3 -c', '10.0.0.2', '-J > iperf_result.json')
*** h1 : ('ping -c 100', '10.0.0.2', '| grep "time=" | awk \'{print $5, $7}\\' | sed -e \\'s/t
ime=//g\\' -e \\'s/icmp_seq=//g\\' > ping.dat')
*** Stopping network
*** Stopping 1 controllers
c0
*** Stopping 3 links
...
*** Stopping 2 switches
s1 s2
*** Stopping 2 hosts
h1 h2
*** Done
sudo chown mininet:mininet ping.dat
./ping_plot
mininet@mininet-um:~/work/exp16
```



Воспроизводимые эксперименты

```
*** Starting network
*** Configuring hosts
h1 h2
*** Starting controller
c0
*** Starting 2 switches
s1 s2 ...
*** Waiting for switches to connect
s1 s2
*** Set delay
*** s1 : ('sudo tc qdisc add dev h1-eth0 root tbf rate 10gbit burst 5000000 limit 15000000',
)
Cannot find device "h1-eth0"
*** Traffic generation
*** h2 : ('iperf3 -s -D -1',)
*** h1 : ('iperf3 -c', '10.0.0.2', '-J > iperf_result.json')
*** 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 3 links
...
*** Stopping 2 switches
s1 s2
*** Stopping 2 hosts
h1 h2
*** Done
sudo chown mininet:mininet ping.dat
./ping_plot
mininet@mininet:~/work/exp26
```



Выводы

Я познакомилась с принципами работы дисциплины очереди Token Bucket Filter, которая формирует входящий/исходящий трафик для ограничения пропускной способности, а также получила навыки моделирования и исследования поведения трафика посредством проведения интерактивного и воспроизводимого экспериментов в Mininet.