

## آزمایش 5: کنترل ازدحام TCP و UDP

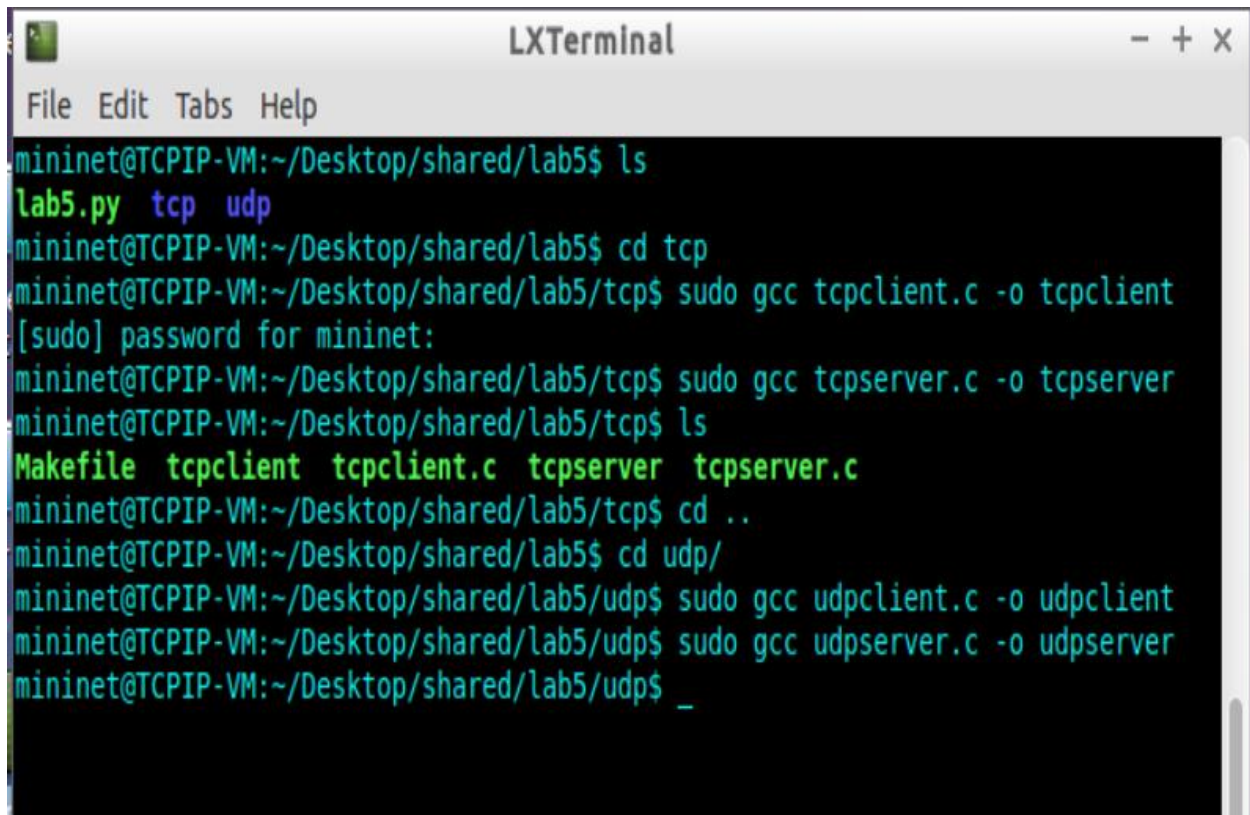
زینب باقیان

امیر محمد درپوش

محمد صالح پزند

الف) روال آزمایش:

ابتدا برنامه را راه اندازی میکنیم:



```
LXTerminal
File Edit Tabs Help
mininet@TCPIP-VM:~/Desktop/shared/lab5$ ls
lab5.py tcp udp
mininet@TCPIP-VM:~/Desktop/shared/lab5$ cd tcp
mininet@TCPIP-VM:~/Desktop/shared/lab5/tcp$ sudo gcc tcpclient.c -o tcpclient
[sudo] password for mininet:
mininet@TCPIP-VM:~/Desktop/shared/lab5/tcp$ sudo gcc tcpserver.c -o tcpserver
mininet@TCPIP-VM:~/Desktop/shared/lab5/tcp$ ls
Makefile tcpclient tcpclient.c tcpserver tcpserver.c
mininet@TCPIP-VM:~/Desktop/shared/lab5/tcp$ cd ..
mininet@TCPIP-VM:~/Desktop/shared/lab5$ cd udp/
mininet@TCPIP-VM:~/Desktop/shared/lab5/udp$ sudo gcc udpclient.c -o udpclient
mininet@TCPIP-VM:~/Desktop/shared/lab5/udp$ sudo gcc udpserver.c -o udpserver
mininet@TCPIP-VM:~/Desktop/shared/lab5/udp$ _
```

حالا مکانیزم کنترل ازدحام ماشین مجازی را چک میکنیم که در اینجا cubid است پس به reno تغییرش میدهیم:

```
mininet@TCPIP-VM:~/Desktop/shared/lab5/udp$ chmod +x tcp/tcpclient tcp/tcpserver
udp/udpclient udp/udpserver
chmod: cannot access 'tcp/tcpclient': No such file or directory
chmod: cannot access 'tcp/tcpserver': No such file or directory
chmod: cannot access 'udp/udpclient': No such file or directory
chmod: cannot access 'udp/udpserver': No such file or directory
mininet@TCPIP-VM:~/Desktop/shared/lab5/udp$ cd ..
mininet@TCPIP-VM:~/Desktop/shared/lab5$ chmod +x tcp/tcpclient tcp/tcpserver udp
/udpclient udp/udpserver
mininet@TCPIP-VM:~/Desktop/shared/lab5$ cat /proc/sys/net/ipv4/tcp_congestion_co
ntrol
cubic
mininet@TCPIP-VM:~/Desktop/shared/lab5$ sudo su
root@TCPIP-VM:/home/mininet/Desktop/shared/lab5# echo reno >/proc/sys/net/ipv4/t
cp_congestion_control
root@TCPIP-VM:/home/mininet/Desktop/shared/lab5# cat /proc/sys/net/ipv4/tcp_cong
estion_control
reno
root@TCPIP-VM:/home/mininet/Desktop/shared/lab5# _
```

ب) جریان های TCP و UDP

فایل lab5.py را به شکل زیر تغییر میدهیم:

```
info('\n** Adding Hosts\n')
h1 = net.addHost('h1', ip='10.10.0.1/24', hostname='h1', privateLogDir=True, privateRunDir=True, inMountNamespace=True, inPIDNamespace=True, inUTSNamespace=True)
h2 = net.addHost('h2', ip='10.10.0.2/24', hostname='h2', privateLogDir=True, privateRunDir=True, inMountNamespace=True, inPIDNamespace=True, inUTSNamespace=True)
h3 = net.addHost('h3', ip='10.10.1.3/24', hostname='h3', privateLogDir=True, privateRunDir=True, inMountNamespace=True, inPIDNamespace=True, inUTSNamespace=True)
r1 = net.addHost('r1', ip='10.10.0.10/24', hostname='r1', privateLogDir=True, privateRunDir=True, inMountNamespace=True, inPIDNamespace=True, inUTSNamespace=True)
```

```

info('Executing custom commands (if)')
output = net.nameToNode.keys
r1.cmd('ifconfig r1-eth1 10.10.1.10 netmask 255.255.255.0')
r1.cmd('echo 1 > /proc/sys/net/ipv4/ip_forward')
h1.cmd('ip route add default via 10.10.0.10')
h2.cmd('ip route add default via 10.10.0.10')
h3.cmd('ip route add default via 10.10.1.10')

```

حالا اسکریپت را اجرا میکنیم تا توپولوژی ساخته شود:

The screenshot shows a Mininet environment setup. The main window displays the output of running 'python lab5.py', which includes steps like 'Adding Controller', 'Adding Hosts', 'Adding Switches', 'Creating Links', and 'Configuring hosts'. A sub-window titled 'host: r1' shows the CLI for host r1, where the user has entered 'ifconfig r1-eth1 10.10.1.10 netmask 255.255.255.0' and 'echo 1 > /proc/sys/net/ipv4/ip\_forward'.

```

root@TCPIP-VM: /home/mininet/Desktop/shared/lab5# sudo -E python lab5.py
** Creating an instance of Lab5 network topology

** Adding Controller

** Adding Hosts

** Adding Switches

** Creating Links

** Modifying Link Parameters
(3.00Mbit) *** Configuring hosts
h1 h2 h3 r1
*** Starting controller
*** Starting 2 switches
sw1 sw2
*** Configuring hosts
** Executing custom commands
** Enabling xterm for hosts only
** Running CLI
*** Starting CLI:
mininet>

```

برای اطمینان از اتصال نود ها از pingall استفاده میکنیم:

```

** Enabling xterm for hosts only
** Running CLI
*** Starting CLI:
mininet> pingall
*** Ping: testing ping reachability
h1 -> h2 h3 r1
h2 -> h1 h3 r1
h3 -> h1 h2 r1
r1 -> h1 h2 h3
*** Results: 0% dropped (12/12 received)
mininet> _

```

ب-1 ( سوال 1:

در h3 با یک سرور به پورت 10000 وصل میشویم تا گوش کند و در h1 از طرف کلاینت با پورت 10000 و نرخ 100kbps برای h3 داده میفرستیم:

نتایج بار اول:

```

host: h1
root@TCP/IP-VN:/home/mininet/Desktop/shared/lab5/udp# ./udpclient 10.10.1.3 1000
0 100
1.0s - sent: 14 pkts, 107.7 kbits/s
2.1s - sent: 27 pkts, 99.7 kbits/s
3.1s - sent: 40 pkts, 100.3 kbits/s
4.2s - sent: 53 pkts, 99.5 kbits/s
5.2s - sent: 66 pkts, 100.4 kbits/s
6.2s - sent: 79 pkts, 100.2 kbits/s
7.3s - sent: 92 pkts, 99.9 kbits/s
8.3s - sent: 105 pkts, 100.3 kbits/s
9.4s - sent: 118 pkts, 100.0 kbits/s
10.4s - sent: 131 pkts, 99.4 kbits/s
11.4s - sent: 144 pkts, 100.5 kbits/s
12.5s - sent: 157 pkts, 100.1 kbits/s
13.5s - sent: 170 pkts, 99.6 kbits/s
14.6s - sent: 183 pkts, 99.8 kbits/s
15.6s - sent: 196 pkts, 100.0 kbits/s
16.6s - sent: 209 pkts, 100.7 kbits/s
17.7s - sent: 222 pkts, 100.0 kbits/s
18.7s - sent: 235 pkts, 99.8 kbits/s
19.8s - sent: 248 pkts, 99.1 kbits/s
^Cpackets sent = 248, avg rate= 100.1kbps
root@TCP/IP-VN:/home/mininet/Desktop/shared/lab5/udp#

```

```
host: h3
root@TCPIP-VM:/home/mininet/Desktop/shared/lab5/udp# ./udpsrvr 10000
0.0s - received: 1/ sent: 1 pkts (loss 0.000%), 0.3 kbit/s
31.5s - received: 14/ sent: 14 pkts (loss 0.000%), 100.0 kbit/s
32.5s - received: 27/ sent: 27 pkts (loss 0.000%), 99.7 kbit/s
33.5s - received: 40/ sent: 40 pkts (loss 0.000%), 100.4 kbit/s
34.6s - received: 53/ sent: 53 pkts (loss 0.000%), 99.2 kbit/s
35.6s - received: 66/ sent: 66 pkts (loss 0.000%), 100.7 kbit/s
36.7s - received: 79/ sent: 79 pkts (loss 0.000%), 100.3 kbit/s
37.7s - received: 92/ sent: 92 pkts (loss 0.000%), 99.8 kbit/s
38.7s - received: 105/ sent: 105 pkts (loss 0.000%), 100.3 kbit/s
39.8s - received: 118/ sent: 118 pkts (loss 0.000%), 100.0 kbit/s
40.8s - received: 131/ sent: 131 pkts (loss 0.000%), 99.5 kbit/s
41.9s - received: 144/ sent: 144 pkts (loss 0.000%), 100.5 kbit/s
42.9s - received: 157/ sent: 157 pkts (loss 0.000%), 100.0 kbit/s
43.9s - received: 170/ sent: 170 pkts (loss 0.000%), 99.6 kbit/s
45.0s - received: 183/ sent: 183 pkts (loss 0.000%), 99.9 kbit/s
46.0s - received: 196/ sent: 196 pkts (loss 0.000%), 100.1 kbit/s
47.1s - received: 209/ sent: 209 pkts (loss 0.000%), 100.5 kbit/s
48.1s - received: 222/ sent: 222 pkts (loss 0.000%), 100.0 kbit/s
49.1s - received: 235/ sent: 235 pkts (loss 0.000%), 99.8 kbit/s
50.2s - received: 248/ sent: 248 pkts (loss 0.000%), 99.1 kbit/s
packet received = 248 / 248 sent: 0.000% loss
```

نتایج بار دوم:

```
host: h1
root@TCPIP-VM:/home/mininet/Desktop/shared/lab5/udp# ./udpclient 10.10.1.3 1000
0 100
1.0s - sent: 14 pkts, 107.5 kbits/s
2.1s - sent: 27 pkts, 100.0 kbits/s
3.1s - sent: 40 pkts, 100.1 kbits/s
4.2s - sent: 53 pkts, 100.0 kbits/s
5.2s - sent: 66 pkts, 100.0 kbits/s
6.2s - sent: 79 pkts, 100.1 kbits/s
7.3s - sent: 92 pkts, 100.1 kbits/s
8.3s - sent: 105 pkts, 100.1 kbits/s
9.4s - sent: 118 pkts, 99.7 kbits/s
10.4s - sent: 131 pkts, 100.5 kbits/s
11.4s - sent: 144 pkts, 100.0 kbits/s
12.5s - sent: 157 pkts, 99.9 kbits/s
13.5s - sent: 170 pkts, 100.6 kbits/s
14.6s - sent: 183 pkts, 100.7 kbits/s
15.6s - sent: 196 pkts, 100.0 kbits/s
16.6s - sent: 209 pkts, 100.2 kbits/s
17.7s - sent: 222 pkts, 99.8 kbits/s
18.7s - sent: 235 pkts, 100.1 kbits/s
19.8s - sent: 248 pkts, 100.0 kbits/s
20.8s - sent: 261 pkts, 100.0 kbits/s
^Cpackets sent = 261, avg rate= 100.1kbps
root@TCPIP-VM:/home/mininet/Desktop/shared/lab5/udp#
```



```
host: h3
packet received = 248 / 248 sent: 0.000% loss
51.2s - received: 1/ sent: 1 pkts (loss 0.000%), 0.1 kbit/s
171.5s - received: 14/ sent: 14 pkts (loss 0.000%), 99.8 kbit/s
172.6s - received: 27/ sent: 27 pkts (loss 0.000%), 100.1 kbit/s
173.6s - received: 40/ sent: 40 pkts (loss 0.000%), 99.9 kbit/s
174.6s - received: 53/ sent: 53 pkts (loss 0.000%), 100.2 kbit/s
175.7s - received: 66/ sent: 66 pkts (loss 0.000%), 100.2 kbit/s
176.7s - received: 79/ sent: 79 pkts (loss 0.000%), 100.0 kbit/s
177.7s - received: 92/ sent: 92 pkts (loss 0.000%), 100.1 kbit/s
178.8s - received: 105/ sent: 105 pkts (loss 0.000%), 100.0 kbit/s
179.8s - received: 118/ sent: 118 pkts (loss 0.000%), 99.7 kbit/s
180.9s - received: 131/ sent: 131 pkts (loss 0.000%), 100.5 kbit/s
181.9s - received: 144/ sent: 144 pkts (loss 0.000%), 100.0 kbit/s
182.9s - received: 157/ sent: 157 pkts (loss 0.000%), 100.0 kbit/s
184.0s - received: 170/ sent: 170 pkts (loss 0.000%), 100.0 kbit/s
185.0s - received: 183/ sent: 183 pkts (loss 0.000%), 100.2 kbit/s
186.1s - received: 196/ sent: 196 pkts (loss 0.000%), 100.0 kbit/s
187.1s - received: 209/ sent: 209 pkts (loss 0.000%), 100.1 kbit/s
188.1s - received: 222/ sent: 222 pkts (loss 0.000%), 100.0 kbit/s
189.2s - received: 235/ sent: 235 pkts (loss 0.000%), 100.1 kbit/s
190.2s - received: 248/ sent: 248 pkts (loss 0.000%), 100.0 kbit/s
191.3s - received: 261/ sent: 261 pkts (loss 0.000%), 100.0 kbit/s
packet received = 261 / 261 sent: 0.000% loss
```

همانطور که میبینیم در هر دو تکرار هیچ پکیجی loss نشده و goodput هم مقدار 100 kbps را دارد.

سوال 2:

1Mbps test:

```
host: h1
root@TCPIP-VM:/home/mininet/Desktop/shared/lab5/udp# ./udpcient 10.10.1.3 1000
0 1000
1.0s - sent: 126 pkts, 1007.9 kbits/s
2.0s - sent: 251 pkts, 1000.0 kbits/s
3.0s - sent: 376 pkts, 999.7 kbits/s
4.0s - sent: 501 pkts, 999.7 kbits/s
5.0s - sent: 627 pkts, 999.8 kbits/s
6.0s - sent: 753 pkts, 999.0 kbits/s
7.0s - sent: 879 pkts, 1001.7 kbits/s
8.0s - sent: 1005 pkts, 1001.7 kbits/s
9.0s - sent: 1130 pkts, 998.8 kbits/s
10.0s - sent: 1256 pkts, 1001.7 kbits/s
11.0s - sent: 1382 pkts, 999.5 kbits/s
12.1s - sent: 1507 pkts, 996.3 kbits/s
13.1s - sent: 1633 pkts, 1006.9 kbits/s
14.1s - sent: 1758 pkts, 999.3 kbits/s
15.1s - sent: 1884 pkts, 1002.4 kbits/s
16.1s - sent: 2009 pkts, 997.7 kbits/s
17.1s - sent: 2135 pkts, 1001.3 kbits/s
18.1s - sent: 2261 pkts, 1001.9 kbits/s
19.1s - sent: 2386 pkts, 997.0 kbits/s
^Cpackets sent = 2416, avg rate=1000.1kbps
root@TCPIP-VM:/home/mininet/Desktop/shared/lab5/udp#
```

```
host: h3
191.3s - received: 261/ sent: 261 pkts (loss 0.000%), 100.0 kbit/s
packet received = 261 / 261 sent: 0.000% loss
192.3s - received: 1/ sent: 1 pkts (loss 0.000%), 0.1 kbit/s
268.0s - received: 126/ sent: 126 pkts (loss 0.000%), 999.1 kbit/s
269.0s - received: 252/ sent: 252 pkts (loss 0.000%), 1000.9 kbit/s
270.0s - received: 378/ sent: 378 pkts (loss 0.000%), 1000.6 kbit/s
271.0s - received: 503/ sent: 503 pkts (loss 0.000%), 998.8 kbit/s
272.0s - received: 629/ sent: 629 pkts (loss 0.000%), 1001.0 kbit/s
273.1s - received: 754/ sent: 754 pkts (loss 0.000%), 999.5 kbit/s
274.1s - received: 880/ sent: 880 pkts (loss 0.000%), 1000.5 kbit/s
275.1s - received: 1006/ sent: 1006 pkts (loss 0.000%), 1000.7 kbit/s
276.1s - received: 1131/ sent: 1131 pkts (loss 0.000%), 991.9 kbit/s
277.1s - received: 1257/ sent: 1257 pkts (loss 0.000%), 1003.7 kbit/s
278.1s - received: 1383/ sent: 1383 pkts (loss 0.000%), 1004.6 kbit/s
279.1s - received: 1509/ sent: 1509 pkts (loss 0.000%), 1000.4 kbit/s
280.1s - received: 1635/ sent: 1635 pkts (loss 0.000%), 1000.4 kbit/s
281.1s - received: 1759/ sent: 1759 pkts (loss 0.000%), 991.9 kbit/s
282.1s - received: 1885/ sent: 1885 pkts (loss 0.000%), 1004.3 kbit/s
283.1s - received: 2011/ sent: 2011 pkts (loss 0.000%), 1004.9 kbit/s
284.1s - received: 2137/ sent: 2137 pkts (loss 0.000%), 1001.3 kbit/s
285.1s - received: 2263/ sent: 2263 pkts (loss 0.000%), 999.4 kbit/s
286.1s - received: 2388/ sent: 2388 pkts (loss 0.000%), 996.0 kbit/s
packet received = 2416 / 2416 sent: 0.000% loss
```

10Mbps test:

```
host: h1
root@TCPIP-VN:/home/mininet/Desktop/shared/lab5/udp# ./udclient 10.10.1.3 1000
0 10000
1.0s - sent: 1252 pkts, 10008,0 kbits/s
2.0s - sent: 2503 pkts, 9997,9 kbits/s
3.0s - sent: 3754 pkts, 10006,8 kbits/s
4.0s - sent: 5006 pkts, 9999,3 kbits/s
5.0s - sent: 6257 pkts, 10006,7 kbits/s
6.0s - sent: 7508 pkts, 10003,3 kbits/s
7.0s - sent: 8759 pkts, 10005,8 kbits/s
8.0s - sent: 10010 pkts, 10007,4 kbits/s
9.0s - sent: 11261 pkts, 10000,9 kbits/s
10.0s - sent: 12506 pkts, 9940,2 kbits/s
11.0s - sent: 13765 pkts, 10062,9 kbits/s
12.0s - sent: 15017 pkts, 10011,5 kbits/s
13.0s - sent: 16267 pkts, 9965,3 kbits/s
14.0s - sent: 17519 pkts, 9979,6 kbits/s
15.0s - sent: 18769 pkts, 9988,0 kbits/s
16.0s - sent: 20029 pkts, 10066,2 kbits/s
17.0s - sent: 21280 pkts, 10007,6 kbits/s
18.0s - sent: 22531 pkts, 10005,6 kbits/s
19.0s - sent: 23784 pkts, 10014,1 kbits/s
20.0s - sent: 25035 pkts, 10002,4 kbits/s
^Cpackets sent = 25451, avg rate=8539,1kbps
root@TCPIP-VN:/home/mininet/Desktop/shared/lab5/udp#
```

```
host: h3
335.6s - received: 611/ sent: 611 pkts (loss 0.000%), 2322,6 kbit/s
336.6s - received: 965/ sent: 965 pkts (loss 0.000%), 2827,9 kbit/s
337.6s - received: 1200/ sent: 1200 pkts (loss 0.000%), 1875,4 kbit/s
338.6s - received: 1553/ sent: 2289 pkts (loss 32.154%), 2819,3 kbit/s
339.6s - received: 1907/ sent: 3558 pkts (loss 46.402%), 2830,9 kbit/s
340.6s - received: 2267/ sent: 5247 pkts (loss 56.794%), 2878,2 kbit/s
341.6s - received: 2628/ sent: 6527 pkts (loss 59.736%), 2880,9 kbit/s
342.6s - received: 2988/ sent: 7797 pkts (loss 61.678%), 2878,9 kbit/s
343.6s - received: 3345/ sent: 9038 pkts (loss 62.990%), 2261,6 kbit/s
344.9s - received: 3587/ sent: 9878 pkts (loss 63.687%), 1933,8 kbit/s
345.9s - received: 3910/ sent: 14496 pkts (loss 73.027%), 2578,2 kbit/s
346.9s - received: 4202/ sent: 14788 pkts (loss 71.585%), 2332,4 kbit/s
347.9s - received: 4530/ sent: 15116 pkts (loss 70.032%), 2620,0 kbit/s
348.9s - received: 4815/ sent: 15401 pkts (loss 68.736%), 2278,8 kbit/s
349.9s - received: 5166/ sent: 16466 pkts (loss 68.626%), 2806,2 kbit/s
350.9s - received: 5523/ sent: 17841 pkts (loss 69.043%), 2851,4 kbit/s
351.9s - received: 5817/ sent: 19120 pkts (loss 69.576%), 2346,7 kbit/s
352.9s - received: 6174/ sent: 20395 pkts (loss 69.728%), 2849,7 kbit/s
353.9s - received: 6517/ sent: 21592 pkts (loss 69.818%), 2742,8 kbit/s
354.9s - received: 6787/ sent: 22747 pkts (loss 70.163%), 2153,2 kbit/s
355.9s - received: 7070/ sent: 23764 pkts (loss 70.249%), 2253,1 kbit/s
356.9s - received: 7348/ sent: 24790 pkts (loss 70.359%), 2218,3 kbit/s
packet received = 7538 / 25450 sent: 70.381% loss
```



## 100Mbps test:

```

host: h1
root@TCPIP-VM:/home/mininet/Desktop/shared/lab5/udp# ./udpclient 10.10.1.3 1000
0 100000
 1.0s - sent: 12483 pkts, 99857.7 kbits/s
 2.0s - sent: 24971 pkts, 99902.8 kbits/s
 3.0s - sent: 37454 pkts, 99863.7 kbits/s
 4.0s - sent: 49932 pkts, 99823.6 kbits/s
 5.0s - sent: 62415 pkts, 99712.1 kbits/s
 6.0s - sent: 74918 pkts, 99997.1 kbits/s
 7.0s - sent: 87413 pkts, 99953.6 kbits/s
 8.0s - sent: 99852 pkts, 99957.2 kbits/s
 9.0s - sent:112459 pkts, 100819.6 kbits/s
10.0s - sent:124952 pkts, 99943.5 kbits/s
11.0s - sent:137436 pkts, 99729.7 kbits/s
12.0s - sent:149903 pkts, 98891.4 kbits/s
13.0s - sent:162528 pkts, 100996.8 kbits/s
14.0s - sent:175014 pkts, 99886.5 kbits/s
15.0s - sent:187492 pkts, 99800.1 kbits/s
16.0s - sent:199986 pkts, 99951.6 kbits/s
17.0s - sent:212471 pkts, 99870.7 kbits/s
18.0s - sent:224941 pkts, 99756.8 kbits/s
19.0s - sent:237439 pkts, 99981.1 kbits/s
^C^Crcv: Interrupted system call
root@TCPIP-VM:/home/mininet/Desktop/shared/lab5/udp#

```

```

host: h3
 3.6s - received: 354/ sent: 354 pkts (loss 0.000%), 2822.1 kbit/s
 4.6s - received: 714/ sent: 714 pkts (loss 0.000%), 2878.0 kbit/s
 5.6s - received: 1072/ sent: 2736 pkts (loss 60.819%), 2862.8 kbit/s
 6.6s - received: 1432/ sent: 15223 pkts (loss 90.593%), 2879.1 kbit/s
 7.6s - received: 1792/ sent: 27711 pkts (loss 93.533%), 2878.5 kbit/s
 8.6s - received: 2152/ sent: 40274 pkts (loss 94.657%), 2879.9 kbit/s
 9.6s - received: 2512/ sent: 52759 pkts (loss 95.239%), 2878.6 kbit/s
10.6s - received: 2787/ sent: 62286 pkts (loss 95.525%), 2194.9 kbit/s
11.6s - received: 3106/ sent: 73357 pkts (loss 95.766%), 2546.4 kbit/s
12.6s - received: 3467/ sent: 85886 pkts (loss 95.963%), 2878.9 kbit/s
13.6s - received: 3827/ sent:136282 pkts (loss 97.192%), 2878.6 kbit/s
14.6s - received: 4181/ sent:136636 pkts (loss 96.940%), 2816.3 kbit/s
15.6s - received: 4526/ sent:136981 pkts (loss 96.696%), 2757.9 kbit/s
16.6s - received: 4886/ sent:139528 pkts (loss 96.498%), 2878.4 kbit/s
17.6s - received: 5246/ sent:152228 pkts (loss 96.554%), 2880.0 kbit/s
18.6s - received: 5606/ sent:165306 pkts (loss 96.609%), 2879.4 kbit/s
19.6s - received: 5966/ sent:177796 pkts (loss 96.644%), 2878.3 kbit/s
20.6s - received: 6295/ sent:189206 pkts (loss 96.673%), 2624.8 kbit/s
21.6s - received: 6655/ sent:201694 pkts (loss 96.700%), 2879.2 kbit/s
22.6s - received: 6963/ sent:212379 pkts (loss 96.721%), 2448.5 kbit/s
23.6s - received: 7231/ sent:222789 pkts (loss 96.754%), 2138.2 kbit/s
24.6s - received: 7592/ sent:235296 pkts (loss 96.773%), 2880.0 kbit/s
packet received = 7843 / 243997 sent; 96.786% loss

```

1Gbps test:

```
host: h1
root@TCPIP-VM:/home/mininet/Desktop/shared/lab5/udp# ./udpclient 10.10.1.3 1000
0 1000000
 1.0s - sent:123349 pkts, 986792.0 kbits/s
 2.0s - sent:246728 pkts, 986967.1 kbits/s
 3.0s - sent:370110 pkts, 986965.2 kbits/s
 4.0s - sent:493487 pkts, 986956.9 kbits/s
 5.0s - sent:616864 pkts, 986931.1 kbits/s
 6.0s - sent:740202 pkts, 986704.0 kbits/s
 7.0s - sent:863611 pkts, 987271.1 kbits/s
 8.0s - sent:986967 pkts, 986847.1 kbits/s
 9.0s - sent:1110342 pkts, 986956.5 kbits/s
10.0s - sent:1233725 pkts, 986954.3 kbits/s
11.0s - sent:1357088 pkts, 986888.2 kbits/s
12.0s - sent:1480454 pkts, 986902.4 kbits/s
13.0s - sent:1603834 pkts, 987040.0 kbits/s
14.0s - sent:1727185 pkts, 986797.2 kbits/s
^C^Crecv: Interrupted system call
root@TCPIP-VM:/home/mininet/Desktop/shared/lab5/udp#
```

```
host: h3
root@TCPIP-VM:/home/mininet/Desktop/shared/lab5/udp# ./udpserver 10000
 0.0s - received: 1/ sent: 4 pkts (loss 75.000%), 1.9 kbit/s
 4.1s - received: 362/ sent: 1365 pkts (loss 73.480%), 2886.7 kbit/s
 5.1s - received: 722/ sent: 1521 pkts (loss 52.531%), 2879.2 kbit/s
 6.1s - received: 1082/ sent: 29210 pkts (loss 96.296%), 2879.6 kbit/s
 7.1s - received: 1442/ sent:152577 pkts (loss 99.055%), 2879.2 kbit/s
 8.1s - received: 1802/ sent:275960 pkts (loss 99.347%), 2879.7 kbit/s
 9.1s - received: 2162/ sent:399404 pkts (loss 99.459%), 2879.2 kbit/s
10.1s - received: 2522/ sent:522696 pkts (loss 99.518%), 2879.1 kbit/s
11.1s - received: 2882/ sent:646078 pkts (loss 99.554%), 2879.0 kbit/s
12.1s - received: 3242/ sent:769449 pkts (loss 99.579%), 2879.1 kbit/s
13.1s - received: 3602/ sent:892869 pkts (loss 99.597%), 2880.0 kbit/s
14.1s - received: 3962/ sent:1331336 pkts (loss 99.702%), 2878.8 kbit/s
15.1s - received: 4322/ sent:1331696 pkts (loss 99.675%), 2879.2 kbit/s
16.1s - received: 4682/ sent:1332056 pkts (loss 99.649%), 2879.2 kbit/s
17.1s - received: 5042/ sent:1386309 pkts (loss 99.636%), 2879.1 kbit/s
18.2s - received: 5402/ sent:1510061 pkts (loss 99.642%), 2877.4 kbit/s
19.2s - received: 5762/ sent:1633422 pkts (loss 99.647%), 2880.0 kbit/s
packet received = 6098 / 1748647 sent: 99.651% loss
```

طبق نتایج در این پروتکل به ازای نرخ 10Mbps و بالاتر مقدار loss پس از چند ثانیه بشدت زیاد میشود. این امر احتمالا به دلیل پر شدن ظرفیت لینک بین r1 و sw2 است به اینگونه که با افزایش نرخ ارسال ترافیک در این لینک افزایش میابد و با کردن ظرفیت باعث drop شدن پکیج ها میشود. برای حل این موضوع میتوان با افزایش پهنای باند لینک ها به خصوص r1 و sw2 این امکان را فراهم کنیم تا حجم بیشتری ارسال و دریافت شود و بسته های کمتری loss شوند.

سوال 3:

بار اول:

```

host: h1
138,7: 2534.8kbps avg ( 2805.5[inst], 2514.0[mov.avg]) cwnd 558 rtt2265.5ms
139,7: 2536.1kbps avg ( 2715.0[inst], 2534.1[mov.avg]) cwnd 558 rtt2283.5ms
141,3: 2517.1kbps avg ( 899.5[inst], 2370.6[mov.avg]) cwnd 558 rtt2731.0ms
142,3: 2517.7kbps avg ( 2591.1[inst], 2392.7[mov.avg]) cwnd 559 rtt3467.5ms
143,3: 2518.3kbps avg ( 2614.6[inst], 2414.9[mov.avg]) cwnd 559 rtt3507.0ms
144,3: 2520.0kbps avg ( 2760.2[inst], 2449.4[mov.avg]) cwnd 559 rtt2352.5ms
145,3: 2520.6kbps avg ( 2600.7[inst], 2464.5[mov.avg]) cwnd 559 rtt2340.0ms
146,3: 2518.6kbps avg ( 2229.5[inst], 2441.0[mov.avg]) cwnd 559 rtt2534.5ms
147,3: 2518.6kbps avg ( 2229.5[inst], 2441.0[mov.avg]) cwnd 560 rtt2624.5ms
147,3: 2518.3kbps avg ( 2486.7[inst], 2445.6[mov.avg]) cwnd 560 rtt2623.5ms
149,3: 2520.8kbps avg ( 2704.1[inst], 2471.4[mov.avg]) cwnd 560 rtt2338.0ms
151,3: 2524.5kbps avg ( 2794.8[inst], 2503.8[mov.avg]) cwnd 561 rtt2305.5ms
152,3: 2525.0kbps avg ( 2601.9[inst], 2513.6[mov.avg]) cwnd 561 rtt2333.5ms
153,3: 2526.8kbps avg ( 2805.5[inst], 2542.8[mov.avg]) cwnd 561 rtt2339.5ms
154,3: 2528.5kbps avg ( 2796.1[inst], 2568.1[mov.avg]) cwnd 561 rtt2295.0ms
155,3: 2528.1kbps avg ( 2466.1[inst], 2557.9[mov.avg]) cwnd 561 rtt2382.0ms
156,3: 2528.1kbps avg ( 2466.1[inst], 2557.9[mov.avg]) cwnd 562 rtt2380.0ms
156,3: 2529.9kbps avg ( 2805.5[inst], 2582.7[mov.avg]) cwnd 562 rtt2380.0ms
157,3: 2531.7kbps avg ( 2805.5[inst], 2605.0[mov.avg]) cwnd 562 rtt2270.0ms
158,3: 2533.3kbps avg ( 2782.5[inst], 2622.7[mov.avg]) cwnd 562 rtt2276.0ms
159,3: 2535.0kbps avg ( 2805.5[inst], 2641.0[mov.avg]) cwnd 562 rtt2276.0ms
160,3: 2536.5kbps avg ( 2782.9[inst], 2655.2[mov.avg]) cwnd 562 rtt2276.0ms
^C
root@TCPIP-VM:/home/mininet/Desktop/shared/lab5/tcp#

```

```
host: h3
root@TCPIP-VM:/home/mininet/Desktop/shared/lab5/tcp# ./tcpserver 10001
Handling client 10.10.0.1
with child process: 23469
^C
root@TCPIP-VM:/home/mininet/Desktop/shared/lab5/tcp#
```

بار دوم:

```
host: h1
101,8: 2621.1kbps avg ( 2309.1[inst], 2514.7[mov.avg]) cwnd 566 rtt2865.0ms
102,8: 2619.2kbps avg ( 2427.6[inst], 2506.0[mov.avg]) cwnd 566 rtt2797.5ms
103,8: 2619.7kbps avg ( 2667.2[inst], 2522.1[mov.avg]) cwnd 567 rtt2550.5ms
104,8: 2619.5kbps avg ( 2601.9[inst], 2530.1[mov.avg]) cwnd 567 rtt2456.0ms
105,8: 2620.8kbps avg ( 2750.2[inst], 2552.1[mov.avg]) cwnd 567 rtt2408.5ms
107,8: 2621.5kbps avg ( 2660.5[inst], 2562.9[mov.avg]) cwnd 567 rtt2401.0ms
108,8: 2621.5kbps avg ( 2621.6[inst], 2568.8[mov.avg]) cwnd 568 rtt2433.0ms
110,8: 2623.6kbps avg ( 2739.2[inst], 2585.8[mov.avg]) cwnd 568 rtt2383.5ms
111,8: 2625.3kbps avg ( 2805.5[inst], 2607.8[mov.avg]) cwnd 568 rtt2295.5ms
112,8: 2626.4kbps avg ( 2746.1[inst], 2621.6[mov.avg]) cwnd 568 rtt2313.5ms
113,8: 2624.9kbps avg ( 2462.3[inst], 2605.7[mov.avg]) cwnd 569 rtt2429.0ms
115,8: 2626.3kbps avg ( 2707.3[inst], 2615.9[mov.avg]) cwnd 569 rtt2387.5ms
116,8: 2625.4kbps avg ( 2522.6[inst], 2606.5[mov.avg]) cwnd 569 rtt2403.0ms
117,8: 2626.8kbps avg ( 2782.9[inst], 2624.2[mov.avg]) cwnd 569 rtt2403.5ms
118,8: 2625.5kbps avg ( 2479.3[inst], 2609.7[mov.avg]) cwnd 570 rtt2438.0ms
119,8: 2625.1kbps avg ( 2569.2[inst], 2605.6[mov.avg]) cwnd 570 rtt2493.0ms
120,8: 2624.7kbps avg ( 2578.4[inst], 2602.9[mov.avg]) cwnd 570 rtt2453.5ms
121,8: 2625.0kbps avg ( 2669.8[inst], 2609.6[mov.avg]) cwnd 570 rtt2465.5ms
122,8: 2625.0kbps avg ( 2615.5[inst], 2610.2[mov.avg]) cwnd 570 rtt2449.0ms
123,8: 2626.0kbps avg ( 2757.7[inst], 2624.9[mov.avg]) cwnd 571 rtt2391.0ms
124,8: 2627.0kbps avg ( 2749.6[inst], 2637.4[mov.avg]) cwnd 571 rtt2363.0ms
125,8: 2627.9kbps avg ( 2737.1[inst], 2647.4[mov.avg]) cwnd 571 rtt2343.5ms
^C
root@TCPIP-VM:/home/mininet/Desktop/shared/lab5/tcp#
```

```
host: h3
root@TCPIP-VM:/home/mininet/Desktop/shared/lab5/tcp# ./tcpserver 10001
Handling client 10.10.0.1
with child process: 23476
^C
root@TCPIP-VM:/home/mininet/Desktop/shared/lab5/tcp#
```

بعد از گذشت حدود دو دقیقه که مقادیر چاپ شده به حالت پایدار رسیدند و تغییر زیادی نکردند  
میتوانیم ببینیم که goodput به ترتیب 2536 kbps و 2627 kbps برای این پروتکل می باشند  
که این یعنی به طور میانگین 2581.5 kbps به عنوان نتیجه نهایی بدست می آید.