



دانشکده مهندسی کامپیوتر
آزمایشگاه شبکه‌های کامپیوتری

گزارش کار آزمایش ۶

گروه ۴

علی صدیقی ۹۷۵۲۱۳۷۸

دانیال بازمانده ۹۷۵۲۱۱۳۵

۱ بخش الف

برای هر سناریوی تعریف شده برای h2، دو سرور UDP روی h3 ایجاد می کنیم که روی پورت های 10001 و 10002 گوش می دهند. یک کلاینت UDP روی h1 با نرخ 1Mbps و یک کلاینت UDP هم روی h2 با نرخ های 1، 2 و 4.5 Mbps ایجاد می کنیم که به سرورها گوش دهند.

۲ سوال ۱

برای هر یک از سناریوها پس از اجرا خروجی های زیر را خواهیم داشت.

در حالت 1Mbps:

mininet@mininet-vm: ~/lab6	"host: h2"	"host: r1"
<pre>mininet@mininet-vm:~/lab6\$ sudo python lab_network.py ** Creating an instance of Lab6 network topology ** Adding Controller ** Adding Hosts ** Adding Switches ** Creating Links ** Modifying Link Parameters (3.00Mbps) *** Configuring hosts h1 h2 h3 r1 *** Starting controller c0 *** Starting 2 switches sw1 sw2 ... *** Configuring hosts *** Executing custom commands *** Enabling storm for hosts only *** Running CLI *** Starting CLI: mininet> []</pre>	<pre>97.5s - sent: 12190 pkts, 999.0 kbit/s 98.2s - sent: 12236 pkts, 999.0 kbit/s 98.5s - sent: 12441 pkts, 998.0 kbit/s 100.5s - sent: 12587 pkts, 1001.7 kbit/s 101.5s - sent: 12633 pkts, 1000.7 kbit/s 102.5s - sent: 12813 pkts, 1001.6 kbit/s 103.5s - sent: 12544 pkts, 999.9 kbit/s 104.5s - sent: 13070 pkts, 1002.4 kbit/s 106.5s - sent: 13136 pkts, 1002.6 kbit/s 106.5s - sent: 13322 pkts, 1001.8 kbit/s 107.5s - sent: 13447 pkts, 998.5 kbit/s 108.5s - sent: 13573 pkts, 1001.8 kbit/s 109.5s - sent: 13829 pkts, 999.5 kbit/s 110.5s - sent: 13825 pkts, 1002.1 kbit/s 111.5s - sent: 13981 pkts, 1001.1 kbit/s 112.5s - sent: 14077 pkts, 1001.0 kbit/s 113.5s - sent: 14203 pkts, 1002.3 kbit/s 114.5s - sent: 14329 pkts, 1001.4 kbit/s 115.5s - sent: 14454 pkts, 1000.0 kbit/s 116.5s - sent: 14580 pkts, 999.7 kbit/s 117.5s - sent: 14706 pkts, 1001.5 kbit/s 118.5s - sent: 14832 pkts, 1001.0 kbit/s *** Packets sent = 14882, avg rate=1000.0kpps root@mininet-vm:/home/mininet/lab5/lab5/udp#</pre>	<pre>root@mininet-vm:/home/mininet/lab5# []</pre>
"host: h1"	"host: h3"	root@mininet-vm:/home/mininet/lab5/lab5/udp
<pre>144.1s - sent: 18010 pkts, 1001.9 kbit/s 145.1s - sent: 18136 pkts, 1005.7 kbit/s 146.1s - sent: 18262 pkts, 1005.0 kbit/s 147.1s - sent: 18388 pkts, 1000.0 kbit/s 148.1s - sent: 18514 pkts, 1000.0 kbit/s 149.1s - sent: 18640 pkts, 1000.5 kbit/s 150.1s - sent: 18767 pkts, 1005.0 kbit/s 151.1s - sent: 18893 pkts, 1001.5 kbit/s 152.1s - sent: 19019 pkts, 1002.7 kbit/s 153.2s - sent: 19145 pkts, 1005.7 kbit/s 154.2s - sent: 19271 pkts, 1005.5 kbit/s 155.2s - sent: 19397 pkts, 999.5 kbit/s 156.2s - sent: 19523 pkts, 1009.0 kbit/s 157.2s - sent: 19649 pkts, 999.5 kbit/s 158.2s - sent: 19775 pkts, 1006.8 kbit/s 159.2s - sent: 19901 pkts, 1002.1 kbit/s 160.2s - sent: 20027 pkts, 1004.5 kbit/s 161.2s - sent: 20153 pkts, 1002.4 kbit/s 162.2s - sent: 20279 pkts, 1003.4 kbit/s 163.2s - sent: 20405 pkts, 1002.7 kbit/s 164.2s - sent: 20531 pkts, 999.5 kbit/s 165.2s - sent: 20657 pkts, 1005.2 kbit/s *** Packets sent = 20671, avg rate=1000.0kpps root@mininet-vm:/home/mininet/lab5/lab5/udp#</pre>	<pre>200.8s - received: 17975/ sent: 17978 pkts (loss 0.0002), 1000.8 kbit/s 201.8s - received: 18100/ sent: 18100 pkts (loss 0.0000), 1000.0 kbit/s 202.8s - received: 18225/ sent: 18225 pkts (loss 0.0000), 999.3 kbit/s 203.8s - received: 18350/ sent: 18350 pkts (loss 0.0000), 1000.3 kbit/s 204.8s - received: 18477/ sent: 18477 pkts (loss 0.0000), 999.3 kbit/s 205.8s - received: 18602/ sent: 18602 pkts (loss 0.0000), 999.3 kbit/s 206.8s - received: 18728/ sent: 18728 pkts (loss 0.0000), 1001.1 kbit/s 207.8s - received: 18853/ sent: 18853 pkts (loss 0.0000), 999.5 kbit/s 208.8s - received: 18979/ sent: 18979 pkts (loss 0.0000), 1000.0 kbit/s 209.8s - received: 19105/ sent: 19105 pkts (loss 0.0000), 999.3 kbit/s 210.8s - received: 19230/ sent: 19230 pkts (loss 0.0000), 1000.0 kbit/s 211.8s - received: 19356/ sent: 19356 pkts (loss 0.0000), 999.5 kbit/s 212.8s - received: 19482/ sent: 19482 pkts (loss 0.0000), 1000.2 kbit/s 213.8s - received: 19607/ sent: 19607 pkts (loss 0.0000), 999.5 kbit/s 214.8s - received: 19733/ sent: 19733 pkts (loss 0.0000), 1000.8 kbit/s 215.8s - received: 19859/ sent: 19859 pkts (loss 0.0000), 999.4 kbit/s 216.8s - received: 19984/ sent: 19984 pkts (loss 0.0000), 1000.5 kbit/s 217.8s - received: 20110/ sent: 20110 pkts (loss 0.0000), 999.8 kbit/s 218.8s - received: 20236/ sent: 20236 pkts (loss 0.0000), 1000.0 kbit/s 219.8s - received: 20362/ sent: 20362 pkts (loss 0.0000), 1000.2 kbit/s 220.8s - received: 20487/ sent: 20487 pkts (loss 0.0000), 999.5 kbit/s 221.8s - received: 20613/ sent: 20613 pkts (loss 0.0000), 1000.5 kbit/s *** Packets received = 20671 / 20671 sent; 0.0002 loss</pre>	<pre>137.5s - received: 12190/ sent: 12190 pkts (loss 0.0002), 1000.8 kbit/s 138.5s - received: 12315/ sent: 12315 pkts (loss 0.0000), 999.8 kbit/s 139.5s - received: 12441/ sent: 12441 pkts (loss 0.0000), 999.7 kbit/s 200.5s - received: 12567/ sent: 12567 pkts (loss 0.0000), 1000.2 kbit/s 201.5s - received: 12693/ sent: 12693 pkts (loss 0.0000), 999.3 kbit/s 202.5s - received: 12819/ sent: 12819 pkts (loss 0.0000), 1000.0 kbit/s 203.5s - received: 12944/ sent: 12944 pkts (loss 0.0000), 999.9 kbit/s 204.5s - received: 13070/ sent: 13070 pkts (loss 0.0000), 1000.0 kbit/s 205.5s - received: 13196/ sent: 13196 pkts (loss 0.0000), 1000.0 kbit/s 206.5s - received: 13322/ sent: 13322 pkts (loss 0.0000), 999.9 kbit/s 207.5s - received: 13447/ sent: 13447 pkts (loss 0.0000), 999.5 kbit/s 208.5s - received: 13573/ sent: 13573 pkts (loss 0.0000), 1000.4 kbit/s 209.5s - received: 13698/ sent: 13698 pkts (loss 0.0000), 999.5 kbit/s 210.5s - received: 13825/ sent: 13825 pkts (loss 0.0000), 1000.0 kbit/s 211.5s - received: 13951/ sent: 13951 pkts (loss 0.0000), 999.5 kbit/s 212.5s - received: 14077/ sent: 14077 pkts (loss 0.0000), 1000.7 kbit/s 213.5s - received: 14202/ sent: 14202 pkts (loss 0.0000), 999.5 kbit/s 214.5s - received: 14328/ sent: 14328 pkts (loss 0.0000), 1000.7 kbit/s 215.5s - received: 14454/ sent: 14454 pkts (loss 0.0000), 999.5 kbit/s 216.5s - received: 14580/ sent: 14580 pkts (loss 0.0000), 1001.1 kbit/s 217.5s - received: 14706/ sent: 14706 pkts (loss 0.0000), 1000.1 kbit/s 218.5s - received: 14832/ sent: 14832 pkts (loss 0.0000), 999.5 kbit/s *** Packets received = 14882 / 14882 sent; 0.0002 loss</pre>

h1: goodput = 1Mbps, loss = 0%

h2: goodput = 1Mbps, loss = 0%

در حالت 2Mbps:

mininet@mininet-vm: ~/lab6	"host: h2"	"host: r1"
<pre>mininet@mininet-vm:~/lab6\$ sudo python lab_network.py ** Creating an instance of Lab6 network topology ** Adding Controller ** Adding Hosts ** Adding Switches ** Creating Links ** Modifying Link Parameters (3.00Mbps) *** Configuring hosts h1 h2 h3 r1 *** Starting controller c0 *** Starting 2 switches sw1 sw2 ... *** Configuring hosts *** Executing custom commands *** Enabling storm for hosts only *** Running CLI *** Starting CLI: mininet> []</pre>	<pre>23.1s - sent: 7270 pkts, 1999.1 kbit/s 30.1s - sent: 8521 pkts, 2000.2 kbit/s 31.1s - sent: 7772 pkts, 2000.5 kbit/s 32.1s - sent: 8023 pkts, 2000.3 kbit/s 33.1s - sent: 8274 pkts, 2000.3 kbit/s 34.1s - sent: 8525 pkts, 2000.1 kbit/s 35.1s - sent: 8776 pkts, 2000.5 kbit/s 36.1s - sent: 9027 pkts, 1999.7 kbit/s 37.1s - sent: 9278 pkts, 1999.6 kbit/s 38.1s - sent: 9529 pkts, 1999.6 kbit/s 39.1s - sent: 9780 pkts, 2001.5 kbit/s 40.1s - sent: 10031 pkts, 2001.5 kbit/s 41.1s - sent: 10282 pkts, 2001.5 kbit/s 42.1s - sent: 10533 pkts, 2001.5 kbit/s 43.1s - sent: 10784 pkts, 2000.0 kbit/s 44.1s - sent: 11035 pkts, 1999.3 kbit/s 45.1s - sent: 11286 pkts, 2001.3 kbit/s 46.1s - sent: 11537 pkts, 2001.7 kbit/s 47.1s - sent: 11788 pkts, 2000.0 kbit/s 48.1s - sent: 12039 pkts, 1999.9 kbit/s 49.1s - sent: 12290 pkts, 2000.3 kbit/s 50.1s - sent: 12541 pkts, 1998.5 kbit/s *** Packets sent = 12685, avg rate=1918.1kpps root@mininet-vm:/home/mininet/lab5/lab5/udp#</pre>	<pre>root@mininet-vm:/home/mininet/lab5# []</pre>
"host: h1"	"host: h3"	root@mininet-vm:/home/mininet/lab5/lab5/udp
<pre>23.1s - sent: 3644 pkts, 1000.0 kbit/s 30.2s - sent: 3770 pkts, 999.4 kbit/s 31.2s - sent: 3896 pkts, 1000.3 kbit/s 32.2s - sent: 4021 pkts, 999.3 kbit/s 33.2s - sent: 4146 pkts, 999.3 kbit/s 34.2s - sent: 4272 pkts, 1000.4 kbit/s 35.2s - sent: 4397 pkts, 999.2 kbit/s 36.2s - sent: 4523 pkts, 1000.3 kbit/s 37.2s - sent: 4648 pkts, 1000.0 kbit/s 38.2s - sent: 4774 pkts, 1000.5 kbit/s 39.2s - sent: 4900 pkts, 1000.1 kbit/s 40.2s - sent: 5025 pkts, 999.8 kbit/s 41.2s - sent: 5151 pkts, 1000.3 kbit/s 42.2s - sent: 5277 pkts, 1000.1 kbit/s 43.2s - sent: 5403 pkts, 1000.5 kbit/s 44.2s - sent: 5528 pkts, 999.7 kbit/s 45.2s - sent: 5654 pkts, 1000.3 kbit/s 46.2s - sent: 5780 pkts, 1000.2 kbit/s 47.2s - sent: 5906 pkts, 999.3 kbit/s 48.2s - sent: 6032 pkts, 1000.1 kbit/s 49.2s - sent: 6158 pkts, 1000.0 kbit/s 50.2s - sent: 6284 pkts, 999.3 kbit/s *** Packets sent = 5284, avg rate=986.3kpps root@mininet-vm:/home/mininet/lab5/lab5/udp#</pre>	<pre>310.8s - received: 3602/ sent: 3602 pkts (loss 0.0000), 998.7 kbit/s 311.8s - received: 3727/ sent: 3727 pkts (loss 0.0000), 998.8 kbit/s 312.8s - received: 3852/ sent: 3852 pkts (loss 0.0000), 999.2 kbit/s 313.8s - received: 3977/ sent: 3977 pkts (loss 0.0000), 999.5 kbit/s 314.8s - received: 4102/ sent: 4102 pkts (loss 0.0000), 999.5 kbit/s 315.8s - received: 4227/ sent: 4227 pkts (loss 0.0000), 999.2 kbit/s 316.8s - received: 4352/ sent: 4352 pkts (loss 0.0000), 999.6 kbit/s 317.8s - received: 4477/ sent: 4477 pkts (loss 0.0000), 999.0 kbit/s 318.8s - received: 4602/ sent: 4602 pkts (loss 0.0000), 999.1 kbit/s 319.8s - received: 4727/ sent: 4727 pkts (loss 0.0000), 999.7 kbit/s 320.8s - received: 4852/ sent: 4852 pkts (loss 0.0000), 994.2 kbit/s 321.8s - received: 4977/ sent: 4977 pkts (loss 0.0000), 999.8 kbit/s 322.8s - received: 5102/ sent: 5102 pkts (loss 0.0000), 999.5 kbit/s 323.8s - received: 5227/ sent: 5227 pkts (loss 0.0000), 999.8 kbit/s 324.8s - received: 5352/ sent: 5352 pkts (loss 0.0000), 999.5 kbit/s 325.8s - received: 5477/ sent: 5477 pkts (loss 0.0000), 999.7 kbit/s 326.8s - received: 5602/ sent: 5602 pkts (loss 0.0000), 999.5 kbit/s 327.8s - received: 5727/ sent: 5727 pkts (loss 0.0000), 999.5 kbit/s 328.8s - received: 5852/ sent: 5852 pkts (loss 0.0000), 999.5 kbit/s 329.8s - received: 5977/ sent: 5977 pkts (loss 0.0000), 999.7 kbit/s 330.8s - received: 6102/ sent: 6102 pkts (loss 0.0000), 999.2 kbit/s 331.8s - received: 6227/ sent: 6227 pkts (loss 0.0000), 997.3 kbit/s *** Packets received = 6284 / 6284 sent; 0.0000 loss</pre>	<pre>306.1s - received: 7482/ sent: 7482 pkts (loss 0.0000), 1315.9 kbit/s 307.1s - received: 7607/ sent: 7607 pkts (loss 0.0000), 1314.3 kbit/s 308.2s - received: 7732/ sent: 7732 pkts (loss 0.0000), 1313.7 kbit/s 309.2s - received: 7857/ sent: 7857 pkts (loss 0.0000), 1313.0 kbit/s 310.2s - received: 7982/ sent: 7982 pkts (loss 0.0000), 1313.9 kbit/s 311.2s - received: 8107/ sent: 8107 pkts (loss 0.0000), 1313.7 kbit/s 312.2s - received: 8232/ sent: 8232 pkts (loss 0.0000), 1313.5 kbit/s 313.2s - received: 8357/ sent: 8357 pkts (loss 0.0000), 1313.8 kbit/s 314.2s - received: 8482/ sent: 8482 pkts (loss 0.0000), 1313.1 kbit/s 315.2s - received: 8607/ sent: 8607 pkts (loss 0.0000), 1313.5 kbit/s 316.2s - received: 8732/ sent: 8732 pkts (loss 0.0000), 1313.0 kbit/s 317.2s - received: 8857/ sent: 8857 pkts (loss 0.0000), 1313.9 kbit/s 318.2s - received: 8982/ sent: 8982 pkts (loss 0.0000), 1313.4 kbit/s 319.2s - received: 9107/ sent: 9107 pkts (loss 0.0000), 1313.9 kbit/s 320.2s - received: 9232/ sent: 9232 pkts (loss 0.0000), 1313.5 kbit/s 321.2s - received: 9357/ sent: 9357 pkts (loss 0.0000), 1313.7 kbit/s 322.2s - received: 9482/ sent: 9482 pkts (loss 0.0000), 1313.9 kbit/s 323.2s - received: 9607/ sent: 9607 pkts (loss 0.0000), 1313.8 kbit/s 324.2s - received: 9732/ sent: 9732 pkts (loss 0.0000), 1313.1 kbit/s 325.2s - received: 9857/ sent: 9857 pkts (loss 0.0000), 1313.5 kbit/s 326.2s - received: 9982/ sent: 9982 pkts (loss 0.0000), 1313.0 kbit/s *** Packets received = 12685 / 12685 sent; 0.0000 loss</pre>

h1: goodput = 1986.3Kbps, loss = 0%

h2: goodput = 1918Kbps, loss = 0%

در حالت 4.5Mbps

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mininet@mininet-vm: ~/lab6
mininet@mininet-vm:~/lab6 sudo python lab6_network.py
** Creating an instance of Lab6 network topology

** Adding Controller

** Adding Hosts

** Adding Switches

** Creating Links

** Modifying Link Parameters
(3.00Mbit) *** Configuring hosts
h1 & h3 r1
*** Starting controller
c0
*** Starting 2 switches
sw1 sw2 ...
** Configuring hosts
** Executing custom commands
** Enabling items for hosts only
** Running CLI
*** Starting CLI:
mininet>

"host: h2"
48.1s - sent: 27042 pkts, 4531.5 kbit/s
49.1s - sent: 27096 pkts, 4501.5 kbit/s
50.1s - sent: 26188 pkts, 4501.7 kbit/s
51.1s - sent: 26751 pkts, 4501.4 kbit/s
52.1s - sent: 26234 pkts, 4488.1 kbit/s
53.1s - sent: 23857 pkts, 4504.0 kbit/s
54.1s - sent: 23400 pkts, 4502.4 kbit/s
55.1s - sent: 30983 pkts, 4501.2 kbit/s
56.1s - sent: 31546 pkts, 4457.5 kbit/s
57.1s - sent: 32110 pkts, 4501.5 kbit/s
58.1s - sent: 32673 pkts, 4488.8 kbit/s
59.1s - sent: 33237 pkts, 4504.5 kbit/s
60.1s - sent: 33801 pkts, 4505.2 kbit/s
61.1s - sent: 34364 pkts, 4488.1 kbit/s
62.1s - sent: 34928 pkts, 4504.1 kbit/s
63.1s - sent: 35492 pkts, 4506.3 kbit/s
64.1s - sent: 36056 pkts, 4502.4 kbit/s
65.1s - sent: 36619 pkts, 4500.7 kbit/s
66.1s - sent: 37183 pkts, 4503.8 kbit/s
67.1s - sent: 37746 pkts, 4508.1 kbit/s
68.1s - sent: 38310 pkts, 4501.7 kbit/s
69.1s - sent: 38874 pkts, 4500.8 kbit/s
*packets sent = 39063, avg rate=4325.8Mbps
root@mininet-vm:/home/mininet/lab5/lab5/udp

"host: h1"
54.3s - sent: 6790 pkts, 1000.0 kbit/s
55.3s - sent: 6916 pkts, 1000.1 kbit/s
56.3s - sent: 7042 pkts, 1000.0 kbit/s
57.3s - sent: 7168 pkts, 1000.1 kbit/s
58.3s - sent: 7293 pkts, 1000.0 kbit/s
59.3s - sent: 7419 pkts, 1000.1 kbit/s
60.4s - sent: 7545 pkts, 999.3 kbit/s
61.4s - sent: 7671 pkts, 999.6 kbit/s
62.4s - sent: 7797 pkts, 1000.7 kbit/s
63.4s - sent: 7923 pkts, 999.4 kbit/s
64.4s - sent: 8049 pkts, 1000.0 kbit/s
65.4s - sent: 8175 pkts, 1000.8 kbit/s
66.4s - sent: 8300 pkts, 1000.0 kbit/s
67.4s - sent: 8426 pkts, 1000.1 kbit/s
68.4s - sent: 8551 pkts, 999.3 kbit/s
69.4s - sent: 8676 pkts, 999.5 kbit/s
70.4s - sent: 8802 pkts, 1000.4 kbit/s
71.4s - sent: 8927 pkts, 999.6 kbit/s
72.4s - sent: 9052 pkts, 999.4 kbit/s
73.4s - sent: 9178 pkts, 1003.3 kbit/s
74.4s - sent: 9304 pkts, 999.3 kbit/s
75.4s - sent: 9430 pkts, 1000.1 kbit/s
*packets sent = 9539, avg rate=970.9Mbps
root@mininet-vm:/home/mininet/lab5/lab5/udp

"host: h3"
430.3s - received: 3335/ sent: 6728 pkts (loss 50.4032), 360.1 kbit/s
431.3s - received: 3380/ sent: 6880 pkts (loss 50.7232), 359.8 kbit/s
432.3s - received: 3423/ sent: 6936 pkts (loss 51.0027), 359.4 kbit/s
433.3s - received: 3469/ sent: 7111 pkts (loss 51.2162), 367.3 kbit/s
434.3s - received: 3515/ sent: 7239 pkts (loss 51.4444), 359.3 kbit/s
435.3s - received: 3563/ sent: 7361 pkts (loss 51.5480), 426.3 kbit/s
436.3s - received: 3624/ sent: 7491 pkts (loss 51.6222), 439.5 kbit/s
437.3s - received: 3670/ sent: 7616 pkts (loss 51.6580), 454.3 kbit/s
438.3s - received: 3736/ sent: 7747 pkts (loss 51.7752), 420.2 kbit/s
439.3s - received: 3779/ sent: 7875 pkts (loss 52.0132), 336.4 kbit/s
440.3s - received: 3827/ sent: 8001 pkts (loss 52.1150), 413.5 kbit/s
441.3s - received: 3880/ sent: 8127 pkts (loss 52.2584), 388.6 kbit/s
442.3s - received: 3929/ sent: 8256 pkts (loss 52.3782), 382.4 kbit/s
443.3s - received: 3976/ sent: 8380 pkts (loss 52.5544), 375.2 kbit/s
444.3s - received: 4017/ sent: 8507 pkts (loss 52.7800), 322.7 kbit/s
445.3s - received: 4059/ sent: 8633 pkts (loss 52.8944), 325.3 kbit/s
446.3s - received: 4117/ sent: 8922 pkts (loss 53.8562), 460.1 kbit/s
447.3s - received: 4163/ sent: 8996 pkts (loss 53.4800), 525.1 kbit/s
448.3s - received: 4249/ sent: 9104 pkts (loss 53.5700), 524.3 kbit/s
449.3s - received: 4311/ sent: 9138 pkts (loss 52.8232), 434.5 kbit/s
450.3s - received: 4360/ sent: 9323 pkts (loss 53.3311), 330.2 kbit/s
451.3s - received: 4412/ sent: 9392 pkts (loss 53.0242), 402.6 kbit/s
packet received = 4927 / 9539 sent; 52.9225 loss

root@mininet-vm:/home/mininet/lab5/lab5/udp

"host: r1"
426.7s - received: 16775/ sent: 27150 pkts (loss 41.3182), 2495.9 kbit/s
427.7s - received: 16993/ sent: 27723 pkts (loss 41.5612), 2543.2 kbit/s
428.7s - received: 16465/ sent: 26234 pkts (loss 41.5985), 2485.3 kbit/s
429.7s - received: 16722/ sent: 26847 pkts (loss 42.0322), 2527.4 kbit/s
430.7s - received: 17032/ sent: 23410 pkts (loss 42.0882), 2479.1 kbit/s
431.7s - received: 17377/ sent: 25920 pkts (loss 42.4543), 2452.7 kbit/s
432.7s - received: 17643/ sent: 30533 pkts (loss 42.2262), 2443.5 kbit/s
433.7s - received: 17950/ sent: 31102 pkts (loss 42.3073), 2445.7 kbit/s
434.7s - received: 18262/ sent: 31666 pkts (loss 42.3262), 2490.0 kbit/s
435.7s - received: 18577/ sent: 32223 pkts (loss 42.3592), 2515.3 kbit/s
436.7s - received: 18882/ sent: 27935 pkts (loss 42.4215), 2455.3 kbit/s
437.7s - received: 19195/ sent: 33398 pkts (loss 42.4542), 2502.4 kbit/s
438.7s - received: 19511/ sent: 33818 pkts (loss 42.4782), 2511.1 kbit/s
439.7s - received: 19823/ sent: 34481 pkts (loss 42.5100), 2494.4 kbit/s
440.7s - received: 20139/ sent: 35045 pkts (loss 42.5312), 2527.5 kbit/s
441.7s - received: 20460/ sent: 35586 pkts (loss 42.5423), 2527.0 kbit/s
442.7s - received: 20757/ sent: 36829 pkts (loss 43.6402), 2369.8 kbit/s
443.7s - received: 21050/ sent: 37174 pkts (loss 43.2522), 2369.8 kbit/s
444.7s - received: 21346/ sent: 37415 pkts (loss 42.8520), 2351.0 kbit/s
445.7s - received: 21650/ sent: 37860 pkts (loss 42.8152), 2431.2 kbit/s
446.7s - received: 21955/ sent: 38415 pkts (loss 42.4543), 2455.3 kbit/s
447.7s - received: 22263/ sent: 38883 pkts (loss 42.8752), 2510.2 kbit/s
packet received = 22312 / 39063 sent; 42.870% loss

```

h1: goodput = 970.9Kbps, loss = 52% h2: goodput = 4325Kbps, loss = 42%

۳ سوال ۲

بله تفاوت‌هایی وجود دارند اما زیاد نیستند و تفاوت اندکی دارند که ناشی از این است که آنالیز loss ما تقریبی است و فرض کرده‌ایم پهنای باند مربوط به host ها جداگانه و ثابت هستند.

۴ بخش ب

سناریوهای اجرایی مانند بخش الف هستند با این تفاوت که یک ارتباط اضافه از نوع tcp بین سرور h3 و کلاینت h2 برقرار می‌شود.

۵ سوال ۳

برای هر یک از سناریوها پس از اجرا خروجی‌های زیر را خواهیم داشت.

در حالت 1Mbps:

<pre>root@mininet-virtual-machine: /home/mininet/lab5/lab5/tcp x 39.1s - sent: 1320.4 kbps avg (0.0 [inst], 1427.4 [nov.avg]) cwnd 283 rtt12553.5ms 40.1s - sent: 1286.7 kbps avg (0.0 [inst], 1284.7 [nov.avg]) cwnd 281 rtt12560.9ms 41.1s - sent: 1322.0 kbps avg (0.0 [inst], 1470.1 [nov.avg]) cwnd 283 rtt12511.0ms 42.1s - sent: 1322.1 kbps avg (0.0 [inst], 1420.1 [nov.avg]) cwnd 283 rtt12523.9ms 43.1s - sent: 1333.7 kbps avg (0.0 [inst], 1704.1 [nov.avg]) cwnd 285 rtt12215.7ms 44.1s - sent: 1330.1 kbps avg (0.0 [inst], 1510.7 [nov.avg]) cwnd 285 rtt12165.0ms 45.1s - sent: 1372.7 kbps avg (0.0 [inst], 1557.4 [nov.avg]) cwnd 304 rtt12223.3ms 46.1s - sent: 1365.0 kbps avg (0.0 [inst], 1508.3 [nov.avg]) cwnd 314 rtt12241.5ms 47.1s - sent: 1359.2 kbps avg (0.0 [inst], 1453.6 [nov.avg]) cwnd 322 rtt12225.2ms 48.1s - sent: 1345.8 kbps avg (0.0 [inst], 1413.2 [nov.avg]) cwnd 327 rtt12306.0ms 49.1s - sent: 1345.8 kbps avg (0.0 [inst], 1386.7 [nov.avg]) cwnd 332 rtt12347.5ms 50.1s - sent: 1341.4 kbps avg (0.0 [inst], 1357.4 [nov.avg]) cwnd 336 rtt12391.1ms 51.1s - sent: 1334.4 kbps avg (0.0 [inst], 1321.1 [nov.avg]) cwnd 341 rtt12393.8ms 52.1s - sent: 1329.8 kbps avg (0.0 [inst], 1303.3 [nov.avg]) cwnd 349 rtt12419.9ms 53.1s - sent: 1322.7 kbps avg (0.0 [inst], 1300.6 [nov.avg]) cwnd 362 rtt12436.3ms 54.1s - sent: 1322.7 kbps avg (0.0 [inst], 1266.6 [nov.avg]) cwnd 379 rtt12446.1ms 55.1s - sent: 1313.1 kbps avg (0.0 [inst], 1252.6 [nov.avg]) cwnd 407 rtt12469.4ms 56.1s - sent: 1317.8 kbps avg (0.0 [inst], 1252.2 [nov.avg]) cwnd 446 rtt12514.5ms 57.1s - sent: 1316.4 kbps avg (0.0 [inst], 1250.7 [nov.avg]) cwnd 502 rtt12557.6ms 58.1s - sent: 1307.1 kbps avg (0.0 [inst], 1204.1 [nov.avg]) cwnd 526 rtt13220.2ms 59.1s - sent: 1284.6 kbps avg (0.0 [inst], 1085.7 [nov.avg]) cwnd 486 rtt12703.2ms 60.1s - sent: 1262.3 kbps avg (0.0 [inst], 975.3 [nov.avg]) cwnd 435 rtt12845.4ms ^C root@mininet-virtual-machine: /home/mininet/lab5/lab5/tcp []</pre>	<pre>"host: h2" x 45.3s - sent: 5661 pkts, 1000.1 kbits/s 46.3s - sent: 5787 pkts, 1000.6 kbits/s 47.3s - sent: 5932 pkts, 1000.9 kbits/s 48.3s - sent: 6038 pkts, 1000.1 kbits/s 49.3s - sent: 6184 pkts, 1000.0 kbits/s 50.3s - sent: 6289 pkts, 999.7 kbits/s 51.3s - sent: 6415 pkts, 1000.4 kbits/s 52.3s - sent: 6541 pkts, 999.9 kbits/s 53.3s - sent: 6674 pkts, 1000.1 kbits/s 54.3s - sent: 6793 pkts, 1000.2 kbits/s 55.3s - sent: 6931 pkts, 1000.1 kbits/s 56.3s - sent: 7044 pkts, 1000.0 kbits/s 57.3s - sent: 7159 pkts, 999.9 kbits/s 58.3s - sent: 7247 pkts, 1000.3 kbits/s 59.3s - sent: 7421 pkts, 1000.9 kbits/s 60.3s - sent: 7546 pkts, 1000.0 kbits/s 61.3s - sent: 7672 pkts, 1000.1 kbits/s 62.3s - sent: 7798 pkts, 1000.1 kbits/s 63.3s - sent: 7923 pkts, 1000.0 kbits/s 64.3s - sent: 8040 pkts, 1001.5 kbits/s 65.3s - sent: 8179 pkts, 1001.8 kbits/s 66.3s - sent: 8300 pkts, 999.6 kbits/s ^C ^Cpackets sent = 63955, avg rate= 992.3 kbps root@mininet-virtual-machine: /home/mininet/lab5/lab5/tcp []</pre>	<pre>root@mininet-virtual-machine: /home/mininet/lab5/lab5/tcp x root@mininet-virtual-machine: /home/mininet/lab5/lab5/udp# cd .. root@mininet-virtual-machine: /home/mininet/lab5/lab5# cd tcp/ root@mininet-virtual-machine: /home/mininet/lab5/lab5/tcp# ./tcpserver 10002 Handling client 10.10.0.2 with child process: 1547 Handling client 10.10.0.2 with child process: 1570 Handling client 10.10.0.2 with child process: 1581 ^C ^C</pre>
<pre>"host: h1" x 39.2s - sent: 4912 pkts, 1001.0 kbits/s 40.2s - sent: 5037 pkts, 999.2 kbits/s 41.2s - sent: 5163 pkts, 1002.1 kbits/s 42.2s - sent: 5289 pkts, 1001.8 kbits/s 43.2s - sent: 5414 pkts, 999.8 kbits/s 44.2s - sent: 5540 pkts, 1001.6 kbits/s 45.2s - sent: 5665 pkts, 999.6 kbits/s 46.2s - sent: 5791 pkts, 999.7 kbits/s 47.2s - sent: 5917 pkts, 1000.4 kbits/s 48.2s - sent: 6043 pkts, 999.5 kbits/s 49.2s - sent: 6169 pkts, 999.5 kbits/s 50.2s - sent: 6295 pkts, 1001.5 kbits/s 51.2s - sent: 6421 pkts, 1000.9 kbits/s 52.2s - sent: 6547 pkts, 999.7 kbits/s 53.2s - sent: 6673 pkts, 1000.1 kbits/s 54.2s - sent: 6799 pkts, 1000.5 kbits/s 55.2s - sent: 6925 pkts, 999.3 kbits/s 56.2s - sent: 7051 pkts, 999.8 kbits/s 57.2s - sent: 7177 pkts, 999.5 kbits/s 58.2s - sent: 7303 pkts, 999.5 kbits/s 59.2s - sent: 7429 pkts, 1000.8 kbits/s 60.2s - sent: 7555 pkts, 1000.1 kbits/s ^C ^Cpackets sent = 7555, avg rate= 944.8 kbps root@mininet-virtual-machine: /home/mininet/lab5/lab5/tcp []</pre>	<pre>"host: h3" x 59.0s - received: 4234/ sent: 4904 pkts (loss 13.658%) 894.4 kbit/s 59.0s - received: 4350/ sent: 5020 pkts (loss 13.381%) 822.6 kbit/s 60.0s - received: 4467/ sent: 5145 pkts (loss 13.178%) 803.9 kbit/s 61.0s - received: 4584/ sent: 5270 pkts (loss 12.923%) 862.6 kbit/s 62.0s - received: 4701/ sent: 5389 pkts (loss 12.678%) 816.2 kbit/s 63.0s - received: 4821/ sent: 5508 pkts (loss 12.473%) 825.5 kbit/s 64.0s - received: 4939/ sent: 5628 pkts (loss 12.268%) 862.9 kbit/s 65.0s - received: 5058/ sent: 5754 pkts (loss 12.079%) 839.5 kbit/s 66.0s - received: 5174/ sent: 5877 pkts (loss 11.927%) 815.6 kbit/s 67.0s - received: 5294/ sent: 5998 pkts (loss 11.840%) 856.7 kbit/s 68.0s - received: 5410/ sent: 6123 pkts (loss 11.645%) 825.9 kbit/s 69.0s - received: 5527/ sent: 6246 pkts (loss 11.478%) 840.1 kbit/s 70.0s - received: 5643/ sent: 6369 pkts (loss 11.362%) 896.1 kbit/s 71.1s - received: 5754/ sent: 6487 pkts (loss 11.300%) 881.7 kbit/s 72.1s - received: 5869/ sent: 6602 pkts (loss 11.272%) 884.7 kbit/s 73.1s - received: 5985/ sent: 6719 pkts (loss 11.222%) 875.0 kbit/s 74.1s - received: 6099/ sent: 6823 pkts (loss 11.230%) 738.1 kbit/s 75.1s - received: 6167/ sent: 6914 pkts (loss 11.283%) 765.0 kbit/s 76.1s - received: 6285/ sent: 7062 pkts (loss 11.272%) 873.1 kbit/s 77.1s - received: 6392/ sent: 7209 pkts (loss 11.333%) 1000.2 kbit/s 78.1s - received: 6509/ sent: 7362 pkts (loss 11.706%) 869.9 kbit/s 79.1s - received: 6515/ sent: 7503 pkts (loss 11.822%) 820.7 kbit/s ^C ^Cpacket received = 6700 / 7555 sent: 11,7842 loss root@mininet-virtual-machine: /home/mininet/lab5/lab5/udp# []</pre>	<pre>root@mininet-virtual-machine: /home/mininet/lab5/lab5/udp x 59.2s - received: 4345/ sent: 5516 pkts (loss 23.084%) 885.7 kbit/s 59.2s - received: 4517/ sent: 5773 pkts (loss 23.062%) 775.2 kbit/s 59.2s - received: 4577/ sent: 5889 pkts (loss 22.750%) 914.1 kbit/s 59.2s - received: 4570/ sent: 5916 pkts (loss 22.742%) 900.6 kbit/s 60.2s - received: 4767/ sent: 6136 pkts (loss 22.352%) 729.0 kbit/s 61.2s - received: 4852/ sent: 6262 pkts (loss 22.357%) 786.2 kbit/s 62.2s - received: 4931/ sent: 6381 pkts (loss 22.083%) 797.9 kbit/s 63.2s - received: 5017/ sent: 6504 pkts (loss 22.033%) 753.1 kbit/s 64.2s - received: 5123/ sent: 6626 pkts (loss 22.234%) 853.9 kbit/s 65.2s - received: 5239/ sent: 6745 pkts (loss 22.578%) 811.9 kbit/s 66.2s - received: 5358/ sent: 6874 pkts (loss 22.922%) 772.7 kbit/s 67.2s - received: 5477/ sent: 6996 pkts (loss 22.190%) 853.9 kbit/s 68.2s - received: 5593/ sent: 7119 pkts (loss 22.150%) 729.3 kbit/s 69.2s - received: 5639/ sent: 7235 pkts (loss 22.027%) 787.6 kbit/s 70.2s - received: 5727/ sent: 7347 pkts (loss 22.211%) 854.9 kbit/s 71.2s - received: 5801/ sent: 7457 pkts (loss 22.207%) 838.9 kbit/s 72.2s - received: 5909/ sent: 7565 pkts (loss 22.327%) 869.3 kbit/s 73.2s - received: 5982/ sent: 7678 pkts (loss 22.350%) 886.9 kbit/s 74.2s - received: 6095/ sent: 7823 pkts (loss 22.600%) 739.9 kbit/s 75.2s - received: 6145/ sent: 7979 pkts (loss 22.934%) 749.5 kbit/s 76.2s - received: 6239/ sent: 8126 pkts (loss 23.222%) 726.3 kbit/s 77.2s - received: 6337/ sent: 8251 pkts (loss 23.197%) 779.9 kbit/s ^C ^Cpacket received = 6471 / 8385 sent: 22,8264 loss root@mininet-virtual-machine: /home/mininet/lab5/lab5/udp []</pre>

h1: goodput = 944.8Kbps

h2-UDP: goodput = 952.9Kbps

h2-TCP: goodput = 975.3Kbps

در حالت 2Mbps:

<pre>root@mininet-virtual-machine: /home/mininet/lab5/lab5/tcp x 31.4s - sent: 574.8 kbps avg (500.1 [inst], 567.7 [nov.avg]) cwnd 83 rtt12847.6ms 32.4s - sent: 556.8 kbps avg (0.0 [inst], 510.9 [nov.avg]) cwnd 74 rtt12923.7ms 33.4s - sent: 533.8 kbps avg (0.0 [inst], 459.8 [nov.avg]) cwnd 73 rtt12923.3ms 34.4s - sent: 536.8 kbps avg (0.0 [inst], 455.8 [nov.avg]) cwnd 89 rtt12916.8ms 35.4s - sent: 522.8 kbps avg (420.2 [inst], 452.2 [nov.avg]) cwnd 89 rtt12915.3ms 36.5s - sent: 517.7 kbps avg (0.0 [inst], 407.0 [nov.avg]) cwnd 27 rtt13390.1ms 37.5s - sent: 536.8 kbps avg (1215.0 [inst], 497.8 [nov.avg]) cwnd 82 rtt12987.4ms 38.5s - sent: 522.8 kbps avg (0.0 [inst], 439.0 [nov.avg]) cwnd 62 rtt12987.4ms 39.5s - sent: 510.8 kbps avg (0.0 [inst], 393.0 [nov.avg]) cwnd 27 rtt12893.0ms 40.5s - sent: 497.8 kbps avg (0.0 [inst], 399.0 [nov.avg]) cwnd 26 rtt12897.7ms 41.5s - sent: 485.8 kbps avg (0.0 [inst], 323.5 [nov.avg]) cwnd 26 rtt12897.7ms 42.5s - sent: 477.8 kbps avg (154.1 [inst], 306.7 [nov.avg]) cwnd 22 rtt12846.7ms 43.5s - sent: 465.8 kbps avg (0.0 [inst], 276.1 [nov.avg]) cwnd 27 rtt12846.7ms 44.5s - sent: 455.8 kbps avg (0.0 [inst], 248.5 [nov.avg]) cwnd 27 rtt12846.7ms 45.5s - sent: 445.8 kbps avg (462.9 [inst], 261.8 [nov.avg]) cwnd 24 rtt12841.8ms 46.5s - sent: 445.8 kbps avg (0.0 [inst], 242.0 [nov.avg]) cwnd 24 rtt12841.8ms 47.5s - sent: 435.8 kbps avg (0.0 [inst], 217.8 [nov.avg]) cwnd 24 rtt12841.8ms 48.5s - sent: 427.8 kbps avg (541.1 [inst], 201.0 [nov.avg]) cwnd 25 rtt12841.8ms 49.5s - sent: 426.8 kbps avg (0.0 [inst], 225.2 [nov.avg]) cwnd 25 rtt12841.8ms 50.5s - sent: 420.8 kbps avg (0.0 [inst], 202.6 [nov.avg]) cwnd 25 rtt12841.8ms 51.5s - sent: 416.8 kbps avg (220.3 [inst], 204.5 [nov.avg]) cwnd 25 rtt12839.8ms 52.5s - sent: 408.8 kbps avg (0.0 [inst], 184.0 [nov.avg]) cwnd 25 rtt12839.8ms ^C root@mininet-virtual-machine: /home/mininet/lab5/lab5/tcp []</pre>	<pre>"host: h2" x 36.1s - sent: 9137 pkts, 1999.4 kbits/s 37.1s - sent: 9208 pkts, 2002.7 kbits/s 38.2s - sent: 9539 pkts, 2001.0 kbits/s 39.2s - sent: 9799 pkts, 2001.0 kbits/s 40.2s - sent: 10041 pkts, 1995.8 kbits/s 41.2s - sent: 10292 pkts, 2006.8 kbits/s 42.2s - sent: 10545 pkts, 2000.3 kbits/s 43.2s - sent: 10794 pkts, 2002.0 kbits/s 44.2s - sent: 10945 pkts, 1998.3 kbits/s 45.2s - sent: 11198 pkts, 2004.0 kbits/s 46.2s - sent: 11547 pkts, 1995.8 kbits/s 47.2s - sent: 11798 pkts, 2002.8 kbits/s 48.2s - sent: 12049 pkts, 2000.8 kbits/s 49.2s - sent: 12300 pkts, 2000.5 kbits/s 50.2s - sent: 12551 pkts, 2002.0 kbits/s 51.2s - sent: 12802 pkts, 2000.7 kbits/s 52.2s - sent: 13053 pkts, 1999.6 kbits/s 53.2s - sent: 13304 pkts, 2002.4 kbits/s 54.2s - sent: 13554 pkts, 1999.9 kbits/s 55.2s - sent: 13804 pkts, 1999.4 kbits/s 56.2s - sent: 14055 pkts, 2001.8 kbits/s 57.2s - sent: 14305 pkts, 1999.9 kbits/s ^C ^Cpackets sent = 14410, avg rate=1914.0 kbps root@mininet-virtual-machine: /home/mininet/lab5/lab5/udp# []</pre>	<pre>root@mininet-virtual-machine: /home/mininet/lab5/lab5/tcp x root@mininet-virtual-machine: /home/mininet/lab5/lab5/udp# cd .. root@mininet-virtual-machine: /home/mininet/lab5/lab5# cd tcp/ root@mininet-virtual-machine: /home/mininet/lab5/lab5/tcp# ./tcpserver 10002 Handling client 10.10.0.2 with child process: 1547 Handling client 10.10.0.2 with child process: 1570 Handling client 10.10.0.2 with child process: 1588 ^C ^C</pre>
<pre>"host: h1" x 30.2s - sent: 3770 pkts, 999.5 kbits/s 31.2s - sent: 3896 pkts, 1000.8 kbits/s 32.2s - sent: 4021 pkts, 999.9 kbits/s 33.2s - sent: 4147 pkts, 999.6 kbits/s 34.2s - sent: 4273 pkts, 999.5 kbits/s 35.2s - sent: 4399 pkts, 1001.2 kbits/s 36.2s - sent: 4525 pkts, 1000.1 kbits/s 37.2s - sent: 4651 pkts, 999.5 kbits/s 38.2s - sent: 4777 pkts, 1002.1 kbits/s 39.2s - sent: 4903 pkts, 1000.0 kbits/s 40.2s - sent: 5029 pkts, 1001.4 kbits/s 41.2s - sent: 5155 pkts, 1002.4 kbits/s 42.2s - sent: 5281 pkts, 1000.6 kbits/s 43.2s - sent: 5407 pkts, 1001.1 kbits/s 44.2s - sent: 5533 pkts, 1000.5 kbits/s 45.2s - sent: 5659 pkts, 1000.7 kbits/s 46.2s - sent: 5785 pkts, 1000.7 kbits/s 47.2s - sent: 5911 pkts, 1000.7 kbits/s 48.2s - sent: 6037 pkts, 999.8 kbits/s 49.2s - sent: 6163 pkts, 1001.0 kbits/s 50.2s - sent: 6289 pkts, 1000.9 kbits/s 51.2s - sent: 6415 pkts, 1000.1 kbits/s ^C ^Cpackets sent = 6510, avg rate= 948.3 kbps root@mininet-virtual-machine: /home/mininet/lab5/lab5/tcp []</pre>	<pre>"host: h3" x 138.8s - received: 3485/ sent: 3882 pkts (loss 9.893%) 965.0 kbit/s 139.8s - received: 3615/ sent: 3988 pkts (loss 9.544%) 865.4 kbit/s 140.8s - received: 3732/ sent: 4121 pkts (loss 9.433%) 1025.9 kbit/s 141.8s - received: 3857/ sent: 4246 pkts (loss 9.044%) 953.2 kbit/s 142.8s - received: 3975/ sent: 4372 pkts (loss 9.081%) 937.5 kbit/s 143.8s - received: 4101/ sent: 4498 pkts (loss 8.620%) 1006.4 kbit/s 144.8s - received: 4228/ sent: 4624 pkts (loss 8.826%) 959.6 kbit/s 145.8s - received: 4344/ sent: 4750 pkts (loss 8.547%) 978.1 kbit/s 146.8s - received: 4468/ sent: 4875 pkts (loss 8.345%) 951.0 kbit/s 147.8s - received: 4589/ sent: 5004 pkts (loss 8.200%) 939.3 kbit/s 148.8s - received: 4707/ sent: 5125 pkts (loss 8.152%) 966.3 kbit/s 149.8s - received: 4830/ sent: 5250 pkts (loss 7.962%) 966.1 kbit/s 150.8s - received: 4951/ sent: 5377 pkts (loss 7.829%) 939.9 kbit/s 151.8s - received: 5075/ sent: 5503 pkts (loss 7.778%) 884.7 kbit/s 152.8s - received: 5194/ sent: 5628 pkts (loss 7.639%) 1002.1 kbit/s 153.8s - received: 5318/ sent: 5754 pkts (loss 7.577%) 933.0 kbit/s 154.8s - received: 5442/ sent: 5880 pkts (loss 7.445%) 965.8 kbit/s 155.8s - received: 5565/ sent: 5995 pkts (loss 7.211%) 869.5 kbit/s 156.8s - received: 5684/ sent: 6121 pkts (loss 7.291%) 941.9 kbit/s 157.8s - received: 5810/ sent: 6257 pkts (loss 7.144%) 1002.7 kbit/s 158.8s - received: 5932/ sent: 6333 pkts (loss 7.052%) 970.1 kbit/s 159.8s - received: 6055/ sent: 6599 pkts (loss 6.373%) 981.4 kbit/s ^C ^Cpacket received = 6161 / 6510 sent: 6,3636 loss root@mininet-virtual-machine: /home/mininet/lab5/lab5/udp# []</pre>	<pre>root@mininet-virtual-machine: /home/mininet/lab5/lab5/udp x 135.9s - received: 7654/ sent: 9866 pkts (loss 15.454%) 1889.6 kbit/s 136.9s - received: 7852/ sent: 9933 pkts (loss 15.404%) 1815.9 kbit/s 137.9s - received: 8124/ sent: 9586 pkts (loss 15.251%) 1854.3 kbit/s 138.9s - received: 8393/ sent: 9693 pkts (loss 15.244%) 1632.1 kbit/s 139.9s - received: 8567/ sent: 10068 pkts (loss 15.072%) 1844.3 kbit/s 140.9s - received: 8786/ sent: 10392 pkts (loss 14.866%) 1829.8 kbit/s 141.9s - received: 8913/ sent: 10696 pkts (loss 14.283%) 1729.5 kbit/s 142.9s - received: 9054/ sent: 10698 pkts (loss 14.584%) 1884.7 kbit/s 143.9s - received: 9475/ sent: 11086 pkts (loss 14.522%) 1801.3 kbit/s 144.9s - received: 9689/ sent: 11323 pkts (loss 14.402%) 1799.9 kbit/s 145.9s - received: 9933/ sent: 11586 pkts (loss 14.267%) 1874.1 kbit/s 146.9s - received: 10155/ sent: 11833 pkts (loss 14.210%) 1774.3 kbit/s 147.9s - received: 10390/ sent: 12030 pkts (loss 14.123%) 1797.1 kbit/s 148.9s - received: 10615/ sent: 12338 pkts (loss 13.953%) 1875.6 kbit/s 149.9s - received: 10854/ sent: 12693 pkts (loss 13.244%) 1753.9 kbit/s 150.9s - received: 11063/ sent: 12842 pkts (loss 13.263%) 1826.8 kbit/s 151.9s - received: 11288/ sent: 12992 pkts (loss 13.703%) 1874.3 kbit/s 152.9s - received: 11517/ sent: 13244 pkts (loss 13.722%) 1717.6 kbit/s 153.9s - received: 11744/ sent: 13595 pkts (loss 13.515%) 1842.8 kbit/s 154.9s - received: 11978/ sent: 13846 pkts (loss 13.491%) 1871.2 kbit/s 155.9s - received: 12187/ sent: 14094 pkts (loss 13.502%) 1703.6 kbit/s 156.9s - received: 12494/ sent: 14407 pkts (loss 13.278%) 2418.0 kbit/s ^C ^Cpacket received = 12595 / 14418 sent: 15,2682 loss root@mininet-virtual-machine: /home/mininet/lab5/lab5/udp []</pre>

h1: goodput = 948.3Kbps

h2-UDP: goodput = 1914.2Kbps

h2-TCP: goodput = 200Kbps

در حالت 4.5Mbps

```

root@mininet-vn: /home/mininet/lab5/lab5/tcp x
37.3s: 10.4Mbps avg (-0.0[inet], 7.4[mov,avg]) cwnd 3 rtt2773.7ms
38.3s: 10.1Mbps avg 44.2[inet], 11.0[mov,avg] cwnd 1 rtt2774.5ms
40.0s: 10.8Mbps avg (-0.0[inet], 9.6[mov,avg]) cwnd 1 rtt2774.5ms
41.0s: 10.1Mbps avg (-0.0[inet], 8.8[mov,avg]) cwnd 1 rtt2774.5ms
42.0s: 10.8Mbps avg 11.0[inet], 9.4[mov,avg] cwnd 2 rtt2775.2ms
43.0s: 17.5Mbps avg (-0.0[inet], 8.0[mov,avg]) cwnd 2 rtt2775.2ms
44.1s: 17.6Mbps avg 22.1[inet], 9.8[mov,avg] cwnd 4 rtt2778.4ms
45.1s: 17.2Mbps avg (-0.0[inet], 8.0[mov,avg]) cwnd 4 rtt2778.4ms
46.1s: 16.8Mbps avg (-0.0[inet], 7.8[mov,avg]) cwnd 4 rtt2778.4ms
47.1s: 16.5Mbps avg (-0.0[inet], 7.0[mov,avg]) cwnd 2 rtt2778.8ms
48.2s: 16.1Mbps avg (-0.0[inet], 6.5[mov,avg]) cwnd 2 rtt2778.8ms
49.2s: 15.8Mbps avg (-0.0[inet], 5.9[mov,avg]) cwnd 2 rtt2779.8ms
50.2s: 16.1Mbps avg 38.1[inet], 8.4[mov,avg] cwnd 2 rtt2777.7ms
51.2s: 15.8Mbps avg (-0.0[inet], 7.6[mov,avg]) cwnd 2 rtt2777.7ms
52.2s: 15.5Mbps avg (-0.0[inet], 6.8[mov,avg]) cwnd 2 rtt2777.7ms
53.3s: 15.4Mbps avg 11.0[inet], 7.2[mov,avg] cwnd 2 rtt2783.1ms
54.3s: 15.1Mbps avg 0.0[inet], 6.6[mov,avg] cwnd 2 rtt2783.1ms
55.3s: 14.9Mbps avg (-0.0[inet], 5.9[mov,avg]) cwnd 2 rtt2783.1ms
56.3s: 14.8Mbps avg (-0.0[inet], 5.3[mov,avg]) cwnd 2 rtt2783.1ms
57.4s: 14.3Mbps avg (-0.0[inet], 4.8[mov,avg]) cwnd 1 rtt2783.1ms
58.4s: 14.1Mbps avg (-0.0[inet], 4.3[mov,avg]) cwnd 1 rtt2783.1ms
59.4s: 13.8Mbps avg (-0.0[inet], 3.8[mov,avg]) cwnd 1 rtt2783.1ms
root@mininet-vn:/home/mininet/lab5/lab5/tcp#

"host: h2" x
43.1s - sent: 24234 pkts, 4517.6 kbit/s
44.1s - sent: 24789 pkts, 4503.4 kbit/s
45.1s - sent: 25351 pkts, 4498.4 kbit/s
46.1s - sent: 25925 pkts, 4504.1 kbit/s
47.1s - sent: 26488 pkts, 4496.7 kbit/s
48.1s - sent: 27092 pkts, 4505.0 kbit/s
49.1s - sent: 27615 pkts, 4503.2 kbit/s
50.1s - sent: 28179 pkts, 4506.8 kbit/s
51.1s - sent: 28742 pkts, 4498.4 kbit/s
52.1s - sent: 29305 pkts, 4502.8 kbit/s
53.1s - sent: 29869 pkts, 4506.3 kbit/s
54.1s - sent: 30432 pkts, 4500.9 kbit/s
55.1s - sent: 30995 pkts, 4503.1 kbit/s
56.1s - sent: 31558 pkts, 4507.3 kbit/s
57.1s - sent: 32126 pkts, 4505.8 kbit/s
58.1s - sent: 32689 pkts, 4500.2 kbit/s
59.1s - sent: 33252 pkts, 4499.5 kbit/s
60.1s - sent: 33815 pkts, 4503.9 kbit/s
61.1s - sent: 34379 pkts, 4503.2 kbit/s
62.1s - sent: 34943 pkts, 4503.3 kbit/s
63.1s - sent: 35506 pkts, 4503.7 kbit/s
64.1s - sent: 36069 pkts, 4499.3 kbit/s
root@mininet-vn:/home/mininet/lab5/lab5/udp#

root@mininet-vn:/home/mininet/lab5/lab5/tcp#
"host: h1" x
36.2s - sent: 4504 pkts, 989.4 kbit/s
37.2s - sent: 4506 pkts, 1000.3 kbit/s
38.2s - sent: 4775 pkts, 989.8 kbit/s
39.2s - sent: 4501 pkts, 1000.3 kbit/s
40.2s - sent: 5006 pkts, 989.3 kbit/s
41.2s - sent: 5152 pkts, 1000.3 kbit/s
42.2s - sent: 5276 pkts, 1000.4 kbit/s
43.2s - sent: 5403 pkts, 989.4 kbit/s
44.2s - sent: 5529 pkts, 1000.5 kbit/s
45.2s - sent: 5595 pkts, 1000.5 kbit/s
46.2s - sent: 5761 pkts, 1000.2 kbit/s
47.2s - sent: 5597 pkts, 989.3 kbit/s
48.2s - sent: 6003 pkts, 1000.6 kbit/s
49.2s - sent: 6159 pkts, 989.7 kbit/s
50.2s - sent: 6395 pkts, 989.8 kbit/s
51.2s - sent: 6411 pkts, 1000.9 kbit/s
52.2s - sent: 6537 pkts, 1000.1 kbit/s
53.2s - sent: 6653 pkts, 1000.0 kbit/s
54.2s - sent: 6768 pkts, 989.3 kbit/s
55.2s - sent: 6914 pkts, 989.9 kbit/s
56.2s - sent: 7040 pkts, 989.8 kbit/s
57.2s - sent: 7165 pkts, 1000.4 kbit/s
root@mininet-vn:/home/mininet/lab5/lab5/udp#

"host: h3" x
218.2s - received: 1882/ sent: 4507 pkts (loss 99.532%) 351.9 kbit/s
219.2s - received: 1885/ sent: 4532 pkts (loss 99.480%) 423.9 kbit/s
220.2s - received: 1839/ sent: 4779 pkts (loss 93.427%) 425.4 kbit/s
221.2s - received: 1889/ sent: 4504 pkts (loss 99.523%) 387.6 kbit/s
222.2s - received: 2037/ sent: 5334 pkts (loss 99.535%) 380.8 kbit/s
223.2s - received: 2091/ sent: 5161 pkts (loss 99.485%) 425.5 kbit/s
224.2s - received: 2141/ sent: 5287 pkts (loss 99.544%) 356.4 kbit/s
225.2s - received: 2185/ sent: 5412 pkts (loss 99.608%) 389.3 kbit/s
226.2s - received: 2240/ sent: 5541 pkts (loss 99.574%) 419.1 kbit/s
227.2s - received: 2301/ sent: 5568 pkts (loss 99.383%) 467.9 kbit/s
228.2s - received: 2356/ sent: 5793 pkts (loss 99.330%) 434.5 kbit/s
229.2s - received: 2410/ sent: 5921 pkts (loss 99.297%) 422.4 kbit/s
230.2s - received: 2464/ sent: 6047 pkts (loss 99.352%) 420.4 kbit/s
231.2s - received: 2508/ sent: 6173 pkts (loss 99.371%) 348.5 kbit/s
232.2s - received: 2559/ sent: 6298 pkts (loss 99.384%) 389.9 kbit/s
233.2s - received: 2613/ sent: 6423 pkts (loss 99.318%) 433.3 kbit/s
234.2s - received: 2654/ sent: 6551 pkts (loss 99.487%) 320.9 kbit/s
235.2s - received: 2637/ sent: 6676 pkts (loss 99.602%) 345.7 kbit/s
236.2s - received: 2724/ sent: 6912 pkts (loss 99.385%) 355.7 kbit/s
237.2s - received: 2761/ sent: 6928 pkts (loss 99.653%) 373.5 kbit/s
238.2s - received: 2834/ sent: 7164 pkts (loss 99.824%) 420.4 kbit/s
239.2s - received: 2889/ sent: 7180 pkts (loss 99.802%) 411.3 kbit/s
packet received = 2699 / 7210 sent: 59.7932 loss
root@mininet-vn:/home/mininet/lab5/lab5/udp#

root@mininet-vn:/home/mininet/lab5/lab5/udp#
218.2s - received: 14905/ sent: 24897 pkts (loss 40.444%) 2501.7 kbit/s
219.2s - received: 14813/ sent: 24910 pkts (loss 40.533%) 2442.4 kbit/s
220.2s - received: 15156/ sent: 25484 pkts (loss 40.545%) 2496.9 kbit/s
221.2s - received: 15424/ sent: 26047 pkts (loss 40.748%) 2482.5 kbit/s
222.2s - received: 15751/ sent: 26610 pkts (loss 40.812%) 2534.1 kbit/s
223.2s - received: 16058/ sent: 27172 pkts (loss 40.902%) 2452.9 kbit/s
224.2s - received: 16374/ sent: 27734 pkts (loss 41.033%) 2359.7 kbit/s
225.2s - received: 16559/ sent: 28302 pkts (loss 41.142%) 2427.9 kbit/s
226.2s - received: 16855/ sent: 28885 pkts (loss 41.223%) 2463.4 kbit/s
227.2s - received: 17272/ sent: 29469 pkts (loss 41.244%) 2454.0 kbit/s
228.2s - received: 17584/ sent: 29981 pkts (loss 41.363%) 2484.7 kbit/s
229.2s - received: 17858/ sent: 30553 pkts (loss 41.426%) 2495.4 kbit/s
230.2s - received: 18209/ sent: 31110 pkts (loss 41.533%) 2449.1 kbit/s
231.2s - received: 18522/ sent: 31681 pkts (loss 41.536%) 2551.5 kbit/s
232.2s - received: 18839/ sent: 32243 pkts (loss 41.575%) 2507.3 kbit/s
233.2s - received: 19157/ sent: 32806 pkts (loss 41.572%) 2599.5 kbit/s
234.2s - received: 19475/ sent: 33369 pkts (loss 41.537%) 2541.8 kbit/s
235.2s - received: 19789/ sent: 33932 pkts (loss 41.823%) 2477.1 kbit/s
236.2s - received: 20092/ sent: 34494 pkts (loss 41.222%) 2454.5 kbit/s
237.2s - received: 20477/ sent: 35064 pkts (loss 41.756%) 2597.7 kbit/s
238.2s - received: 20729/ sent: 35631 pkts (loss 41.577%) 2845.4 kbit/s
239.2s - received: 21137/ sent: 36192 pkts (loss 41.538%) 2893.3 kbit/s
packet received = 21240 / 36394 sent: 41.575% loss

```

h1: goodput = 927.3Kbps h2-UDP: goodput = 4313.4Kbps h2-TCP: goodput = 4.3Kbps

تفاوت‌هایی وجود دارند اما زیاد نیستند و تفاوت اندکی دارند که ناشی از این است که آنالیز loss ما تقریبی است و فرض کرده‌ایم پهنای باند مربوط به host ها جداگانه و ثابت هستند.

۶ بخش ج

پس از خروج از mininet و پاک کردن توپولوژی قبلی با استفاده از دستور `sudo mn -c`، خط مربوط به تنظیمات روتر را در فایل پایتون تغییر می‌دهیم و دوباره توپولوژی را می‌سازیم. برای تغییر این خط، طول صف روتر را به ۱۰۰۰ بسته کاهش دادیم و پهنای باند اینترفیس `eth1` را روی 5Mbps تنظیم می‌کنیم و `enable_ecn` را نیز False می‌گذاریم.

```

mininet@mininet-vn: ~/lab6
GNU nano 4.8 lab6_network.py
link_h2sw1 = net.addLink( h2, sw1)
link_h3sw2 = net.addLink( h3, sw2)
link_r1sw1 = net.addLink( r1, sw1, intfName1='r1-eth0')
link_r1sw2 = net.addLink( r1, sw2, intfName1='r1-eth1')

info('*** Modifying Link Parameters ***')
....
Default parameters for links:
bw = None,
delay = None,
jitter = None,
loss = None,
disable_gro = True,
speedup = 0,
use_hfsc = False,
use_tbf = False,
latency_ms = None,
enable_ecn = False,
enable_red = False,
max_queue_size = None
....
link_r1sw2.intf1.config( bw=5, max_queue_size=1000, enable_ecn=False)

net.start()

info('*** Configuring hosts ***')

```

۷ سوال ۴

یک سرور TCP روی h3 ایجاد می‌کنیم که روی پورت‌های 10001 گوش می‌دهد. یک کلاینت TCP هم روی h1 ایجاد می‌کنیم که به سرور مربوطه گوش دهند. پس از پایداری نرخ‌ها داریم:

```

"host: h3"
root@mininet-vmt/home/mininet/lab6# cd ./
root@mininet-vmt/home/mininet# cd lab5/lab5/tcp
root@mininet-vmt/home/mininet/lab5/lab5/tcp# ./tcpserver 10001
Handling client 10.10.0.1
with child process: 2316
[]

"host: h1"
102.8: 4640.4kbps avg ( 4627.7[inst], 5615.2[mov,avg]) cwnd 1130 rtt2559.4ms
102.8: 4640.4kbps avg ( 4627.7[inst], 5615.2[mov,avg]) cwnd 1131 rtt2559.4ms
103.8: 4640.2kbps avg ( 4618.1[inst], 5515.5[mov,avg]) cwnd 1154 rtt2643.5ms
104.9: 4640.5kbps avg ( 4672.4[inst], 5431.2[mov,avg]) cwnd 1172 rtt2711.2ms
105.9: 4640.8kbps avg ( 4631.6[inst], 5553.2[mov,avg]) cwnd 1185 rtt2766.2ms
106.9: 4640.8kbps avg ( 4639.4[inst], 5391.6[mov,avg]) cwnd 1194 rtt2816.5ms
107.9: 4640.7kbps avg ( 4649.4[inst], 5218.6[mov,avg]) cwnd 1200 rtt2868.7ms
109.0: 4640.8kbps avg ( 4627.8[inst], 5159.5[mov,avg]) cwnd 1206 rtt2891.5ms
110.0: 4640.8kbps avg ( 4641.7[inst], 5107.7[mov,avg]) cwnd 1213 rtt2913.2ms
111.0: 4640.7kbps avg ( 4632.3[inst], 5062.2[mov,avg]) cwnd 1223 rtt2926.5ms
112.0: 4640.8kbps avg ( 4626.0[inst], 5018.6[mov,avg]) cwnd 1239 rtt2941.1ms
112.0: 4640.8kbps avg ( 4626.0[inst], 5018.6[mov,avg]) cwnd 1240 rtt2941.8ms
113.0: 4640.7kbps avg ( 4661.7[inst], 4982.9[mov,avg]) cwnd 1263 rtt2955.4ms
113.1: 4640.7kbps avg ( 4661.7[inst], 4982.9[mov,avg]) cwnd 1264 rtt2955.5ms
114.1: 4640.8kbps avg ( 4628.0[inst], 4947.4[mov,avg]) cwnd 1297 rtt2982.5ms
115.1: 4640.8kbps avg ( 4632.5[inst], 4915.9[mov,avg]) cwnd 1343 rtt3019.8ms
116.1: 4640.8kbps avg ( 4640.3[inst], 4888.4[mov,avg]) cwnd 1403 rtt3080.6ms
116.1: 4640.8kbps avg ( 4640.3[inst], 4888.4[mov,avg]) cwnd 1404 rtt3080.6ms
117.1: 4640.4kbps avg ( 4636.9[inst], 4862.2[mov,avg]) cwnd 1480 rtt3155.1ms
117.2: 4640.4kbps avg ( 4626.9[inst], 4862.2[mov,avg]) cwnd 1481 rtt3156.2ms
118.2: 4640.5kbps avg ( 4652.4[inst], 4841.2[mov,avg]) cwnd 1574 rtt3247.6ms
118.2: 4640.5kbps avg ( 4652.4[inst], 4841.2[mov,avg]) cwnd 1575 rtt3248.0ms
?
root@mininet-vmt/home/mininet/lab5/lab5/tcp#

```

مقدار نرخ ماشین منبع h1 برابر 4640Kbps و مقدار RTT حدود 3247ms و مجموعه مقادیر پنجره ازدحام نیز در بازه‌ی [1000, 1575] قرار گرفته است.

۸ سوال ۵

در این مرحله قابلیت ECN را با تغییر دادن ویژگی enable_ecn به True فعالسازی می‌کنیم و آزمایش مرحله قبل را دوباره اجرا می‌کنیم.

```

mininet@mininet-vm: ~/lab6
GNU nano 4.0 lab6_network.py
link_r1sw2 = net.add_link(r1, sw2, intfName1='r1-eth1')

info('*** Modifying Link Parameters ***')
...
Default parameters for links:
bw = None,
delay = None,
jitter = None,
loss = None,
disable_gro = True,
speedup = 0,
use_hfsc = False,
use_tbf = False,
latency_ms = None,
enable_ecn = False,
enable_red = False,
max_queue_size = None
...
link_r1sw2.intf1.config(bw=5, max_queue_size=1000, enable_ecn=True)

net.start()

info('*** Configuring Hosts ***')
info('*** Executing custom commands ***')
output = net.nameToNode.keys

```

```

"host: h1"
94.2: 4647.7kbps avg ( 4626.7[inst], 4646.0[mov.avg]) cwnd 17 rtt 41.6ms
94.4: 4647.7kbps avg ( 4626.7[inst], 4646.0[mov.avg]) cwnd 19 rtt 43.4ms
94.6: 4647.7kbps avg ( 4626.7[inst], 4646.0[mov.avg]) cwnd 21 rtt 49.2ms
94.9: 4647.3kbps avg ( 4611.7[inst], 4642.6[mov.avg]) cwnd 16 rtt 55.4ms
95.0: 4647.3kbps avg ( 4611.7[inst], 4642.6[mov.avg]) cwnd 12 rtt 29.4ms
95.3: 4647.3kbps avg ( 4611.7[inst], 4642.6[mov.avg]) cwnd 16 rtt 35.3ms
95.5: 4647.3kbps avg ( 4611.7[inst], 4642.6[mov.avg]) cwnd 19 rtt 43.0ms
95.7: 4647.3kbps avg ( 4611.7[inst], 4642.6[mov.avg]) cwnd 21 rtt 49.6ms
95.9: 4647.9kbps avg ( 4663.3[inst], 4644.6[mov.avg]) cwnd 16 rtt 49.6ms
96.1: 4647.9kbps avg ( 4663.3[inst], 4644.6[mov.avg]) cwnd 18 rtt 42.7ms
96.4: 4647.9kbps avg ( 4663.3[inst], 4644.6[mov.avg]) cwnd 21 rtt 47.8ms
96.6: 4647.9kbps avg ( 4663.3[inst], 4644.6[mov.avg]) cwnd 16 rtt 50.4ms
96.8: 4647.9kbps avg ( 4663.3[inst], 4644.6[mov.avg]) cwnd 18 rtt 44.1ms
97.0: 4647.3kbps avg ( 4637.4[inst], 4643.9[mov.avg]) cwnd 20 rtt 46.8ms
97.2: 4647.3kbps avg ( 4637.4[inst], 4643.9[mov.avg]) cwnd 23 rtt 52.8ms
97.5: 4647.3kbps avg ( 4637.4[inst], 4643.9[mov.avg]) cwnd 12 rtt 30.3ms
97.7: 4647.3kbps avg ( 4637.4[inst], 4643.9[mov.avg]) cwnd 15 rtt 34.5ms
97.9: 4647.3kbps avg ( 4637.4[inst], 4643.9[mov.avg]) cwnd 18 rtt 40.2ms
98.1: 4647.2kbps avg ( 4637.4[inst], 4643.3[mov.avg]) cwnd 21 rtt 46.9ms
98.3: 4647.2kbps avg ( 4637.4[inst], 4643.3[mov.avg]) cwnd 23 rtt 52.8ms
98.6: 4647.2kbps avg ( 4637.4[inst], 4643.3[mov.avg]) cwnd 17 rtt 40.3ms
98.8: 4647.2kbps avg ( 4637.4[inst], 4643.3[mov.avg]) cwnd 20 rtt 46.4ms
^C
root@mininet-vm:/home/mininet/lab5/lab5/tcp#

```

```

"host: h3"
root@mininet-vm:/home/mininet/lab5# cd ../lab5/lab5/
root@mininet-vm:/home/mininet/lab5/lab5# cd tcp
root@mininet-vm:/home/mininet/lab5/lab5/tcp# ./tcpserver 10001
Handling client 10.10.0.1
with child process: 3170
[]

```

مقدار نرخ ماشین منبع h1 برابر 4647Kbps و مقدار RTT حدود 45ms و مجموعه مقادیر پنجره ازدحام نیز در بازه‌ی [15, 23] قرار گرفته است.

۹ سوال ۶

با مقایسه بین مقادیر به‌دست‌آمده برای سوال ۴ و ۵ می‌توان نتیجه گرفت فعالسازی قابلیت ECN مقادیر RTT، Congestion window و Average Rate هر سه مورد کاهش پیدا می‌کنند.