آزمایش 5: کنترل ازدحام TCP و UDP

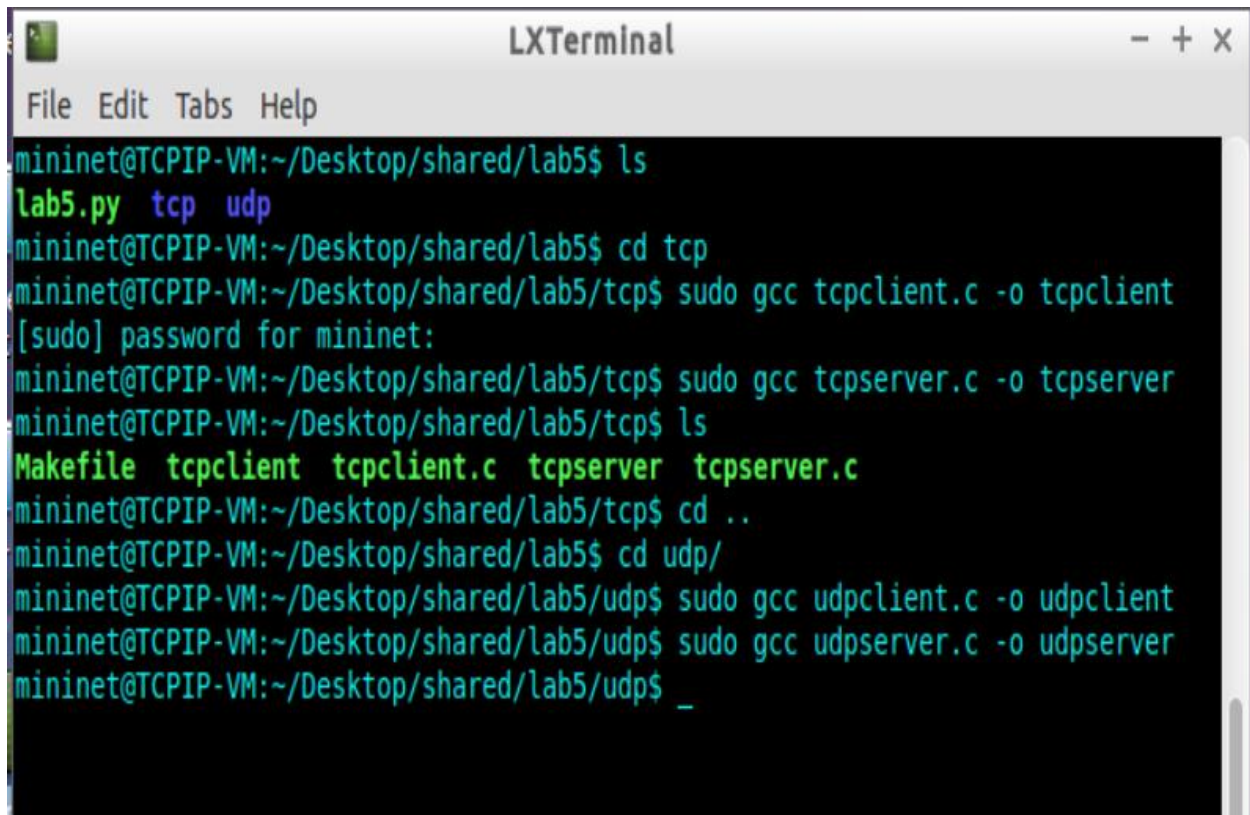**زینب باقیان**

امیرمحمد درپوش

محمدصالح پژند

الف) روال آزمایش:

ابتدا برنامه را راه اندازی میکنیم:

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

تغییرش میدهیم:

ب) جریان های TCP و UDP

فایل lab5.py را به شکل زیر تغییر میدهیم:

```
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:

```
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) سوال1:

در h3 با یک سرور به پورت 10000 وصل میشویم تا گوش کند و در h1 از طرف کلاینت با
پورت 10000 و نرخ kbps100 برای h3 داده میفرستیم:

نتایج بار اول:


```
host: h1                              - + x
root@TCPIP-VM:/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@TCPIP-VM:/home/mininet/Desktop/shared/lab5/udp#
```

نتایج بار دوم:

```
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 هردو تکرار هیچ پکیجی loss نشده و goodput هم مقدار kbps100 را
دارد.

1Mbps test:


```
host: h1                              − + ×
root@TCPIP-VM:/home/mininet/Desktop/shared/lab5/udp# ./udpclient 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-VM:/home/mininet/Desktop/shared/lab5/udp# ./udpclient 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-VM:/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, 98957.2 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^Crecv: 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:

بار دوم:

بعد از گذشت حدود دو دقیقه که مقادیر چاپ شده به حالت پایدار رسیدند و تغییر زیادی نکردند

میتوانیم ببینیم که goodput به ترتیب kbps2536 و kbps2627 برای این پروتکل می باشند

که این یعنی به طور میانگین kbps2581.5 به عنوان نتیجه نهایی بدست می آید.