

### 3. Bandwidth limits

The topology is setup according to the given diagram:

```

"Node: h1"
root@ubuntu-mininet:/home/mininet/loyola# ifconfig
1: lo: <LOOPBACK,UP,LOWER_UP> mtu 65536 qdisc noqueue state UNKNOWN group default
    link/ether 00:00:00:00:00:00 brd 00:00:00:00:00:00
    inet 127.0.0.1/8 scope host lo
        valid_lft forever preferred_lft forever
    inet6 ::1/128 scope host
        valid_lft forever preferred_lft forever
2: h1-eth0: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc fq state UP group default
    link/ether 00:00:00:00:00:01 brd ff:ff:ff:ff:ff:ff link-netnsid 0
    inet 10.0.1.10/24 brd 10.0.1.255 scope global h1-eth
        valid_lft forever preferred_lft forever
    inet6 fe80::200:ff:fe00:26d4 scope link
        valid_lft forever preferred_lft forever
root@ubuntu-mininet:/home/mininet/loyola# python3 sender.py 20000 10.0.4.10 54
Looking up address of 10.0.4.10...got it: 10.0.4.10
Traceback (most recent call last):
  File "sender.py", line 97, in <module>
    ...

"Node: h2"
root@ubuntu-mininet:/home/mininet/loyola# ifconfig
1: lo: <LOOPBACK,UP,LOWER_UP> mtu 65536 qdisc noqueue state UNKNOWN group default
    link/ether 00:00:00:00:00:00 brd 00:00:00:00:00:00
    inet 127.0.0.1/8 scope host lo
        valid_lft forever preferred_lft forever
    inet6 ::1/128 scope host
        valid_lft forever preferred_lft forever
2: h2-eth0: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc fq state UP group default
    link/ether 00:00:00:00:00:02 brd ff:ff:ff:ff:ff:ff link-netnsid 0
    inet 10.0.2.10/24 brd 10.0.2.255 scope global h2-eth
        valid_lft forever preferred_lft forever
    inet6 fe80::200:ff:fe00:26d4 scope link
        valid_lft forever preferred_lft forever
root@ubuntu-mininet:/home/mininet/loyola# python3 sender.py 20000 10.0.4.10 54
Looking up address of 10.0.4.10...got it: 10.0.4.10
total time: 16.783289545207002 seconds

"Node: r"
mininet:/home/mininet/loyola# tc qdisc del dev r-eth4 root
mininet:/home/mininet/loyola# tc qdisc add dev r-eth4 root handle 1: 10
mininet:/home/mininet/loyola# tc class add dev r-eth4 parent 1: 1: htb rate 1mbit
mininet:/home/mininet/loyola# tc class add dev r-eth4 parent 1: 2: htb rate 5mbit
mininet:/home/mininet/loyola# tc class add dev r-eth4 parent 1: 3: htb rate 10mbit
mininet:/home/mininet/loyola# tc filter add dev r-eth4 protocol ip parent 1: u32 match ip src 10.0.1.10 flowid 1:1
mininet:/home/mininet/loyola# tc filter add dev r-eth4 protocol ip parent 1: u32 match ip src 10.0.2.10 flowid 1:2
mininet:/home/mininet/loyola# tc filter add dev r-eth4 protocol ip parent 1: u32 match ip src 10.0.3.10 flowid 1:3
mininet:/home/mininet/loyola#

"Node: h4"
mininet:/home/mininet/loyola# tc qdisc del dev r-eth4 root
mininet:/home/mininet/loyola# tc qdisc add dev r-eth4 root handle 1: 10
mininet:/home/mininet/loyola# tc class add dev r-eth4 parent 1: 1: htb rate 1mbit
mininet:/home/mininet/loyola# tc class add dev r-eth4 parent 1: 2: htb rate 5mbit
mininet:/home/mininet/loyola# tc class add dev r-eth4 parent 1: 3: htb rate 10mbit
mininet:/home/mininet/loyola# tc filter add dev r-eth4 protocol ip parent 1: u32 match ip src 10.0.1.10 flowid 1:1
mininet:/home/mininet/loyola# tc filter add dev r-eth4 protocol ip parent 1: u32 match ip src 10.0.2.10 flowid 1:2
mininet:/home/mininet/loyola# tc filter add dev r-eth4 protocol ip parent 1: u32 match ip src 10.0.3.10 flowid 1:3
mininet:/home/mininet/loyola#

*** Configuring hosts
h1 h2 h3 h4 r enabling forwarding on r
*** Starting controller
c0
*** Starting 0 switches

*** Starting CLI:
mininet> nodes
available nodes are:
c0 h1 h2 h3 h4 r
mininet> xterm h1 h2 h3 h4
mininet> xterm r
mininet> []
  
```

Below screenshot shows the commands used to setup bandwidth limits on the router 'r':

```

"Node: r"
root@ubuntu-mininet:/home/mininet/loyola# tc qdisc del dev r-eth4 root
root@ubuntu-mininet:/home/mininet/loyola# tc qdisc add dev r-eth4 root handle 1: htb default 10
root@ubuntu-mininet:/home/mininet/loyola# tc class add dev r-eth4 parent 1: c1
assid 1:1 htb rate 1mbit
root@ubuntu-mininet:/home/mininet/loyola# tc class add dev r-eth4 parent 1: c1
assid 1:2 htb rate 5mbit
root@ubuntu-mininet:/home/mininet/loyola# tc class add dev r-eth4 parent 1: c1
assid 1:3 htb rate 10mbit
root@ubuntu-mininet:/home/mininet/loyola# tc filter add dev r-eth4 protocol ip
parent 1: u32 match ip src 10.0.1.10 flowid 1:1
root@ubuntu-mininet:/home/mininet/loyola# tc filter add dev r-eth4 protocol ip
parent 1: u32 match ip src 10.0.2.10 flowid 1:2
root@ubuntu-mininet:/home/mininet/loyola# tc filter add dev r-eth4 protocol ip
parent 1: u32 match ip src 10.0.3.10 flowid 1:3
root@ubuntu-mininet:/home/mininet/loyola#
  
```

The dualreceive.py output confirms that limits are working perfect for h1 and h2 in the ratio 1:5.

```

Node: h4
15.002081155776978      1,803,760      5,952,280
16.001725912094116      1,922,496      5,953,728
17.002074003219604      2,044,128      5,953,728
18.00192642211914      2,161,416      5,953,728
19.00153613090515      2,283,048      8,209,712
20.00084686279297      2,401,784      8,209,712
21.00132179260254      2,520,520      8,243,016
22.00167465209961      2,639,256      8,243,016
23.001407146453857      2,760,888      8,243,016
24.00139284133911      2,881,072      8,243,016
25.001768112182617      2,999,808      8,243,016
26.00192666053772      3,118,544      15,031,240
27.004033088684082      3,237,280      15,632,160
28.005815505981445      3,358,912      16,227,288
29.004743576049805      3,477,648      16,822,416
30.005233764648438      3,597,832      17,417,544
31.002771615982056      3,715,120      18,009,776
32.002814531326294      3,835,304      18,606,352
33.001872539520264      3,956,936      19,198,584
34.004910945892334      4,075,672      19,793,712
checkpoint when connection 2 finished: 4,116,216      20,000,000
ratio: 0.2058108
Finishing time: 34.34651327133179
root@lubuntu-mininet:/home/mininet/loyola#

```

Output of dualreceive.py also confirms that bandwidth limits for h1 and h3 works perfectly with the ratio 1:10:

```

Node: h4
root@lubuntu-mininet:/home/mininet/loyola# python3 dualreceive2.py 20000
accepted connections
7.62939453125e-06      0      0
1.0042853355407715      150,144      215,304
2.0081465244293213      270,328      1,344,744
3.001765012741089      389,064      2,530,656
4.001587152481079      507,800      3,729,600
5.0016796588897705      627,984      4,919,856
6.001630783081055      746,720      6,114,456
7.001392364501953      865,456      7,309,056
8.001824855804443      984,192      8,503,656
9.002402782440186      1,104,376      9,250,824
10.002014636993408      1,226,008      9,250,824
11.002127408981323      1,344,744      9,250,824
12.002008438110352      1,463,480      9,250,824
13.001599788665771      1,582,216      10,417,912
14.003005027770996      1,703,848      11,770,344
15.003775835037231      1,821,136      11,770,344
16.001415967941284      1,942,768      16,383,672
17.00150156021118      2,061,504      19,247,816
checkpoint when connection 2 finished: 2,137,400      20,000,000
ratio: 0.10687
Finishing time: 17.632323026657104
root@lubuntu-mininet:/home/mininet/loyola#

```

List of commands used:

```
tc qdisc del dev r-eth4 root
```

```
tc qdisc add dev r-eth4 root handle 1: htb default 10
```

```
tc class add dev r-eth4 parent 1: classid 1:1 htb rate  
1mbit
```

```
tc class add dev r-eth4 parent 1: classid 1:2 htb rate  
5mbit
```

```
tc class add dev r-eth4 parent 1: classid 1:3 htb rate  
10mbit
```

```
tc filter add dev r-eth4 protocol ip parent 1: u32 match  
ip src 10.0.1.10 flowid 1:1
```

```
tc filter add dev r-eth4 protocol ip parent 1: u32 match  
ip src 10.0.2.10 flowid 1:2
```

```
tc filter add dev r-eth4 protocol ip parent 1: u32 match  
ip src 10.0.3.10 flowid 1:3
```