

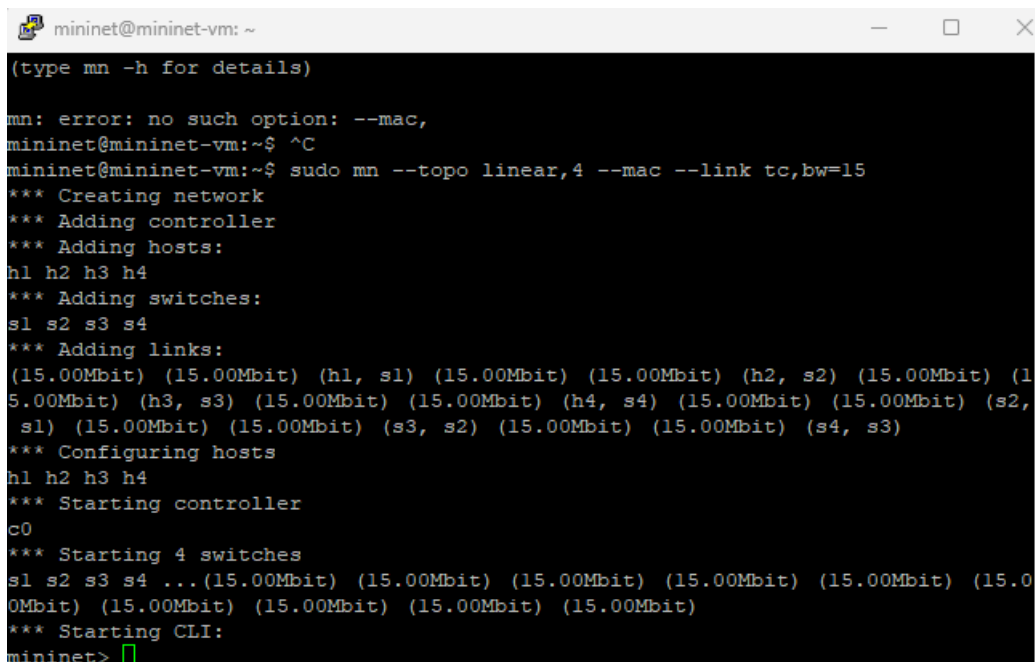
# Trabalho Mininet

# Adicionando IP na porta eth1 para abrir conexão com o putty:

```
sudo ifconfig eth1 192.168.56.101 netmask 255.255.255.0 up
```

A-) Criando a topologia linear com 4 host, mac padronizado e largura de banda de 15Mbps

```
sudo mn --topo linear,4 --mac --link tc,bw=15
```



```
mininet@mininet-vm: ~  
(type mn -h for details)  
  
mn: error: no such option: --mac,  
mininet@mininet-vm:~$ ^C  
mininet@mininet-vm:~$ sudo mn --topo linear,4 --mac --link tc,bw=15  
*** Creating network  
*** Adding controller  
*** Adding hosts:  
h1 h2 h3 h4  
*** Adding switches:  
s1 s2 s3 s4  
*** Adding links:  
(15.00Mbit) (15.00Mbit) (h1, s1) (15.00Mbit) (15.00Mbit) (h2, s2) (15.00Mbit) (15.00Mbit) (h3, s3) (15.00Mbit) (15.00Mbit) (h4, s4) (15.00Mbit) (15.00Mbit) (s2, s1) (15.00Mbit) (15.00Mbit) (s3, s2) (15.00Mbit) (15.00Mbit) (s4, s3)  
*** Configuring hosts  
h1 h2 h3 h4  
*** Starting controller  
c0  
*** Starting 4 switches  
s1 s2 s3 s4 ... (15.00Mbit) (15.00Mbit) (15.00Mbit) (15.00Mbit) (15.00Mbit) (15.00Mbit) (15.00Mbit) (15.00Mbit) (15.00Mbit) (15.00Mbit) (15.00Mbit) (15.00Mbit) (15.00Mbit) (15.00Mbit)  
*** Starting CLI:  
mininet> █
```

B-) Verificação de MAC, IP: h1 ifconfig -a, h2 ifconfig -a, h3 ifconfig -a e h4 ifconfig -a

```

mininet@mininet-vm: ~
mininet> h1 ifconfig -a
h1-eth0  Link encap:Ethernet  HWaddr 00:00:00:00:00:01
         inet addr:10.0.0.1  Bcast:10.255.255.255  Mask:255.0.0.0
         UP BROADCAST RUNNING MULTICAST  MTU:1500  Metric:1
         RX packets:0 errors:0 dropped:0 overruns:0 frame:0
         TX packets:0 errors:0 dropped:0 overruns:0 carrier:0
         collisions:0 txqueuelen:1000
         RX bytes:0 (0.0 B)  TX bytes:0 (0.0 B)

lo       Link encap:Local Loopback
         inet addr:127.0.0.1  Mask:255.0.0.0
         UP LOOPBACK RUNNING  MTU:65536  Metric:1
         RX packets:0 errors:0 dropped:0 overruns:0 frame:0
         TX packets:0 errors:0 dropped:0 overruns:0 carrier:0
         collisions:0 txqueuelen:1
         RX bytes:0 (0.0 B)  TX bytes:0 (0.0 B)

mininet> h2 ifconfig -a
h2-eth0  Link encap:Ethernet  HWaddr 00:00:00:00:00:02
         inet addr:10.0.0.2  Bcast:10.255.255.255  Mask:255.0.0.0
         UP BROADCAST RUNNING MULTICAST  MTU:1500  Metric:1
         RX packets:0 errors:0 dropped:0 overruns:0 frame:0
         TX packets:0 errors:0 dropped:0 overruns:0 carrier:0
         collisions:0 txqueuelen:1000
         RX bytes:0 (0.0 B)  TX bytes:0 (0.0 B)

lo       Link encap:Local Loopback
         inet addr:127.0.0.1  Mask:255.0.0.0
         UP LOOPBACK RUNNING  MTU:65536  Metric:1
         RX packets:0 errors:0 dropped:0 overruns:0 frame:0
         TX packets:0 errors:0 dropped:0 overruns:0 carrier:0
         collisions:0 txqueuelen:1
         RX bytes:0 (0.0 B)  TX bytes:0 (0.0 B)

mininet> h3 ifconfig -a
h3-eth0  Link encap:Ethernet  HWaddr 00:00:00:00:00:03
         inet addr:10.0.0.3  Bcast:10.255.255.255  Mask:255.0.0.0
         UP BROADCAST RUNNING MULTICAST  MTU:1500  Metric:1
         RX packets:0 errors:0 dropped:0 overruns:0 frame:0
         TX packets:0 errors:0 dropped:0 overruns:0 carrier:0
         collisions:0 txqueuelen:1000
         RX bytes:0 (0.0 B)  TX bytes:0 (0.0 B)

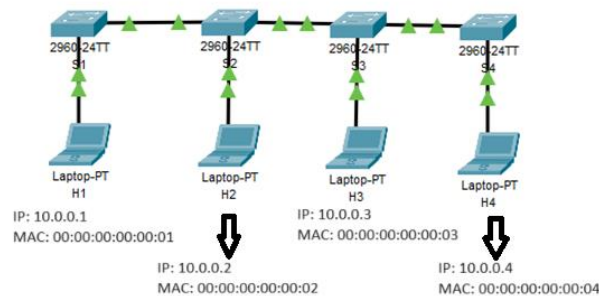
lo       Link encap:Local Loopback
         inet addr:127.0.0.1  Mask:255.0.0.0
         UP LOOPBACK RUNNING  MTU:65536  Metric:1
         RX packets:0 errors:0 dropped:0 overruns:0 frame:0
         TX packets:0 errors:0 dropped:0 overruns:0 carrier:0
         collisions:0 txqueuelen:1
         RX bytes:0 (0.0 B)  TX bytes:0 (0.0 B)

mininet> h4 ifconfig -a
h4-eth0  Link encap:Ethernet  HWaddr 00:00:00:00:00:04
         inet addr:10.0.0.4  Bcast:10.255.255.255  Mask:255.0.0.0
         RX packets:0 errors:0 dropped:0 overruns:0 frame:0
         TX packets:0 errors:0 dropped:0 overruns:0 carrier:0
         collisions:0 txqueuelen:1000
         RX bytes:0 (0.0 B)  TX bytes:0 (0.0 B)

lo       Link encap:Local Loopback
         inet addr:127.0.0.1  Mask:255.0.0.0
         UP LOOPBACK RUNNING  MTU:65536  Metric:1

```

### C-) Desenho ilustrativo da topologia



### D-) Teste de ping entres os nós

```

mininet@mininet-vm: ~
h1 h2 h3 h4
*** Adding switches:
s1 s2 s3 s4
*** Adding links:
(15.00Mbit) (15.00Mbit) (h1, s1) (15.00Mbit) (15.00Mbit) (h2, s2) (15.00Mbit) (15.00
Mbit) (h3, s3) (15.00Mbit) (15.00Mbit) (h4, s4) (15.00Mbit) (15.00Mbit) (s2, s1) (15
.00Mbit) (15.00Mbit) (s3, s2) (15.00Mbit) (15.00Mbit) (s4, s3)
*** Configuring hosts
h1 h2 h3 h4
*** Starting controller
c0
*** Starting 4 switches
s1 s2 s3 s4 ... (15.00Mbit) (15.00Mbit) (15.00Mbit) (15.00Mbit) (15.00Mbit) (15.00Mbi
t) (15.00Mbit) (15.00Mbit) (15.00Mbit) (15.00Mbit)
*** Starting CLI:
mininet> xterm h1 h2 h3 h4
mininet> pingall
*** Ping: testing ping reachability
h1 -> h2 h3 h4
h2 -> h1 h3 h4
h3 -> h1 h2 h4
h4 -> h1 h2 h3
*** Results: 0% dropped (12/12 received)
mininet>

```

```

Node: h1
0x0020: 0000 0000 0001 0a00 0001 .....
09:57:20.595586 IP 10.0.0.1 > 10.0.0.2: ICMP echo request, id 4945, seq 1, length 64
0x0000: 0000 0000 0002 0000 0000 0001 0800 4500 .....E.
0x0010: 0054 9013 4000 4001 9633 0a00 0001 0a00 ...T..@..z.....
0x0020: 0002 0800 11b8 1351 0001 f0dc 2b66 0000 .....Q.....+f..
0x0030: 0000 efd8 0800 0000 0000 1011 1213 1415 .....V.....+f..
0x0040: 1617 1819 1a1b 1c1d 1e1f 2021 2223 2425 .....l"#$%&
0x0050: 2627 2829 2a2b 2c2d 2e2f 3031 3233 3435 &'()*+,-./012345
0x0060: 3637 .....
09:57:20.596535 IP 10.0.0.2 > 10.0.0.1: ICMP echo reply, id 4945, seq 1, length 64
0x0000: 0000 0000 0001 0000 0000 0002 0800 4500 .....E.
0x0010: 0054 fcb4 0000 4001 69f2 0a00 0002 0a00 ...T...@..i.....
0x0020: 0001 0000 13b8 1351 0001 f0dc 2b66 0000 .....Q.....+f..
0x0030: 0000 efd8 0800 0000 0000 1011 1213 1415 .....V.....+f..
0x0040: 1617 1819 1a1b 1c1d 1e1f 2021 2223 2425 .....l"#$%&
0x0050: 2627 2829 2a2b 2c2d 2e2f 3031 3233 3435 &'()*+,-./012345
0x0060: 3637 .....
09:57:20.593243 ARP, Request who-has 10.0.0.3 tell 10.0.0.1, length 28
0x0000: ffff ffff ffff 0000 0000 0001 0806 0001 .....
0x0010: 0800 0604 0001 0000 0000 0001 0a00 0001 .....
0x0020: 0000 0000 0000 0a00 0003 .....
09:57:20.596532 ARP, Reply 10.0.0.3 is-at 00:00:00:00:00:03, length 28

Node: h2
0x0000: 0000 0000 0002 0000 0000 0003 0806 0001 .....
0x0010: 0800 0604 0002 0000 0000 0003 0a00 0003 .....
0x0020: 0000 0000 0002 0a00 0002 .....
09:57:20.656301 IP 10.0.0.2 > 10.0.0.3: ICMP echo request, id 4950, seq 1, length 64
0x0000: 0000 0000 0003 0000 0000 0002 0800 4500 .....E.
0x0010: 0054 3204 4000 4001 f4a0 0a00 0002 0a00 ...T..@..@.....
0x0020: 0003 0800 abac 1356 0001 f0dc 2b66 0000 .....V.....+f..
0x0030: 0000 54e6 0900 0000 0000 1011 1213 1415 .....T.....
0x0040: 1617 1819 1a1b 1c1d 1e1f 2021 2223 2425 .....l"#$%&
0x0050: 2627 2829 2a2b 2c2d 2e2f 3031 3233 3435 &'()*+,-./012345
0x0060: 3637 .....
09:57:20.666396 IP 10.0.0.3 > 10.0.0.2: ICMP echo reply, id 4950, seq 1, length 64
0x0000: 0000 0000 0002 0000 0000 0003 0800 4500 .....E.
0x0010: 0054 9679 0000 4001 d02b 0a00 0003 0a00 ...T.y..@..+.....
0x0020: 0002 0000 b3ac 1356 0001 f0dc 2b66 0000 .....V.....+f..
0x0030: 0000 54e6 0900 0000 0000 1011 1213 1415 .....T.....
0x0040: 1617 1819 1a1b 1c1d 1e1f 2021 2223 2425 .....l"#$%&
0x0050: 2627 2829 2a2b 2c2d 2e2f 3031 3233 3435 &'()*+,-./012345
0x0060: 3637 .....
09:57:20.827247 ARP, Request who-has 10.0.0.4 tell 10.0.0.2, length 28
0x0000: ffff ffff ffff 0000 0000 0002 0806 0001 .....
0x0010: 0800 0604 0001 0000 0000 0002 0a00 0002 .....

Node: h3
09:57:20.611696 IP 10.0.0.1 > 10.0.0.3: ICMP echo request, id 4947, seq 1, length 64
0x0000: 0000 0000 0003 0000 0000 0001 0800 4500 .....E.
0x0010: 0054 abff 4000 4001 7aa6 0a00 0001 0a00 ...T..@..z.....
0x0020: 0003 0800 5071 1353 0001 f0dc 2b66 0000 ...Pq.S.....+f..
0x0030: 0000 b024 0900 0000 0000 1011 1213 1415 ...S.....
0x0040: 1617 1819 1a1b 1c1d 1e1f 2021 2223 2425 .....l"#$%&
0x0050: 2627 2829 2a2b 2c2d 2e2f 3031 3233 3435 &'()*+,-./012345
0x0060: 3637 .....
09:57:20.611718 IP 10.0.0.3 > 10.0.0.1: ICMP echo reply, id 4947, seq 1, length 64
0x0000: 0000 0000 0003 0000 0000 0003 0800 4500 .....E.
0x0010: 0054 73fc 0000 4001 f2a9 0a00 0003 0a00 ...Ts...@..z.....
0x0020: 0001 0000 5871 1353 0001 f0dc 2b66 0000 ...Kq.S.....+f..
0x0030: 0000 b024 0900 0000 0000 1011 1213 1415 ...S.....
0x0040: 1617 1819 1a1b 1c1d 1e1f 2021 2223 2425 .....l"#$%&
0x0050: 2627 2829 2a2b 2c2d 2e2f 3031 3233 3435 &'()*+,-./012345
0x0060: 3637 .....
09:57:20.622228 ARP, Request who-has 10.0.0.4 tell 10.0.0.1, length 28
0x0000: ffff ffff ffff 0000 0000 0001 0806 0001 .....
0x0010: 0800 0604 0001 0000 0000 0001 0a00 0001 .....
0x0020: 0000 0000 0000 0a00 0004 .....
09:57:20.652457 ARP, Request who-has 10.0.0.3 tell 10.0.0.2, length 28
0x0000: ffff ffff ffff 0000 0000 0002 0806 0001 .....

Node: h4
09:57:20.830757 ARP, Reply 10.0.0.4 is-at 00:00:00:00:00:04, length 28
0x0000: 0000 0000 0002 0000 0000 0004 0806 0001 .....
0x0010: 0800 0604 0002 0000 0000 0004 0a00 0004 .....
0x0020: 0000 0000 0002 0a00 0002 .....
09:57:20.846363 IP 10.0.0.2 > 10.0.0.4: ICMP echo request, id 4951, seq 1, length 64
0x0000: 0000 0000 0004 0000 0000 0002 0800 4500 .....E.
0x0010: 0054 1aaa 4000 4001 0bfa 0a00 0002 0a00 ...T..@..@.....
0x0020: 0004 0800 a5f2 1357 0001 f0dc 2b66 0000 .....W.....+f..
0x0030: 0000 579f 0c00 0000 0000 1011 1213 1415 ...W.....
0x0040: 1617 1819 1a1b 1c1d 1e1f 2021 2223 2425 .....l"#$%&
0x0050: 2627 2829 2a2b 2c2d 2e2f 3031 3233 3435 &'()*+,-./012345
0x0060: 3637 .....
09:57:20.846379 IP 10.0.0.4 > 10.0.0.2: ICMP echo reply, id 4951, seq 1, length 64
0x0000: 0000 0000 0002 0000 0000 0004 0800 4500 .....E.
0x0010: 0054 bdlc 0000 4001 a895 0a00 0004 0a00 ...T...@..@.....
0x0020: 0002 0000 adf2 1357 0001 f0dc 2b66 0000 .....W.....+f..
0x0030: 0000 579f 0c00 0000 0000 1011 1213 1415 ...W.....
0x0040: 1617 1819 1a1b 1c1d 1e1f 2021 2223 2425 .....l"#$%&
0x0050: 2627 2829 2a2b 2c2d 2e2f 3031 3233 3435 &'()*+,-./012345
0x0060: 3637 .....
09:57:20.870101 ARP, Request who-has 10.0.0.4 tell 10.0.0.3, length 28
0x0000: ffff ffff ffff 0000 0000 0003 0806 0001 .....

```

## E-) Teste iperf de 10s com banda de 1Mbps

- Criando a topologia com 1Mbps: `sudo mn --topo linear,4 --mac --link tc,bw=1`
- Abrindo os terminais xterm: `xterm h1 h2`
- Configurando h1 como servidor com 10s de intervalo: `iperf -s -p 5555 -i 10`
- Configurando h2 como cliente: `iperf -c 10.0.0.1 -p 5555 -i 1 -t 10`

```

Node: h1
root@mininet-vml:~# iperf -s -p 5555 -i 1

Server listening on TCP port 5555
TCP window size: 85.3 KByte (default)

[ 24] local 10.0.0.1 port 5555 connected with 10.0.0.2 port 47506
[ 10] Interval      Transfer      Bandwidth
[ 24] 0.0- 1.0 sec    119 KBytes    973 Kbits/sec
[ 24] 1.0- 2.0 sec    119 KBytes    973 Kbits/sec
[ 24] 2.0- 3.0 sec    116 KBytes    950 Kbits/sec
[ 24] 3.0- 4.0 sec    116 KBytes    950 Kbits/sec
[ 24] 4.0- 5.0 sec    116 KBytes    950 Kbits/sec
[ 24] 5.0- 6.0 sec    117 KBytes    961 Kbits/sec
[ 24] 6.0- 7.0 sec    116 KBytes    950 Kbits/sec
[ 24] 7.0- 8.0 sec    119 KBytes    973 Kbits/sec
[ 24] 8.0- 9.0 sec    116 KBytes    950 Kbits/sec
[ 24] 9.0-10.0 sec    116 KBytes    950 Kbits/sec
[ 24] 10.0-11.0 sec   119 KBytes    973 Kbits/sec
[ 24] 11.0-12.0 sec   115 KBytes    938 Kbits/sec
[ 24] 12.0-13.0 sec   119 KBytes    973 Kbits/sec
[ 24] 0.0-13.1 sec    1.50 MBytes    968 Kbits/sec

Node: h2
root@mininet-vml:~# iperf -c 10.0.0.1 -p 5555 -i 1 -t 10

Client connecting to 10.0.0.1, TCP port 5555
TCP window size: 85.3 KByte (default)

[ 23] local 10.0.0.2 port 47506 connected with 10.0.0.1 port 5555
[ 10] Interval      Transfer      Bandwidth
[ 23] 0.0- 1.0 sec    256 KBytes    2.10 Mbits/sec
[ 23] 1.0- 2.0 sec    256 KBytes    2.10 Mbits/sec
[ 23] 2.0- 3.0 sec    128 KBytes    1.05 Mbits/sec
[ 23] 3.0- 4.0 sec    128 KBytes    1.05 Mbits/sec
[ 23] 4.0- 5.0 sec     0.00 Bytes     0.00 bits/sec
[ 23] 5.0- 6.0 sec    128 KBytes    1.05 Mbits/sec
[ 23] 6.0- 7.0 sec    128 KBytes    1.05 Mbits/sec
[ 23] 7.0- 8.0 sec    128 KBytes    1.05 Mbits/sec
[ 23] 8.0- 9.0 sec    128 KBytes    1.05 Mbits/sec
[ 23] 9.0-10.0 sec    128 KBytes    1.05 Mbits/sec
[ 23] 0.0-12.1 sec    1.50 MBytes    1.04 Mbits/sec
root@mininet-vml:~#

```

## F-) Teste iperf de 10s com banda de 3Mbps

- Criando a topologia com 3Mbps: `sudo mn --topo linear,4 --mac --link tc,bw=3`
- Abrindo os terminais xterm: `xterm h1 h2`
- Configurando h1 como servidor com 10s de intervalo: `iperf -s -p 5555 -i 10`
- Configurando h2 como cliente: `iperf -c 10.0.0.1 -p 5555 -i 1 -t 10`

```
Node: h1
root@mininet-vn:~# iperf -s -p 5555 -i 1
Server listening on TCP port 5555
TCP window size: 85.3 KByte (default)

[ 24] local 10.0.0.1 port 5555 connected with 10.0.0.2 port 47478
[ ID] Interval      Transfer    Bandwidth
[ 24] 0.0- 1.0 sec   352 KBytes  2.88 Mbits/sec
[ 24] 1.0- 2.0 sec   351 KBytes  2.87 Mbits/sec
[ 24] 2.0- 3.0 sec   349 KBytes  2.86 Mbits/sec
[ 24] 3.0- 4.0 sec   351 KBytes  2.87 Mbits/sec
[ 24] 4.0- 5.0 sec   352 KBytes  2.88 Mbits/sec
[ 24] 5.0- 6.0 sec   348 KBytes  2.85 Mbits/sec
[ 24] 6.0- 7.0 sec   352 KBytes  2.88 Mbits/sec
[ 24] 7.0- 8.0 sec   351 KBytes  2.87 Mbits/sec
[ 24] 8.0- 9.0 sec   349 KBytes  2.86 Mbits/sec
[ 24] 9.0-10.0 sec   351 KBytes  2.87 Mbits/sec
[ 24] 10.0-11.0 sec   349 KBytes  2.86 Mbits/sec
[ 24] 0.0-11.3 sec   3.88 MBytes  2.87 Mbits/sec

Node: h2
root@mininet-vn:~# iperf -c 10.0.0.1 -p 5555 -i 1 -t 10
Client connecting to 10.0.0.1, TCP port 5555
TCP window size: 85.3 KByte (default)

[ 23] local 10.0.0.2 port 47478 connected with 10.0.0.1 port 5555
[ ID] Interval      Transfer    Bandwidth
[ 23] 0.0- 1.0 sec   640 KBytes  5.24 Mbits/sec
[ 23] 1.0- 2.0 sec   384 KBytes  3.15 Mbits/sec
[ 23] 2.0- 3.0 sec   384 KBytes  3.15 Mbits/sec
[ 23] 3.0- 4.0 sec   256 KBytes  2.10 Mbits/sec
[ 23] 4.0- 5.0 sec   384 KBytes  3.15 Mbits/sec
[ 23] 5.0- 6.0 sec   384 KBytes  3.15 Mbits/sec
[ 23] 6.0- 7.0 sec   384 KBytes  3.15 Mbits/sec
[ 23] 7.0- 8.0 sec   256 KBytes  2.10 Mbits/sec
[ 23] 8.0- 9.0 sec   384 KBytes  3.15 Mbits/sec
[ 23] 9.0-10.0 sec   384 KBytes  3.15 Mbits/sec
[ 23] 0.0-10.6 sec   3.88 MBytes  3.07 Mbits/sec
```

## F-) Teste iperf de 10s com banda de 12Mbps

- Criando a topologia com 1Mbps: `sudo mn --topo linear,4 --mac --link tc,bw=12`
- Abrindo os terminais xterm: `xterm h1 h2`
- Configurando h1 como servidor com 10s de intervalo: `iperf -s -p 5555 -i 1`
- Configurando h2 como cliente: `iperf -c 10.0.0.1 -p 5555 -i 1 -t 10`

```
Node: h1
root@mininet-vn:~# iperf -s -p 5555 -i 1
Server listening on TCP port 5555
TCP window size: 85.3 KByte (default)

[ 24] local 10.0.0.1 port 5555 connected with 10.0.0.2 port 47458
[ ID] Interval      Transfer    Bandwidth
[ 24] 0.0- 1.0 sec   1.35 MBytes  11.3 Mbits/sec
[ 24] 1.0- 2.0 sec   1.35 MBytes  11.3 Mbits/sec
[ 24] 2.0- 3.0 sec   1.34 MBytes  11.3 Mbits/sec
[ 24] 3.0- 4.0 sec   1.35 MBytes  11.3 Mbits/sec
[ 24] 4.0- 5.0 sec   1.33 MBytes  11.2 Mbits/sec
[ 24] 5.0- 6.0 sec   1.32 MBytes  11.1 Mbits/sec
[ 24] 6.0- 7.0 sec   1.34 MBytes  11.3 Mbits/sec
[ 24] 7.0- 8.0 sec   1.35 MBytes  11.3 Mbits/sec
[ 24] 8.0- 9.0 sec   1.35 MBytes  11.3 Mbits/sec
[ 24] 9.0-10.0 sec   1.35 MBytes  11.4 Mbits/sec
[ 24] 0.0-10.3 sec   13.9 MBytes  11.3 Mbits/sec

Node: h2
root@mininet-vn:~# iperf -c 10.0.0.1 -p 5555 -i 1 -t 10
Client connecting to 10.0.0.1, TCP port 5555
TCP window size: 85.3 KByte (default)

[ 23] local 10.0.0.2 port 47458 connected with 10.0.0.1 port 5555
[ ID] Interval      Transfer    Bandwidth
[ 23] 0.0- 1.0 sec   1.75 MBytes  14.7 Mbits/sec
[ 23] 1.0- 2.0 sec   1.25 MBytes  10.5 Mbits/sec
[ 23] 2.0- 3.0 sec   1.38 MBytes  11.5 Mbits/sec
[ 23] 3.0- 4.0 sec   1.25 MBytes  10.5 Mbits/sec
[ 23] 4.0- 5.0 sec   1.38 MBytes  11.5 Mbits/sec
[ 23] 5.0- 6.0 sec   1.38 MBytes  11.5 Mbits/sec
[ 23] 6.0- 7.0 sec   1.38 MBytes  11.5 Mbits/sec
[ 23] 7.0- 8.0 sec   1.25 MBytes  10.5 Mbits/sec
[ 23] 8.0- 9.0 sec   1.38 MBytes  11.5 Mbits/sec
[ 23] 9.0-10.0 sec   1.38 MBytes  11.5 Mbits/sec
[ 23] 0.0-10.1 sec   13.9 MBytes  11.5 Mbits/sec
```

## F-) Teste iperf de 10s com banda de 18Mbps

- Criando a topologia com 1Mbps: `sudo mn --topo linear,4 --mac --link tc,bw=18`
- Abrindo os terminais xterm: `xterm h1 h2`
- Configurando h1 como servidor com 10s de intervalo: `iperf -s -p 5555 -i 1`
- Configurando h2 como cliente: `iperf -c 10.0.0.1 -p 5555 -i 1 -t 10`

```
Node: h1
root@mininet-vn:~# iperf -s -p 5555 -i 1
Server listening on TCP port 5555
TCP window size: 85.3 KByte (default)

[ 24] local 10.0.0.1 port 5555 connected with 10.0.0.2 port 47430
[ ID] Interval      Transfer    Bandwidth
[ 24] 0.0- 1.0 sec   2.01 MBytes  16.8 Mbits/sec
[ 24] 1.0- 2.0 sec   2.01 MBytes  16.8 Mbits/sec
[ 24] 2.0- 3.0 sec   2.02 MBytes  17.0 Mbits/sec
[ 24] 3.0- 4.0 sec   2.03 MBytes  17.0 Mbits/sec
[ 24] 4.0- 5.0 sec   2.03 MBytes  17.1 Mbits/sec
[ 24] 5.0- 6.0 sec   2.04 MBytes  17.1 Mbits/sec
[ 24] 6.0- 7.0 sec   2.02 MBytes  16.9 Mbits/sec
[ 24] 7.0- 8.0 sec   2.02 MBytes  17.0 Mbits/sec
[ 24] 8.0- 9.0 sec   2.03 MBytes  17.0 Mbits/sec
[ 24] 9.0-10.0 sec   2.03 MBytes  17.0 Mbits/sec
[ 24] 0.0-10.3 sec   20.9 MBytes  17.0 Mbits/sec

Node: h2
root@mininet-vn:~# iperf -c 10.0.0.1 -p 5555 -i 1 -t 10
Client connecting to 10.0.0.1, TCP port 5555
TCP window size: 85.3 KByte (default)

[ 23] local 10.0.0.2 port 47430 connected with 10.0.0.1 port 5555
[ ID] Interval      Transfer    Bandwidth
[ 23] 0.0- 1.0 sec   2.25 MBytes  18.9 Mbits/sec
[ 23] 1.0- 2.0 sec   2.00 MBytes  16.8 Mbits/sec
[ 23] 2.0- 3.0 sec   2.00 MBytes  16.8 Mbits/sec
[ 23] 3.0- 4.0 sec   2.12 MBytes  17.8 Mbits/sec
[ 23] 4.0- 5.0 sec   2.00 MBytes  16.8 Mbits/sec
[ 23] 5.0- 6.0 sec   2.12 MBytes  17.8 Mbits/sec
[ 23] 6.0- 7.0 sec   2.00 MBytes  16.8 Mbits/sec
[ 23] 7.0- 8.0 sec   2.12 MBytes  17.8 Mbits/sec
[ 23] 8.0- 9.0 sec   2.00 MBytes  16.8 Mbits/sec
[ 23] 9.0-10.0 sec   2.12 MBytes  17.8 Mbits/sec
[ 23] 0.0-10.2 sec   20.9 MBytes  17.2 Mbits/sec
```

# Deletar uma topologia existente:

`sudo mn -c`

2 -) Criar uma topologia em python para o desenho ilustrado

Link do GitHub: [Trabalhos-Inatel/C115-Dispositivos\\_Conectados/Trabalho\\_Mininet](https://github.com/Trabalhos-Inatel/C115-Dispositivos_Conectados/Trabalho_Mininet) at main · Jonathan-Stefan/Trabalhos-Inatel (github.com)

A-) Criando a topologia customizada:

`sudo mn --custom topo_5switches_6hosts.py --topo mytopo`

b-) Inspeção das portas, endereços IP e MAC:

```
mininet> net
h1 h1-eth0:s1-eth1
h2 h2-eth0:s2-eth2
h3 h3-eth0:s4-eth2
h4 h4-eth0:s4-eth3
h5 h5-eth0:s5-eth2
h6 h6-eth0:s5-eth3
s1 lo: s1-eth1:h1-eth0 s1-eth2:s2-eth1
s2 lo: s2-eth1:s1-eth2 s2-eth2:h2-eth0 s2-eth3:s3-eth1
s3 lo: s3-eth1:s2-eth3 s3-eth2:s4-eth1 s3-eth3:s5-eth1
s4 lo: s4-eth1:s3-eth2 s4-eth2:h3-eth0 s4-eth3:h4-eth0
s5 lo: s5-eth1:s3-eth3 s5-eth2:h5-eth0 s5-eth3:h6-eth0
c0
```

```
mininet> h1 ifconfig -a
h1-eth0  Link encap:Ethernet  HWaddr 00:00:00:00:00:01
         inet addr:192.168.0.1  Bcast:192.168.0.15  Mask:255.255.255.240
         UP BROADCAST RUNNING MULTICAST  MTU:1500  Metric:1
         RX packets:0 errors:0 dropped:0 overruns:0 frame:0
         TX packets:0 errors:0 dropped:0 overruns:0 carrier:0
         collisions:0 txqueuelen:1000
         RX bytes:0 (0.0 B)  TX bytes:0 (0.0 B)

lo       Link encap:Local Loopback
         inet addr:127.0.0.1  Mask:255.0.0.0
         UP LOOPBACK RUNNING  MTU:65536  Metric:1
         RX packets:0 errors:0 dropped:0 overruns:0 frame:0
         TX packets:0 errors:0 dropped:0 overruns:0 carrier:0
         collisions:0 txqueuelen:1
         RX bytes:0 (0.0 B)  TX bytes:0 (0.0 B)
```

```
mininet> h2 ifconfig -a
h2-eth0  Link encap:Ethernet  HWaddr 00:00:00:00:00:02
         inet addr:192.168.0.2  Bcast:192.168.0.15  Mask:255.255.255.240
         UP BROADCAST RUNNING MULTICAST  MTU:1500  Metric:1
         RX packets:0 errors:0 dropped:0 overruns:0 frame:0
         TX packets:0 errors:0 dropped:0 overruns:0 carrier:0
         collisions:0 txqueuelen:1000
         RX bytes:0 (0.0 B)  TX bytes:0 (0.0 B)

lo       Link encap:Local Loopback
         inet addr:127.0.0.1  Mask:255.0.0.0
         UP LOOPBACK RUNNING  MTU:65536  Metric:1
         RX packets:0 errors:0 dropped:0 overruns:0 frame:0
         TX packets:0 errors:0 dropped:0 overruns:0 carrier:0
         collisions:0 txqueuelen:1
         RX bytes:0 (0.0 B)  TX bytes:0 (0.0 B)
```

```
mininet> h3 ifconfig -a
h3-eth0  Link encap:Ethernet  HWaddr 00:00:00:00:00:03
         inet addr:192.168.0.3  Bcast:192.168.0.15  Mask:255.255.255.240
         UP BROADCAST RUNNING MULTICAST  MTU:1500  Metric:1
         RX packets:0 errors:0 dropped:0 overruns:0 frame:0
         TX packets:0 errors:0 dropped:0 overruns:0 carrier:0
         collisions:0 txqueuelen:1000
         RX bytes:0 (0.0 B)  TX bytes:0 (0.0 B)

lo       Link encap:Local Loopback
         inet addr:127.0.0.1  Mask:255.0.0.0
         UP LOOPBACK RUNNING  MTU:65536  Metric:1
         RX packets:0 errors:0 dropped:0 overruns:0 frame:0
         TX packets:0 errors:0 dropped:0 overruns:0 carrier:0
         collisions:0 txqueuelen:1
         RX bytes:0 (0.0 B)  TX bytes:0 (0.0 B)
```

```
mininet> h4 ifconfig -a
h4-eth0  Link encap:Ethernet  HWaddr 00:00:00:00:00:04
         inet addr:192.168.0.4  Bcast:192.168.0.15  Mask:255.255.255.240
         UP BROADCAST RUNNING MULTICAST  MTU:1500  Metric:1
         RX packets:0 errors:0 dropped:0 overruns:0 frame:0
         TX packets:0 errors:0 dropped:0 overruns:0 carrier:0
         collisions:0 txqueuelen:1000
         RX bytes:0 (0.0 B)  TX bytes:0 (0.0 B)

lo       Link encap:Local Loopback
         inet addr:127.0.0.1  Mask:255.0.0.0
         UP LOOPBACK RUNNING  MTU:65536  Metric:1
         RX packets:0 errors:0 dropped:0 overruns:0 frame:0
         TX packets:0 errors:0 dropped:0 overruns:0 carrier:0
         collisions:0 txqueuelen:1
         RX bytes:0 (0.0 B)  TX bytes:0 (0.0 B)
```

```
mininet> h5 ifconfig -a
h5-eth0  Link encap:Ethernet  HWaddr 00:00:00:00:00:05
         inet addr:192.168.0.5  Bcast:192.168.0.15  Mask:255.255.255.240
         UP BROADCAST RUNNING MULTICAST  MTU:1500  Metric:1
         RX packets:0 errors:0 dropped:0 overruns:0 frame:0
         TX packets:0 errors:0 dropped:0 overruns:0 carrier:0
         collisions:0 txqueuelen:1000
         RX bytes:0 (0.0 B)  TX bytes:0 (0.0 B)

lo       Link encap:Local Loopback
         inet addr:127.0.0.1  Mask:255.0.0.0
         UP LOOPBACK RUNNING  MTU:65536  Metric:1
         RX packets:0 errors:0 dropped:0 overruns:0 frame:0
         TX packets:0 errors:0 dropped:0 overruns:0 carrier:0
         collisions:0 txqueuelen:1
         RX bytes:0 (0.0 B)  TX bytes:0 (0.0 B)
```



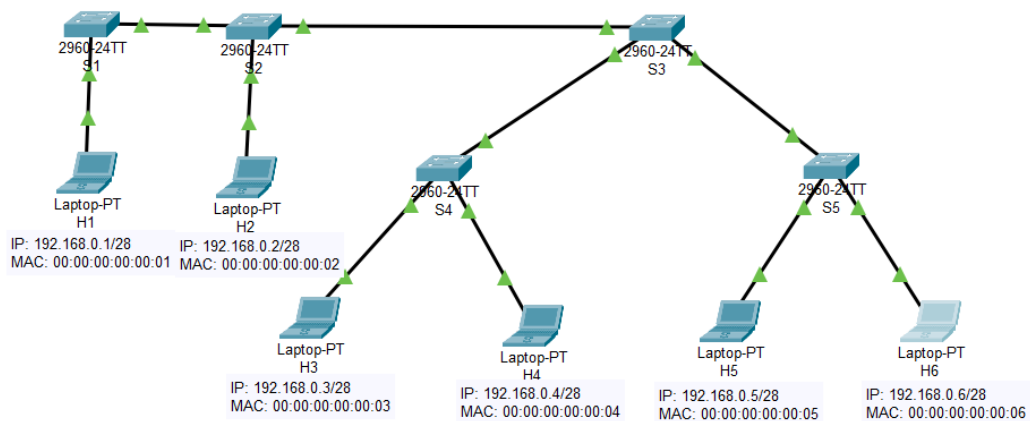
```

mininet> h6 ifconfig -a
h6-eth0  Link encap:Ethernet  HWaddr 00:00:00:00:00:06
         inet addr:192.168.0.6  Bcast:192.168.0.15  Mask:255.255.255.240
         UP BROADCAST RUNNING MULTICAST  MTU:1500  Metric:1
         RX packets:0 errors:0 dropped:0 overruns:0 frame:0
         TX packets:0 errors:0 dropped:0 overruns:0 carrier:0
         collisions:0 txqueuelen:1000
         RX bytes:0 (0.0 B)  TX bytes:0 (0.0 B)

lo       Link encap:Local Loopback
         inet addr:127.0.0.1  Mask:255.0.0.0
         UP LOOPBACK RUNNING  MTU:65536  Metric:1
         RX packets:0 errors:0 dropped:0 overruns:0 frame:0
         TX packets:0 errors:0 dropped:0 overruns:0 carrier:0
         collisions:0 txqueuelen:1
         RX bytes:0 (0.0 B)  TX bytes:0 (0.0 B)

```

C-) Desenho da topologia com as informações obtidas



D-) Teste de pings com os switches normais

```

mininet@mininet-vm: ~

*** Ping: testing ping reachability
h1 -> h2 h3 h4 h5 h6
h2 -> h1 h3 h4 h5 h6
h3 -> h1 h2 h4 h5 h6
h4 -> h1 h2 h3 h5 h6
h5 -> h1 h2 h3 h4 h6
h6 -> h1 h2 h3 h4 h5
*** Results: 0% dropped (30/30 received)

```

```
h1 h2 h3 h4 h5
root@mininet-vn:~# ping 192.168.0.2 -c4
PING 192.168.0.2 (192.168.0.2) 56(84) bytes of data.
64 bytes from 192.168.0.2: icmp_seq=1 ttl=64 time=1.87 ms
64 bytes from 192.168.0.2: icmp_seq=2 ttl=64 time=1.51 ms
64 bytes from 192.168.0.2: icmp_seq=3 ttl=64 time=0.91 ms
64 bytes from 192.168.0.2: icmp_seq=4 ttl=64 time=0.075 ms

--- 192.168.0.2 ping statistics ---
4 packets transmitted, 4 received, 0% packet loss, time 3004ms
rtt min/avg/max/ndev = 0.076/0.370/1.871/0.742 ms
root@mininet-vn:~# ping 192.168.0.5 -c4
PING 192.168.0.5 (192.168.0.5) 56(84) bytes of data.
64 bytes from 192.168.0.5: icmp_seq=1 ttl=64 time=0.01 ms
64 bytes from 192.168.0.5: icmp_seq=2 ttl=64 time=0.01 ms
64 bytes from 192.168.0.5: icmp_seq=3 ttl=64 time=0.573 ms
64 bytes from 192.168.0.5: icmp_seq=4 ttl=64 time=0.055 ms

--- 192.168.0.5 ping statistics ---
4 packets transmitted, 4 received, 0% packet loss, time 3004ms
rtt min/avg/max/ndev = 0.053/0.584/7.686/3.390 ms
root@mininet-vn:~#

root@mininet-vn:~# ping 192.168.0.1 -c4
PING 192.168.0.1 (192.168.0.1) 56(84) bytes of data.
64 bytes from 192.168.0.1: icmp_seq=1 ttl=64 time=1.1 ms
64 bytes from 192.168.0.1: icmp_seq=2 ttl=64 time=0.905 ms
64 bytes from 192.168.0.1: icmp_seq=3 ttl=64 time=0.110 ms
64 bytes from 192.168.0.1: icmp_seq=4 ttl=64 time=0.123 ms

--- 192.168.0.1 ping statistics ---
4 packets transmitted, 4 received, 0% packet loss, time 3003ms
rtt min/avg/max/ndev = 0.110/0.321/2.150/5.107 ms
root@mininet-vn:~# ping 192.168.0.3 -c4
PING 192.168.0.3 (192.168.0.3) 56(84) bytes of data.
64 bytes from 192.168.0.3: icmp_seq=1 ttl=64 time=2.00 ms
64 bytes from 192.168.0.3: icmp_seq=2 ttl=64 time=0.485 ms
64 bytes from 192.168.0.3: icmp_seq=3 ttl=64 time=0.075 ms
64 bytes from 192.168.0.3: icmp_seq=4 ttl=64 time=0.095 ms

--- 192.168.0.3 ping statistics ---
4 packets transmitted, 4 received, 0% packet loss, time 3001ms
rtt min/avg/max/ndev = 0.079/0.559/2.009/0.792 ms
root@mininet-vn:~#

root@mininet-vn:~# ping 192.168.0.4 -c4
PING 192.168.0.4 (192.168.0.4) 56(84) bytes of data.
64 bytes from 192.168.0.4: icmp_seq=1 ttl=64 time=1.41 ms
64 bytes from 192.168.0.4: icmp_seq=2 ttl=64 time=0.581 ms
64 bytes from 192.168.0.4: icmp_seq=3 ttl=64 time=0.127 ms
64 bytes from 192.168.0.4: icmp_seq=4 ttl=64 time=0.095 ms

--- 192.168.0.4 ping statistics ---
4 packets transmitted, 4 received, 0% packet loss, time 3002ms
rtt min/avg/max/ndev = 0.093/0.553/1.413/0.532 ms
root@mininet-vn:~# ping 192.168.0.2 (192.168.0.2) 56(84) bytes of data.
64 bytes from 192.168.0.2: icmp_seq=1 ttl=64 time=2.33 ms
64 bytes from 192.168.0.2: icmp_seq=2 ttl=64 time=0.132 ms
64 bytes from 192.168.0.2: icmp_seq=3 ttl=64 time=0.041 ms
64 bytes from 192.168.0.2: icmp_seq=4 ttl=64 time=0.041 ms

--- 192.168.0.2 ping statistics ---
4 packets transmitted, 4 received, 0% packet loss, time 3003ms
rtt min/avg/max/ndev = 0.041/1.472/3.244/1.402 ms
root@mininet-vn:~#

root@mininet-vn:~# ping 192.168.0.6 -c4
PING 192.168.0.6 (192.168.0.6) 56(84) bytes of data.
64 bytes from 192.168.0.6: icmp_seq=1 ttl=64 time=1.18 ms
64 bytes from 192.168.0.6: icmp_seq=2 ttl=64 time=1.13 ms
64 bytes from 192.168.0.6: icmp_seq=3 ttl=64 time=0.13 ms
64 bytes from 192.168.0.6: icmp_seq=4 ttl=64 time=0.055 ms

--- 192.168.0.6 ping statistics ---
4 packets transmitted, 4 received, 0% packet loss, time 3009ms
rtt min/avg/max/ndev = 0.055/4.000/10.122/3.821 ms
root@mininet-vn:~# ping 192.168.0.1 -c4
PING 192.168.0.1 (192.168.0.1) 56(84) bytes of data.
64 bytes from 192.168.0.1: icmp_seq=1 ttl=64 time=0.782 ms
64 bytes from 192.168.0.1: icmp_seq=2 ttl=64 time=0.767 ms
64 bytes from 192.168.0.1: icmp_seq=3 ttl=64 time=0.302 ms
64 bytes from 192.168.0.1: icmp_seq=4 ttl=64 time=0.142 ms

--- 192.168.0.1 ping statistics ---
4 packets transmitted, 4 received, 0% packet loss, time 3005ms
rtt min/avg/max/ndev = 0.042/2.710/7.820/3.123 ms
root@mininet-vn:~#

root@mininet-vn:~# ping 192.168.0.2 -c4
PING 192.168.0.2 (192.168.0.2) 56(84) bytes of data.
64 bytes from 192.168.0.2: icmp_seq=1 ttl=64 time=0.70 ms
64 bytes from 192.168.0.2: icmp_seq=2 ttl=64 time=0.695 ms
64 bytes from 192.168.0.2: icmp_seq=3 ttl=64 time=0.088 ms
64 bytes from 192.168.0.2: icmp_seq=4 ttl=64 time=0.040 ms

--- 192.168.0.2 ping statistics ---
4 packets transmitted, 4 received, 0% packet loss, time 3001ms
rtt min/avg/max/ndev = 0.040/2.382/6.709/3.662 ms
root@mininet-vn:~# ping 192.168.0.3 -c4
PING 192.168.0.3 (192.168.0.3) 56(84) bytes of data.
64 bytes from 192.168.0.3: icmp_seq=1 ttl=64 time=3.00 ms
64 bytes from 192.168.0.3: icmp_seq=2 ttl=64 time=0.088 ms
64 bytes from 192.168.0.3: icmp_seq=3 ttl=64 time=0.822 ms
64 bytes from 192.168.0.3: icmp_seq=4 ttl=64 time=0.095 ms

--- 192.168.0.3 ping statistics ---
4 packets transmitted, 4 received, 0% packet loss, time 3009ms
rtt min/avg/max/ndev = 0.095/2.027/4.489/1.805 ms
root@mininet-vn:~#
```

E-) Criando regras de MAC para diferentes hosts

```
h1 h2 h3 h4 h5 h6
root@mininet-vn:~# ping 192.168.0.2 -c4
PING 192.168.0.2 (192.168.0.2) 56(84) bytes of data.
64 bytes from 192.168.0.2: icmp_seq=1 ttl=64 time=0.378 ms
64 bytes from 192.168.0.2: icmp_seq=2 ttl=64 time=0.101 ms
64 bytes from 192.168.0.2: icmp_seq=3 ttl=64 time=0.092 ms
64 bytes from 192.168.0.2: icmp_seq=4 ttl=64 time=0.101 ms

--- 192.168.0.2 ping statistics ---
4 packets transmitted, 4 received, 0% packet loss, time 2993ms
rtt min/avg/max/ndev = 0.092/0.168/0.378/0.121 ms
root@mininet-vn:~# sudo ovs-ofctl dump-flows s1
NXST_FLOW reply (xid=0x4):
 cookie=0x0, duration=1148.224s, table=0, n_packets=9, n_bytes=826, idle_age=167,
 , dl_src=00:00:00:00:01,dl_dst=00:00:00:00:00:02 actions=output:2
 cookie=0x0, duration=1127.173s, table=0, n_packets=9, n_bytes=826, idle_age=167,
 , dl_src=00:00:00:00:00:02,dl_dst=00:00:00:00:00:01 actions=output:1
 cookie=0x0, duration=1093.936s, table=0, n_packets=10, n_bytes=868, idle_age=14
 1, , dl_src=00:00:00:00:00:01,dl_dst=00:00:00:00:00:00:06 actions=output:2
 cookie=0x0, duration=1068.723s, table=0, n_packets=10, n_bytes=868, idle_age=14
 1, , dl_src=00:00:00:00:00:06,dl_dst=00:00:00:00:00:01 actions=output:1
root@mininet-vn:~#

root@mininet-vn:~# sudo ovs-ofctl dump-flows s3
NXST_FLOW reply (xid=0x4):
 cookie=0x0, duration=470.270s, table=0, n_packets=10, n_bytes=868, idle_age=162
 , dl_src=00:00:00:00:00:01,dl_dst=00:00:00:00:00:06 actions=output:3
 cookie=0x0, duration=431.892s, table=0, n_packets=10, n_bytes=868, idle_age=162
 , dl_src=00:00:00:00:00:06,dl_dst=00:00:00:00:00:01 actions=output:1
root@mininet-vn:~#

root@mininet-vn:~# ping 192.168.0.1 -c4
PING 192.168.0.1 (192.168.0.1) 56(84) bytes of data.
64 bytes from 192.168.0.1: icmp_seq=1 ttl=64 time=0.206 ms
64 bytes from 192.168.0.1: icmp_seq=2 ttl=64 time=0.045 ms
64 bytes from 192.168.0.1: icmp_seq=3 ttl=64 time=0.042 ms
64 bytes from 192.168.0.1: icmp_seq=4 ttl=64 time=0.103 ms

--- 192.168.0.1 ping statistics ---
4 packets transmitted, 4 received, 0% packet loss, time 3000ms
rtt min/avg/max/ndev = 0.042/0.099/0.206/0.066 ms
root@mininet-vn:~# sudo ovs-ofctl dump-flows s5
NXST_FLOW reply (xid=0x4):
 cookie=0x0, duration=283.164s, table=0, n_packets=10, n_bytes=868, idle_age=165
 , dl_src=00:00:00:00:00:01,dl_dst=00:00:00:00:00:06 actions=output:3
 cookie=0x0, duration=262.824s, table=0, n_packets=10, n_bytes=868, idle_age=165
 , dl_src=00:00:00:00:00:06,dl_dst=00:00:00:00:00:01 actions=output:1
root@mininet-vn:~#

root@mininet-vn:~# ping 192.168.0.1 -c4
PING 192.168.0.1 (192.168.0.1) 56(84) bytes of data.
64 bytes from 192.168.0.1: icmp_seq=1 ttl=64 time=0.048 ms
64 bytes from 192.168.0.1: icmp_seq=2 ttl=64 time=0.034 ms
64 bytes from 192.168.0.1: icmp_seq=3 ttl=64 time=0.030 ms
64 bytes from 192.168.0.1: icmp_seq=4 ttl=64 time=0.104 ms

--- 192.168.0.1 ping statistics ---
4 packets transmitted, 4 received, 0% packet loss, time 2998ms
rtt min/avg/max/ndev = 0.030/0.054/0.104/0.025 ms
root@mininet-vn:~#

root@mininet-vn:~# ping 192.168.0.2 -c4
PING 192.168.0.2 (192.168.0.2) 56(84) bytes of data.
64 bytes from 192.168.0.2: icmp_seq=1 ttl=64 time=0.256 ms
64 bytes from 192.168.0.2: icmp_seq=2 ttl=64 time=0.051 ms
64 bytes from 192.168.0.2: icmp_seq=3 ttl=64 time=0.031 ms
64 bytes from 192.168.0.2: icmp_seq=4 ttl=64 time=0.031 ms

--- 192.168.0.2 ping statistics ---
4 packets transmitted, 4 received, 0% packet loss, time 2997ms
rtt min/avg/max/ndev = 0.031/0.092/0.256/0.095 ms
root@mininet-vn:~# ping 192.168.0.5 -c4
PING 192.168.0.5 (192.168.0.5) 56(84) bytes of data.
64 bytes from 192.168.0.5: icmp_seq=1 ttl=64 time=0.502 ms
64 bytes from 192.168.0.5: icmp_seq=2 ttl=64 time=0.049 ms
64 bytes from 192.168.0.5: icmp_seq=3 ttl=64 time=0.051 ms
64 bytes from 192.168.0.5: icmp_seq=4 ttl=64 time=0.048 ms

--- 192.168.0.5 ping statistics ---
4 packets transmitted, 4 received, 0% packet loss, time 3002ms
rtt min/avg/max/ndev = 0.048/0.172/0.502/0.191 ms
root@mininet-vn:~#

root@mininet-vn:~# ping 192.168.0.1 -c4
PING 192.168.0.1 (192.168.0.1) 56(84) bytes of data.
64 bytes from 192.168.0.1: icmp_seq=1 ttl=64 time=1.23 ms
64 bytes from 192.168.0.1: icmp_seq=2 ttl=64 time=0.134 ms
64 bytes from 192.168.0.1: icmp_seq=3 ttl=64 time=0.095 ms
64 bytes from 192.168.0.1: icmp_seq=4 ttl=64 time=0.094 ms

--- 192.168.0.1 ping statistics ---
4 packets transmitted, 4 received, 0% packet loss, time 3006ms
rtt min/avg/max/ndev = 0.094/0.390/1.239/0.489 ms
root@mininet-vn:~#
```

F-) Testes de Ping h1 → h2, h1 → h6, h2 → h1 e h6 → h1

```
h1 h2 h3 h4 h5 h6
root@mininet-vn:~# ping 192.168.0.2 -c4
PING 192.168.0.2 (192.168.0.2) 56(84) bytes of data.
64 bytes from 192.168.0.2: icmp_seq=1 ttl=64 time=0.256 ms
64 bytes from 192.168.0.2: icmp_seq=2 ttl=64 time=0.051 ms
64 bytes from 192.168.0.2: icmp_seq=3 ttl=64 time=0.031 ms
64 bytes from 192.168.0.2: icmp_seq=4 ttl=64 time=0.031 ms

--- 192.168.0.2 ping statistics ---
4 packets transmitted, 4 received, 0% packet loss, time 2997ms
rtt min/avg/max/ndev = 0.031/0.092/0.256/0.095 ms
root@mininet-vn:~# ping 192.168.0.5 -c4
PING 192.168.0.5 (192.168.0.5) 56(84) bytes of data.
64 bytes from 192.168.0.5: icmp_seq=1 ttl=64 time=0.502 ms
64 bytes from 192.168.0.5: icmp_seq=2 ttl=64 time=0.049 ms
64 bytes from 192.168.0.5: icmp_seq=3 ttl=64 time=0.051 ms
64 bytes from 192.168.0.5: icmp_seq=4 ttl=64 time=0.048 ms

--- 192.168.0.5 ping statistics ---
4 packets transmitted, 4 received, 0% packet loss, time 3002ms
rtt min/avg/max/ndev = 0.048/0.172/0.502/0.191 ms
root@mininet-vn:~#

root@mininet-vn:~# ping 192.168.0.1 -c4
PING 192.168.0.1 (192.168.0.1) 56(84) bytes of data.
64 bytes from 192.168.0.1: icmp_seq=1 ttl=64 time=1.23 ms
64 bytes from 192.168.0.1: icmp_seq=2 ttl=64 time=0.134 ms
64 bytes from 192.168.0.1: icmp_seq=3 ttl=64 time=0.095 ms
64 bytes from 192.168.0.1: icmp_seq=4 ttl=64 time=0.094 ms

--- 192.168.0.1 ping statistics ---
4 packets transmitted, 4 received, 0% packet loss, time 3006ms
rtt min/avg/max/ndev = 0.094/0.390/1.239/0.489 ms
root@mininet-vn:~#
```