

Trabalho Mininet - C115 A

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Criação da Topologia

```
mininet@mininet-vm: ~$ sudo mn --topo linear,6 --mac --link tc,bw=25
*** Creating network
*** Adding controller
*** Adding hosts:
h1 h2 h3 h4 h5 h6
*** Adding switches:
s1 s2 s3 s4 s5 s6
*** Adding links:
(25.00Mbit) (25.00Mbit) (h1, s1) (25.00Mbit) (25.00Mbit) (h2, s2) (25.00Mbit) (2
5.00Mbit) (h3, s3) (25.00Mbit) (25.00Mbit) (h4, s4) (25.00Mbit) (25.00Mbit) (h5,
s5) (25.00Mbit) (25.00Mbit) (h6, s6) (25.00Mbit) (25.00Mbit) (s2, s1) (25.00Mbi
t) (25.00Mbit) (s3, s2) (25.00Mbit) (25.00Mbit) (s4, s3) (25.00Mbit) (25.00Mbit)
(s5, s4) (25.00Mbit) (25.00Mbit) (s6, s5)
*** Configuring hosts
h1 h2 h3 h4 h5 h6
*** Starting controller
c0
*** Starting 6 switches
s1 s2 s3 s4 s5 s6 ... (25.00Mbit) (25.00Mbit) (25.00Mbit) (25.00Mbit) (25.00Mbit)
(25.00Mbit) (25.00Mbit) (25.00Mbit) (25.00Mbit) (25.00Mbit) (25.00Mbit) (25.00M
bit) (25.00Mbit) (25.00Mbit) (25.00Mbit)
*** Starting CLI:
mininet>
```

Topologia linear com 6 switches, 6 portas e um controlador. O endereço MAC foi padronizado e a largura da banda bw foi definida em 25 Mbps.

Interface da Topologia

```
mininet> nodes
available nodes are:
c0 h1 h2 h3 h4 h5 h6 s1 s2 s3 s4 s5 s6
mininet> net
h1 h1-eth0:s1-eth1
h2 h2-eth0:s2-eth1
h3 h3-eth0:s3-eth1
h4 h4-eth0:s4-eth1
h5 h5-eth0:s5-eth1
h6 h6-eth0:s6-eth1
s1 lo: s1-eth1:h1-eth0 s1-eth2:s2-eth2
s2 lo: s2-eth1:h2-eth0 s2-eth2:s1-eth2 s2-eth3:s3-eth2
s3 lo: s3-eth1:h3-eth0 s3-eth2:s2-eth3 s3-eth3:s4-eth2
s4 lo: s4-eth1:h4-eth0 s4-eth2:s3-eth3 s4-eth3:s5-eth2
s5 lo: s5-eth1:h5-eth0 s5-eth2:s4-eth3 s5-eth3:s6-eth2
s6 lo: s6-eth1:h6-eth0 s6-eth2:s5-eth3
c0
mininet>
```

Inspeção das portas e switches da topologia.

```
mininet> dump
<Host h1: h1-eth0:10.0.0.1 pid=4973>
<Host h2: h2-eth0:10.0.0.2 pid=4975>
<Host h3: h3-eth0:10.0.0.3 pid=4977>
<Host h4: h4-eth0:10.0.0.4 pid=4979>
<Host h5: h5-eth0:10.0.0.5 pid=4981>
<Host h6: h6-eth0:10.0.0.6 pid=4983>
<OVSSwitch s1: lo:127.0.0.1,s1-eth1:None,s1-eth2:None pid=4988>
<OVSSwitch s2: lo:127.0.0.1,s2-eth1:None,s2-eth2:None,s2-eth3:None pid=4991>
<OVSSwitch s3: lo:127.0.0.1,s3-eth1:None,s3-eth2:None,s3-eth3:None pid=4994>
<OVSSwitch s4: lo:127.0.0.1,s4-eth1:None,s4-eth2:None,s4-eth3:None pid=4997>
<OVSSwitch s5: lo:127.0.0.1,s5-eth1:None,s5-eth2:None,s5-eth3:None pid=5000>
<OVSSwitch s6: lo:127.0.0.1,s6-eth1:None,s6-eth2:None pid=5003>
<Controller c0: 127.0.0.1:6653 pid=4966>
mininet>
```

Ligações entre os diferentes nós da topologia.

Configuração dos Hosts

```
mininet> h1 ifconfig -a
h1-eth0  Link encap:Ethernet HWaddr 00:00:00:00:00:01 MAC
IP 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:0
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 MAC
IP 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:0
RX bytes:0 (0.0 B) TX bytes:0 (0.0 B)
```

```
mininet> █
```

Inspeção dos endereços MAC e IP das portas H1 e H2.

Configuração dos Switchs

Segue abaixo a configuração do switch s1:

```
mininet> sl ifconfig -a
eth0      Link encap:Ethernet  HWaddr 08:00:27:7e:0f:24
          inet addr:192.168.56.104  Bcast:192.168.56.255  Mask:255.255.255.0
          UP BROADCAST RUNNING MULTICAST  MTU:1500  Metric:1
          RX packets:6673 errors:0 dropped:0 overruns:0 frame:0
          TX packets:5603 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:1000
          RX bytes:1059132 (1.0 MB)  TX bytes:1502146 (1.5 MB)

eth1      Link encap:Ethernet  HWaddr 08:00:27:a7:c9:40
          inet addr:10.0.2.15  Bcast:10.0.2.255  Mask:255.255.255.0
          UP BROADCAST RUNNING MULTICAST  MTU:1500  Metric:1
          RX packets:578 errors:0 dropped:0 overruns:0 frame:0
          TX packets:602 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:1000
          RX bytes:52562 (52.5 KB)  TX bytes:52090 (52.0 KB)

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:15320 errors:0 dropped:0 overruns:0 frame:0
          TX packets:15320 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:0
          RX bytes:2079292 (2.0 MB)  TX bytes:2079292 (2.0 MB)

ovs-system Link encap:Ethernet  HWaddr 42:24:37:10:0a:80
          BROADCAST 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:0
          RX bytes:0 (0.0 B)  TX bytes:0 (0.0 B)

s1        Link encap:Ethernet  HWaddr 6a:86:b9:a2:b0:43
          UP BROADCAST RUNNING  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:0
          RX bytes:0 (0.0 B)  TX bytes:0 (0.0 B)

s2        Link encap:Ethernet  HWaddr 02:8a:1f:dl:b0:48
          UP BROADCAST RUNNING  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:0
          RX bytes:0 (0.0 B)  TX bytes:0 (0.0 B)

s3        Link encap:Ethernet  HWaddr 7a:a6:2b:f4:1f:46
          UP BROADCAST RUNNING  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:0
          RX bytes:0 (0.0 B)  TX bytes:0 (0.0 B)

s4        Link encap:Ethernet  HWaddr ea:60:70:cc:fa:40
          UP BROADCAST RUNNING  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:0
          RX bytes:0 (0.0 B)  TX bytes:0 (0.0 B)

s5        Link encap:Ethernet  HWaddr ce:fc:4d:3l:el:43
          UP BROADCAST RUNNING  MTU:1500  Metric:1
          RX packets:0 errors:0 dropped:0 overruns:0 frame:0
```

```

s6      Link encap:Ethernet  HWaddr 9a:1b:7b:b4:e2:4e
        UP BROADCAST RUNNING 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:0
        RX bytes:0 (0.0 B)  TX bytes:0 (0.0 B)

s1-eth1 Link encap:Ethernet  HWaddr 86:71:d2:c1:f5:a7
        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)

s1-eth2 Link encap:Ethernet  HWaddr 62:07:89:42:cc:48
        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)

s2-eth1 Link encap:Ethernet  HWaddr fa:e2:77:b5:24:5e
        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)

s2-eth2 Link encap:Ethernet  HWaddr 4e:ce:60:36:29:9f
        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)

s2-eth3 Link encap:Ethernet  HWaddr 86:ed:83:8f:ff:56
        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)

s3-eth1 Link encap:Ethernet  HWaddr be:64:f8:64:60:3e
        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)

s3-eth2 Link encap:Ethernet  HWaddr 5e:ca:b9:46:b4:26
        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)

s3-eth3 Link encap:Ethernet  HWaddr b6:5e:47:cf:b3:a9
        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)

```

```
s4-eth1  Link encap:Ethernet  HWaddr 82:03:5b:a2:4a:a9
          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)

s4-eth2  Link encap:Ethernet  HWaddr b6:56:0f:33:93:3f
          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)

s4-eth3  Link encap:Ethernet  HWaddr 0e:cf:d8:e4:76:37
          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)

s5-eth1  Link encap:Ethernet  HWaddr 8e:71:13:6a:2d:8a
          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)

s5-eth2  Link encap:Ethernet  HWaddr b2:aa:34:78:14:f5
          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)

s5-eth3  Link encap:Ethernet  HWaddr 72:3e:7e:cd:00:f8
          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)

s6-eth1  Link encap:Ethernet  HWaddr 9a:33:65:5e:a6:30
          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)

s6-eth2  Link encap:Ethernet  HWaddr 02:5d:9b:93:93:a6
          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)
```

```
mininet> █
```

Testes de Conectividade

```
mininet> h1 ping h2
PING 10.0.0.2 (10.0.0.2) 56(84) bytes of data.
64 bytes from 10.0.0.2: icmp_seq=1 ttl=64 time=12.1 ms
64 bytes from 10.0.0.2: icmp_seq=2 ttl=64 time=0.998 ms
64 bytes from 10.0.0.2: icmp_seq=3 ttl=64 time=0.081 ms
64 bytes from 10.0.0.2: icmp_seq=4 ttl=64 time=0.089 ms
64 bytes from 10.0.0.2: icmp_seq=5 ttl=64 time=0.097 ms
64 bytes from 10.0.0.2: icmp_seq=6 ttl=64 time=0.062 ms
64 bytes from 10.0.0.2: icmp_seq=7 ttl=64 time=1.13 ms
^C
--- 10.0.0.2 ping statistics ---
7 packets transmitted, 7 received, 0% packet loss, time 5999ms
rtt min/avg/max/mdev = 0.062/2.087/12.150/4.130 ms
mininet> █
```

```
mininet> h2 ping -c 5 h3
PING 10.0.0.3 (10.0.0.3) 56(84) bytes of data.
64 bytes from 10.0.0.3: icmp_seq=1 ttl=64 time=5.27 ms
64 bytes from 10.0.0.3: icmp_seq=2 ttl=64 time=1.39 ms
64 bytes from 10.0.0.3: icmp_seq=3 ttl=64 time=0.081 ms
64 bytes from 10.0.0.3: icmp_seq=4 ttl=64 time=0.067 ms
64 bytes from 10.0.0.3: icmp_seq=5 ttl=64 time=0.053 ms

--- 10.0.0.3 ping statistics ---
5 packets transmitted, 5 received, 0% packet loss, time 4002ms
rtt min/avg/max/mdev = 0.053/1.375/5.278/2.018 ms
mininet> █
```

```
mininet> pingall
*** 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)
mininet> █
```

Na primeira imagem, foi feito um teste de conectividade entre o host 1 e o host 2, sem limite de interações. Na segunda imagem, foi determinado que o host 3 recebesse no máximo 5 pacotes do host 2. Por fim, na última imagem foi demonstrada a conectividade de toda a topologia através do comando pingall.

Interface de Desempenho (iperf)

"Node: h1"

root@mininet-vm:~# iperf -s -p 5555 -i 1

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

[32]	local 10.0.0.1 port 5555 connected with 10.0.0.2 port 39638
[ID]	Interval Transfer Bandwidth
[32]	0.0- 1.0 sec 2.83 MBytes 23.7 Mbits/sec
[32]	1.0- 2.0 sec 2.80 MBytes 23.5 Mbits/sec
[32]	2.0- 3.0 sec 2.84 MBytes 23.8 Mbits/sec
[32]	3.0- 4.0 sec 2.78 MBytes 23.3 Mbits/sec
[32]	4.0- 5.0 sec 2.84 MBytes 23.8 Mbits/sec
[32]	5.0- 6.0 sec 2.82 MBytes 23.7 Mbits/sec
[32]	6.0- 7.0 sec 2.52 MBytes 21.2 Mbits/sec
[32]	7.0- 8.0 sec 2.82 MBytes 23.6 Mbits/sec
[32]	8.0- 9.0 sec 2.80 MBytes 23.5 Mbits/sec
[32]	9.0-10.0 sec 2.84 MBytes 23.8 Mbits/sec
[32]	10.0-11.0 sec 2.80 MBytes 23.5 Mbits/sec
[32]	11.0-12.0 sec 2.82 MBytes 23.6 Mbits/sec
[32]	12.0-13.0 sec 2.84 MBytes 23.8 Mbits/sec
[32]	13.0-14.0 sec 2.73 MBytes 22.9 Mbits/sec
[32]	14.0-15.0 sec 2.82 MBytes 23.6 Mbits/sec
[32]	0.0-15.4 sec 43.1 MBytes 23.4 Mbits/sec

root@mininet-vm:~#

"Node: h2"

root@mininet-vm:~# iperf -c 10.0.0.1 -p 5555 -i 1 -t 15

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

[31]	local 10.0.0.2 port 39638 connected with 10.0.0.1 port 5555
[ID]	Interval Transfer Bandwidth
[31]	0.0- 1.0 sec 3.75 MBytes 31.5 Mbits/sec
[31]	1.0- 2.0 sec 3.00 MBytes 25.2 Mbits/sec
[31]	2.0- 3.0 sec 3.00 MBytes 25.2 Mbits/sec
[31]	3.0- 4.0 sec 2.50 MBytes 21.0 Mbits/sec
[31]	4.0- 5.0 sec 2.88 MBytes 24.1 Mbits/sec
[31]	5.0- 6.0 sec 3.00 MBytes 25.2 Mbits/sec
[31]	6.0- 7.0 sec 2.50 MBytes 21.0 Mbits/sec
[31]	7.0- 8.0 sec 2.50 MBytes 21.0 Mbits/sec
[31]	8.0- 9.0 sec 3.00 MBytes 25.2 Mbits/sec
[31]	9.0-10.0 sec 3.00 MBytes 25.2 Mbits/sec
[31]	10.0-11.0 sec 2.50 MBytes 21.0 Mbits/sec
[31]	11.0-12.0 sec 3.00 MBytes 25.2 Mbits/sec
[31]	12.0-13.0 sec 2.88 MBytes 24.1 Mbits/sec
[31]	13.0-14.0 sec 2.50 MBytes 21.0 Mbits/sec
[31]	14.0-15.0 sec 3.00 MBytes 25.2 Mbits/sec
[31]	0.0-15.1 sec 43.1 MBytes 24.0 Mbits/sec

root@mininet-vm:~#

O host h2 foi configurado como sendo um servidor TCP com porta 5555, capaz de executar 1 teste iperf a cada 15 segundos. Por sua vez, o host h1 foi configurado como sendo o cliente, também com porta 5555.