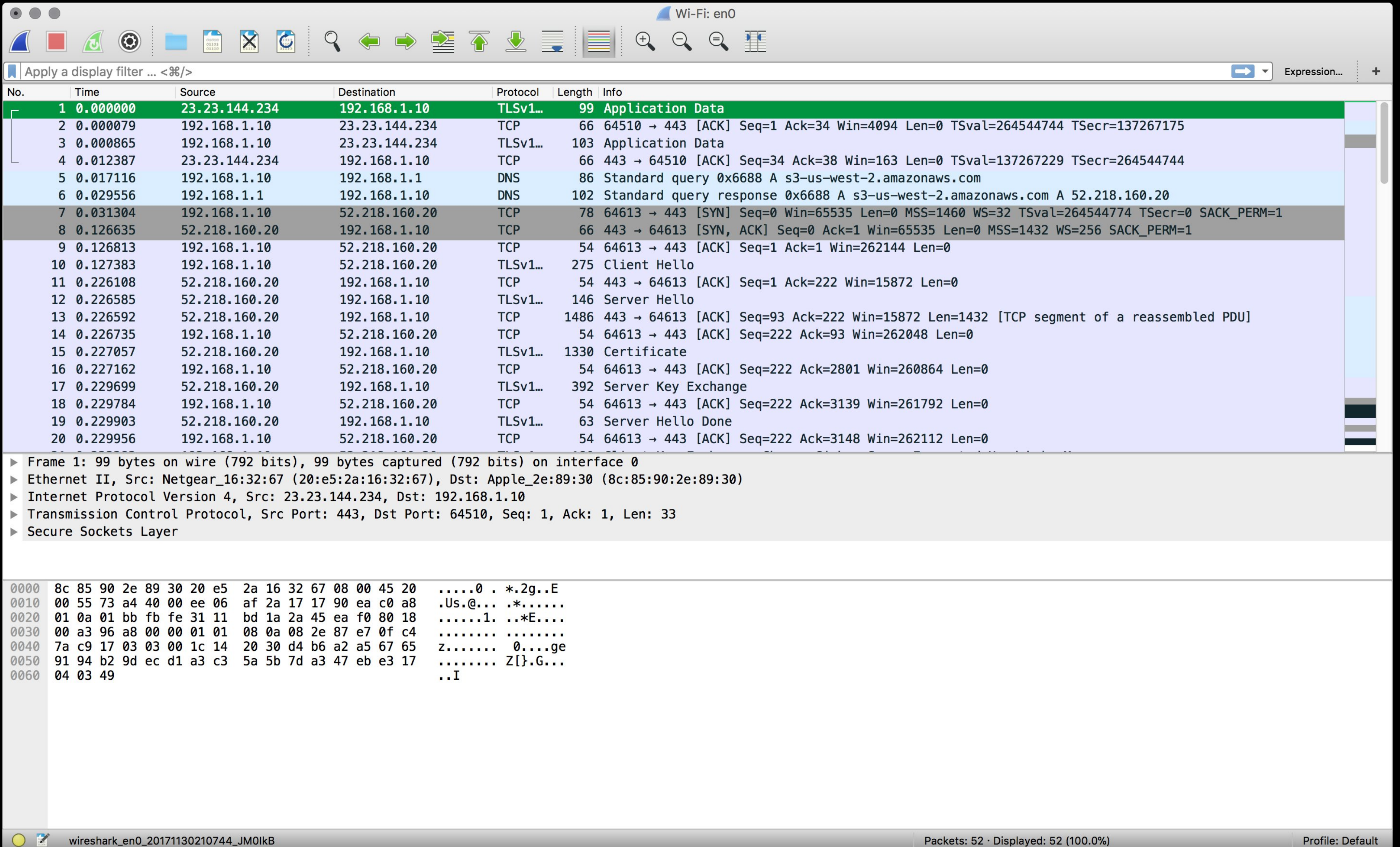```
mininet@mininet-vm:~$ traceroute www.google.com
traceroute to www.google.com (173.194.68.103), 30 hops max, 60 byte packets
 1 10.0.2.2 (10.0.2.2) 0.219 ms 0.152 ms 0.129 ms
 2 192.168.1.1 (192.168.1.1) 1.878 ms 1.913 ms 1.958 ms
 3 96.120.104.101 (96.120.104.101) 14.375 ms 15.018 ms 15.103 ms
 4 xe-10-0-3-32767-sur03.gambrills.md.bad.comcast.net (69.139.215.41) 17.006 m
s 17.264 ms 17.910 ms
 5 ae-39-0-ar01.capitolhghts.md.bad.comcast.net (68.85.130.81) 18.799 ms 19.2
56 ms 21.450 ms
 6 ae-13-ar01.capitolhghts.md.bad.comcast.net (68.87.168.61) 23.576 ms 14.445
 ms 16.769 ms
 7 be-33657-cr02.ashburn.va.ibone.comcast.net (68.86.90.57) 16.809 ms 19.417
ms 20.530 ms
 8 be-10142-pe01.ashburn.va.ibone.comcast.net (68.86.86.34) 20.279 ms 20.357
ms 20.540 ms
 9 50.242.150.138 (50.242.150.138) 23.416 ms 96-87-8-186-static.hfc.comcastbus
iness.net (96.87.8.186) 23.475 ms 23.546 ms
10 * * *
11 216.239.54.110 (216.239.54.110) 24.125 ms 209.85.246.158 (209.85.246.158)
26.626 ms 216.239.54.124 (216.239.54.124) 18.589 ms
12 108.170.246.3 (108.170.246.3) 18.353 ms 108.170.246.34 (108.170.246.34) 18
.639 ms 108.170.246.66 (108.170.246.66) 21.683 ms
13 216.239.47.127 (216.239.47.127) 21.743 ms 216.239.49.197 (216.239.49.197)
61.570 ms 216.239.48.101 (216.239.48.101) 21.835 ms
14 216.239.48.2 (216.239.48.2) 27.468 ms 28.133 ms 29.441 ms
15 216.239.49.200 (216.239.49.200) 29.202 ms 216.239.54.42 (216.239.54.42) 27
.915 ms 216.239.46.202 (216.239.46.202) 33.572 ms
16 * * *
17 qr-in-f103.1e100.net (173.194.68.103) 17.128 ms 23.630 ms 23.232 ms
mininet@mininet-vm:~$
```

Wi-Fi: en0

Expression... +

| No. | Time | Source | Destination | Protocol | Length | Info |
|---|---|---|---|---|---|---|
| 1 | 0.000000 | 23.23.144.234 | 192.168.1.10 | TLSv1… | 99 | Application Data |
| 2 | 0.000079 | 192.168.1.10 | 23.23.144.234 | TCP | 66 | 64510 → 443 [ACK] Seq=1 Ack=34 Win=4094 Len=0 TSval=264544744 TSecr=137267175 |
| 3 | 0.000865 | 192.168.1.10 | 23.23.144.234 | TLSv1… | 103 | Application Data |
| 4 | 0.012387 | 23.23.144.234 | 192.168.1.10 | TCP | 66 | 443 → 64510 [ACK] Seq=34 Ack=38 Win=163 Len=0 TSval=137267229 TSecr=264544744 |
| 5 | 0.017116 | 192.168.1.10 | 192.168.1.1 | DNS | 86 | Standard query 0x6688 A s3-us-west-2.amazonaws.com |
| 6 | 0.029556 | 192.168.1.1 | 192.168.1.10 | DNS | 102 | Standard query response 0x6688 A s3-us-west-2.amazonaws.com A 52.218.160.20 |
| 7 | 0.031304 | 192.168.1.10 | 52.218.160.20 | TCP | 78 | 64613 → 443 [SYN] Seq=0 Win=65535 Len=0 MSS=1460 WS=32 TSval=264544774 TSecr=0 SACK_PERM=1 |
| 8 | 0.126635 | 52.218.160.20 | 192.168.1.10 | TCP | 66 | 443 → 64613 [SYN, ACK] Seq=0 Ack=1 Win=65535 Len=0 MSS=1432 WS=256 SACK_PERM=1 |
| 9 | 0.126813 | 192.168.1.10 | 52.218.160.20 | TCP | 54 | 64613 → 443 [ACK] Seq=1 Ack=1 Win=262144 Len=0 |
| 10 | 0.127383 | 192.168.1.10 | 52.218.160.20 | TLSv1… | 275 | Client Hello |
| 11 | 0.226108 | 52.218.160.20 | 192.168.1.10 | TCP | 54 | 443 → 64613 [ACK] Seq=1 Ack=222 Win=15872 Len=0 |
| 12 | 0.226585 | 52.218.160.20 | 192.168.1.10 | TLSv1… | 146 | Server Hello |
| 13 | 0.226592 | 52.218.160.20 | 192.168.1.10 | TCP | 1486 | 443 → 64613 [ACK] Seq=93 Ack=222 Win=15872 Len=1432 [TCP segment of a reassembled PDU] |
| 14 | 0.226735 | 192.168.1.10 | 52.218.160.20 | TCP | 54 | 64613 → 443 [ACK] Seq=222 Ack=93 Win=262048 Len=0 |
| 15 | 0.227057 | 52.218.160.20 | 192.168.1.10 | TLSv1… | 1330 | Certificate |
| 16 | 0.227162 | 192.168.1.10 | 52.218.160.20 | TCP | 54 | 64613 → 443 [ACK] Seq=222 Ack=2801 Win=260864 Len=0 |
| 17 | 0.229699 | 52.218.160.20 | 192.168.1.10 | TLSv1… | 392 | Server Key Exchange |
| 18 | 0.229784 | 192.168.1.10 | 52.218.160.20 | TCP | 54 | 64613 → 443 [ACK] Seq=222 Ack=3139 Win=261792 Len=0 |
| 19 | 0.229903 | 52.218.160.20 | 192.168.1.10 | TLSv1… | 63 | Server Hello Done |
| 20 | 0.229956 | 192.168.1.10 | 52.218.160.20 | TCP | 54 | 64613 → 443 [ACK] Seq=222 Ack=3148 Win=262112 Len=0 |

▶ Frame 1: 99 bytes on wire (792 bits), 99 bytes captured (792 bits) on interface 0
▶ Ethernet II, Src: Netgear_16:32:67 (20:e5:2a:16:32:67), Dst: Apple_2e:89:30 (8c:85:90:2e:89:30)
▶ Internet Protocol Version 4, Src: 23.23.144.234, Dst: 192.168.1.10
▶ Transmission Control Protocol, Src Port: 443, Dst Port: 64510, Seq: 1, Ack: 1, Len: 33
▶ Secure Sockets Layer

```
0000  8c 85 90 2e 89 30 20 e5  2a 16 32 67 08 00 45 20   .....0 . *.2g..E
0010  00 55 73 a4 40 00 ee 06  af 2a 17 17 90 ea c0 a8   .Us.@... .*......
0020  01 0a 01 bb fb fe 31 11  bd 1a 2a 45 ea f0 80 18   ......1. ..*E....
0030  00 a3 96 a8 00 00 01 01  08 0a 08 2e 87 e7 0f c4   ........ ........
0040  7a c9 17 03 03 00 1c 14  20 30 d4 b6 a2 a5 67 65   z.......  0....ge
0050  91 94 b2 9d ec d1 a3 c3  5a 5b 7d a3 47 eb e3 17   ........ Z[}.G...
0060  04 03 49                                           ..I
```

```
Mininet-VM [Running]

mininet@mininet-vm:~$ sudo mn
*** Creating network
*** Adding controller
*** Adding hosts:
h1 h2
*** Adding switches:
s1
*** Adding links:
(h1, s1) (h2, s1)
*** Configuring hosts
h1 h2
*** Starting controller
c0
*** Starting 1 switches
s1 ...
*** Starting CLI:
mininet> nodes
available nodes are:
c0 h1 h2 s1
mininet> links
h1-eth0<->s1-eth1 (OK OK)
h2-eth0<->s1-eth2 (OK OK)
mininet> net
h1 h1-eth0:s1-eth1
h2 h2-eth0:s1-eth2
s1 lo:  s1-eth1:h1-eth0 s1-eth2:h2-eth0
c0
mininet>
```

Left ⌘

```
                          Mininet-VM [Running]
c0 h1 h2 s1
mininet> links
h1-eth0<->s1-eth1 (OK OK)
h2-eth0<->s1-eth2 (OK OK)
mininet> net
h1 h1-eth0:s1-eth1
h2 h2-eth0:s1-eth2
s1 lo:  s1-eth1:h1-eth0 s1-eth2:h2-eth0
c0
mininet>
mininet>
mininet>
mininet> h1 ifconfig -a
h1-eth0    Link encap:Ethernet  HWaddr 52:17:fe:8d:de:92
           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>
```

Left ⌘

```
mininet@mininet-vm:~$ sudo mn
*** Creating network
*** Adding controller
*** Adding hosts:
h1 h2
*** Adding switches:
s1
*** Adding links:
(h1, s1) (h2, s1)
*** Configuring hosts
h1 h2
*** Starting controller
c0
*** Starting 1 switches
s1 ...
*** Starting CLI:
mininet>
mininet>
mininet>
mininet>
mininet> s1 ifconfig -a
```

Left ⌘

```
ovs-system Link encap:Ethernet  HWaddr 92:9b:03:c6:04:2b
          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 0a:c9:1d:5d:16:45
          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 3a:d9:e1:37:cf:c1
          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 ca:fe:7d:13:84:22
          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> _
```

```
                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 3a:d9:e1:37:cf:c1
                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 ca:fe:7d:13:84:22
                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>
mininet>
mininet>
mininet> h1 ps -a
  PID TTY          TIME CMD
 1312 tty1     00:00:00 bash
 2596 tty1     00:00:00 sudo
 2597 tty1     00:00:00 mn
 2675 pts/1    00:00:00 controller
 2715 pts/2    00:00:00 ps
mininet>
```

```
                  RX bytes:0 (0.0 B)  TX bytes:0 (0.0 B)

s1-eth2      Link encap:Ethernet   HWaddr ca:fe:7d:13:84:22
             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>
mininet>
mininet>
mininet> h1 ps -a
  PID TTY          TIME CMD
 1312 tty1     00:00:00 bash
 2596 tty1     00:00:00 sudo
 2597 tty1     00:00:00 mn
 2675 pts/1    00:00:00 controller
 2715 pts/2    00:00:00 ps
mininet>
mininet>
mininet>
mininet> s1 ps -a
  PID TTY          TIME CMD
 1312 tty1     00:00:00 bash
 2596 tty1     00:00:00 sudo
 2597 tty1     00:00:00 mn
 2675 pts/1    00:00:00 controller
 2720 pts/4    00:00:00 ps
mininet>
```

```
mininet>
mininet>
mininet> h1 ps -a
  PID TTY          TIME CMD
 1312 tty1      00:00:00 bash
 2596 tty1      00:00:00 sudo
 2597 tty1      00:00:00 mn
 2675 pts/1     00:00:00 controller
 2715 pts/2     00:00:00 ps
mininet>
mininet>
mininet>
mininet> s1 ps -a
  PID TTY          TIME CMD
 1312 tty1      00:00:00 bash
 2596 tty1      00:00:00 sudo
 2597 tty1      00:00:00 mn
 2675 pts/1     00:00:00 controller
 2720 pts/4     00:00:00 ps
mininet>
mininet>
mininet>
mininet> h1 ping -c 1 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=2.22 ms

--- 10.0.0.2 ping statistics ---
1 packets transmitted, 1 received, 0% packet loss, time 0ms
rtt min/avg/max/mdev = 2.226/2.226/2.226/0.000 ms
mininet>
```

```
Mininet-VM [Running]

mininet>
mininet>
mininet> s1 ps -a
  PID TTY          TIME CMD
 1312 tty1     00:00:00 bash
 2596 tty1     00:00:00 sudo
 2597 tty1     00:00:00 mn
 2675 pts/1    00:00:00 controller
 2720 pts/4    00:00:00 ps
mininet>
mininet>
mininet>
mininet> h1 ping -c 1 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=2.22 ms

--- 10.0.0.2 ping statistics ---
1 packets transmitted, 1 received, 0% packet loss, time 0ms
rtt min/avg/max/mdev = 2.226/2.226/2.226/0.000 ms
mininet>
mininet>
mininet>
mininet> h1 ping -c 1 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=0.501 ms

--- 10.0.0.2 ping statistics ---
1 packets transmitted, 1 received, 0% packet loss, time 0ms
rtt min/avg/max/mdev = 0.501/0.501/0.501/0.000 ms
mininet>

                                                          Left ⌘
```

```
 2720 pts/4    00:00:00 ps
mininet>
mininet>
mininet>
mininet> h1 ping -c 1 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=2.22 ms

--- 10.0.0.2 ping statistics ---
1 packets transmitted, 1 received, 0% packet loss, time 0ms
rtt min/avg/max/mdev = 2.226/2.226/2.226/0.000 ms
mininet>
mininet>
mininet>
mininet> h1 ping -c 1 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=0.501 ms

--- 10.0.0.2 ping statistics ---
1 packets transmitted, 1 received, 0% packet loss, time 0ms
rtt min/avg/max/mdev = 0.501/0.501/0.501/0.000 ms
mininet>
mininet>
mininet>
mininet> pingall
*** Ping: testing ping reachability
h1 -> h2
h2 -> h1
*** Results: 0% dropped (2/2 received)
mininet> _
```

Mininet-VM [Running]

Left ⌘

```
Mininet-VM_1 [Running]

mininet@mininet-vm:~$ ping -c 5 www.washingtonpost.com
PING e9631.j.akamaiedge.net (104.70.63.229) 56(84) bytes of data.
64 bytes from a104-70-63-229.deploy.static.akamaitechnologies.com (104.70.63.229
): icmp_seq=1 ttl=63 time=31.6 ms
64 bytes from a104-70-63-229.deploy.static.akamaitechnologies.com (104.70.63.229
): icmp_seq=2 ttl=63 time=12.3 ms
64 bytes from a104-70-63-229.deploy.static.akamaitechnologies.com (104.70.63.229
): icmp_seq=3 ttl=63 time=13.5 ms
64 bytes from a104-70-63-229.deploy.static.akamaitechnologies.com (104.70.63.229
): icmp_seq=4 ttl=63 time=12.4 ms
64 bytes from a104-70-63-229.deploy.static.akamaitechnologies.com (104.70.63.229
): icmp_seq=5 ttl=63 time=14.4 ms

--- e9631.j.akamaiedge.net ping statistics ---
5 packets transmitted, 5 received, 0% packet loss, time 4008ms
rtt min/avg/max/mdev = 12.370/16.905/31.680/7.427 ms
mininet@mininet-vm:~$ _

                                                    Left ⌘
```