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CN LAB : WEEK 7

IPv4 Addressing and Static Routing

Objective: To setup a network with two routers and exchange packets across routers.

Hardware Requirements:

- Desktops/Laptops: 4
- Switch : 3
- Patch Cords (1.5m): 6
- External NIC : 2

Software Requirements:

- Wireshark Tool
- Ubuntu Linux Operating System

Topology Description: Design a network with at least 2 router networks. Host Ha should be able to communicate with Host Hd using newly assigned addresses.

Task 1: Assign IP addresses to all computers A, B, C and D (Source Host Ha, Router R1, Router R2 & Destination Host Hd)

Step 1: Assign the IP address to the Ha.

```
$ sudo ip addr add 172.16.10.1/24 dev eth1
```

```
$ ip addr show
```

```
student@CSELAB: ~  
student@CSELAB:~$ ip addr show  
1: lo: <LOOPBACK,UP,LOWER_UP> mtu 65536 qdisc noqueue state UNKNOWN group default qlen 1  
    link/loopback 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: enp2s0: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc pfifo_fast state UP group default qlen 1000  
    link/ether b8:ae:ed:a5:a5:d4 brd ff:ff:ff:ff:ff:ff  
    inet 172.16.10.1/24 brd 172.16.10.255 scope global enp2s0  
        valid_lft forever preferred_lft forever  
    inet6 fe80::67ef:4c43:a82c:b073/64 scope link  
        valid_lft forever preferred_lft forever
```

Step 2: Assign the IP address to R1.

```
$ sudo ip addr add 172.16.10.201/24 dev eth1
```

```
$ sudo ip addr add 172.16.11.1/24 dev eth2
```

```
$ ip addr show
```

```
student@CSELAB: ~  
student@CSELAB:~$ ifconfig  
enp2s0: Link encap:Ethernet  HWaddr b8:ae:ed:a5:a5:e4  
        inet addr:172.16.10.201  Bcast:172.16.10.255  Mask:255.255.255.0  
        inet6 addr: fe80::58a4:9eab:6935:dea4/64 Scope:Link  
        UP BROADCAST RUNNING MULTICAST  MTU:1500  Metric:1  
        RX packets:39 errors:0 dropped:0 overruns:0 frame:0  
        TX packets:101 errors:0 dropped:0 overruns:0 carrier:0  
        collisions:0 txqueuelen:1000  
        RX bytes:5247 (5.2 KB)  TX bytes:13288 (13.2 KB)  
  
enxd03745b8dbb4: Link encap:Ethernet  HWaddr d0:37:45:b8:db:b4  
        inet addr:172.16.11.1  Bcast:172.16.11.255  Mask:255.255.255.0  
        inet6 addr: fe80::6a1e:fe5c:914:de01/64 Scope:Link  
        UP BROADCAST RUNNING MULTICAST  MTU:1500  Metric:1  
        RX packets:65 errors:0 dropped:0 overruns:0 frame:0  
        TX packets:159 errors:0 dropped:0 overruns:0 carrier:0  
        collisions:0 txqueuelen:1000  
        RX bytes:6051 (6.0 KB)  TX bytes:25225 (25.2 KB)  
  
lo: Link encap:Local Loopback  
        inet addr:127.0.0.1  Mask:255.0.0.0  
        inet6 addr: ::1/128 Scope:Host  
        UP LOOPBACK RUNNING  MTU:65536  Metric:1  
        RX packets:2212 errors:0 dropped:0 overruns:0 frame:0  
        TX packets:2212 errors:0 dropped:0 overruns:0 carrier:0  
        collisions:0 txqueuelen:1  
        RX bytes:166112 (166.1 KB)  TX bytes:166112 (166.1 KB)
```

Step 3: Assign the IP address to R2.

```
$ sudo ip addr add 172.16.11.201/24 dev eth2
```

```
$ sudo ip addr add 172.16.12.1/24 dev eth1
```

```
$ ip addr show
```

Step 4: Assign the IP address to the Hd.

```
$ sudo ip addr add 172.16.12.201/24 dev eth1
```

```
$ ip addr show
```

Note 1: As we know the machines are physically on the same LAN, so we can get ICMP redirect messages from other machines. Now disable accepting the ICMP redirect packets. On host machines Ha and Hd, give the following command:

```
$ sudo sysctl -w net.ipv4.conf.all.accept_redirects=0
```

```
student@CSELAB:~$ sudo sysctl -w net.ipv4.conf.all.send_redirects=0
net.ipv4.conf.all.send_redirects = 0
student@CSELAB:~$
```

Note 2: As we know the machines are physically on the same LAN, so we can get ICMP redirect messages from other machines. Thus, disable sending of the ICMP redirect packets by these routers with aliased interfaces. Give below command in router machines R1 and R2.

```
$ sudo sysctl -w net.ipv4.conf.all.send_redirects=0
```

```
student@CSELAB:~$ sudo sysctl -w net.ipv4.conf.all.send_redirects=0
[sudo] password for student:
net.ipv4.conf.all.send_redirects = 0
```

Task 2: Converting machines B and C into routers.

Note 1: Check if IP forwarding is enabled or not. `$ sysctl net.ipv4.ip_forward net.ipv4.ip_forward = 0`

Command to set the value of `net.ipv4.ip_forward` in R1 & R2 is given below:

At R1: `$ sudo sysctl -w net.ipv4.ip_forward=1`

At R2: `$ sudo sysctl -w net.ipv4.ip_forward=1`

```
student@CSELAB:~$ sudo sysctl -w net.ipv4.ip_forward=1
net.ipv4.ip_forward = 1
student@CSELAB:~$ sudo ip route add 172.16.12.0/24 via
```

Task 3: Verify the connection between Ha and Hd using ping command.

At Ha: \$ ping 172.16.10.1 (Local network)

```
student@CSELAB:~$ ping 172.16.10.1
PING 172.16.10.1 (172.16.10.1) 56(84) bytes of data.
64 bytes from 172.16.10.1: icmp_seq=1 ttl=64 time=0.023 ms
64 bytes from 172.16.10.1: icmp_seq=2 ttl=64 time=0.020 ms
64 bytes from 172.16.10.1: icmp_seq=3 ttl=64 time=0.022 ms
64 bytes from 172.16.10.1: icmp_seq=4 ttl=64 time=0.023 ms
64 bytes from 172.16.10.1: icmp_seq=5 ttl=64 time=0.022 ms
64 bytes from 172.16.10.1: icmp_seq=6 ttl=64 time=0.022 ms
^C
--- 172.16.10.1 ping statistics ---
6 packets transmitted, 6 received, 0% packet loss, time 5002ms
rtt min/avg/max/mdev = 0.020/0.022/0.023/0.001 ms
student@CSELAB:~$
```

At Hd: \$ ping 172.16.12.1 (Local network)

```
student@CSELAB:~$ ping 172.16.12.1
PING 172.16.12.1 (172.16.12.1) 56(84) bytes of data.
64 bytes from 172.16.12.1: icmp_seq=1 ttl=64 time=1.48 ms
64 bytes from 172.16.12.1: icmp_seq=2 ttl=64 time=0.790 ms
64 bytes from 172.16.12.1: icmp_seq=3 ttl=64 time=0.818 ms
64 bytes from 172.16.12.1: icmp_seq=4 ttl=64 time=0.821 ms
^C
--- 172.16.12.1 ping statistics ---
4 packets transmitted, 4 received, 0% packet loss, time 2999ms
rtt min/avg/max/mdev = 0.790/0.979/1.488/0.294 ms
student@CSELAB:~$
```

Task 4: Insert routing table entries on each system to direct ipv4 packets to ping across the networks.

At Ha: \$ sudo ip route add 172.16.12.0/24 via 172.16.10.201

\$ sudo ip route add 172.16.11.0/24 via 172.16.10.201

\$ ip route show

```
student@CSELAB:~$ ip route show
169.254.0.0/16 dev enp2s0 scope link metric 1000
172.16.10.0/24 dev enp2s0 proto kernel scope link src 172.16.10.1 metric 100

172.16.12.0/24 via 172.16.10.201 dev enp2s0
student@CSELAB:~$ sudo ip route add 172.16.11.0/24 via 172.16.10.201
student@CSELAB:~$ ip route show
169.254.0.0/16 dev enp2s0 scope link metric 1000
172.16.10.0/24 dev enp2s0 proto kernel scope link src 172.16.10.1 metric 100

172.16.11.0/24 via 172.16.10.201 dev enp2s0
172.16.12.0/24 via 172.16.10.201 dev enp2s0
student@CSELAB:~$
```

We need to have routing table entries for other networks such as 172.16.11.0/24 and 172.16.12.0/24.

At R1: \$ sudo ip route add **172.16.12.0/24 via 172.16.11.201**

\$ ip route show

```
student@CSELAB:~$ sudo ip route add 172.16.12.0/24 via 172.16.11.201
student@CSELAB:~$ ip route show
169.254.0.0/16 dev enp2s0 scope link metric 1000
172.16.10.0/24 dev enp2s0 proto kernel scope link src 172.16.10.201 metric 100
172.16.11.0/24 dev enxd03745b8dbb4 proto kernel scope link src 172.16.11.1 metric 100
172.16.12.0/24 via 172.16.11.201 dev enxd03745b8dbb4
```

Since R1 is connected to 172.16.10.0/24 and 172.16.11.0/24 networks we need to have one routing table entry to 172.16.12.0/24.

At R2: \$ sudo ip route add 172.16.10.0/24 via 172.16.11.1

\$ ip route show

```
student@CSELAB:~$ sudo ip route add 172.16.10.0/24 via 172.16.11.1
student@CSELAB:~$ ip route show
169.254.0.0/16 dev enp2s0 scope link metric 1000
172.16.10.0/24 via 172.16.11.1 dev enp2s0
172.16.11.0/24 dev enp2s0 proto kernel scope link src 172.16.11.201 metric 100
172.16.12.0/24 dev enxd03745b8d975 proto kernel scope link src 172.16.12.1 metric 100
student@CSELAB:~$
```

At Hd: \$ sudo ip route add 172.16.10.0/24 via 172.16.12.1

\$ sudo ip route add 172.16.11.0/24 via 172.16.12.1

\$ ip route show

```
student@CSELAB:~$ ip route show
169.254.0.0/16 dev enp2s0 scope link metric 1000
172.16.10.0/24 via 172.16.12.1 dev enp2s0
172.16.11.0/24 via 172.16.12.1 dev enp2s0
172.16.12.0/24 dev enp2s0 proto kernel scope link src 172.16.12.201 metric 100
```

Task 5: After adding routing table, again verify the connection from Ha and Hd using ping command.

Step 1: Testing path from Ha and Hd

\$ ping 172.16.12.1 and \$ ping 172.16.12.201

```
rtt min/avg/max/mdev = 0.683/0.802/0.924/0.074 ms
student@CSELAB:~$ ping 172.16.12.201
PING 172.16.12.201 (172.16.12.201) 56(84) bytes of data.
64 bytes from 172.16.12.201: icmp_seq=1 ttl=62 time=0.934 ms
64 bytes from 172.16.12.201: icmp_seq=2 ttl=62 time=0.849 ms
64 bytes from 172.16.12.201: icmp_seq=3 ttl=62 time=0.853 ms
64 bytes from 172.16.12.201: icmp_seq=4 ttl=62 time=0.922 ms
64 bytes from 172.16.12.201: icmp_seq=5 ttl=62 time=0.869 ms
64 bytes from 172.16.12.201: icmp_seq=6 ttl=62 time=0.724 ms
64 bytes from 172.16.12.201: icmp_seq=7 ttl=62 time=0.790 ms
64 bytes from 172.16.12.201: icmp_seq=8 ttl=62 time=0.722 ms
64 bytes from 172.16.12.201: icmp_seq=9 ttl=62 time=0.753 ms
^C
--- 172.16.12.201 ping statistics ---
9 packets transmitted, 9 received, 0% packet loss, time 8000ms
rtt min/avg/max/mdev = 0.722/0.824/0.934/0.075 ms
student@CSELAB:~$
```

Step 2: Testing path from Hd and Ha

\$ ping 172.16.12.1 and \$ ping 172.16.12.201

```
student@CSELAB:~$ ping 172.16.12.1
PING 172.16.12.1 (172.16.12.1) 56(84) bytes of data.
64 bytes from 172.16.12.1: icmp_seq=1 ttl=64 time=1.48 ms
64 bytes from 172.16.12.1: icmp_seq=2 ttl=64 time=0.790 ms
64 bytes from 172.16.12.1: icmp_seq=3 ttl=64 time=0.818 ms
64 bytes from 172.16.12.1: icmp_seq=4 ttl=64 time=0.821 ms
^C
--- 172.16.12.1 ping statistics ---
4 packets transmitted, 4 received, 0% packet loss, time 2999ms
rtt min/avg/max/mdev = 0.790/0.979/1.488/0.294 ms
```

Task 6: Check each system neighbor to verify the connection.

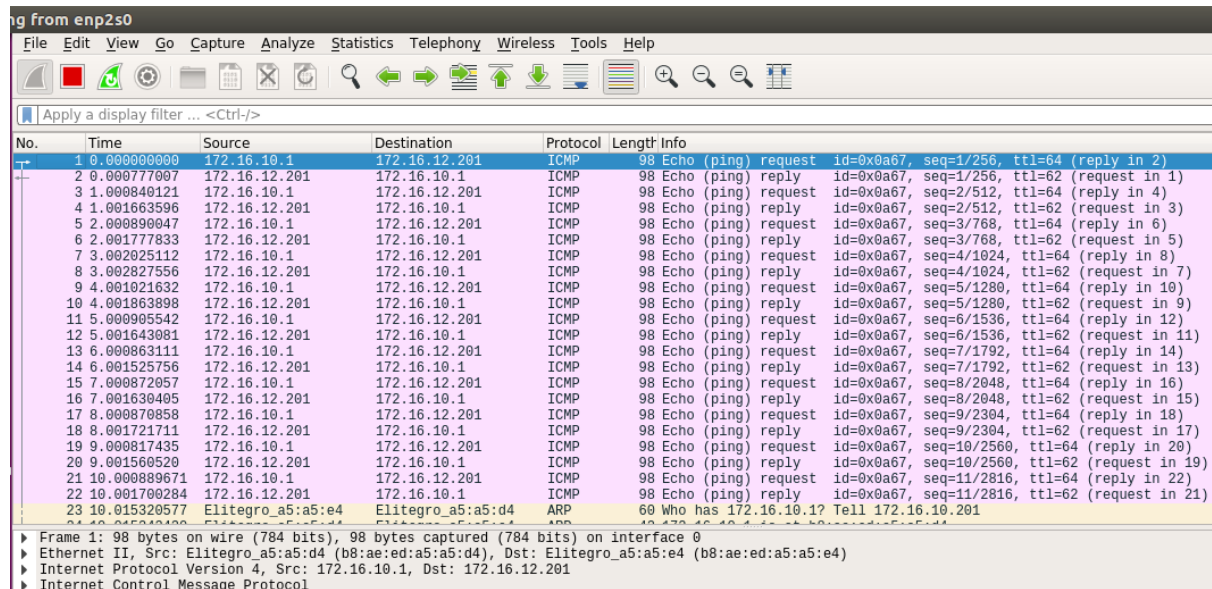
```
172.16.12.0/24 VLA 172.16.11.201 dev enxd03745b8dbb4
student@CSELAB:~$ ip neigh show
172.16.11.201 dev enxd03745b8dbb4 lladdr b8:ae:ed:a5:a5:a6 REACHABLE
172.16.10.1 dev enp2s0 lladdr b8:ae:ed:a5:a5:d4 REACHABLE
```


Task 7: Capture packets from Ha and Hb using Wireshark.

Step 1: Capture packets from Ha and Hd.

At Ha:

T1: \$ sudo wireshark T2: \$ ping 172.16.12.201



ng from enp2s0

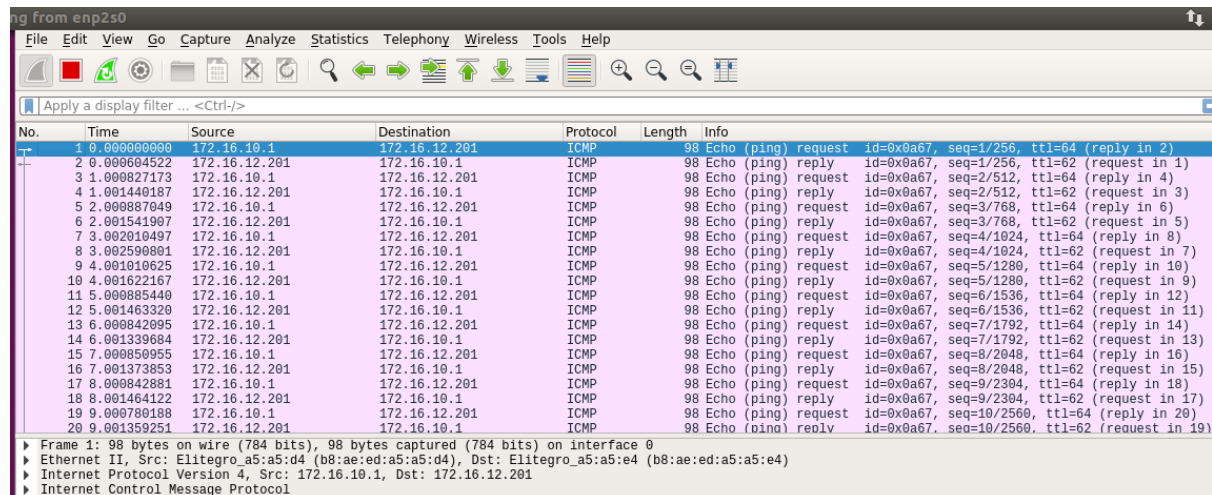
No.	Time	Source	Destination	Protocol	Length	Info
1	0.000000000	172.16.10.1	172.16.12.201	ICMP	98	Echo (ping) request id=0x0a67, seq=1/256, ttl=64 (request in 2)
2	0.000777097	172.16.12.201	172.16.10.1	ICMP	98	Echo (ping) reply id=0x0a67, seq=1/256, ttl=62 (request in 1)
3	1.000849121	172.16.10.1	172.16.12.201	ICMP	98	Echo (ping) request id=0x0a67, seq=2/512, ttl=64 (request in 4)
4	1.001663596	172.16.12.201	172.16.10.1	ICMP	98	Echo (ping) reply id=0x0a67, seq=2/512, ttl=62 (request in 3)
5	2.000899047	172.16.10.1	172.16.12.201	ICMP	98	Echo (ping) request id=0x0a67, seq=3/768, ttl=64 (request in 6)
6	2.001777833	172.16.12.201	172.16.10.1	ICMP	98	Echo (ping) reply id=0x0a67, seq=3/768, ttl=62 (request in 5)
7	3.002025112	172.16.10.1	172.16.12.201	ICMP	98	Echo (ping) request id=0x0a67, seq=4/1024, ttl=64 (request in 8)
8	3.002827556	172.16.12.201	172.16.10.1	ICMP	98	Echo (ping) reply id=0x0a67, seq=4/1024, ttl=62 (request in 7)
9	4.001021632	172.16.10.1	172.16.12.201	ICMP	98	Echo (ping) request id=0x0a67, seq=5/1280, ttl=64 (request in 10)
10	4.001863898	172.16.12.201	172.16.10.1	ICMP	98	Echo (ping) reply id=0x0a67, seq=5/1280, ttl=62 (request in 9)
11	5.000995542	172.16.10.1	172.16.12.201	ICMP	98	Echo (ping) request id=0x0a67, seq=6/1536, ttl=64 (request in 12)
12	5.001643081	172.16.12.201	172.16.10.1	ICMP	98	Echo (ping) reply id=0x0a67, seq=6/1536, ttl=62 (request in 11)
13	6.000863111	172.16.10.1	172.16.12.201	ICMP	98	Echo (ping) request id=0x0a67, seq=7/1792, ttl=64 (request in 14)
14	6.001525756	172.16.12.201	172.16.10.1	ICMP	98	Echo (ping) reply id=0x0a67, seq=7/1792, ttl=62 (request in 13)
15	7.000872957	172.16.10.1	172.16.12.201	ICMP	98	Echo (ping) request id=0x0a67, seq=8/2048, ttl=64 (request in 16)
16	7.001639495	172.16.12.201	172.16.10.1	ICMP	98	Echo (ping) reply id=0x0a67, seq=8/2048, ttl=62 (request in 15)
17	8.000879858	172.16.10.1	172.16.12.201	ICMP	98	Echo (ping) request id=0x0a67, seq=9/2304, ttl=64 (request in 18)
18	8.001721741	172.16.12.201	172.16.10.1	ICMP	98	Echo (ping) reply id=0x0a67, seq=9/2304, ttl=62 (request in 17)
19	9.000917435	172.16.10.1	172.16.12.201	ICMP	98	Echo (ping) request id=0x0a67, seq=10/2560, ttl=64 (request in 20)
20	9.001560520	172.16.12.201	172.16.10.1	ICMP	98	Echo (ping) reply id=0x0a67, seq=10/2560, ttl=62 (request in 19)
21	10.000899671	172.16.10.1	172.16.12.201	ICMP	98	Echo (ping) request id=0x0a67, seq=11/2816, ttl=64 (request in 22)
22	10.001700284	172.16.12.201	172.16.10.1	ICMP	98	Echo (ping) reply id=0x0a67, seq=11/2816, ttl=62 (request in 21)
23	10.015320577	Elitegro_a5:a5:e4	Elitegro_a5:a5:d4	ARP	60	Who has 172.16.10.1? Tell 172.16.10.201

Frame 1: 98 bytes on wire (784 bits), 98 bytes captured (784 bits) on interface 0
Ethernet II, Src: Elitegro_a5:a5:d4 (b8:ae:ed:a5:a5:d4), Dst: Elitegro_a5:a5:e4 (b8:ae:ed:a5:a5:e4)
Internet Protocol Version 4, Src: 172.16.10.1, Dst: 172.16.12.201
Internet Control Message Protocol

Step 2: Capture packets from R1 using both eth1 and eth2 interfaces.

\$ sudo wireshark

At eth1:

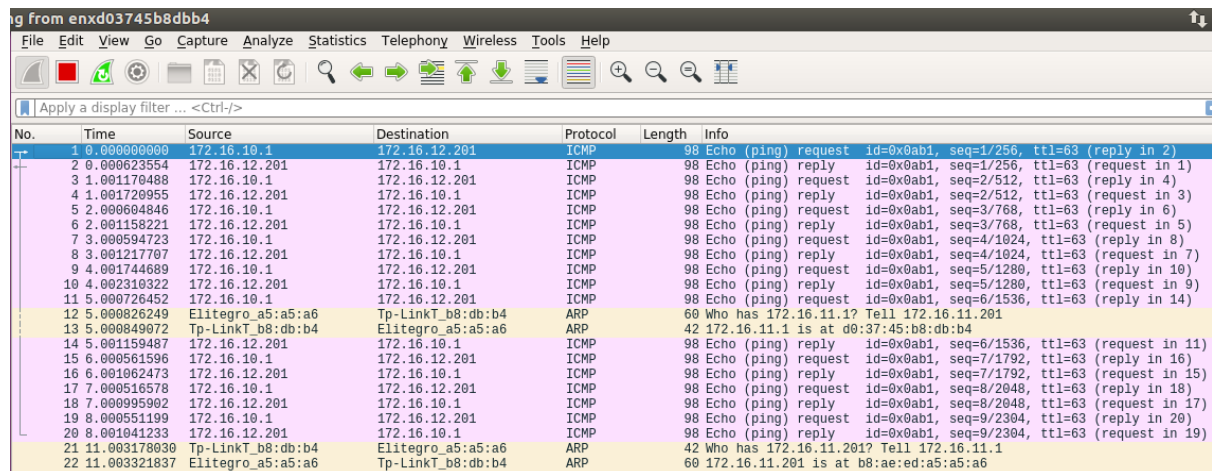


ng from enp2s0

No.	Time	Source	Destination	Protocol	Length	Info
1	0.000000000	172.16.10.1	172.16.12.201	ICMP	98	Echo (ping) request id=0x0a67, seq=1/256, ttl=64 (request in 2)
2	0.000604522	172.16.12.201	172.16.10.1	ICMP	98	Echo (ping) reply id=0x0a67, seq=1/256, ttl=62 (request in 1)
3	1.000827173	172.16.10.1	172.16.12.201	ICMP	98	Echo (ping) request id=0x0a67, seq=2/512, ttl=64 (request in 4)
4	1.001440187	172.16.12.201	172.16.10.1	ICMP	98	Echo (ping) reply id=0x0a67, seq=2/512, ttl=62 (request in 3)
5	2.000887049	172.16.10.1	172.16.12.201	ICMP	98	Echo (ping) request id=0x0a67, seq=3/768, ttl=64 (request in 6)
6	2.001541907	172.16.12.201	172.16.10.1	ICMP	98	Echo (ping) reply id=0x0a67, seq=3/768, ttl=62 (request in 5)
7	3.002010497	172.16.10.1	172.16.12.201	ICMP	98	Echo (ping) request id=0x0a67, seq=4/1024, ttl=64 (request in 8)
8	3.002590801	172.16.12.201	172.16.10.1	ICMP	98	Echo (ping) reply id=0x0a67, seq=4/1024, ttl=62 (request in 7)
9	4.001010625	172.16.10.1	172.16.12.201	ICMP	98	Echo (ping) request id=0x0a67, seq=5/1280, ttl=64 (request in 10)
10	4.001622167	172.16.12.201	172.16.10.1	ICMP	98	Echo (ping) reply id=0x0a67, seq=5/1280, ttl=62 (request in 9)
11	5.000895440	172.16.10.1	172.16.12.201	ICMP	98	Echo (ping) request id=0x0a67, seq=6/1536, ttl=64 (request in 12)
12	5.001463320	172.16.12.201	172.16.10.1	ICMP	98	Echo (ping) reply id=0x0a67, seq=6/1536, ttl=62 (request in 11)
13	6.000842095	172.16.10.1	172.16.12.201	ICMP	98	Echo (ping) request id=0x0a67, seq=7/1792, ttl=64 (request in 14)
14	6.001339684	172.16.12.201	172.16.10.1	ICMP	98	Echo (ping) reply id=0x0a67, seq=7/1792, ttl=62 (request in 13)
15	7.000850955	172.16.10.1	172.16.12.201	ICMP	98	Echo (ping) request id=0x0a67, seq=8/2048, ttl=64 (request in 16)
16	7.001373853	172.16.12.201	172.16.10.1	ICMP	98	Echo (ping) reply id=0x0a67, seq=8/2048, ttl=62 (request in 15)
17	8.000842881	172.16.10.1	172.16.12.201	ICMP	98	Echo (ping) request id=0x0a67, seq=9/2304, ttl=64 (request in 18)
18	8.001464122	172.16.12.201	172.16.10.1	ICMP	98	Echo (ping) reply id=0x0a67, seq=9/2304, ttl=62 (request in 17)
19	9.000780188	172.16.10.1	172.16.12.201	ICMP	98	Echo (ping) request id=0x0a67, seq=10/2560, ttl=64 (request in 20)
20	9.001359251	172.16.12.201	172.16.10.1	ICMP	98	Echo (ping) reply id=0x0a67, seq=10/2560, ttl=62 (request in 19)

Frame 1: 98 bytes on wire (784 bits), 98 bytes captured (784 bits) on interface 0
Ethernet II, Src: Elitegro_a5:a5:d4 (b8:ae:ed:a5:a5:d4), Dst: Elitegro_a5:a5:e4 (b8:ae:ed:a5:a5:e4)
Internet Protocol Version 4, Src: 172.16.10.1, Dst: 172.16.12.201
Internet Control Message Protocol

At eth2:

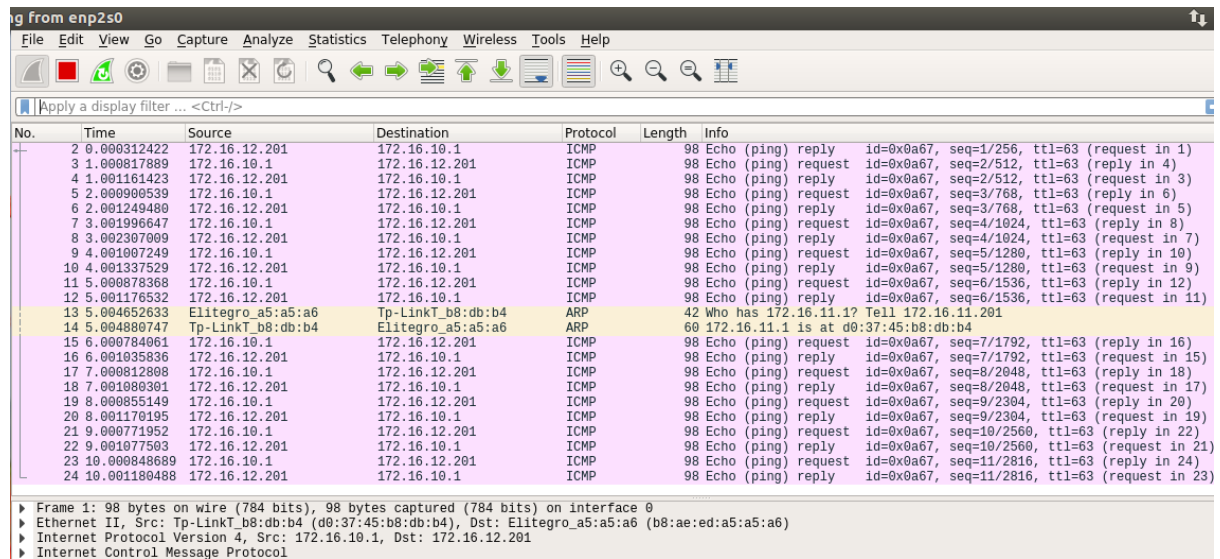


No.	Time	Source	Destination	Protocol	Length	Info
1	0.000000000	172.16.10.1	172.16.12.201	ICMP	98	Echo (ping) request id=0x0ab1, seq=1/256, ttl=63 (reply in 2)
2	0.000623554	172.16.12.201	172.16.10.1	ICMP	98	Echo (ping) reply id=0x0ab1, seq=1/256, ttl=63 (request in 1)
3	1.001170488	172.16.10.1	172.16.12.201	ICMP	98	Echo (ping) request id=0x0ab1, seq=2/512, ttl=63 (reply in 4)
4	1.001720955	172.16.12.201	172.16.10.1	ICMP	98	Echo (ping) reply id=0x0ab1, seq=2/512, ttl=63 (request in 3)
5	2.000604846	172.16.10.1	172.16.12.201	ICMP	98	Echo (ping) request id=0x0ab1, seq=3/768, ttl=63 (reply in 6)
6	2.001158221	172.16.12.201	172.16.10.1	ICMP	98	Echo (ping) reply id=0x0ab1, seq=3/768, ttl=63 (request in 5)
7	3.000594723	172.16.10.1	172.16.12.201	ICMP	98	Echo (ping) request id=0x0ab1, seq=4/1024, ttl=63 (reply in 8)
8	3.001217707	172.16.12.201	172.16.10.1	ICMP	98	Echo (ping) reply id=0x0ab1, seq=4/1024, ttl=63 (request in 7)
9	4.001744689	172.16.10.1	172.16.12.201	ICMP	98	Echo (ping) request id=0x0ab1, seq=5/1280, ttl=63 (reply in 10)
10	4.002310322	172.16.12.201	172.16.10.1	ICMP	98	Echo (ping) reply id=0x0ab1, seq=5/1280, ttl=63 (request in 9)
11	5.000726452	172.16.10.1	172.16.12.201	ICMP	98	Echo (ping) request id=0x0ab1, seq=6/1536, ttl=63 (reply in 14)
12	5.000826249	Elitegro_a5:a5:a6	Tp-LinkT_b8:db:b4	ARP	60	Who has 172.16.11.1? Tell 172.16.11.201
13	5.000849072	Tp-LinkT_b8:db:b4	Elitegro_a5:a5:a6	ARP	42	172.16.11.1 is at d0:37:45:b8:db:b4
14	5.001159487	172.16.12.201	172.16.10.1	ICMP	98	Echo (ping) reply id=0x0ab1, seq=6/1536, ttl=63 (request in 11)
15	6.000561596	172.16.10.1	172.16.12.201	ICMP	98	Echo (ping) request id=0x0ab1, seq=7/1792, ttl=63 (reply in 16)
16	6.001062473	172.16.12.201	172.16.10.1	ICMP	98	Echo (ping) reply id=0x0ab1, seq=7/1792, ttl=63 (request in 15)
17	7.000516578	172.16.10.1	172.16.12.201	ICMP	98	Echo (ping) request id=0x0ab1, seq=8/2048, ttl=63 (reply in 18)
18	7.000995902	172.16.12.201	172.16.10.1	ICMP	98	Echo (ping) reply id=0x0ab1, seq=8/2048, ttl=63 (request in 17)
19	8.000055119	172.16.10.1	172.16.12.201	ICMP	98	Echo (ping) request id=0x0ab1, seq=9/2304, ttl=63 (reply in 20)
20	8.001041233	172.16.12.201	172.16.10.1	ICMP	98	Echo (ping) reply id=0x0ab1, seq=9/2304, ttl=63 (request in 19)
21	11.003178030	Tp-LinkT_b8:db:b4	Elitegro_a5:a5:a6	ARP	42	Who has 172.16.11.1? Tell 172.16.11.1
22	11.003321837	Elitegro_a5:a5:a6	Tp-LinkT_b8:db:b4	ARP	60	172.16.11.201 is at b8:ae:ed:a5:a5:a6

Step 3: Capture packets from R2 using both eth1 and eth2 interfaces.

\$ sudo wireshark

At eth1:



No.	Time	Source	Destination	Protocol	Length	Info
2	0.000312422	172.16.12.201	172.16.10.1	ICMP	98	Echo (ping) reply id=0x0a67, seq=1/256, ttl=63 (request in 1)
3	1.000817889	172.16.10.1	172.16.12.201	ICMP	98	Echo (ping) request id=0x0a67, seq=2/512, ttl=63 (reply in 4)
4	1.001161423	172.16.12.201	172.16.10.1	ICMP	98	Echo (ping) reply id=0x0a67, seq=2/512, ttl=63 (request in 3)
5	2.000900539	172.16.10.1	172.16.12.201	ICMP	98	Echo (ping) request id=0x0a67, seq=3/768, ttl=63 (reply in 6)
6	2.001249480	172.16.12.201	172.16.10.1	ICMP	98	Echo (ping) reply id=0x0a67, seq=3/768, ttl=63 (request in 5)
7	3.001996647	172.16.10.1	172.16.12.201	ICMP	98	Echo (ping) request id=0x0a67, seq=4/1024, ttl=63 (reply in 8)
8	3.002307009	172.16.12.201	172.16.10.1	ICMP	98	Echo (ping) reply id=0x0a67, seq=4/1024, ttl=63 (request in 7)
9	4.001007249	172.16.10.1	172.16.12.201	ICMP	98	Echo (ping) request id=0x0a67, seq=5/1280, ttl=63 (reply in 10)
10	4.001337529	172.16.12.201	172.16.10.1	ICMP	98	Echo (ping) reply id=0x0a67, seq=5/1280, ttl=63 (request in 9)
11	5.000878368	172.16.10.1	172.16.12.201	ICMP	98	Echo (ping) request id=0x0a67, seq=6/1536, ttl=63 (reply in 12)
12	5.001176532	172.16.12.201	172.16.10.1	ICMP	98	Echo (ping) reply id=0x0a67, seq=6/1536, ttl=63 (request in 11)
13	5.004652633	Elitegro_a5:a5:a6	Tp-LinkT_b8:db:b4	ARP	42	Who has 172.16.11.1? Tell 172.16.11.201
14	5.004880747	Tp-LinkT_b8:db:b4	Elitegro_a5:a5:a6	ARP	60	172.16.11.1 is at d0:37:45:b8:db:b4
15	6.000784061	172.16.10.1	172.16.12.201	ICMP	98	Echo (ping) request id=0x0a67, seq=7/1792, ttl=63 (reply in 16)
16	6.001035836	172.16.12.201	172.16.10.1	ICMP	98	Echo (ping) reply id=0x0a67, seq=7/1792, ttl=63 (request in 15)
17	7.000812808	172.16.10.1	172.16.12.201	ICMP	98	Echo (ping) request id=0x0a67, seq=8/2048, ttl=63 (reply in 18)
18	7.001080301	172.16.12.201	172.16.10.1	ICMP	98	Echo (ping) reply id=0x0a67, seq=8/2048, ttl=63 (request in 17)
19	8.000855149	172.16.10.1	172.16.12.201	ICMP	98	Echo (ping) request id=0x0a67, seq=9/2304, ttl=63 (reply in 20)
20	8.001170195	172.16.12.201	172.16.10.1	ICMP	98	Echo (ping) reply id=0x0a67, seq=9/2304, ttl=63 (request in 19)
21	9.000771952	172.16.10.1	172.16.12.201	ICMP	98	Echo (ping) request id=0x0a67, seq=10/2560, ttl=63 (reply in 22)
22	9.001077503	172.16.12.201	172.16.10.1	ICMP	98	Echo (ping) reply id=0x0a67, seq=10/2560, ttl=63 (request in 21)
23	10.000848689	172.16.10.1	172.16.12.201	ICMP	98	Echo (ping) request id=0x0a67, seq=11/2816, ttl=63 (reply in 24)
24	10.001180488	172.16.12.201	172.16.10.1	ICMP	98	Echo (ping) reply id=0x0a67, seq=11/2816, ttl=63 (request in 23)

▶ Frame 1: 98 bytes on wire (784 bits), 98 bytes captured (784 bits) on interface 0
▶ Ethernet II, Src: Tp-LinkT_b8:db:b4 (d0:37:45:b8:db:b4), Dst: Elitegro_a5:a5:a6 (b8:ae:ed:a5:a5:a6)
▶ Internet Protocol Version 4, Src: 172.16.10.1, Dst: 172.16.12.201
▶ Internet Control Message Protocol

At eth2:

ng from enxd03745b8d975

No.	Time	Source	Destination	Protocol	Length	Info
1	0.000000000	172.16.10.1	172.16.12.201	ICMP	98	Echo (ping) request id=0x0ab1, seq=1/256, ttl=62 (reply in 2)
2	0.000314202	172.16.12.201	172.16.10.1	ICMP	98	Echo (ping) reply id=0x0ab1, seq=1/256, ttl=64 (request in 1)
3	1.001146915	172.16.10.1	172.16.12.201	ICMP	98	Echo (ping) request id=0x0ab1, seq=2/512, ttl=62 (reply in 4)
4	1.001424288	172.16.12.201	172.16.10.1	ICMP	98	Echo (ping) reply id=0x0ab1, seq=2/512, ttl=64 (request in 3)
5	2.000576195	172.16.10.1	172.16.12.201	ICMP	98	Echo (ping) request id=0x0ab1, seq=3/768, ttl=62 (reply in 6)
6	2.000864382	172.16.12.201	172.16.10.1	ICMP	98	Echo (ping) reply id=0x0ab1, seq=3/768, ttl=64 (request in 5)
7	3.000602633	172.16.10.1	172.16.12.201	ICMP	98	Echo (ping) request id=0x0ab1, seq=4/1024, ttl=62 (reply in 8)
8	3.000915743	172.16.12.201	172.16.10.1	ICMP	98	Echo (ping) reply id=0x0ab1, seq=4/1024, ttl=64 (request in 7)
9	4.001727196	172.16.10.1	172.16.12.201	ICMP	98	Echo (ping) request id=0x0ab1, seq=5/1280, ttl=62 (reply in 10)
10	4.002014271	172.16.12.201	172.16.10.1	ICMP	98	Echo (ping) reply id=0x0ab1, seq=5/1280, ttl=64 (request in 9)
11	5.000575753	Tp-LinkT_b8:d9:75	Elitegro_a5:a5:81	ARP	42	Who has 172.16.12.201? Tell 172.16.12.1
12	5.000672316	172.16.10.1	172.16.12.201	ICMP	98	Echo (ping) request id=0x0ab1, seq=6/1536, ttl=62 (reply in 14)
13	5.000791033	Elitegro_a5:a5:81	Tp-LinkT_b8:d9:75	ARP	60	172.16.12.201 is at b8:ae:ed:a5:a5:81
14	5.000866738	172.16.12.201	172.16.10.1	ICMP	98	Echo (ping) reply id=0x0ab1, seq=6/1536, ttl=64 (request in 12)
15	6.000511220	172.16.10.1	172.16.12.201	ICMP	98	Echo (ping) request id=0x0ab1, seq=7/1792, ttl=62 (reply in 16)
16	6.000763851	172.16.12.201	172.16.10.1	ICMP	98	Echo (ping) reply id=0x0ab1, seq=7/1792, ttl=64 (request in 15)
17	7.000485826	172.16.10.1	172.16.12.201	ICMP	98	Echo (ping) request id=0x0ab1, seq=8/2048, ttl=62 (reply in 18)
18	7.000724236	172.16.12.201	172.16.10.1	ICMP	98	Echo (ping) reply id=0x0ab1, seq=8/2048, ttl=64 (request in 17)
19	8.000524294	172.16.10.1	172.16.12.201	ICMP	98	Echo (ping) request id=0x0ab1, seq=9/2304, ttl=62 (reply in 20)
20	8.000780277	172.16.12.201	172.16.10.1	ICMP	98	Echo (ping) reply id=0x0ab1, seq=9/2304, ttl=64 (request in 19)

Frame 1: 98 bytes on wire (784 bits), 98 bytes captured (784 bits) on interface 0
Ethernet II, Src: Tp-LinkT_b8:d9:75 (d0:37:45:b8:d9:75), Dst: Elitegro_a5:a5:81 (b8:ae:ed:a5:a5:81)
Internet Protocol Version 4, Src: 172.16.10.1, Dst: 172.16.12.201
Internet Control Message Protocol

Step 4: Capture packets from Hd and Ha.

At Hd:

T1: \$ sudo wireshark

g from enp2s0

No.	Time	Source	Destination	Protocol	Length	Info
1	0.000000000	172.16.10.1	172.16.12.201	ICMP	98	Echo (ping) request id=0x0a67, seq=1/256, ttl=62 (reply in 2)
2	0.000041124	172.16.12.201	172.16.10.1	ICMP	98	Echo (ping) reply id=0x0a67, seq=1/256, ttl=64 (request in 1)
3	1.000801590	172.16.10.1	172.16.12.201	ICMP	98	Echo (ping) request id=0x0a67, seq=2/512, ttl=62 (reply in 4)
4	1.000836439	172.16.12.201	172.16.10.1	ICMP	98	Echo (ping) reply id=0x0a67, seq=2/512, ttl=64 (request in 3)
5	2.000857901	172.16.10.1	172.16.12.201	ICMP	98	Echo (ping) request id=0x0a67, seq=3/768, ttl=62 (reply in 6)
6	2.000896410	172.16.12.201	172.16.10.1	ICMP	98	Echo (ping) reply id=0x0a67, seq=3/768, ttl=64 (request in 5)
7	3.001921744	172.16.10.1	172.16.12.201	ICMP	98	Echo (ping) request id=0x0a67, seq=4/1024, ttl=62 (reply in 8)
8	3.001952429	172.16.12.201	172.16.10.1	ICMP	98	Echo (ping) reply id=0x0a67, seq=4/1024, ttl=64 (request in 7)
9	4.000920260	172.16.10.1	172.16.12.201	ICMP	98	Echo (ping) request id=0x0a67, seq=5/1280, ttl=62 (reply in 10)
10	4.000958994	172.16.12.201	172.16.10.1	ICMP	98	Echo (ping) reply id=0x0a67, seq=5/1280, ttl=64 (request in 9)
11	5.000770673	172.16.10.1	172.16.12.201	ICMP	98	Echo (ping) request id=0x0a67, seq=6/1536, ttl=62 (reply in 12)
12	5.000807014	172.16.12.201	172.16.10.1	ICMP	98	Echo (ping) reply id=0x0a67, seq=6/1536, ttl=64 (request in 11)
13	5.004532407	Tp-LinkT_b8:d9:75	Elitegro_a5:a5:81	ARP	60	Who has 172.16.12.201? Tell 172.16.12.1
14	5.004563340	Elitegro_a5:a5:81	Tp-LinkT_b8:d9:75	ARP	42	172.16.12.201 is at b8:ae:ed:a5:a5:81
15	6.000658739	172.16.10.1	172.16.12.201	ICMP	98	Echo (ping) request id=0x0a67, seq=7/1792, ttl=62 (reply in 16)
16	6.000698346	172.16.12.201	172.16.10.1	ICMP	98	Echo (ping) reply id=0x0a67, seq=7/1792, ttl=64 (request in 15)
17	7.000682090	172.16.10.1	172.16.12.201	ICMP	98	Echo (ping) request id=0x0a67, seq=8/2048, ttl=62 (reply in 18)
18	7.000718324	172.16.12.201	172.16.10.1	ICMP	98	Echo (ping) reply id=0x0a67, seq=8/2048, ttl=64 (request in 17)
19	8.000693338	172.16.10.1	172.16.12.201	ICMP	98	Echo (ping) request id=0x0a67, seq=9/2304, ttl=62 (reply in 20)
20	8.000731320	172.16.12.201	172.16.10.1	ICMP	98	Echo (ping) reply id=0x0a67, seq=9/2304, ttl=64 (request in 19)
21	9.000598064	172.16.10.1	172.16.12.201	ICMP	98	Echo (ping) request id=0x0a67, seq=10/2560, ttl=62 (reply in 22)
22	9.000633652	172.16.12.201	172.16.10.1	ICMP	98	Echo (ping) reply id=0x0a67, seq=10/2560, ttl=64 (request in 21)
23	10.000651149	172.16.10.1	172.16.12.201	ICMP	98	Echo (ping) request id=0x0a67, seq=11/2816, ttl=62 (reply in 24)
24	10.000689522	172.16.12.201	172.16.10.1	ICMP	98	Echo (ping) reply id=0x0a67, seq=11/2816, ttl=64 (request in 23)
25	10.999804264	172.16.10.1	172.16.12.201	ICMP	98	Echo (ping) request id=0x0a67, seq=12/3072, ttl=62 (reply in 26)

Frame 1: 98 bytes on wire (784 bits), 98 bytes captured (784 bits) on interface 0
Ethernet II, Src: Tp-LinkT_b8:d9:75 (d0:37:45:b8:d9:75), Dst: Elitegro_a5:a5:81 (b8:ae:ed:a5:a5:81)
Internet Protocol Version 4, Src: 172.16.10.1, Dst: 172.16.12.201
Internet Control Message Protocol

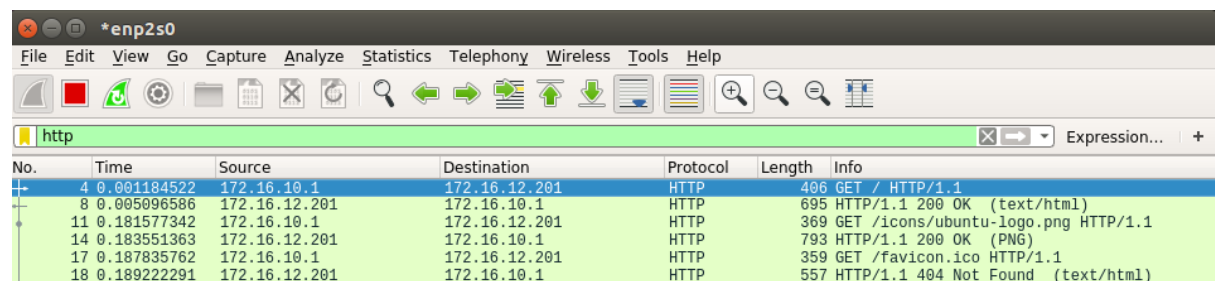
Exercises: Send http packets from Ha to Hd and capture Wireshark for Ha and Hd files

Apache Service at Ha

```
● apache2.service - LSB: Apache2 web server
Loaded: loaded (/etc/init.d/apache2; bad; vendor preset: enabled)
Drop-In: /lib/systemd/system/apache2.service.d
         └─apache2-systemd.conf
Active: active (running) since Thu 2021-04-01 14:43:52 IST; 25min ago
Docs: man:systemd-sysv-generator(8)
Process: 975 ExecStart=/etc/init.d/apache2 start (code=exited, status=0/SUCCESS)
CGroup: /system.slice/apache2.service
        └─1083 /usr/sbin/apache2 -k start
           1093 /usr/sbin/apache2 -k start
           1094 /usr/sbin/apache2 -k start
           1095 /usr/sbin/apache2 -k start
           1096 /usr/sbin/apache2 -k start
           1097 /usr/sbin/apache2 -k start

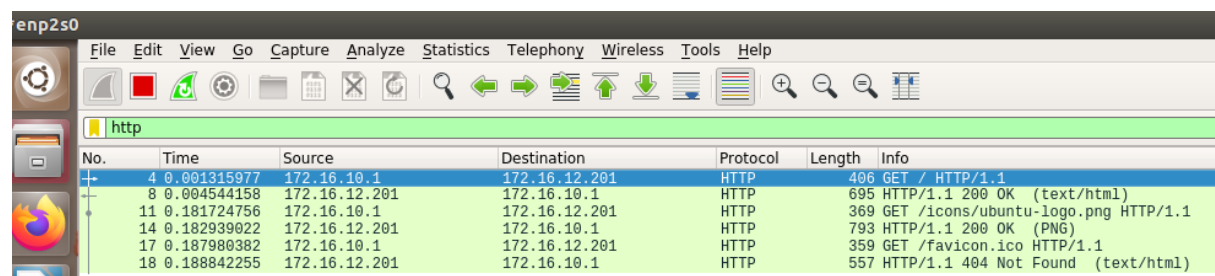
Apr 01 14:43:47 CSELAB systemd[1]: Starting LSB: Apache2 web server...
Apr 01 14:43:49 CSELAB apache2[975]: * Starting Apache httpd web server apache2
Apr 01 14:43:51 CSELAB apache2[975]: AH00558: apache2: Could not reliably determine the server's fully qualified domain name, using 127.0.1.1.
Apr 01 14:43:52 CSELAB apache2[975]: *
Apr 01 14:43:52 CSELAB systemd[1]: Started LSB: Apache2 web server.
```

R1 Capturing HTTP packet



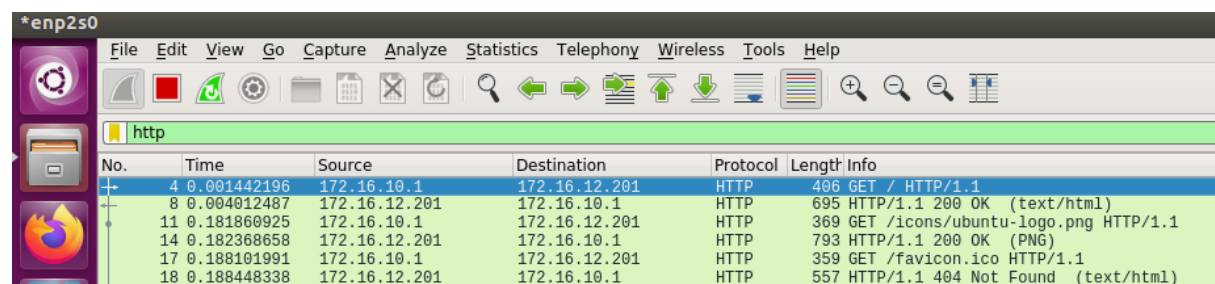
No.	Time	Source	Destination	Protocol	Length	Info
4	0.001184522	172.16.10.1	172.16.12.201	HTTP	406	GET / HTTP/1.1
8	0.005096586	172.16.12.201	172.16.10.1	HTTP	695	HTTP/1.1 200 OK (text/html)
11	0.181577342	172.16.10.1	172.16.12.201	HTTP	369	GET /icons/ubuntu-logo.png HTTP/1.1
14	0.183551363	172.16.12.201	172.16.10.1	HTTP	793	HTTP/1.1 200 OK (PNG)
17	0.187835762	172.16.10.1	172.16.12.201	HTTP	359	GET /favicon.ico HTTP/1.1
18	0.189222291	172.16.12.201	172.16.10.1	HTTP	557	HTTP/1.1 404 Not Found (text/html)

R2 Capturing HTTP packet



No.	Time	Source	Destination	Protocol	Length	Info
4	0.001315977	172.16.10.1	172.16.12.201	HTTP	406	GET / HTTP/1.1
8	0.004544158	172.16.12.201	172.16.10.1	HTTP	695	HTTP/1.1 200 OK (text/html)
11	0.181724756	172.16.10.1	172.16.12.201	HTTP	369	GET /icons/ubuntu-logo.png HTTP/1.1
14	0.182939022	172.16.12.201	172.16.10.1	HTTP	793	HTTP/1.1 200 OK (PNG)
17	0.187980382	172.16.10.1	172.16.12.201	HTTP	359	GET /favicon.ico HTTP/1.1
18	0.188842255	172.16.12.201	172.16.10.1	HTTP	557	HTTP/1.1 404 Not Found (text/html)

Hd Capturing HTTP packet



No.	Time	Source	Destination	Protocol	Length	Info
4	0.001442196	172.16.10.1	172.16.12.201	HTTP	406	GET / HTTP/1.1
8	0.004012487	172.16.12.201	172.16.10.1	HTTP	695	HTTP/1.1 200 OK (text/html)
11	0.181860925	172.16.10.1	172.16.12.201	HTTP	369	GET /icons/ubuntu-logo.png HTTP/1.1
14	0.182368658	172.16.12.201	172.16.10.1	HTTP	793	HTTP/1.1 200 OK (PNG)
17	0.188101991	172.16.10.1	172.16.12.201	HTTP	359	GET /favicon.ico HTTP/1.1
18	0.188448338	172.16.12.201	172.16.10.1	HTTP	557	HTTP/1.1 404 Not Found (text/html)