# COMPUTER NETWORKS LAB
# SRN – PES1UG19CS542
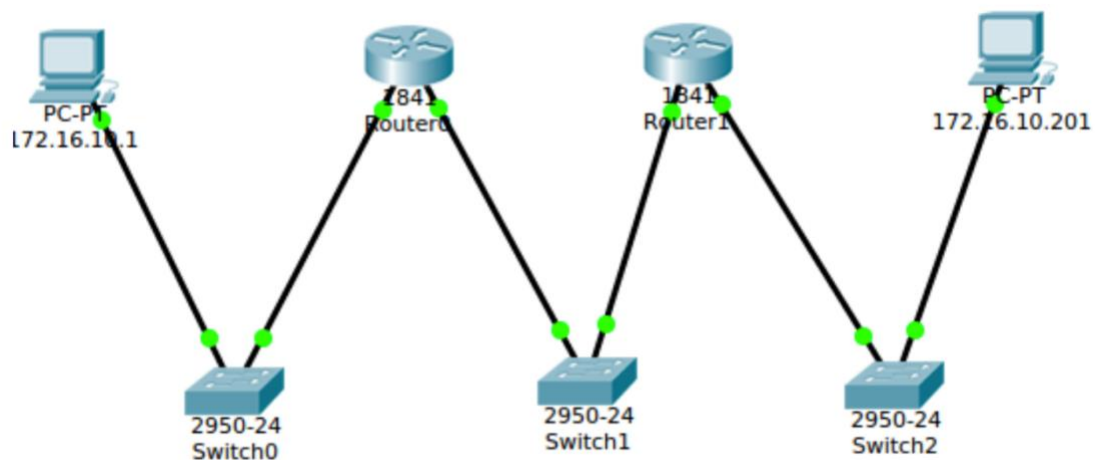# SECTION – I
# NAME- TRISHA JAIN

## IPv4 Addressing and Static Routing

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

**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:~$ sudo ip addr add 172.16.10.1/24 dev enp2s0
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:a6:b5 brd ff:ff:ff:ff:ff:ff
    inet 172.16.10.1/24 scope global enp2s0
       valid_lft forever preferred_lft forever
    inet6 fe80::baae:edff:fea5:a6b5/64 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
$ ifconfig

```
student@CSELAB:~$ ifconfig
enp2s0    Link encap:Ethernet  HWaddr b8:ae:ed:a5:a6:0e
          inet addr:172.16.10.201  Bcast:0.0.0.0  Mask:255.255.255.0
          inet6 addr: fe80::baae:edff:fea5:a60e/64 Scope:Link
          UP BROADCAST RUNNING MULTICAST  MTU:1500  Metric:1
          RX packets:26702 errors:0 dropped:0 overruns:0 frame:0
          TX packets:1379 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:1000
          RX bytes:3709643 (3.7 MB)  TX bytes:153505 (153.5 KB)

enxd03745b8f2f3 Link encap:Ethernet  HWaddr d0:37:45:b8:f2:f3
          inet addr:172.16.11.1  Bcast:0.0.0.0  Mask:255.255.255.0
          inet6 addr: fe80::d237:45ff:feb8:f2f3/64 Scope:Link
          UP BROADCAST RUNNING MULTICAST  MTU:1500  Metric:1
          RX packets:298 errors:0 dropped:0 overruns:0 frame:0
          TX packets:208 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:1000
          RX bytes:43172 (43.1 KB)  TX bytes:33018 (33.0 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:367 errors:0 dropped:0 overruns:0 frame:0
          TX packets:367 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:1
          RX bytes:27961 (27.9 KB)  TX bytes:27961 (27.9 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
$ ifconfig

```
student@CSELAB:~$ ifconfig
enp2s0    Link encap:Ethernet  HWaddr b8:ae:ed:a5:a5:b9
          inet addr:172.16.12.1  Bcast:172.16.12.255  Mask:255.255.255.0
          inet6 addr: fe80::e06d:a6e0:e80e:2053/64 Scope:Link
          UP BROADCAST RUNNING MULTICAST  MTU:1500  Metric:1
          RX packets:19590 errors:0 dropped:0 overruns:0 frame:0
          TX packets:1394 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:1000
          RX bytes:2646988 (2.6 MB)  TX bytes:159130 (159.1 KB)

enxd03745b8f18d Link encap:Ethernet  HWaddr d0:37:45:b8:f1:8d
          inet addr:172.16.11.201  Bcast:172.16.11.255  Mask:255.255.255.0
          inet6 addr: fe80::2f4b:152f:3a88:6d7d/64 Scope:Link
          UP BROADCAST RUNNING MULTICAST  MTU:1500  Metric:1
          RX packets:261 errors:0 dropped:0 overruns:0 frame:0
          TX packets:373 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:1000
          RX bytes:37811 (37.8 KB)  TX bytes:58286 (58.2 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:387 errors:0 dropped:0 overruns:0 frame:0
          TX packets:387 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:1
          RX bytes:29427 (29.4 KB)  TX bytes:29427 (29.4 KB)
```

Step 4: Assign the IP address to the Hd.
$ sudo ip addr add 172.16.12.201/24 dev eth1
$ ifconfig

```
student@CSELAB:~$ ifconfig
enp2s0    Link encap:Ethernet  HWaddr b8:ae:ed:35:c1:dc
          inet addr:172.16.12.201  Bcast:172.16.12.255  Mask:255.255.255.0
          inet6 addr: fe80::6702:7146:7342:f35d/64 Scope:Link
          UP BROADCAST RUNNING MULTICAST  MTU:1500  Metric:1
          RX packets:19069 errors:0 dropped:0 overruns:0 frame:0
          TX packets:1496 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:1000
          RX bytes:2740366 (2.7 MB)  TX bytes:174780 (174.7 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:432 errors:0 dropped:0 overruns:0 frame:0
          TX packets:432 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:1
          RX bytes:34037 (34.0 KB)  TX bytes:34037 (34.0 KB)
```

Disabling accepting the ICMP redirect packets :-

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

Disabling sending of the ICMP redirect packets by these routers with aliased interfaces :-

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

**Task 2**: Convert the machines B and C into routers.

To check if IP forwarding is enabled or not.

$ sysctl net.ipv4.ip_forward

```
student@CSELAB:~$ sysctl net.ipv4.ip_forward
net.ipv4.ip_forward = 0
```

Setting the value of net.ipv4.ip_forward.

$ sudo sysctl –w net.ipv4.ip_forward=1

```
student@CSELAB:~$ sudo sysctl -w net.ipv4.ip_forward=1
net.ipv4.ip_forward = 1
```

**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=62 time=0.630 ms
64 bytes from 172.16.10.1: icmp_seq=2 ttl=62 time=0.799 ms
^C
--- 172.16.10.1 ping statistics ---
2 packets transmitted, 2 received, 0% packet loss, time 999ms
rtt min/avg/max/mdev = 0.630/0.714/0.799/0.088 ms
```

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=0.194 ms
64 bytes from 172.16.12.1: icmp_seq=2 ttl=64 time=0.226 ms
^C
--- 172.16.12.1 ping statistics ---
2 packets transmitted, 2 received, 0% packet loss, time 999ms
rtt min/avg/max/mdev = 0.194/0.210/0.226/0.016 ms
```

**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:~$ sudo ip route add 172.16.12.0/24 via 172.16.10.201
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
172.16.11.0/24 via 172.16.10.201 dev enp2s0
172.16.12.0/24 via 172.16.10.201 dev enp2s0
```

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
172.16.11.0/24 dev enxd03745b8f2f3  proto kernel  scope link  src 172.16.11.1  metric 100
172.16.12.0/24 via 172.16.11.201 dev enxd03745b8f2f3
```

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 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 via 172.16.11.1 dev enxd03745b8f18d
172.16.11.0/24 dev enxd03745b8f18d  proto kernel  scope link  src 172.16.11.201  metric 100
172.16.12.0/24 dev enp2s0  proto kernel  scope link  src 172.16.12.1  metric 100
```

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:~$ sudo ip route add 172.16.10.0/24 via 172.16.12.1
[sudo] password for student:
student@CSELAB:~$ sudo ip route add 172.16.11.0/24 via 172.16.12.1
student@CSELAB:~$ ip route show
169.254.0.0/16 dev enp2s0  scope link  metric 1000
172.16.10.0/24 via 172.16.12.1 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
student@CSELAB:~$
```

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

: Testing path from Ha and Hd

$ 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=63 time=0.568 ms
64 bytes from 172.16.12.1: icmp_seq=2 ttl=63 time=0.591 ms
64 bytes from 172.16.12.1: icmp_seq=3 ttl=63 time=0.634 ms
64 bytes from 172.16.12.1: icmp_seq=4 ttl=63 time=0.571 ms
^C
--- 172.16.12.1 ping statistics ---
4 packets transmitted, 4 received, 0% packet loss, time 2998ms
rtt min/avg/max/mdev = 0.568/0.591/0.634/0.026 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=0.900 ms
64 bytes from 172.16.12.201: icmp_seq=2 ttl=62 time=0.802 ms
64 bytes from 172.16.12.201: icmp_seq=3 ttl=62 time=0.840 ms
64 bytes from 172.16.12.201: icmp_seq=4 ttl=62 time=0.833 ms
64 bytes from 172.16.12.201: icmp_seq=5 ttl=62 time=0.853 ms
^C
--- 172.16.12.201 ping statistics ---
5 packets transmitted, 5 received, 0% packet loss, time 3999ms
rtt min/avg/max/mdev = 0.802/0.845/0.900/0.045 ms
```

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=0.194 ms
64 bytes from 172.16.12.1: icmp_seq=2 ttl=64 time=0.226 ms
^C
--- 172.16.12.1 ping statistics ---
2 packets transmitted, 2 received, 0% packet loss, time 999ms
rtt min/avg/max/mdev = 0.194/0.210/0.226/0.016 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=0.900 ms
64 bytes from 172.16.12.201: icmp_seq=2 ttl=62 time=0.802 ms
64 bytes from 172.16.12.201: icmp_seq=3 ttl=62 time=0.840 ms
64 bytes from 172.16.12.201: icmp_seq=4 ttl=62 time=0.833 ms
64 bytes from 172.16.12.201: icmp_seq=5 ttl=62 time=0.853 ms
^C
--- 172.16.12.201 ping statistics ---
5 packets transmitted, 5 received, 0% packet loss, time 3999ms
rtt min/avg/max/mdev = 0.802/0.845/0.900/0.045 ms
```

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

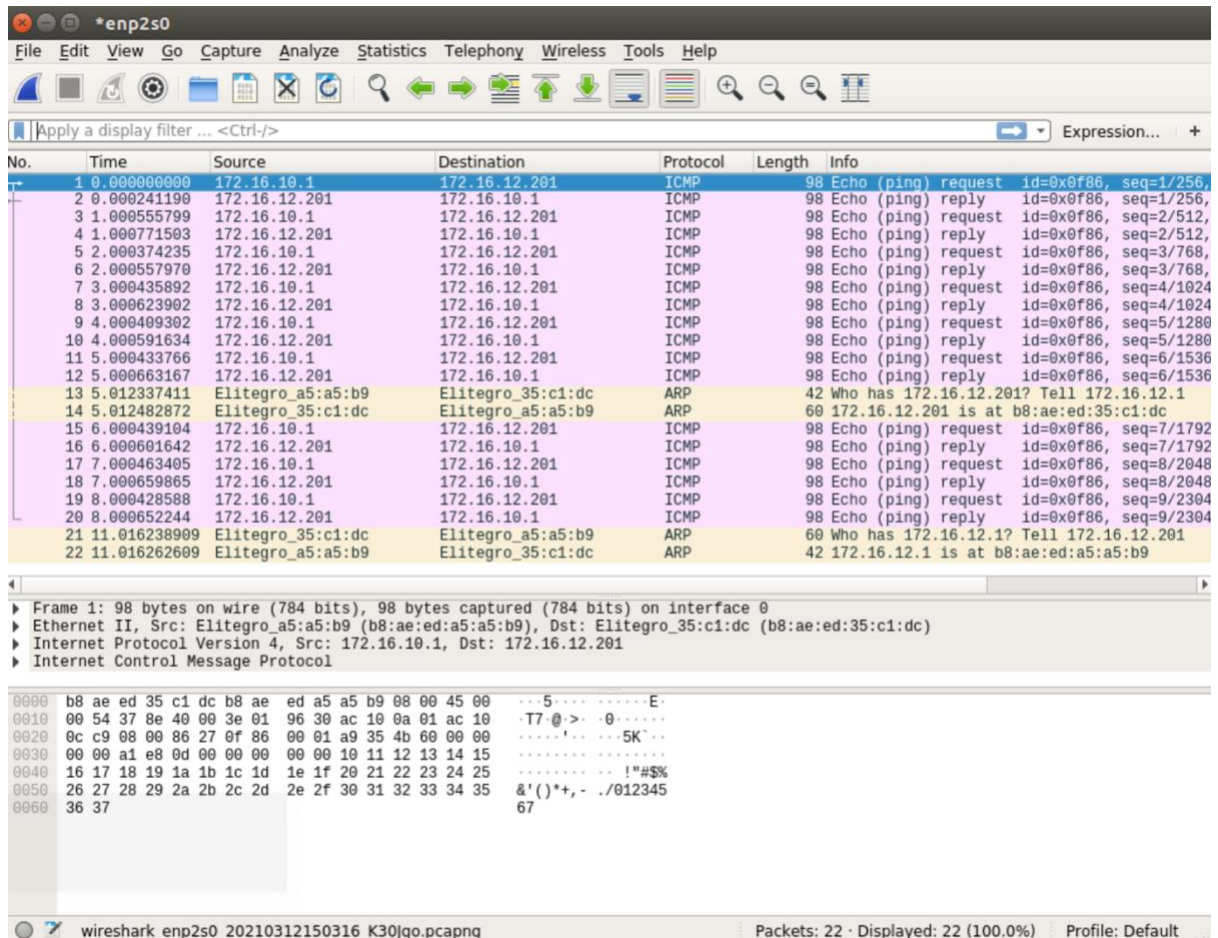Step 1: Capture packets from Ha and Hd.
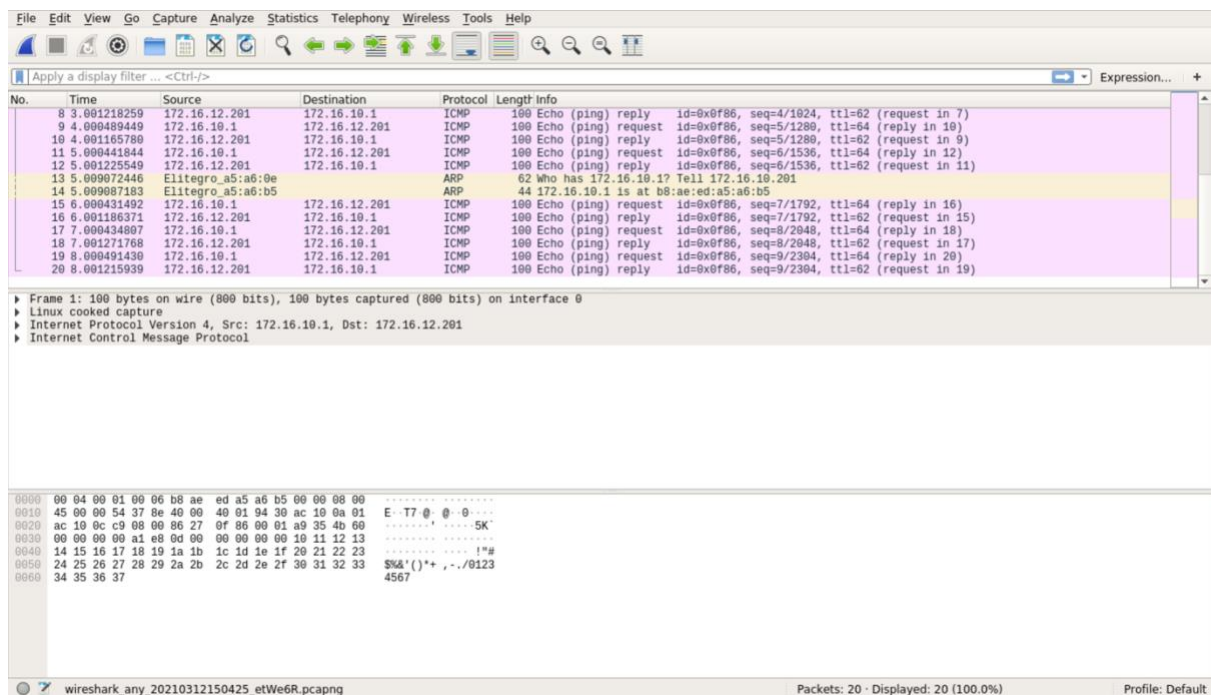


Step 2: Capture packets from R1 using both interfaces.
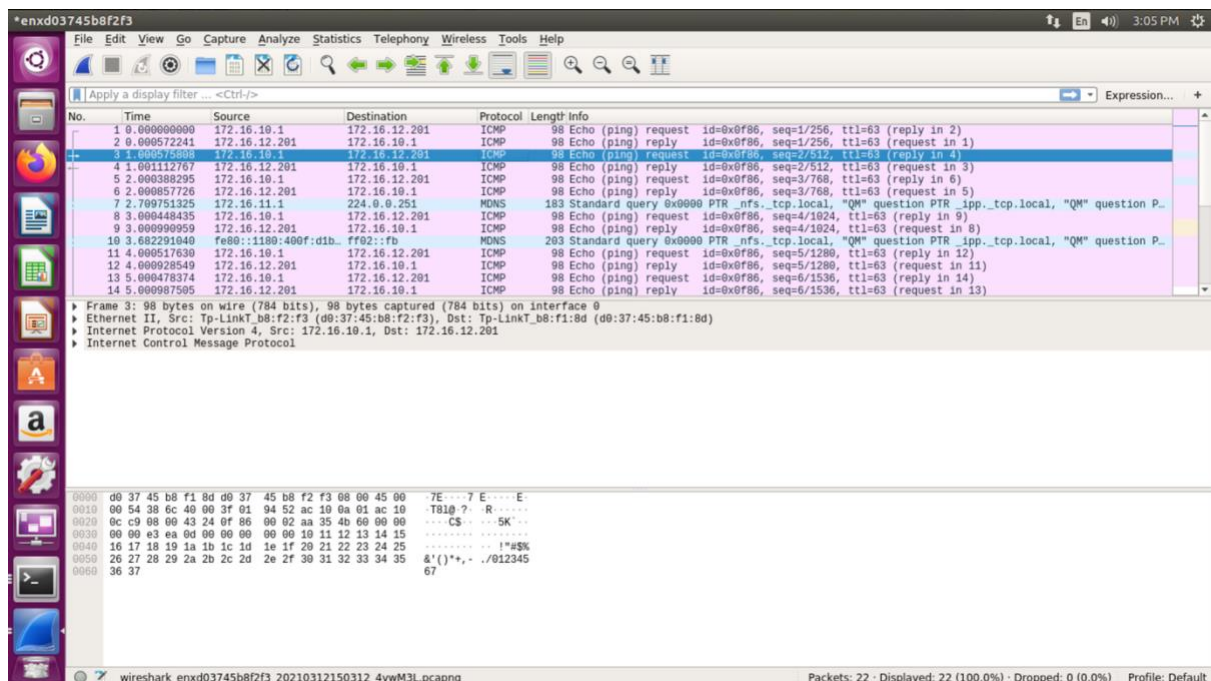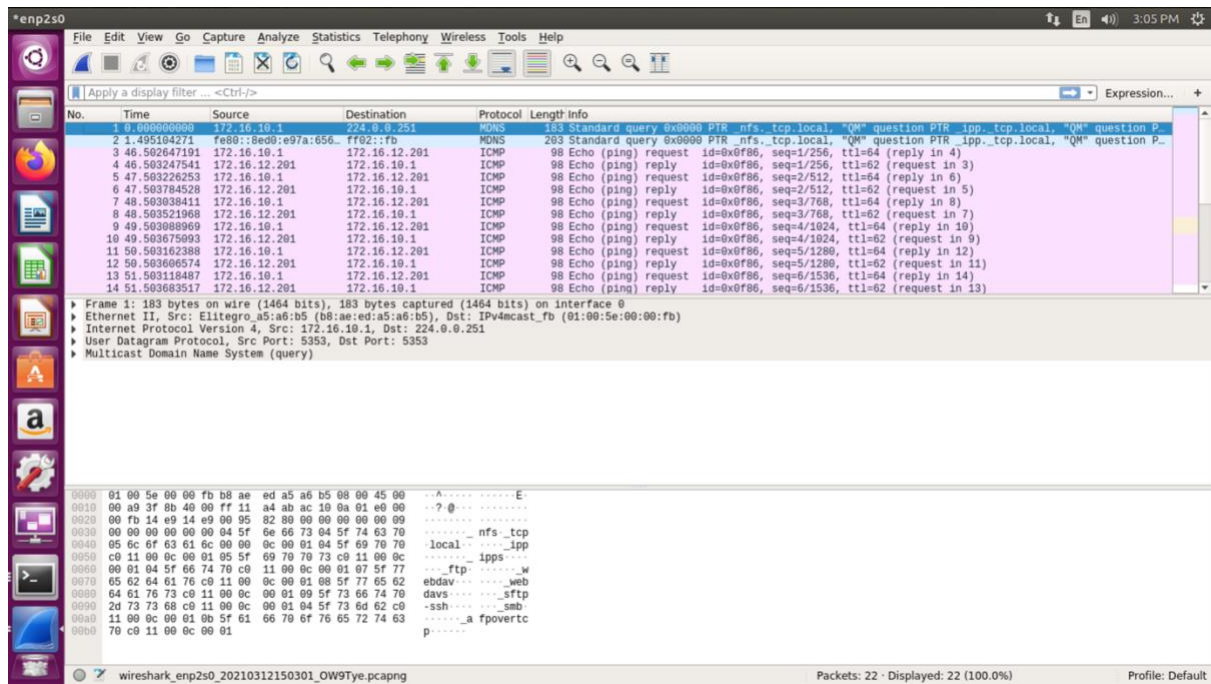
Step 3: Capture packets from R2 using both interfaces.

File  Edit  View  Go  Capture  Analyze  Statistics  Telephony  Wireless  Tools  Help

Apply a display filter ... <Ctrl-/>                                        Expression...

| No. | Time | Source | Destination | Protocol | Length | Info |
|-----|------|--------|-------------|----------|--------|------|
| 5 | 2.000376023 | 172.16.10.1 | 172.16.12.201 | ICMP | 98 | Echo (ping) request  id=0x0f86, seq= |
| 6 | 2.000609282 | 172.16.12.201 | 172.16.10.1 | ICMP | 98 | Echo (ping) reply    id=0x0f86, seq= |
| 7 | 2.709732113 | 172.16.11.1 | 224.0.0.251 | MDNS | 183 | Standard query 0x0000 PTR _nfs._tcp. |
| 8 | 3.000437706 | 172.16.10.1 | 172.16.12.201 | ICMP | 98 | Echo (ping) request  id=0x0f86, seq= |
| 9 | 3.000674077 | 172.16.12.201 | 172.16.10.1 | ICMP | 98 | Echo (ping) reply    id=0x0f86, seq= |
| 10 | 3.682253278 | fe80::1180:400f:d1bb:3… | ff02::fb | MDNS | 203 | Standard query 0x0000 PTR _nfs._tcp. |
| 11 | 4.000420737 | 172.16.10.1 | 172.16.12.201 | ICMP | 98 | Echo (ping) request  id=0x0f86, seq= |
| 12 | 4.000622754 | 172.16.12.201 | 172.16.10.1 | ICMP | 98 | Echo (ping) reply    id=0x0f86, seq= |
| 13 | 5.000445296 | 172.16.10.1 | 172.16.12.201 | ICMP | 98 | Echo (ping) request  id=0x0f86, seq= |
| 14 | 5.000704762 | 172.16.12.201 | 172.16.10.1 | ICMP | 98 | Echo (ping) reply    id=0x0f86, seq= |
| 15 | 5.008862653 | Tp-LinkT_b8:f2:f3 | Tp-LinkT_b8:f1:8d | ARP | 60 | Who has 172.16.11.201? Tell 172.16.1 |
| 16 | 5.008884501 | Tp-LinkT_b8:f1:8d | Tp-LinkT_b8:f2:f3 | ARP | 42 | 172.16.11.201 is at d0:37:45:b8:f1:8 |
| 17 | 6.000450058 | 172.16.10.1 | 172.16.12.201 | ICMP | 98 | Echo (ping) request  id=0x0f86, seq= |
| 18 | 6.000648300 | 172.16.12.201 | 172.16.10.1 | ICMP | 98 | Echo (ping) reply    id=0x0f86, seq= |
| 19 | 7.000467820 | 172.16.10.1 | 172.16.12.201 | ICMP | 98 | Echo (ping) request  id=0x0f86, seq= |
| 20 | 7.000709291 | 172.16.12.201 | 172.16.10.1 | ICMP | 98 | Echo (ping) reply    id=0x0f86, seq= |
| 21 | 8.000442539 | 172.16.10.1 | 172.16.12.201 | ICMP | 98 | Echo (ping) request  id=0x0f86, seq= |
| 22 | 8.000691519 | 172.16.12.201 | 172.16.10.1 | ICMP | 98 | Echo (ping) reply    id=0x0f86, seq= |
| 23 | 11.012374124 | Tp-LinkT_b8:f1:8d | Tp-LinkT_b8:f2:f3 | ARP | 42 | Who has 172.16.11.1? Tell 172.16.11. |
| 24 | 11.012605754 | Tp-LinkT_b8:f2:f3 | Tp-LinkT_b8:f1:8d | ARP | 60 | 172.16.11.1 is at d0:37:45:b8:f2:f3 |

▶ Frame 1: 98 bytes on wire (784 bits), 98 bytes captured (784 bits) on interface 0
▶ Ethernet II, Src: Tp-LinkT_b8:f2:f3 (d0:37:45:b8:f2:f3), Dst: Tp-LinkT_b8:f1:8d (d0:37:45:b8:f1:8d)
▶ Internet Protocol Version 4, Src: 172.16.10.1, Dst: 172.16.12.201
▶ Internet Control Message Protocol

```
0000  d0 37 45 b8 f1 8d d0 37  45 b8 f2 f3 08 00 45 00   ·7E····7 E·····E·
0010  00 54 37 8e 40 00 3f 01  95 30 ac 10 0a 01 ac 10   ·T7·@·?· ·0······
0020  0c c9 08 00 86 27 0f 86  00 01 a9 35 4b 60 00 00   ·····'·· ···5K`··
0030  00 00 a1 e8 0d 00 00 00  00 00 10 11 12 13 14 15   ········ ········
0040  16 17 18 19 1a 1b 1c 1d  1e 1f 20 21 22 23 24 25   ········ ·· !"#$%
0050  26 27 28 29 2a 2b 2c 2d  2e 2f 30 31 32 33 34 35   &'()*+,- ./012345
0060  36 37                                              67
```

○ 🗋  wireshark_enxd03745b8f18d_20210312150325_ioqcrw.pcapng          Packets: 24 · Displayed: 24 (100.0%)     Profile: Default

Step 4: Capture packets from Hd and Ha.