

COMPUTER NETWORKS

LABORATORY

WEEK 10

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Week number: 10

Date: 30/3/2021

Name of the experiment: IPv4 Addressing and Static Routing

Objectives:

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

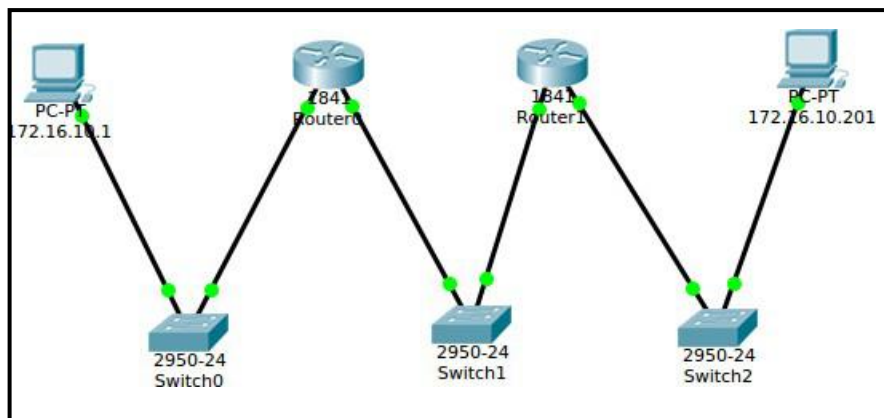
Hardware Requirements:

- | | | |
|-----------------------|---|---|
| 1. Desktops/Laptops | : | 4 |
| 2. Switch | : | 3 |
| 3. Patch Cords (1.5m) | : | 6 |
| 4. External NIC | : | 2 |

Software Requirements:

1. Wireshark Tool
2. 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.



Note:

1. Experiment to be accomplished in a group of 4.
2. Make sure connections are flawless.
3. Assign the IP address using commands or 'Edit connections'.
4. Don't disturb existing hardware setup while setting IP address or doing experiment.
5. Choose your ethernet interface according to your

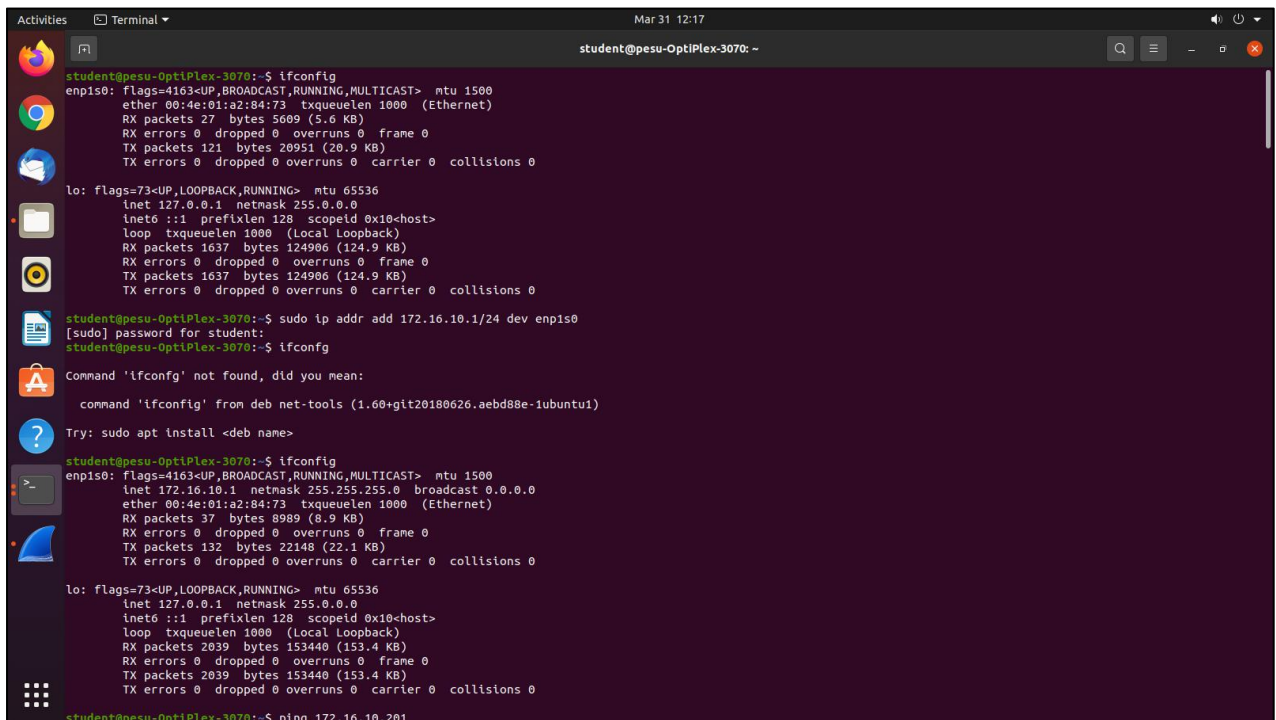
machine. All the connections were made.

Task 1: Assigning of 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@pesu-OptiPlex-3070:~$ ifconfig
enp1s0: flags=4163<UP,BROADCAST,RUNNING,MULTICAST> mtu 1500
    ether 00:4e:01:a2:84:73 txqueuelen 1000 (Ethernet)
    RX packets 27 bytes 5009 (5.6 KB)
    RX errors 0 dropped 0 overruns 0 frame 0
    TX packets 121 bytes 20951 (20.9 KB)
    TX errors 0 dropped 0 overruns 0 carrier 0 collisions 0

lo: flags=73<UP,LOOPBACK,RUNNING> mtu 65536
    inet 127.0.0.1 netmask 255.0.0.0
    inet6 ::1 prefixlen 128 scopeid 0x10<host>
    loop txqueuelen 1000 (Local Loopback)
    RX packets 1637 bytes 124906 (124.9 KB)
    RX errors 0 dropped 0 overruns 0 frame 0
    TX packets 1637 bytes 124906 (124.9 KB)
    TX errors 0 dropped 0 overruns 0 carrier 0 collisions 0

student@pesu-OptiPlex-3070:~$ sudo ip addr add 172.16.10.1/24 dev enp1s0
[sudo] password for student:
student@pesu-OptiPlex-3070:~$ ifconfig
Command 'ifconfig' not found, did you mean:
  command 'ifconfig' from deb net-tools (1.60+git20180626.aebd88e-1ubuntu1)
Try: sudo apt install <deb name>

student@pesu-OptiPlex-3070:~$ ifconfig
enp1s0: flags=4163<UP,BROADCAST,RUNNING,MULTICAST> mtu 1500
    inet 172.16.10.1 netmask 255.255.255.0 broadcast 0.0.0.0
    ether 00:4e:01:a2:84:73 txqueuelen 1000 (Ethernet)
    RX packets 37 bytes 8989 (8.9 KB)
    RX errors 0 dropped 0 overruns 0 frame 0
    TX packets 132 bytes 22148 (22.1 KB)
    TX errors 0 dropped 0 overruns 0 carrier 0 collisions 0

lo: flags=73<UP,LOOPBACK,RUNNING> mtu 65536
    inet 127.0.0.1 netmask 255.0.0.0
    inet6 ::1 prefixlen 128 scopeid 0x10<host>
    loop txqueuelen 1000 (Local Loopback)
    RX packets 2039 bytes 153440 (153.4 KB)
    RX errors 0 dropped 0 overruns 0 frame 0
    TX packets 2039 bytes 153440 (153.4 KB)
    TX errors 0 dropped 0 overruns 0 carrier 0 collisions 0

student@pesu-OptiPlex-3070:~$ ping 172.16.10.201
```

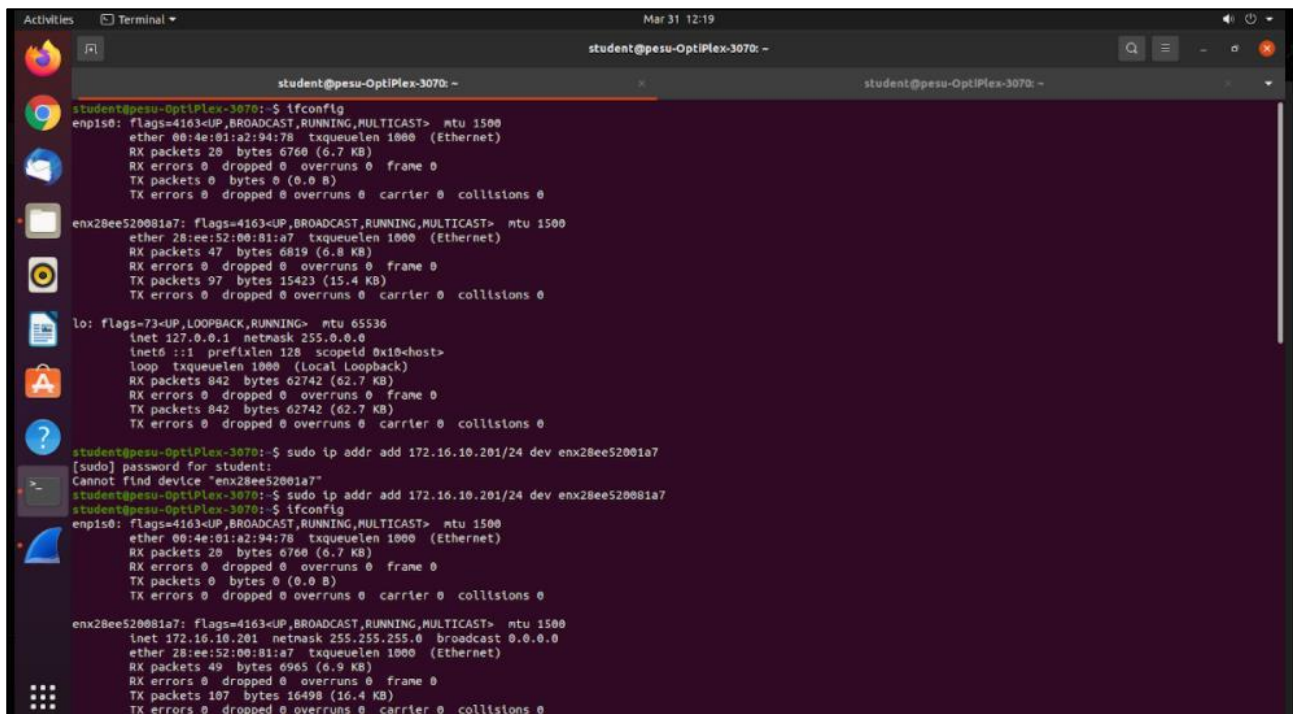
The IP address for the first host is successfully set.

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
```



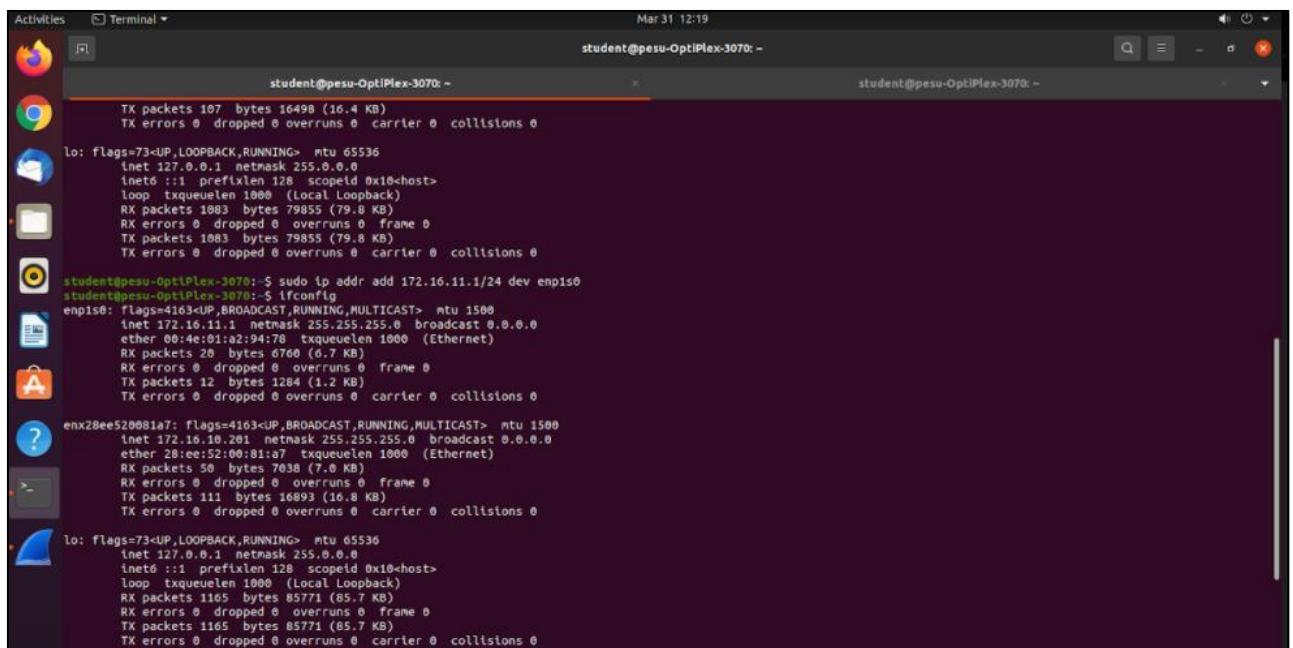
```
student@pesu-OptiPlex-3070:~$ ifconfig
enp1s0: flags=4163<UP,BROADCAST,RUNNING,MULTICAST> mtu 1500
    ether 00:4e:01:a2:94:78 txqueuelen 1000 (Ethernet)
    RX packets 20 bytes 6760 (6.7 KB)
    RX errors 0 dropped 0 overruns 0 frame 0
    TX packets 0 bytes 0 (0.0 B)
    TX errors 0 dropped 0 overruns 0 carrier 0 collisions 0

enx28ee520081a7: flags=4163<UP,BROADCAST,RUNNING,MULTICAST> mtu 1500
    ether 28:ee:52:00:81:a7 txqueuelen 1000 (Ethernet)
    RX packets 47 bytes 6819 (6.8 KB)
    RX errors 0 dropped 0 overruns 0 frame 0
    TX packets 97 bytes 15423 (15.4 KB)
    TX errors 0 dropped 0 overruns 0 carrier 0 collisions 0

lo: flags=73<UP,LOOPBACK,RUNNING> mtu 65536
    inet 127.0.0.1 netmask 255.0.0.0
    inet6 ::1 prefixlen 128 scopeid 0x10<host>
    loop txqueuelen 1000 (Local Loopback)
    RX packets 842 bytes 62742 (62.7 KB)
    RX errors 0 dropped 0 overruns 0 frame 0
    TX packets 842 bytes 62742 (62.7 KB)
    TX errors 0 dropped 0 overruns 0 carrier 0 collisions 0

student@pesu-OptiPlex-3070:~$ sudo ip addr add 172.16.10.201/24 dev enx28ee520081a7
[sudo] password for student:
Cannot find device "enx28ee520081a7"
student@pesu-OptiPlex-3070:~$ sudo ip addr add 172.16.10.201/24 dev enx28ee520081a7
student@pesu-OptiPlex-3070:~$ ifconfig
enp1s0: flags=4163<UP,BROADCAST,RUNNING,MULTICAST> mtu 1500
    ether 00:4e:01:a2:94:78 txqueuelen 1000 (Ethernet)
    RX packets 20 bytes 6760 (6.7 KB)
    RX errors 0 dropped 0 overruns 0 frame 0
    TX packets 0 bytes 0 (0.0 B)
    TX errors 0 dropped 0 overruns 0 carrier 0 collisions 0

enx28ee520081a7: flags=4163<UP,BROADCAST,RUNNING,MULTICAST> mtu 1500
    inet 172.16.10.201 netmask 255.255.255.0 broadcast 0.0.0.0
    ether 28:ee:52:00:81:a7 txqueuelen 1000 (Ethernet)
    RX packets 49 bytes 6965 (6.9 KB)
    RX errors 0 dropped 0 overruns 0 frame 0
    TX packets 107 bytes 16498 (16.4 KB)
    TX errors 0 dropped 0 overruns 0 carrier 0 collisions 0
```



```
TX packets 107 bytes 16498 (16.4 KB)
TX errors 0 dropped 0 overruns 0 carrier 0 collisions 0

lo: flags=73<UP,LOOPBACK,RUNNING> mtu 65536
    inet 127.0.0.1 netmask 255.0.0.0
    inet6 ::1 prefixlen 128 scopeid 0x10<host>
    loop txqueuelen 1000 (Local Loopback)
    RX packets 1083 bytes 79855 (79.8 KB)
    RX errors 0 dropped 0 overruns 0 frame 0
    TX packets 1083 bytes 79855 (79.8 KB)
    TX errors 0 dropped 0 overruns 0 carrier 0 collisions 0

student@pesu-OptiPlex-3070:~$ sudo ip addr add 172.16.11.1/24 dev enp1s0
student@pesu-OptiPlex-3070:~$ ifconfig
enp1s0: flags=4163<UP,BROADCAST,RUNNING,MULTICAST> mtu 1500
    inet 172.16.11.1 netmask 255.255.255.0 broadcast 0.0.0.0
    ether 00:4e:01:a2:94:78 txqueuelen 1000 (Ethernet)
    RX packets 20 bytes 6760 (6.7 KB)
    RX errors 0 dropped 0 overruns 0 frame 0
    TX packets 12 bytes 1284 (1.2 KB)
    TX errors 0 dropped 0 overruns 0 carrier 0 collisions 0

enx28ee520081a7: flags=4163<UP,BROADCAST,RUNNING,MULTICAST> mtu 1500
    inet 172.16.10.201 netmask 255.255.255.0 broadcast 0.0.0.0
    ether 28:ee:52:00:81:a7 txqueuelen 1000 (Ethernet)
    RX packets 50 bytes 7038 (7.0 KB)
    RX errors 0 dropped 0 overruns 0 frame 0
    TX packets 111 bytes 16893 (16.8 KB)
    TX errors 0 dropped 0 overruns 0 carrier 0 collisions 0

lo: flags=73<UP,LOOPBACK,RUNNING> mtu 65536
    inet 127.0.0.1 netmask 255.0.0.0
    inet6 ::1 prefixlen 128 scopeid 0x10<host>
    loop txqueuelen 1000 (Local Loopback)
    RX packets 1165 bytes 85771 (85.7 KB)
    RX errors 0 dropped 0 overruns 0 frame 0
    TX packets 1165 bytes 85771 (85.7 KB)
    TX errors 0 dropped 0 overruns 0 carrier 0 collisions 0
```

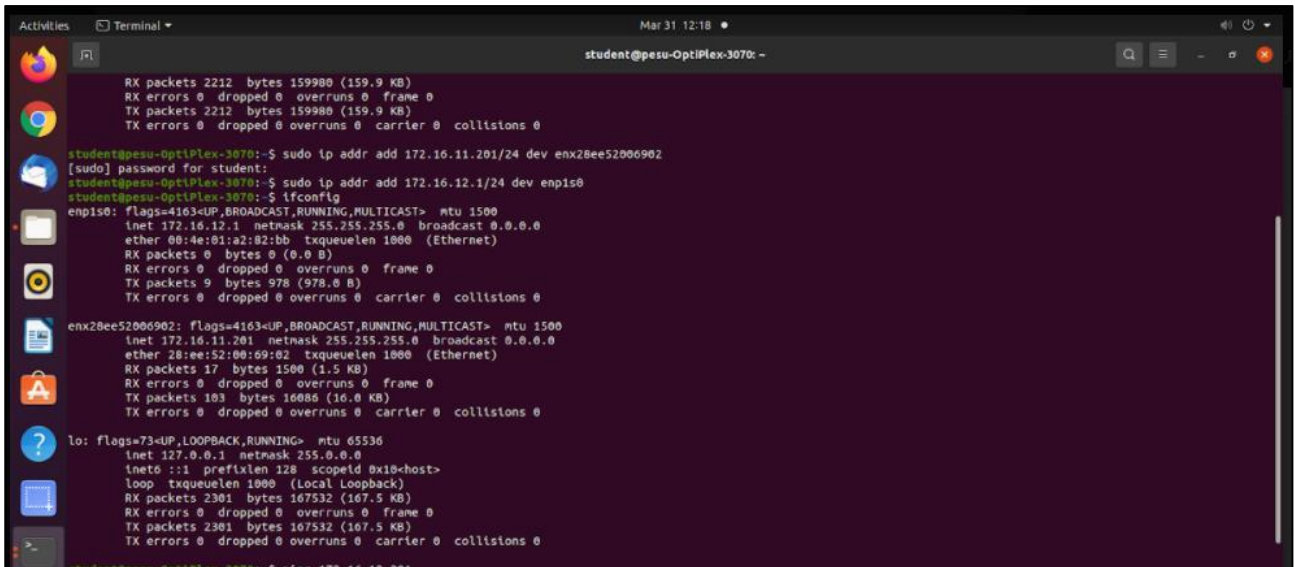
The first router, neighbour to host A, now possesses an IP address.

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
```



A terminal window titled 'student@pesu-OptiPlex-3070: -' showing the execution of network configuration commands. The terminal output includes statistics for the first interface, followed by the command to add the IP address 172.16.11.201/24 to interface enx28ee52006902. After a password prompt, the second command adds the IP address 172.16.12.1/24 to interface enp1s0. The 'ifconfig' command is then run, displaying detailed information for enp1s0 and enx28ee52006902, including their flags, MTU, IP addresses, netmasks, broadcast addresses, and MAC addresses. The loopback interface 'lo' is also shown with its configuration.

```
student@pesu-OptiPlex-3070:~$ ip addr show
RX packets 2212  bytes 159980 (159.9 KB)
RX errors 0  dropped 0  overruns 0  frame 0
TX packets 2212  bytes 159980 (159.9 KB)
TX errors 0  dropped 0  overruns 0  carrier 0  collisions 0

student@pesu-OptiPlex-3070:~$ sudo ip addr add 172.16.11.201/24 dev enx28ee52006902
[sudo] password for student:
student@pesu-OptiPlex-3070:~$ sudo ip addr add 172.16.12.1/24 dev enp1s0
student@pesu-OptiPlex-3070:~$ ifconfig
enp1s0: flags=4163<UP,BROADCAST,RUNNING,MULTICAST>  mtu 1500
        inet 172.16.12.1  netmask 255.255.255.0  broadcast 0.0.0.0
        ether 08:4e:81:a2:82:bb  txqueuelen 1000  (Ethernet)
        RX packets 0  bytes 0 (0.0 B)
        RX errors 0  dropped 0  overruns 0  frame 0
        TX packets 9  bytes 978 (978.0 B)
        TX errors 0  dropped 0  overruns 0  carrier 0  collisions 0

enx28ee52006902: flags=4163<UP,BROADCAST,RUNNING,MULTICAST>  mtu 1500
        inet 172.16.11.201  netmask 255.255.255.0  broadcast 0.0.0.0
        ether 28:ee:52:00:69:02  txqueuelen 1000  (Ethernet)
        RX packets 17  bytes 1500 (1.5 KB)
        RX errors 0  dropped 0  overruns 0  frame 0
        TX packets 103  bytes 16086 (16.0 KB)
        TX errors 0  dropped 0  overruns 0  carrier 0  collisions 0

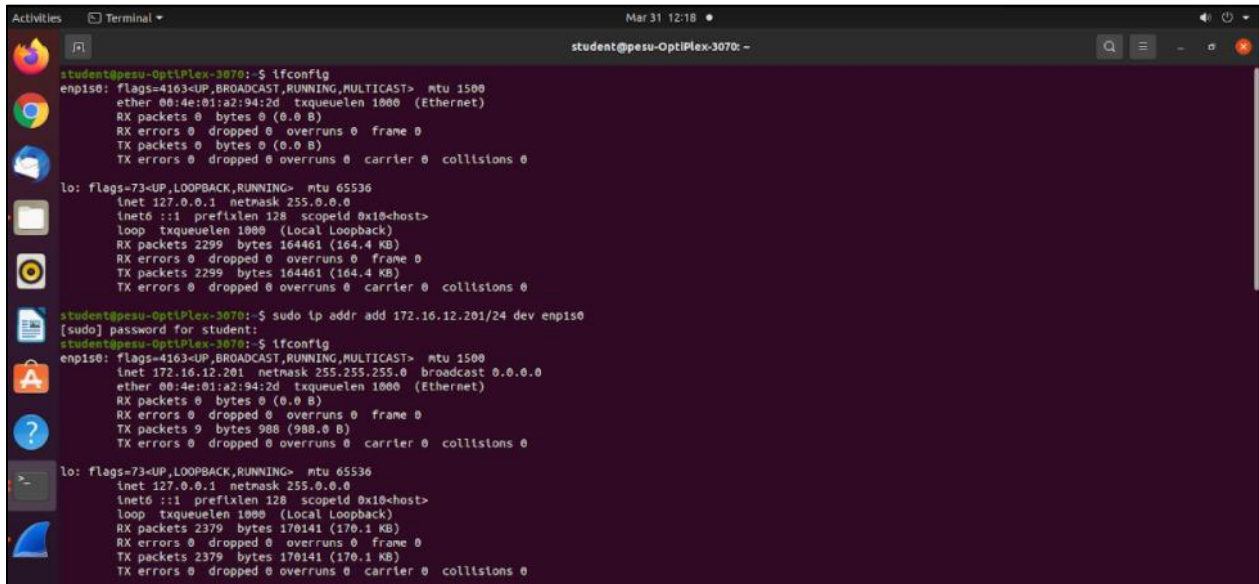
lo: flags=73<UP,LOOPBACK,RUNNING>  mtu 65536
        inet 127.0.0.1  netmask 255.0.0.0
        inet6 ::1  prefixlen 128  scopeid 0x10<host>
        loop  txqueuelen 1000  (Local Loopback)
        RX packets 2301  bytes 167532 (167.5 KB)
        RX errors 0  dropped 0  overruns 0  frame 0
        TX packets 2301  bytes 167532 (167.5 KB)
        TX errors 0  dropped 0  overruns 0  carrier 0  collisions 0
```

The second router, neighbour to host b, now got its IP address assigned

Step 4: Assign the IP address to the Hd.

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

```
$ ip addr show
```

A terminal window titled 'student@pesu-OptiPlex-3070: -' with a date and time of 'Mar 31 12:18'. The terminal shows the output of 'ifconfig' for 'enp1s0' and 'lo'. Then, the command 'sudo ip addr add 172.16.12.201/24 dev enp1s0' is entered, followed by a password prompt '[sudo] password for student:'. After another 'ifconfig' command, the 'enp1s0' interface now shows the assigned IP '172.16.12.201' and netmask '255.255.255.0'.

```
student@pesu-OptiPlex-3070:~$ ifconfig
enp1s0: flags=4163<UP,BROADCAST,RUNNING,MULTICAST> mtu 1500
    ether 00:4e:01:a2:94:2d txqueuelen 1000 (Ethernet)
    RX packets 0 bytes 0 (0.0 B)
    RX errors 0 dropped 0 overruns 0 frame 0
    TX packets 0 bytes 0 (0.0 B)
    TX errors 0 dropped 0 overruns 0 carrier 0 collisions 0

lo: flags=73<UP,LOOPBACK,RUNNING> mtu 65536
    inet 127.0.0.1 netmask 255.0.0.0
    inet6 ::1 prefixlen 128 scopeid 0x10<host>
    loop txqueuelen 1000 (Local Loopback)
    RX packets 2299 bytes 164461 (164.4 KB)
    RX errors 0 dropped 0 overruns 0 frame 0
    TX packets 2299 bytes 164461 (164.4 KB)
    TX errors 0 dropped 0 overruns 0 carrier 0 collisions 0

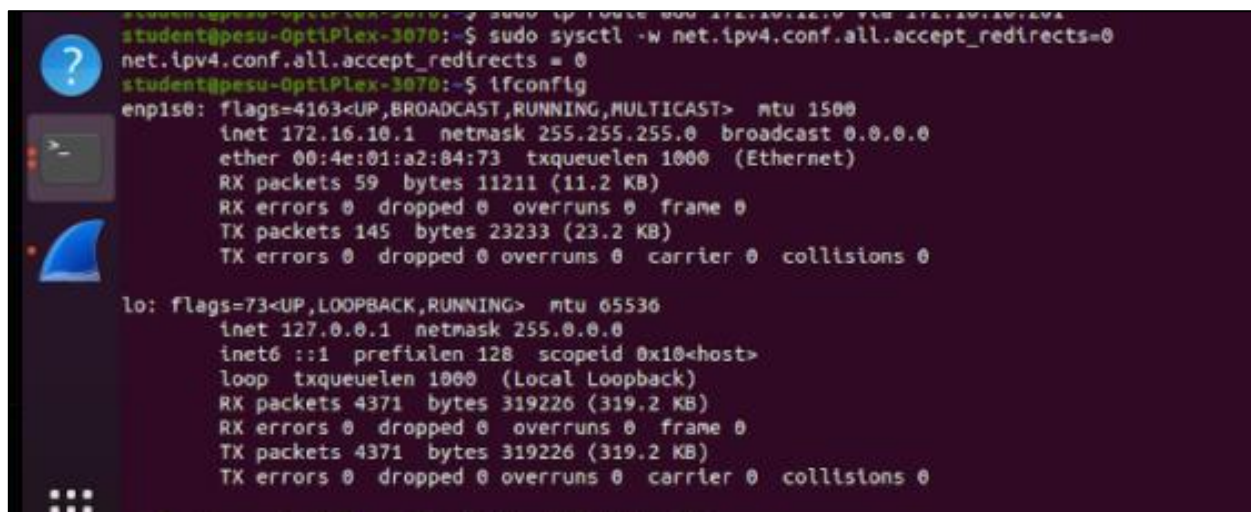
student@pesu-OptiPlex-3070:~$ sudo ip addr add 172.16.12.201/24 dev enp1s0
[sudo] password for student:
student@pesu-OptiPlex-3070:~$ ifconfig
enp1s0: flags=4163<UP,BROADCAST,RUNNING,MULTICAST> mtu 1500
    inet 172.16.12.201 netmask 255.255.255.0 broadcast 0.0.0.0
    ether 00:4e:01:a2:94:2d txqueuelen 1000 (Ethernet)
    RX packets 0 bytes 0 (0.0 B)
    RX errors 0 dropped 0 overruns 0 frame 0
    TX packets 0 bytes 0 (0.0 B)
    TX errors 0 dropped 0 overruns 0 carrier 0 collisions 0

lo: flags=73<UP,LOOPBACK,RUNNING> mtu 65536
    inet 127.0.0.1 netmask 255.0.0.0
    inet6 ::1 prefixlen 128 scopeid 0x10<host>
    loop txqueuelen 1000 (Local Loopback)
    RX packets 2379 bytes 170141 (170.1 KB)
    RX errors 0 dropped 0 overruns 0 frame 0
    TX packets 2379 bytes 170141 (170.1 KB)
    TX errors 0 dropped 0 overruns 0 carrier 0 collisions 0
```

Note 1: The machines are physically on the same LAN, thus you may get ICMP to redirect messages from other machines (in case you make some configuration mistakes). So, as a precautionary measure disable accepting the ICMP redirect packets. By default, Ubuntu Linux enables accepting the ICMP redirect packets. On host machines Ha and Hd, issue the following command:

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

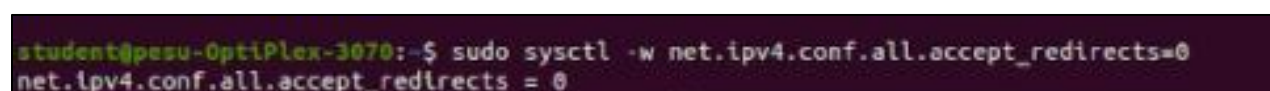
Host A:

A terminal window with a dark purple background and light green text. The prompt is 'student@pesu-OptiPlex-3070:~\$'. The user enters 'sudo sysctl -w net.ipv4.conf.all.accept_redirects=0', followed by 'ifconfig'. The output for 'enp1s0' shows it is up and running with IP 172.16.10.1. The output for 'lo' shows it is up and running with IP 127.0.0.1.

```
student@pesu-OptiPlex-3070:~$ sudo sysctl -w net.ipv4.conf.all.accept_redirects=0
net.ipv4.conf.all.accept_redirects = 0
student@pesu-OptiPlex-3070:~$ ifconfig
enp1s0: flags=4163<UP,BROADCAST,RUNNING,MULTICAST> mtu 1500
    inet 172.16.10.1 netmask 255.255.255.0 broadcast 0.0.0.0
    ether 00:4e:01:a2:84:73 txqueuelen 1000 (Ethernet)
    RX packets 59 bytes 11211 (11.2 KB)
    RX errors 0 dropped 0 overruns 0 frame 0
    TX packets 145 bytes 23233 (23.2 KB)
    TX errors 0 dropped 0 overruns 0 carrier 0 collisions 0

lo: flags=73<UP,LOOPBACK,RUNNING> mtu 65536
    inet 127.0.0.1 netmask 255.0.0.0
    inet6 ::1 prefixlen 128 scopeid 0x10<host>
    loop txqueuelen 1000 (Local Loopback)
    RX packets 4371 bytes 319226 (319.2 KB)
    RX errors 0 dropped 0 overruns 0 frame 0
    TX packets 4371 bytes 319226 (319.2 KB)
    TX errors 0 dropped 0 overruns 0 carrier 0 collisions 0
```

Host D:

A terminal window with a dark purple background and light green text. The prompt is 'student@pesu-OptiPlex-3070:~\$'. The user enters 'sudo sysctl -w net.ipv4.conf.all.accept_redirects=0'.

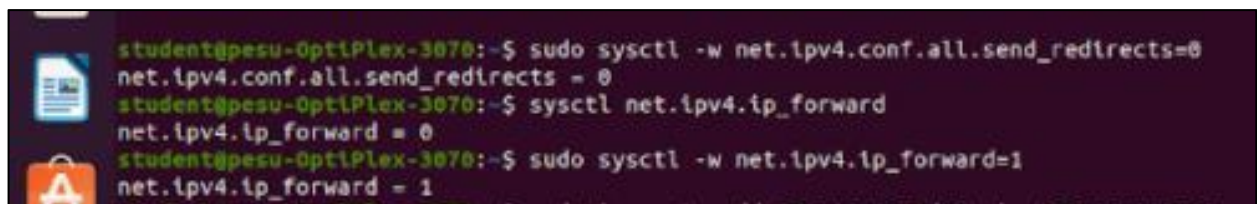
```
student@pesu-OptiPlex-3070:~$ sudo sysctl -w net.ipv4.conf.all.accept_redirects=0
net.ipv4.conf.all.accept_redirects = 0
```


Note 2: Since machines are on the same physical interface, the router is going to send ICMP to redirect message disturbing the routing decision by hosts.

Thus, disable sending of the ICMP redirect packets by these routers with aliased interfaces. To have precautionary measures issue below command in router machines R1 and R2.

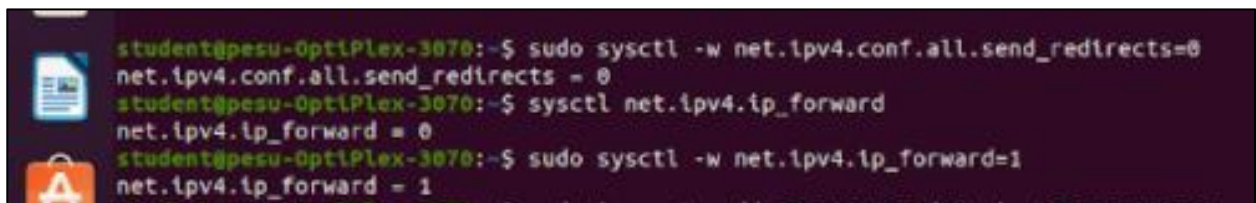
```
$ sudo sysctl -w  
net.ipv4.conf.all.send_redirects=0
```

Router 1:

A terminal window with a dark background and light green text. The prompt is 'student@pesu-OptiPlex-3070:~\$'. The first command is 'sudo sysctl -w net.ipv4.conf.all.send_redirects=0', followed by the output 'net.ipv4.conf.all.send_redirects = 0'. The second command is 'sysctl net.ipv4.ip_forward', followed by the output 'net.ipv4.ip_forward = 0'. The third command is 'sudo sysctl -w net.ipv4.ip_forward=1', followed by the output 'net.ipv4.ip_forward = 1'. There are icons on the left side of the terminal window.

```
student@pesu-OptiPlex-3070:~$ sudo sysctl -w net.ipv4.conf.all.send_redirects=0  
net.ipv4.conf.all.send_redirects = 0  
student@pesu-OptiPlex-3070:~$ sysctl net.ipv4.ip_forward  
net.ipv4.ip_forward = 0  
student@pesu-OptiPlex-3070:~$ sudo sysctl -w net.ipv4.ip_forward=1  
net.ipv4.ip_forward = 1
```

Router 2:

A terminal window with a dark background and light green text. The prompt is 'student@pesu-OptiPlex-3070:~\$'. The first command is 'sudo sysctl -w net.ipv4.conf.all.send_redirects=0', followed by the output 'net.ipv4.conf.all.send_redirects = 0'. The second command is 'sysctl net.ipv4.ip_forward', followed by the output 'net.ipv4.ip_forward = 0'. The third command is 'sudo sysctl -w net.ipv4.ip_forward=1', followed by the output 'net.ipv4.ip_forward = 1'. There are icons on the left side of the terminal window.

```
student@pesu-OptiPlex-3070:~$ sudo sysctl -w net.ipv4.conf.all.send_redirects=0  
net.ipv4.conf.all.send_redirects = 0  
student@pesu-OptiPlex-3070:~$ sysctl net.ipv4.ip_forward  
net.ipv4.ip_forward = 0  
student@pesu-OptiPlex-3070:~$ sudo sysctl -w net.ipv4.ip_forward=1  
net.ipv4.ip_forward = 1
```


Task 2: Conversion of the machines B and C into routers.

Note 1: Check if IP forwarding is enabled or not. We need to query the sysctl kernel value net.ipv4.ip_forward to see if forwarding is enabled or not using sysctl:

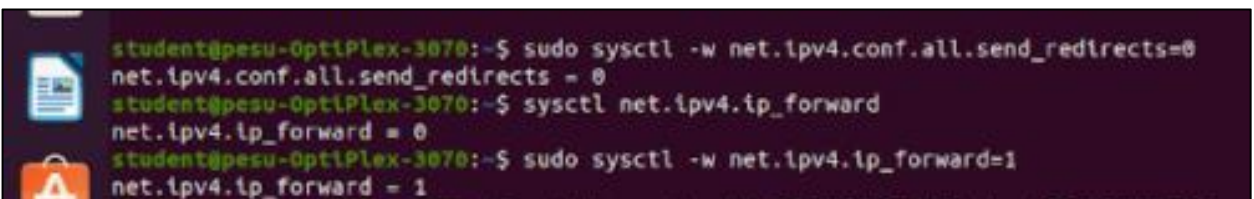
```
$ sysctl net.ipv4.ip_forward
```

Router 1:

A terminal window with a dark purple background. On the left, there are two icons: a document icon and a shopping bag icon. The terminal text shows three commands and their outputs: 1. 'sudo sysctl -w net.ipv4.conf.all.send_redirects=0' followed by 'net.ipv4.conf.all.send_redirects = 0'. 2. 'sysctl net.ipv4.ip_forward' followed by 'net.ipv4.ip_forward = 0'. 3. 'sudo sysctl -w net.ipv4.ip_forward=1' followed by 'net.ipv4.ip_forward = 1'.

```
student@pesu-OptiPlex-3070:~$ sudo sysctl -w net.ipv4.conf.all.send_redirects=0
net.ipv4.conf.all.send_redirects = 0
student@pesu-OptiPlex-3070:~$ sysctl net.ipv4.ip_forward
net.ipv4.ip_forward = 0
student@pesu-OptiPlex-3070:~$ sudo sysctl -w net.ipv4.ip_forward=1
net.ipv4.ip_forward = 1
```

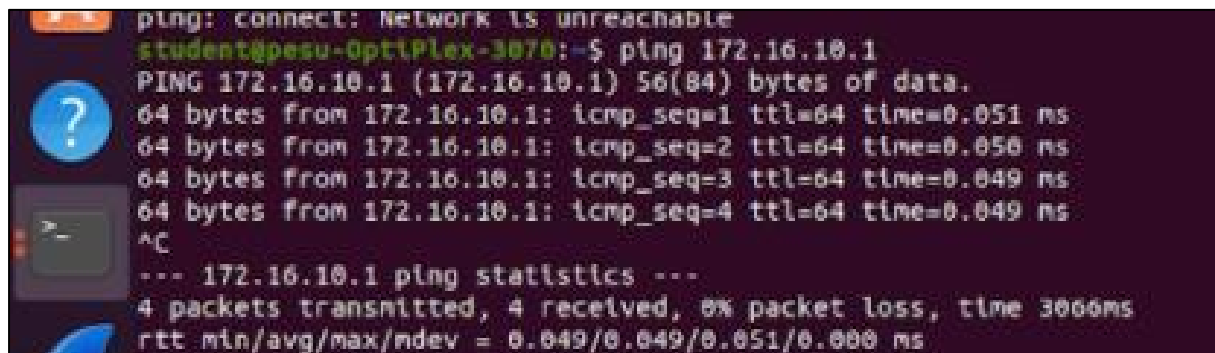
Router 2:

A terminal window with a dark purple background. On the left, there are two icons: a document icon and a shopping bag icon. The terminal text shows three commands and their outputs: 1. 'sudo sysctl -w net.ipv4.conf.all.send_redirects=0' followed by 'net.ipv4.conf.all.send_redirects = 0'. 2. 'sysctl net.ipv4.ip_forward' followed by 'net.ipv4.ip_forward = 0'. 3. 'sudo sysctl -w net.ipv4.ip_forward=1' followed by 'net.ipv4.ip_forward = 1'.

```
student@pesu-OptiPlex-3070:~$ sudo sysctl -w net.ipv4.conf.all.send_redirects=0
net.ipv4.conf.all.send_redirects = 0
student@pesu-OptiPlex-3070:~$ sysctl net.ipv4.ip_forward
net.ipv4.ip_forward = 0
student@pesu-OptiPlex-3070:~$ sudo sysctl -w net.ipv4.ip_forward=1
net.ipv4.ip_forward = 1
```

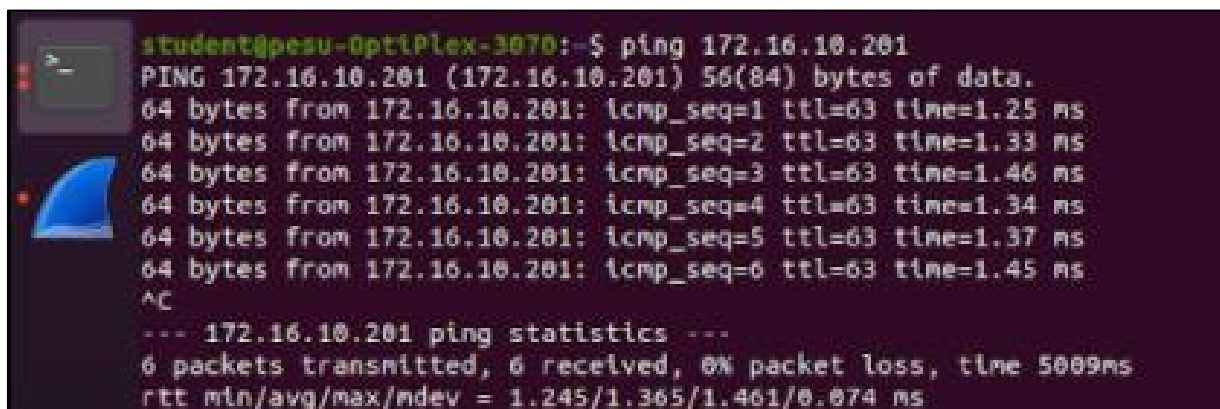
Task 3: Verify the connection between Ha and Hd using ping command. Initially test the connection of systems within the same network.

At Ha: \$ ping 172.16.10.1 (Local network)

A terminal window with a dark purple background. The prompt is 'student@pesu-OptiPlex-3070:~\$'. The command 'ping 172.16.10.1' has been entered. The output shows four successful ping responses with times around 0.05 ms. The statistics show 4 packets transmitted, 4 received, 0% packet loss, and a total time of 3066ms.

```
ping: connect: Network is unreachable
student@pesu-OptiPlex-3070:~$ 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=0.051 ms
64 bytes from 172.16.10.1: icmp_seq=2 ttl=64 time=0.050 ms
64 bytes from 172.16.10.1: icmp_seq=3 ttl=64 time=0.049 ms
64 bytes from 172.16.10.1: icmp_seq=4 ttl=64 time=0.049 ms
^C
--- 172.16.10.1 ping statistics ---
4 packets transmitted, 4 received, 0% packet loss, time 3066ms
rtt min/avg/max/mdev = 0.049/0.049/0.051/0.000 ms
```

At Hd: \$ ping 172.16.10.201 (Local network)

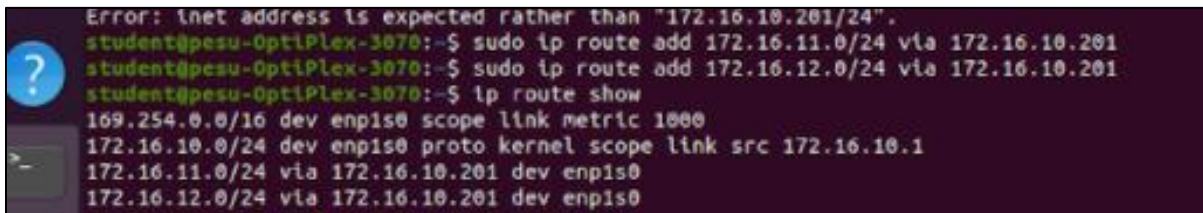
A terminal window with a dark purple background. The prompt is 'student@pesu-OptiPlex-3070:~\$'. The command 'ping 172.16.10.201' has been entered. The output shows six successful ping responses with times around 1.3 ms. The statistics show 6 packets transmitted, 6 received, 0% packet loss, and a total time of 5009ms.

```
student@pesu-OptiPlex-3070:~$ ping 172.16.10.201
PING 172.16.10.201 (172.16.10.201) 56(84) bytes of data.
64 bytes from 172.16.10.201: icmp_seq=1 ttl=63 time=1.25 ms
64 bytes from 172.16.10.201: icmp_seq=2 ttl=63 time=1.33 ms
64 bytes from 172.16.10.201: icmp_seq=3 ttl=63 time=1.46 ms
64 bytes from 172.16.10.201: icmp_seq=4 ttl=63 time=1.34 ms
64 bytes from 172.16.10.201: icmp_seq=5 ttl=63 time=1.37 ms
64 bytes from 172.16.10.201: icmp_seq=6 ttl=63 time=1.45 ms
^C
--- 172.16.10.201 ping statistics ---
6 packets transmitted, 6 received, 0% packet loss, time 5009ms
rtt min/avg/max/mdev = 1.245/1.365/1.461/0.074 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
```

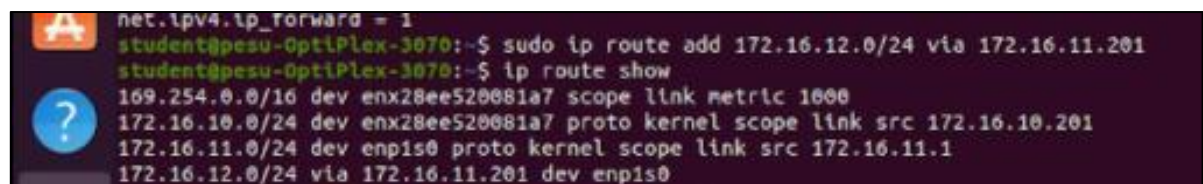
A terminal window with a dark background. The prompt is 'student@pesu-OptiPlex-3070:~'. The user enters three commands: 'sudo ip route add 172.16.11.0/24 via 172.16.10.201', 'sudo ip route add 172.16.12.0/24 via 172.16.10.201', and 'ip route show'. The output of the last command shows the routing table with four entries: '169.254.0.0/16 dev enp1s0 scope link metric 1000', '172.16.10.0/24 dev enp1s0 proto kernel scope link src 172.16.10.1', '172.16.11.0/24 via 172.16.10.201 dev enp1s0', and '172.16.12.0/24 via 172.16.10.201 dev enp1s0'. There is a blue question mark icon on the left side of the terminal window.

```
Error: inet address is expected rather than "172.16.10.201/24".  
student@pesu-OptiPlex-3070:~$ sudo ip route add 172.16.11.0/24 via 172.16.10.201  
student@pesu-OptiPlex-3070:~$ sudo ip route add 172.16.12.0/24 via 172.16.10.201  
student@pesu-OptiPlex-3070:~$ ip route show  
169.254.0.0/16 dev enp1s0 scope link metric 1000  
172.16.10.0/24 dev enp1s0 proto kernel scope link src 172.16.10.1  
172.16.11.0/24 via 172.16.10.201 dev enp1s0  
172.16.12.0/24 via 172.16.10.201 dev enp1s0
```

In the first host since 172.16.10.0/24 network is a local network, we don't need any routing table entry. 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
```

A terminal window with a dark background. The prompt is 'student@pesu-OptiPlex-3070:~'. The user enters three commands: 'net.ipv4.ip_forward = 1', 'sudo ip route add 172.16.12.0/24 via 172.16.11.201', and 'ip route show'. The output of the last command shows the routing table with four entries: '169.254.0.0/16 dev enx28ee520081a7 scope link metric 1000', '172.16.10.0/24 dev enx28ee520081a7 proto kernel scope link src 172.16.10.201', '172.16.11.0/24 dev enp1s0 proto kernel scope link src 172.16.11.1', and '172.16.12.0/24 via 172.16.11.201 dev enp1s0'. There is a blue question mark icon on the left side of the terminal window.

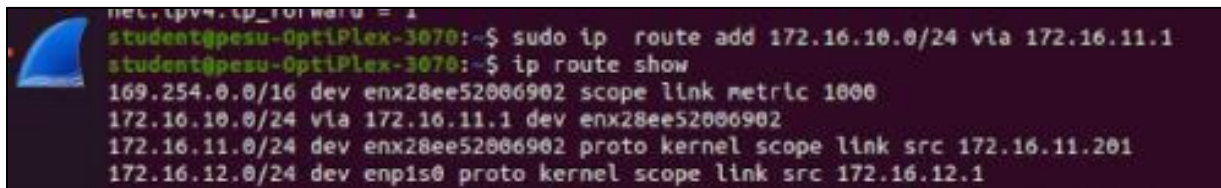
```
net.ipv4.ip_forward = 1  
student@pesu-OptiPlex-3070:~$ sudo ip route add 172.16.12.0/24 via 172.16.11.201  
student@pesu-OptiPlex-3070:~$ ip route show  
169.254.0.0/16 dev enx28ee520081a7 scope link metric 1000  
172.16.10.0/24 dev enx28ee520081a7 proto kernel scope link src 172.16.10.201  
172.16.11.0/24 dev enp1s0 proto kernel scope link src 172.16.11.1  
172.16.12.0/24 via 172.16.11.201 dev enp1s0
```

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
```

A terminal window with a dark background and a blue terminal icon on the left. The text shows the execution of two commands: 'sudo ip route add 172.16.10.0/24 via 172.16.11.1' and 'ip route show'. The output of the second command lists four routes: 169.254.0.0/16, 172.16.10.0/24, 172.16.11.0/24, and 172.16.12.0/24, each with its associated device, protocol, and scope.

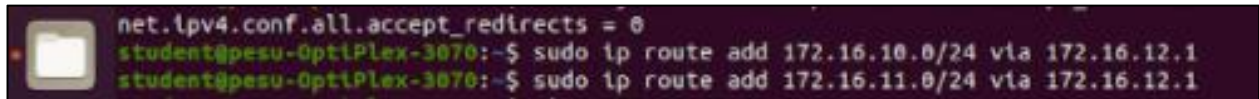
```
net.ipv4.ip_forward = 1  
student@pesu-OptiPlex-3070:~$ sudo ip route add 172.16.10.0/24 via 172.16.11.1  
student@pesu-OptiPlex-3070:~$ ip route show  
169.254.0.0/16 dev enx28ee52006902 scope link metric 1000  
172.16.10.0/24 via 172.16.11.1 dev enx28ee52006902  
172.16.11.0/24 dev enx28ee52006902 proto kernel scope link src 172.16.11.201  
172.16.12.0/24 dev enp1s0 proto kernel scope link src 172.16.12.1
```

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
```

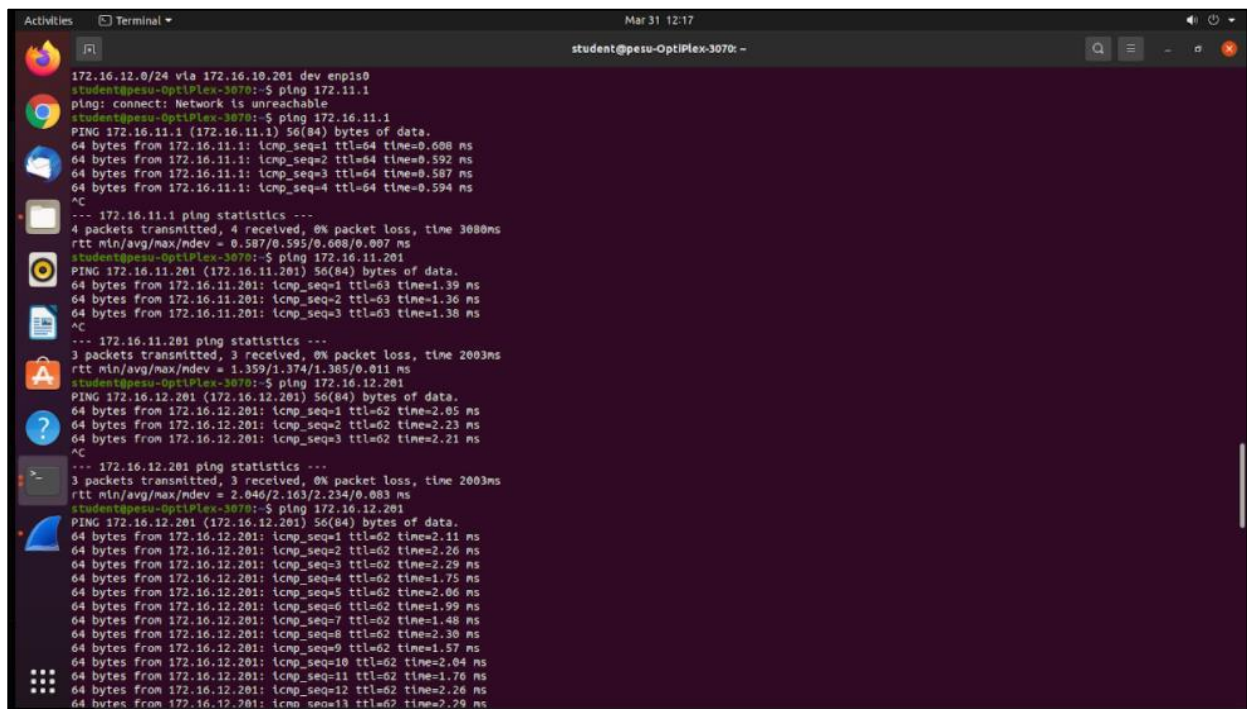


```
net.ipv4.conf.all.accept_redirects = 0  
student@pesu-OptiPlex-3070:~$ sudo ip route add 172.16.10.0/24 via 172.16.12.1  
student@pesu-OptiPlex-3070:~$ sudo ip route add 172.16.11.0/24 via 172.16.12.1
```

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

ip neighbour provides a command-line interface to display the neighbour table (ARP cache)

At Ha:



```
Activities Terminal Mar 31 12:17  
student@pesu-OptiPlex-3070:~  
172.16.12.0/24 via 172.16.10.201 dev enp1s0  
student@pesu-OptiPlex-3070:~$ ping 172.11.1  
ping: connect: Network is unreachable  
student@pesu-OptiPlex-3070:~$ ping 172.16.11.1  
PING 172.16.11.1 (172.16.11.1) 56(84) bytes of data.  
64 bytes from 172.16.11.1: icmp_seq=1 ttl=64 time=0.608 ms  
64 bytes from 172.16.11.1: icmp_seq=2 ttl=64 time=0.592 ms  
64 bytes from 172.16.11.1: icmp_seq=3 ttl=64 time=0.587 ms  
64 bytes from 172.16.11.1: icmp_seq=4 ttl=64 time=0.594 ms  
^C  
--- 172.16.11.1 ping statistics ---  
4 packets transmitted, 4 received, 0% packet loss, time 3000ms  
rtt min/avg/max/mdev = 0.587/0.595/0.608/0.007 ms  
student@pesu-OptiPlex-3070:~$ ping 172.16.11.201  
PING 172.16.11.201 (172.16.11.201) 56(84) bytes of data.  
64 bytes from 172.16.11.201: icmp_seq=1 ttl=63 time=1.39 ms  
64 bytes from 172.16.11.201: icmp_seq=2 ttl=63 time=1.36 ms  
64 bytes from 172.16.11.201: icmp_seq=3 ttl=63 time=1.38 ms  
^C  
--- 172.16.11.201 ping statistics ---  
3 packets transmitted, 3 received, 0% packet loss, time 2003ms  
rtt min/avg/max/mdev = 1.359/1.374/1.385/0.011 ms  
student@pesu-OptiPlex-3070:~$ 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=2.05 ms  
64 bytes from 172.16.12.201: icmp_seq=2 ttl=62 time=2.23 ms  
64 bytes from 172.16.12.201: icmp_seq=3 ttl=62 time=2.21 ms  
^C  
--- 172.16.12.201 ping statistics ---  
3 packets transmitted, 3 received, 0% packet loss, time 2003ms  
rtt min/avg/max/mdev = 2.046/2.163/2.234/0.083 ms  
student@pesu-OptiPlex-3070:~$ 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=2.11 ms  
64 bytes from 172.16.12.201: icmp_seq=2 ttl=62 time=2.26 ms  
64 bytes from 172.16.12.201: icmp_seq=3 ttl=62 time=2.29 ms  
64 bytes from 172.16.12.201: icmp_seq=4 ttl=62 time=1.75 ms  
64 bytes from 172.16.12.201: icmp_seq=5 ttl=62 time=2.06 ms  
64 bytes from 172.16.12.201: icmp_seq=6 ttl=62 time=1.99 ms  
64 bytes from 172.16.12.201: icmp_seq=7 ttl=62 time=1.48 ms  
64 bytes from 172.16.12.201: icmp_seq=8 ttl=62 time=2.30 ms  
64 bytes from 172.16.12.201: icmp_seq=9 ttl=62 time=1.97 ms  
64 bytes from 172.16.12.201: icmp_seq=10 ttl=62 time=2.04 ms  
64 bytes from 172.16.12.201: icmp_seq=11 ttl=62 time=1.76 ms  
64 bytes from 172.16.12.201: icmp_seq=12 ttl=62 time=2.26 ms  
64 bytes from 172.16.12.201: icmp_seq=13 ttl=62 time=2.29 ms
```

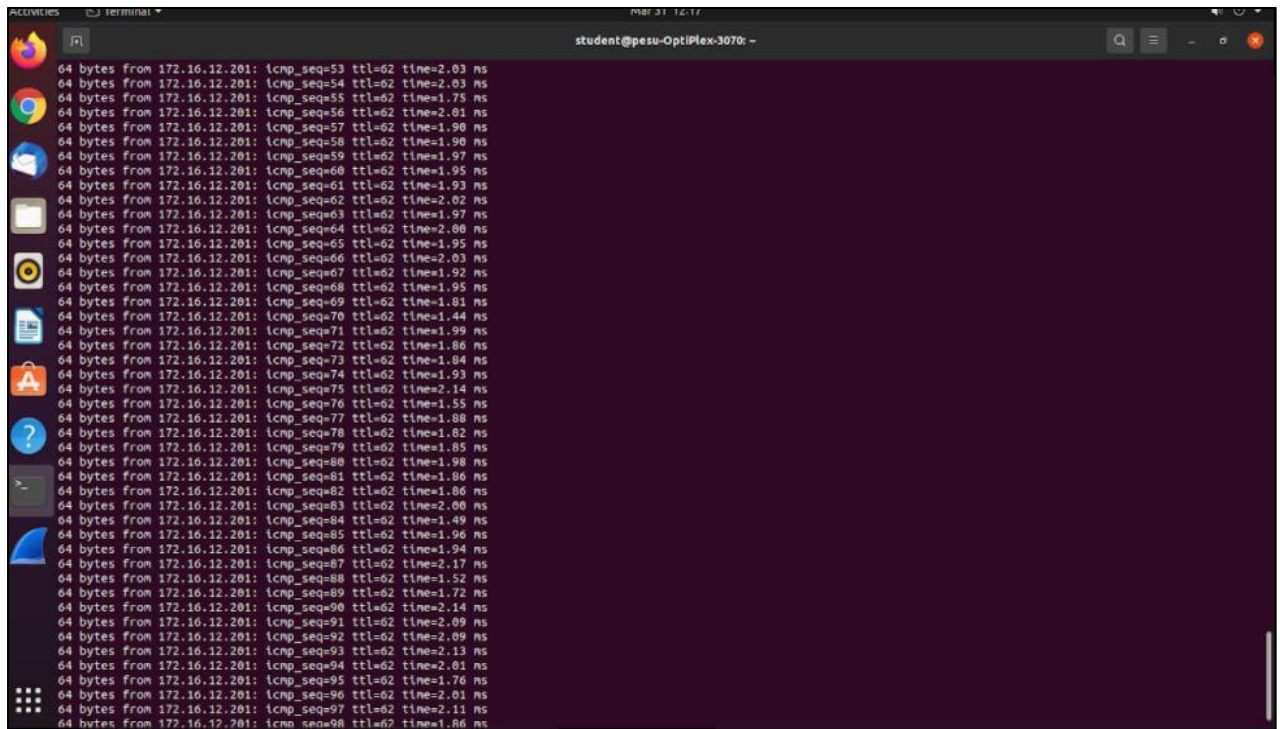

At R1:

```
Activities Terminal Mar 31 12:18 student@pesu-OptiPlex-3070: ~
64 bytes from 172.16.11.1: icmp_seq=3 ttl=63 time=1.39 ns
^C
--- 172.16.11.1 ping statistics ---
3 packets transmitted, 3 received, 0% packet loss, time 2004ms
rtt min/avg/max/ndev = 1.373/1.407/1.456/0.035 ms
student@pesu-OptiPlex-3070:~$ 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=0.596 ms
64 bytes from 172.16.12.1: icmp_seq=2 ttl=64 time=0.619 ms
64 bytes from 172.16.12.1: icmp_seq=3 ttl=64 time=0.709 ms
^C
--- 172.16.12.1 ping statistics ---
3 packets transmitted, 3 received, 0% packet loss, time 2028ms
rtt min/avg/max/ndev = 0.596/0.641/0.709/0.040 ms
student@pesu-OptiPlex-3070:~$ ping 172.16.11.1
PING 172.16.11.1 (172.16.11.1) 56(84) bytes of data.
64 bytes from 172.16.11.1: icmp_seq=1 ttl=63 time=1.37 ms
64 bytes from 172.16.11.1: icmp_seq=2 ttl=63 time=1.45 ms
64 bytes from 172.16.11.1: icmp_seq=3 ttl=63 time=1.44 ms
^C
--- 172.16.11.1 ping statistics ---
3 packets transmitted, 3 received, 0% packet loss, time 2004ms
rtt min/avg/max/ndev = 1.371/1.421/1.448/0.035 ms
student@pesu-OptiPlex-3070:~$ ping 172.16.11.201
PING 172.16.11.201 (172.16.11.201) 56(84) bytes of data.
64 bytes from 172.16.11.201: icmp_seq=1 ttl=64 time=0.595 ms
64 bytes from 172.16.11.201: icmp_seq=2 ttl=64 time=0.702 ms
64 bytes from 172.16.11.201: icmp_seq=3 ttl=64 time=0.702 ms
^C
--- 172.16.11.201 ping statistics ---
3 packets transmitted, 3 received, 0% packet loss, time 2043ms
rtt min/avg/max/ndev = 0.595/0.666/0.702/0.050 ms
student@pesu-OptiPlex-3070:~$ 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=64 time=0.052 ms
^C
--- 172.16.12.201 ping statistics ---
1 packets transmitted, 1 received, 0% packet loss, time 0ms
rtt min/avg/max/ndev = 0.052/0.052/0.052/0.000 ms
student@pesu-OptiPlex-3070:~$ 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=0.595 ms
64 bytes from 172.16.12.1: icmp_seq=2 ttl=64 time=0.702 ms
64 bytes from 172.16.12.1: icmp_seq=3 ttl=64 time=0.705 ms
^C
--- 172.16.12.1 ping statistics ---
```

At R2:

```
rtt min/avg/max/ndev = 2.046/2.163/2.234/0.083 ms
student@pesu-OptiPlex-3070:~$ 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=2.11 ms
64 bytes from 172.16.12.201: icmp_seq=2 ttl=62 time=2.26 ms
64 bytes from 172.16.12.201: icmp_seq=3 ttl=62 time=2.29 ms
64 bytes from 172.16.12.201: icmp_seq=4 ttl=62 time=1.75 ms
64 bytes from 172.16.12.201: icmp_seq=5 ttl=62 time=2.06 ms
64 bytes from 172.16.12.201: icmp_seq=6 ttl=62 time=1.99 ms
64 bytes from 172.16.12.201: icmp_seq=7 ttl=62 time=1.48 ms
64 bytes from 172.16.12.201: icmp_seq=8 ttl=62 time=2.30 ms
64 bytes from 172.16.12.201: icmp_seq=9 ttl=62 time=1.57 ms
64 bytes from 172.16.12.201: icmp_seq=10 ttl=62 time=2.04 ms
64 bytes from 172.16.12.201: icmp_seq=11 ttl=62 time=1.76 ms
64 bytes from 172.16.12.201: icmp_seq=12 ttl=62 time=2.26 ms
64 bytes from 172.16.12.201: icmp_seq=13 ttl=62 time=2.29 ms
```

At Hd:



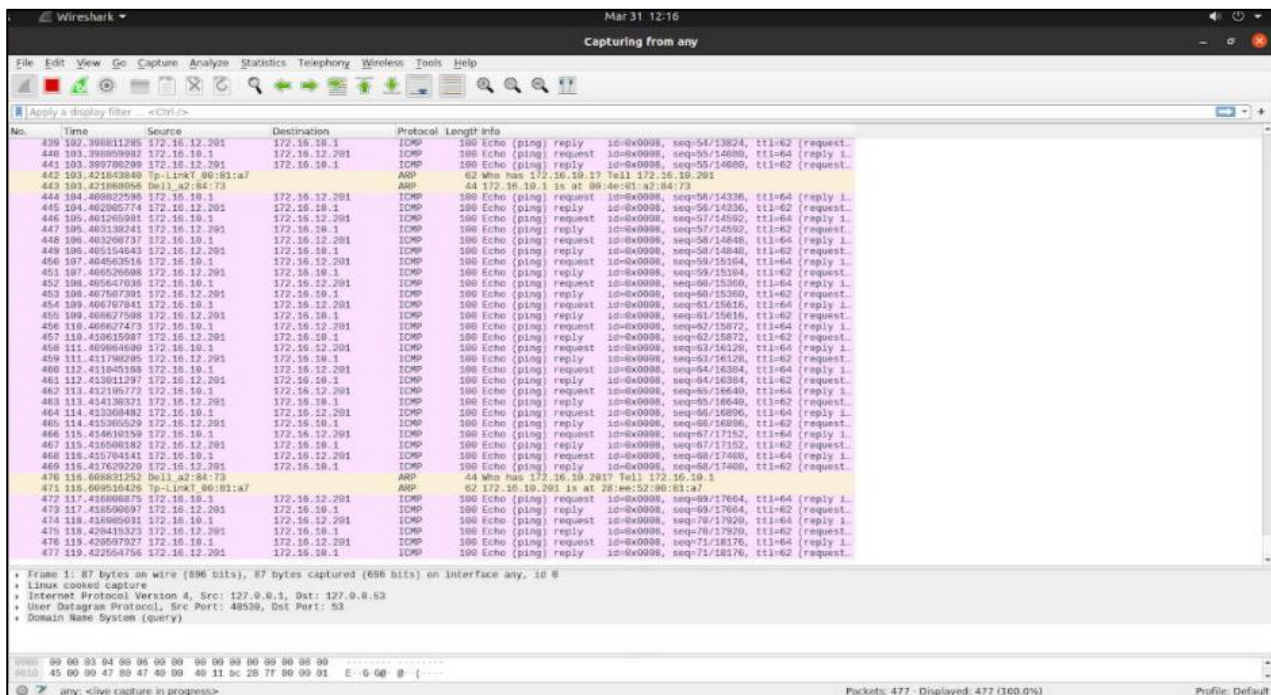
```
student@pesu-OptiPlex-3070: ~  
64 bytes from 172.16.12.201: icmp_seq=53 ttl=62 time=2.03 ns  
64 bytes from 172.16.12.201: icmp_seq=54 ttl=62 time=2.03 ns  
64 bytes from 172.16.12.201: icmp_seq=55 ttl=62 time=1.75 ns  
64 bytes from 172.16.12.201: icmp_seq=56 ttl=62 time=2.01 ns  
64 bytes from 172.16.12.201: icmp_seq=57 ttl=62 time=1.90 ns  
64 bytes from 172.16.12.201: icmp_seq=58 ttl=62 time=1.90 ns  
64 bytes from 172.16.12.201: icmp_seq=59 ttl=62 time=1.97 ns  
64 bytes from 172.16.12.201: icmp_seq=60 ttl=62 time=1.95 ns  
64 bytes from 172.16.12.201: icmp_seq=61 ttl=62 time=1.93 ns  
64 bytes from 172.16.12.201: icmp_seq=62 ttl=62 time=2.02 ns  
64 bytes from 172.16.12.201: icmp_seq=63 ttl=62 time=1.97 ns  
64 bytes from 172.16.12.201: icmp_seq=64 ttl=62 time=2.00 ns  
64 bytes from 172.16.12.201: icmp_seq=65 ttl=62 time=1.95 ns  
64 bytes from 172.16.12.201: icmp_seq=66 ttl=62 time=2.03 ns  
64 bytes from 172.16.12.201: icmp_seq=67 ttl=62 time=1.92 ns  
64 bytes from 172.16.12.201: icmp_seq=68 ttl=62 time=1.95 ns  
64 bytes from 172.16.12.201: icmp_seq=69 ttl=62 time=1.81 ns  
64 bytes from 172.16.12.201: icmp_seq=70 ttl=62 time=1.44 ns  
64 bytes from 172.16.12.201: icmp_seq=71 ttl=62 time=1.99 ns  
64 bytes from 172.16.12.201: icmp_seq=72 ttl=62 time=1.86 ns  
64 bytes from 172.16.12.201: icmp_seq=73 ttl=62 time=1.84 ns  
64 bytes from 172.16.12.201: icmp_seq=74 ttl=62 time=1.93 ns  
64 bytes from 172.16.12.201: icmp_seq=75 ttl=62 time=2.14 ns  
64 bytes from 172.16.12.201: icmp_seq=76 ttl=62 time=1.55 ns  
64 bytes from 172.16.12.201: icmp_seq=77 ttl=62 time=1.88 ns  
64 bytes from 172.16.12.201: icmp_seq=78 ttl=62 time=1.82 ns  
64 bytes from 172.16.12.201: icmp_seq=79 ttl=62 time=1.85 ns  
64 bytes from 172.16.12.201: icmp_seq=80 ttl=62 time=1.98 ns  
64 bytes from 172.16.12.201: icmp_seq=81 ttl=62 time=1.86 ns  
64 bytes from 172.16.12.201: icmp_seq=82 ttl=62 time=1.86 ns  
64 bytes from 172.16.12.201: icmp_seq=83 ttl=62 time=2.00 ns  
64 bytes from 172.16.12.201: icmp_seq=84 ttl=62 time=1.49 ns  
64 bytes from 172.16.12.201: icmp_seq=85 ttl=62 time=1.96 ns  
64 bytes from 172.16.12.201: icmp_seq=86 ttl=62 time=1.94 ns  
64 bytes from 172.16.12.201: icmp_seq=87 ttl=62 time=2.17 ns  
64 bytes from 172.16.12.201: icmp_seq=88 ttl=62 time=1.52 ns  
64 bytes from 172.16.12.201: icmp_seq=89 ttl=62 time=1.72 ns  
64 bytes from 172.16.12.201: icmp_seq=90 ttl=62 time=2.14 ns  
64 bytes from 172.16.12.201: icmp_seq=91 ttl=62 time=2.09 ns  
64 bytes from 172.16.12.201: icmp_seq=92 ttl=62 time=2.09 ns  
64 bytes from 172.16.12.201: icmp_seq=93 ttl=62 time=2.13 ns  
64 bytes from 172.16.12.201: icmp_seq=94 ttl=62 time=2.01 ns  
64 bytes from 172.16.12.201: icmp_seq=95 ttl=62 time=1.76 ns  
64 bytes from 172.16.12.201: icmp_seq=96 ttl=62 time=2.01 ns  
64 bytes from 172.16.12.201: icmp_seq=97 ttl=62 time=2.11 ns  
64 bytes from 172.16.12.201: icmp_seq=98 ttl=62 time=1.86 ns
```


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

Step 1: Capture packets from Ha and Hd. At Ha:

T1: \$ sudo wireshark

T2: \$ ping 172.16.12.201



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

```
$ sudo wireshark
```

At eth1 (left) and at eth2 (right):

Capturing from enp2s8						Capturing from enx28ee520069e0					
No.	Time	Source	Destination	Protocol	Length Info	No.	Time	Source	Destination	Protocol	Length Info
27	12.282408251	172.16.10.1	172.16.12.201	ICMP	98 Echo (pin	31	13.386406948	172.16.10.1	172.16.12.201	ICMP	98 Echo (pin
28	12.28283277	172.16.12.201	172.16.10.1	ICMP	98 Echo (pin	32	13.386847522	172.16.12.201	172.16.10.1	ICMP	98 Echo (pin
29	13.386408996	172.16.10.1	172.16.12.201	ICMP	98 Echo (pin	33	14.330379424	172.16.10.1	172.16.12.201	ICMP	98 Echo (pin
30	13.386882304	172.16.12.201	172.16.10.1	ICMP	98 Echo (pin	34	14.330851206	172.16.12.201	172.16.10.1	ICMP	98 Echo (pin
31	14.330371598	172.16.10.1	172.16.12.201	ICMP	98 Echo (pin	35	15.354357693	172.16.10.1	172.16.12.201	ICMP	98 Echo (pin
32	14.330886610	172.16.12.201	172.16.10.1	ICMP	98 Echo (pin	36	15.354848881	172.16.12.201	172.16.10.1	ICMP	98 Echo (pin
33	15.354358856	172.16.10.1	172.16.12.201	ICMP	98 Echo (pin	37	16.378353102	172.16.10.1	172.16.12.201	ICMP	98 Echo (pin
34	15.354884099	172.16.12.201	172.16.10.1	ICMP	98 Echo (pin	38	16.378847944	172.16.12.201	172.16.10.1	ICMP	98 Echo (pin
35	16.378355473	172.16.10.1	172.16.12.201	ICMP	98 Echo (pin	39	17.402319984	172.16.10.1	172.16.12.201	ICMP	98 Echo (pin
36	16.378884135	172.16.12.201	172.16.10.1	ICMP	98 Echo (pin	40	17.402730074	172.16.12.201	172.16.10.1	ICMP	98 Echo (pin
37	17.402321027	172.16.10.1	172.16.12.201	ICMP	98 Echo (pin	41	18.426558185	172.16.10.1	172.16.12.201	ICMP	98 Echo (pin
38	17.402766541	172.16.12.201	172.16.10.1	ICMP	98 Echo (pin	42	18.426972857	172.16.12.201	172.16.10.1	ICMP	98 Echo (pin
39	18.426560241	172.16.10.1	172.16.12.201	ICMP	98 Echo (pin	43	19.450296887	172.16.10.1	172.16.12.201	ICMP	98 Echo (pin
40	18.427087654	172.16.12.201	172.16.10.1	ICMP	98 Echo (pin	44	19.450722747	172.16.12.201	172.16.10.1	ICMP	98 Echo (pin
41	19.450299238	172.16.10.1	172.16.12.201	ICMP	98 Echo (pin	45	20.478286175	172.16.10.1	172.16.12.201	ICMP	98 Echo (pin
42	19.450757148	172.16.12.201	172.16.10.1	ICMP	98 Echo (pin	46	20.478723178	172.16.12.201	172.16.10.1	ICMP	98 Echo (pin

Frame 1: 98 bytes on wire (784 bits), 98 bytes captured (784 bits) on interface 0
Ethernet II, Src: Micro-St-79:53:5e (08:19:db:79:53:5e), Dst: Micro-St-79:54:6d (08:19:db:79:54:6d)
Internet Protocol Version 4, Src: 172.16.10.1, Dst: 172.16.12.201
Internet Control Message Protocol

Frame 1: 98 bytes on wire (784 bits), 98 bytes captured (784 bits) on interface 0
Ethernet II, Src: Tp-LinkT-00:69:e0 (28:ee:52:00:69:e0), Dst: Tp-LinkT-00:2a:4d (28:ee:52:00:2a:4d)
Internet Protocol Version 4, Src: 172.16.10.1, Dst: 172.16.12.201
Internet Control Message Protocol

enp2s8: <live capture in progress> Packets: 44 Displayed: 44 (100.0%) Profile: Default enx28ee520069e0...re in progress> Packets: 46 Displayed: 46 (100.0%) Profile: Default

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

```
$ sudo wireshark
```

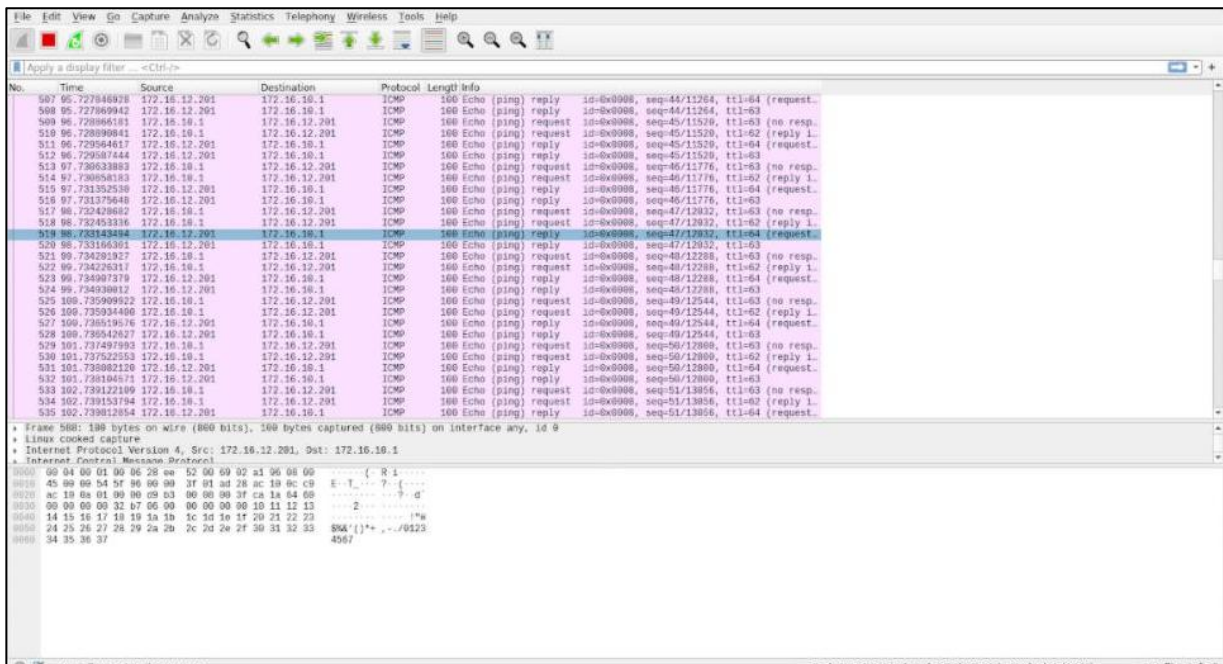
At eth1:

Capturing from any					
No.	Time	Source	Destination	Protocol	Length Info
1198	211.873363223	172.16.12.201	172.16.10.1	ICMP	100 Echo (ping) reply 10-0x0000, seq=130/33280, ttl=63 (request)
1199	211.873385129	172.16.12.201	172.16.10.1	ICMP	100 Echo (ping) reply 10-0x0000, seq=130/33280, ttl=62 (request)
1200	212.873955881	172.16.10.1	172.16.12.201	ICMP	100 Echo (ping) request 10-0x0000, seq=131/33536, ttl=64 (no res.)
1201	212.873979457	172.16.10.1	172.16.12.201	ICMP	100 Echo (ping) request 10-0x0000, seq=131/33536, ttl=63 (reply)
1202	212.875438191	172.16.12.201	172.16.10.1	ICMP	100 Echo (ping) reply 10-0x0000, seq=131/33536, ttl=63 (request)
1203	212.875458509	172.16.12.201	172.16.10.1	ICMP	100 Echo (ping) reply 10-0x0000, seq=131/33536, ttl=62 (request)
1204	213.875119250	172.16.10.1	172.16.12.201	ICMP	100 Echo (ping) request 10-0x0000, seq=132/33792, ttl=64 (no res.)
1205	213.875142619	172.16.10.1	172.16.12.201	ICMP	100 Echo (ping) request 10-0x0000, seq=132/33792, ttl=63 (reply)
1206	213.876441856	172.16.12.201	172.16.10.1	ICMP	100 Echo (ping) reply 10-0x0000, seq=132/33792, ttl=63 (request)
1207	213.876464506	172.16.12.201	172.16.10.1	ICMP	100 Echo (ping) reply 10-0x0000, seq=132/33792, ttl=62 (request)
1208	214.876259334	172.16.10.1	172.16.12.201	ICMP	100 Echo (ping) request 10-0x0000, seq=133/34048, ttl=64 (no res.)
1209	214.876282117	172.16.10.1	172.16.12.201	ICMP	100 Echo (ping) request 10-0x0000, seq=133/34048, ttl=63 (reply)
1210	214.877728180	172.16.12.201	172.16.10.1	ICMP	100 Echo (ping) reply 10-0x0000, seq=133/34048, ttl=63 (request)
1211	214.877759081	172.16.12.201	172.16.10.1	ICMP	100 Echo (ping) reply 10-0x0000, seq=133/34048, ttl=62 (request)
1212	215.877494142	172.16.10.1	172.16.12.201	ICMP	100 Echo (ping) request 10-0x0000, seq=134/34304, ttl=64 (no res.)
1213	215.877617178	172.16.10.1	172.16.12.201	ICMP	100 Echo (ping) request 10-0x0000, seq=134/34304, ttl=63 (reply)
1214	215.878971366	172.16.12.201	172.16.10.1	ICMP	100 Echo (ping) reply 10-0x0000, seq=134/34304, ttl=63 (request)
1215	215.878993988	172.16.12.201	172.16.10.1	ICMP	100 Echo (ping) reply 10-0x0000, seq=134/34304, ttl=62 (request)
1216	216.878853367	172.16.10.1	172.16.12.201	ICMP	100 Echo (ping) request 10-0x0000, seq=135/34560, ttl=64 (no res.)
1217	216.878874770	172.16.10.1	172.16.12.201	ICMP	100 Echo (ping) request 10-0x0000, seq=135/34560, ttl=63 (reply)
1218	216.880993761	172.16.12.201	172.16.10.1	ICMP	100 Echo (ping) reply 10-0x0000, seq=135/34560, ttl=63 (request)
1219	216.8809116185	172.16.12.201	172.16.10.1	ICMP	100 Echo (ping) reply 10-0x0000, seq=135/34560, ttl=62 (request)
1220	217.8818172588	172.16.10.1	172.16.12.201	ICMP	100 Echo (ping) request 10-0x0000, seq=136/34816, ttl=64 (no res.)
1221	217.881895665	172.16.10.1	172.16.12.201	ICMP	100 Echo (ping) request 10-0x0000, seq=136/34816, ttl=63 (reply)
1222	217.882546192	172.16.12.201	172.16.10.1	ICMP	100 Echo (ping) reply 10-0x0000, seq=136/34816, ttl=63 (request)
1223	217.882568442	172.16.12.201	172.16.10.1	ICMP	100 Echo (ping) reply 10-0x0000, seq=136/34816, ttl=62 (request)
1224	218.882644113	172.16.10.1	172.16.12.201	ICMP	100 Echo (ping) request 10-0x0000, seq=137/35072, ttl=64 (no res.)
1225	218.882665451	172.16.10.1	172.16.12.201	ICMP	100 Echo (ping) request 10-0x0000, seq=137/35072, ttl=63 (reply)
1226	218.884817783	172.16.12.201	172.16.10.1	ICMP	100 Echo (ping) reply 10-0x0000, seq=137/35072, ttl=63 (request)
1227	218.884838569	172.16.12.201	172.16.10.1	ICMP	100 Echo (ping) reply 10-0x0000, seq=137/35072, ttl=62 (request)
1228	219.8848588327	172.16.10.1	172.16.12.201	ICMP	100 Echo (ping) request 10-0x0000, seq=138/35328, ttl=64 (no res.)
1229	219.884848327	172.16.10.1	172.16.12.201	ICMP	100 Echo (ping) request 10-0x0000, seq=138/35328, ttl=63 (reply)
1230	219.885256488	172.16.12.201	172.16.10.1	ICMP	100 Echo (ping) reply 10-0x0000, seq=138/35328, ttl=63 (request)
1231	219.885272488	172.16.12.201	172.16.10.1	ICMP	100 Echo (ping) reply 10-0x0000, seq=138/35328, ttl=62 (request)

Frame 1: 87 bytes on wire (696 bits), 87 bytes captured (696 bits) on interface any, id 0

any: <live capture in progress> Packets: 1253 Displayed: 1253 (100.0%) Profile: Default

At eth2:



No.	Time	Source	Destination	Protocol	Length	Info
507	95.727848928	172.16.12.201	172.16.10.1	ICMP	60	Echo (ping) reply id=0x0000, seq=44/12264, ttl=64 (request. ...)
508	95.727869942	172.16.12.201	172.16.10.1	ICMP	60	Echo (ping) request id=0x0000, seq=44/12264, ttl=63 (no resp. ...)
509	96.728065181	172.16.10.1	172.16.12.201	ICMP	60	Echo (ping) request id=0x0000, seq=45/12520, ttl=63 (no resp. ...)
510	96.728090841	172.16.10.1	172.16.12.201	ICMP	60	Echo (ping) request id=0x0000, seq=45/12520, ttl=62 (reply i. ...)
511	96.729544617	172.16.12.201	172.16.10.1	ICMP	60	Echo (ping) reply id=0x0000, seq=45/12520, ttl=64 (request. ...)
512	96.729581444	172.16.12.201	172.16.10.1	ICMP	60	Echo (ping) reply id=0x0000, seq=45/12520, ttl=63 (no resp. ...)
513	97.730633883	172.16.10.1	172.16.12.201	ICMP	60	Echo (ping) request id=0x0000, seq=46/12776, ttl=63 (no resp. ...)
514	97.730658183	172.16.10.1	172.16.12.201	ICMP	60	Echo (ping) request id=0x0000, seq=46/12776, ttl=62 (reply i. ...)
515	97.731353530	172.16.12.201	172.16.10.1	ICMP	60	Echo (ping) reply id=0x0000, seq=46/12776, ttl=64 (request. ...)
516	97.731379440	172.16.12.201	172.16.10.1	ICMP	60	Echo (ping) reply id=0x0000, seq=46/12776, ttl=63 (no resp. ...)
517	98.732428642	172.16.10.1	172.16.12.201	ICMP	60	Echo (ping) request id=0x0000, seq=47/12832, ttl=63 (no resp. ...)
518	98.732453336	172.16.10.1	172.16.12.201	ICMP	60	Echo (ping) request id=0x0000, seq=47/12832, ttl=62 (reply i. ...)
519	98.733143484	172.16.12.201	172.16.10.1	ICMP	60	Echo (ping) reply id=0x0000, seq=47/12832, ttl=64 (request. ...)
520	98.733166361	172.16.12.201	172.16.10.1	ICMP	60	Echo (ping) reply id=0x0000, seq=47/12832, ttl=63 (no resp. ...)
521	99.734292327	172.16.10.1	172.16.12.201	ICMP	60	Echo (ping) request id=0x0000, seq=48/12288, ttl=63 (no resp. ...)
522	99.734293317	172.16.10.1	172.16.12.201	ICMP	60	Echo (ping) request id=0x0000, seq=48/12288, ttl=62 (reply i. ...)
523	99.734907379	172.16.12.201	172.16.10.1	ICMP	60	Echo (ping) reply id=0x0000, seq=48/12288, ttl=64 (request. ...)
524	99.734930812	172.16.12.201	172.16.10.1	ICMP	60	Echo (ping) reply id=0x0000, seq=48/12288, ttl=63 (no resp. ...)
525	100.735909952	172.16.10.1	172.16.12.201	ICMP	60	Echo (ping) request id=0x0000, seq=49/12544, ttl=63 (no resp. ...)
526	100.735934480	172.16.10.1	172.16.12.201	ICMP	60	Echo (ping) request id=0x0000, seq=49/12544, ttl=62 (reply i. ...)
527	100.735959576	172.16.12.201	172.16.10.1	ICMP	60	Echo (ping) reply id=0x0000, seq=49/12544, ttl=64 (request. ...)
528	100.735982637	172.16.10.1	172.16.12.201	ICMP	60	Echo (ping) request id=0x0000, seq=50/12800, ttl=63 (no resp. ...)
529	101.737497993	172.16.10.1	172.16.12.201	ICMP	60	Echo (ping) request id=0x0000, seq=50/12800, ttl=62 (reply i. ...)
530	101.737522553	172.16.10.1	172.16.12.201	ICMP	60	Echo (ping) request id=0x0000, seq=50/12800, ttl=61 (reply i. ...)
531	101.737580210	172.16.10.1	172.16.12.201	ICMP	60	Echo (ping) request id=0x0000, seq=50/12800, ttl=60 (reply i. ...)
532	101.738104671	172.16.12.201	172.16.10.1	ICMP	60	Echo (ping) reply id=0x0000, seq=50/12800, ttl=64 (request. ...)
533	102.739122189	172.16.10.1	172.16.12.201	ICMP	60	Echo (ping) request id=0x0000, seq=51/13856, ttl=63 (no resp. ...)
534	102.739153784	172.16.10.1	172.16.12.201	ICMP	60	Echo (ping) request id=0x0000, seq=51/13856, ttl=62 (reply i. ...)
535	102.739812054	172.16.12.201	172.16.10.1	ICMP	60	Echo (ping) reply id=0x0000, seq=51/13856, ttl=64 (request. ...)

Frame 580: 186 bytes on wire (860 bits), 160 bytes captured (640 bits) on interface any, id 0

Ethernet II, Src: Linux cooked capture, Dst: 172.16.10.1

Internet Protocol Version 4, Src: 172.16.12.201, Dst: 172.16.10.1

0000 00 04 00 01 00 06 28 00 52 00 00 02 01 06 08 00 R 1

0008 45 09 00 54 5f 86 06 00 3f 01 ad 28 ac 19 0c c9 E-1... 7: (...)

0016 ac 19 0a 01 00 00 05 03 00 00 3f ca 1a 64 00 8: d

0024 00 00 00 00 32 67 06 00 00 00 00 11 11 13 ... 2

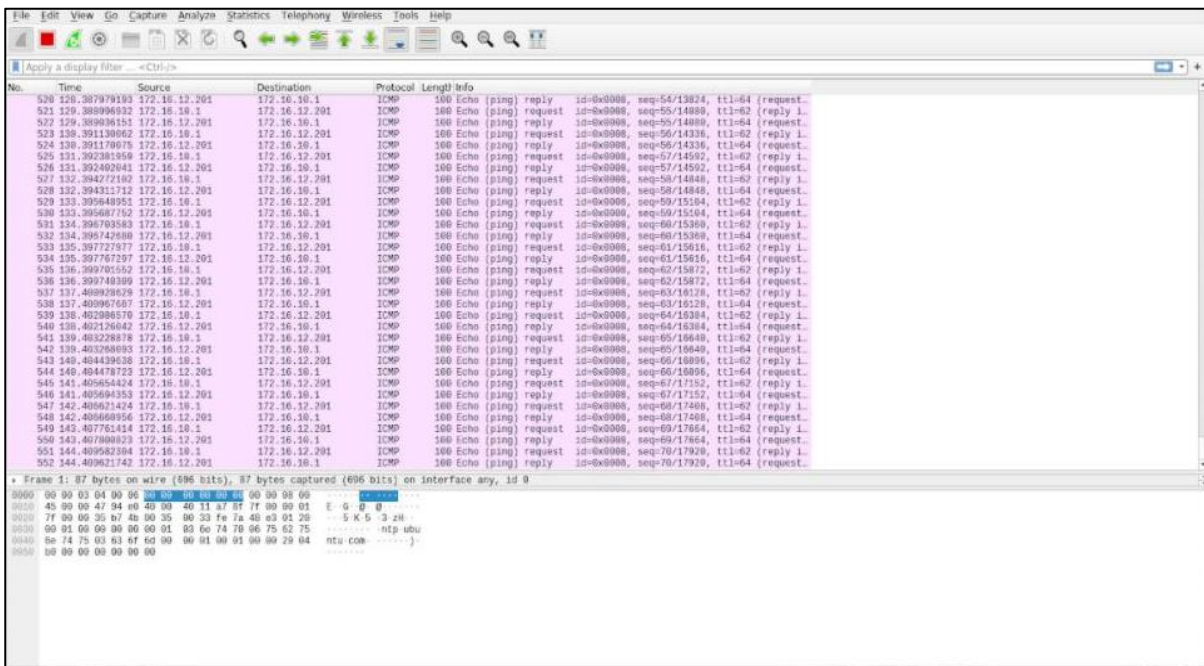
0032 14 15 16 17 18 19 1a 1b 1c 1d 1e 1f 20 21 22 23 17*

0040 24 25 26 27 28 29 2a 2b 2c 2d 2e 2f 30 31 32 33 SSK()!*/0123

0048 34 35 36 37 4567

Step 4: Capture packets from Hd
and Ha. At Hd:

T1: \$ sudo wireshark



No.	Time	Source	Destination	Protocol	Length	Info
520	126.387979193	172.16.12.201	172.16.10.1	ICMP	60	Echo (ping) reply id=0x0000, seq=54/13824, ttl=64 (request. ...)
521	126.388996332	172.16.10.1	172.16.12.201	ICMP	60	Echo (ping) request id=0x0000, seq=55/14080, ttl=62 (reply i. ...)
522	126.389061551	172.16.12.201	172.16.10.1	ICMP	60	Echo (ping) request id=0x0000, seq=55/14080, ttl=64 (request. ...)
523	138.391130062	172.16.10.1	172.16.12.201	ICMP	60	Echo (ping) request id=0x0000, seq=56/14336, ttl=62 (reply i. ...)
524	138.391170075	172.16.12.201	172.16.10.1	ICMP	60	Echo (ping) reply id=0x0000, seq=56/14336, ttl=64 (request. ...)
525	131.392381858	172.16.10.1	172.16.12.201	ICMP	60	Echo (ping) request id=0x0000, seq=57/14592, ttl=62 (reply i. ...)
526	131.392402041	172.16.12.201	172.16.10.1	ICMP	60	Echo (ping) reply id=0x0000, seq=57/14592, ttl=64 (request. ...)
527	132.394721807	172.16.10.1	172.16.12.201	ICMP	60	Echo (ping) request id=0x0000, seq=58/14848, ttl=62 (reply i. ...)
528	132.394821732	172.16.12.201	172.16.10.1	ICMP	60	Echo (ping) request id=0x0000, seq=58/14848, ttl=64 (request. ...)
529	133.395648951	172.16.10.1	172.16.12.201	ICMP	60	Echo (ping) request id=0x0000, seq=59/15104, ttl=62 (reply i. ...)
530	133.395687752	172.16.12.201	172.16.10.1	ICMP	60	Echo (ping) reply id=0x0000, seq=59/15104, ttl=64 (request. ...)
531	134.396793583	172.16.10.1	172.16.12.201	ICMP	60	Echo (ping) request id=0x0000, seq=60/15360, ttl=62 (reply i. ...)
532	134.396742608	172.16.12.201	172.16.10.1	ICMP	60	Echo (ping) reply id=0x0000, seq=60/15360, ttl=64 (request. ...)
533	135.397727377	172.16.10.1	172.16.12.201	ICMP	60	Echo (ping) request id=0x0000, seq=61/15616, ttl=62 (reply i. ...)
534	135.397767297	172.16.12.201	172.16.10.1	ICMP	60	Echo (ping) reply id=0x0000, seq=61/15616, ttl=64 (request. ...)
535	136.399070552	172.16.10.1	172.16.12.201	ICMP	60	Echo (ping) request id=0x0000, seq=62/15872, ttl=62 (reply i. ...)
536	136.399740309	172.16.12.201	172.16.10.1	ICMP	60	Echo (ping) reply id=0x0000, seq=62/15872, ttl=64 (request. ...)
537	140.409298279	172.16.10.1	172.16.12.201	ICMP	60	Echo (ping) request id=0x0000, seq=63/16128, ttl=62 (reply i. ...)
538	137.409967607	172.16.12.201	172.16.10.1	ICMP	60	Echo (ping) reply id=0x0000, seq=63/16128, ttl=64 (request. ...)
539	138.402086570	172.16.10.1	172.16.12.201	ICMP	60	Echo (ping) request id=0x0000, seq=64/16384, ttl=62 (reply i. ...)
540	138.402126042	172.16.12.201	172.16.10.1	ICMP	60	Echo (ping) request id=0x0000, seq=64/16384, ttl=64 (request. ...)
541	139.403228878	172.16.10.1	172.16.12.201	ICMP	60	Echo (ping) request id=0x0000, seq=65/16640, ttl=62 (reply i. ...)
542	139.403268883	172.16.12.201	172.16.10.1	ICMP	60	Echo (ping) reply id=0x0000, seq=65/16640, ttl=64 (request. ...)
543	140.404439038	172.16.10.1	172.16.12.201	ICMP	60	Echo (ping) request id=0x0000, seq=66/16896, ttl=62 (reply i. ...)
544	140.404478723	172.16.12.201	172.16.10.1	ICMP	60	Echo (ping) reply id=0x0000, seq=66/16896, ttl=64 (request. ...)
545	141.405664244	172.16.10.1	172.16.12.201	ICMP	60	Echo (ping) request id=0x0000, seq=67/17152, ttl=62 (reply i. ...)
546	141.405694353	172.16.12.201	172.16.10.1	ICMP	60	Echo (ping) reply id=0x0000, seq=67/17152, ttl=64 (request. ...)
547	142.406671424	172.16.10.1	172.16.12.201	ICMP	60	Echo (ping) request id=0x0000, seq=68/17408, ttl=62 (reply i. ...)
548	142.406686956	172.16.12.201	172.16.10.1	ICMP	60	Echo (ping) request id=0x0000, seq=68/17408, ttl=64 (request. ...)
549	143.407761414	172.16.10.1	172.16.12.201	ICMP	60	Echo (ping) request id=0x0000, seq=69/17664, ttl=62 (reply i. ...)
550	143.407800823	172.16.12.201	172.16.10.1	ICMP	60	Echo (ping) reply id=0x0000, seq=69/17664, ttl=64 (request. ...)
551	144.409582304	172.16.10.1	172.16.12.201	ICMP	60	Echo (ping) request id=0x0000, seq=70/17920, ttl=62 (reply i. ...)
552	144.409621742	172.16.12.201	172.16.10.1	ICMP	60	Echo (ping) reply id=0x0000, seq=70/17920, ttl=64 (request. ...)

Frame 81: 87 bytes on wire (696 bits), 87 bytes captured (696 bits) on interface any, id 0

Ethernet II, Src: Linux cooked capture, Dst: 172.16.10.1

0000 00 00 00 04 00 00 00 00 00 00 00 00 00 00 00

0008 45 00 00 07 94 00 40 00 50 11 87 7f 00 00 01 E G 0 0 ...

0016 7f 00 00 05 b7 4b 00 35 00 33 fe 1a 4b e3 01 20 ... S K 5 3 2H ...

0024 00 01 00 00 00 00 00 01 83 6e 74 70 06 75 62 75 ntp ubu

0032 0e 74 75 03 83 8f 6d 00 00 00 01 00 01 00 29 04 nta con

0040 00 00 00 00 00 00 00 00
