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Subject: Computer Network Laboratory
WEEK No: 8

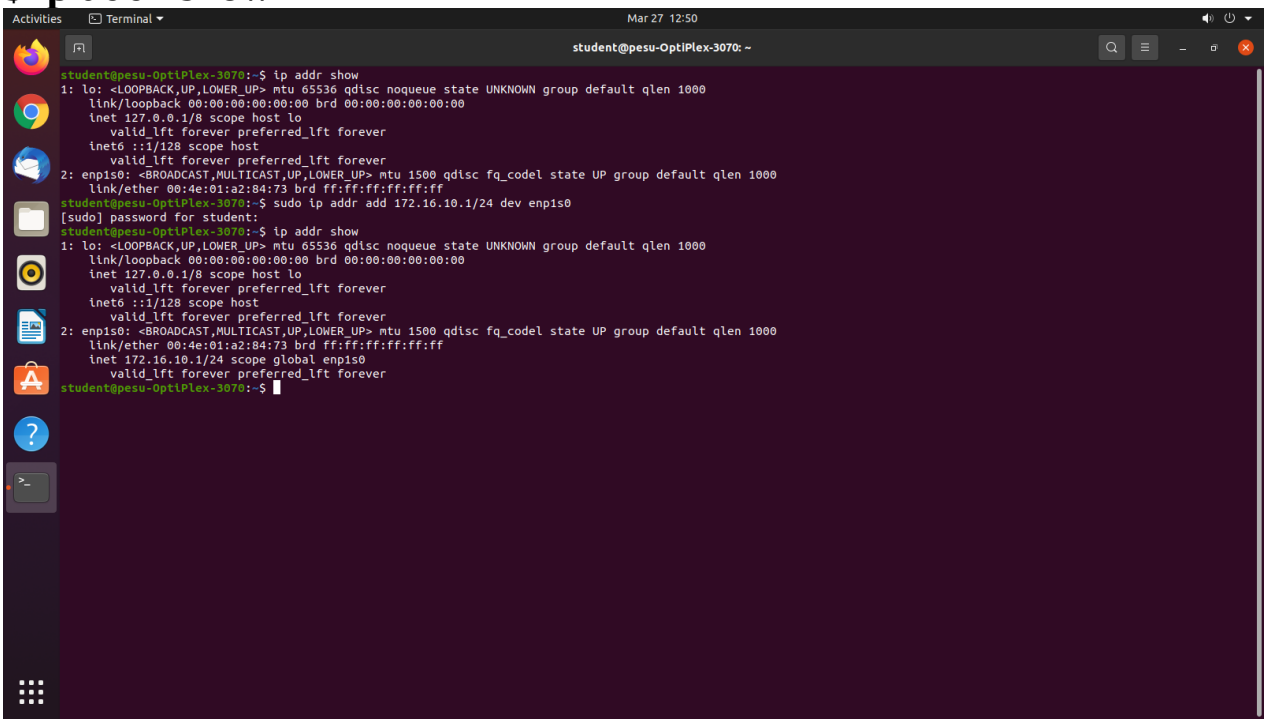
Objective: To setup a network with two routers and exchange packets across routers.

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

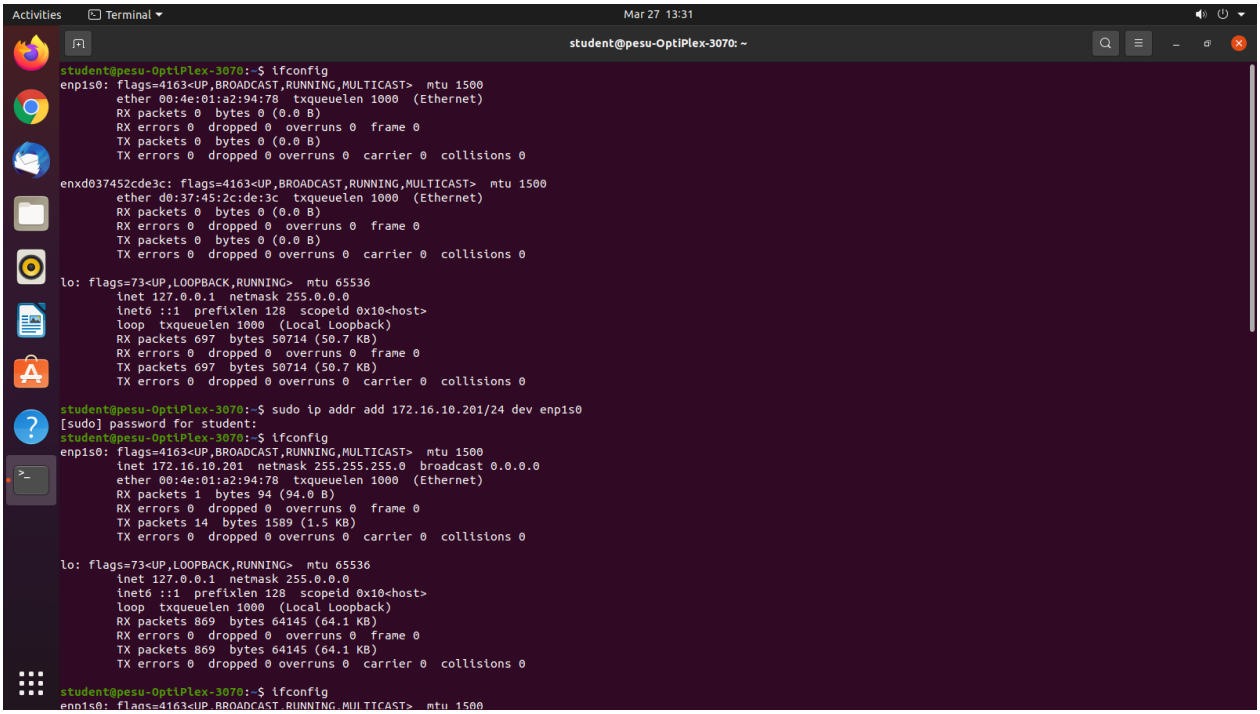


Step 2: Assign the IP address to R1.

$ 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



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

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

enx28ee52006905: flags=4163<UP,BROADCAST,RUNNING,MULTICAST>  mtu 1500
        ether 28:ee:52:00:69:05  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 880  bytes 63831 (63.8 KB)
        RX errors 0  dropped 0  overruns 0  frame 0
        TX packets 880  bytes 63831 (63.8 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 enp1s0
[sudo] password for student:
student@pesu-OptiPlex-3070:~$ sudo ip addr add 172.16.12.1/24 dev enx28ee52006905
student@pesu-OptiPlex-3070:~$ ifconfig
enp1s0: flags=4163<UP,BROADCAST,RUNNING,MULTICAST>  mtu 1500
        inet 172.16.11.201  netmask 255.255.255.0  broadcast 0.0.0.0
        ether 00:4e:01: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 13  bytes 1383 (1.3 KB)
        TX errors 0  dropped 0 overruns 0  carrier 0  collisions 0

enx28ee52006905: flags=4163<UP,BROADCAST,RUNNING,MULTICAST>  mtu 1500
        inet 172.16.12.1  netmask 255.255.255.0  broadcast 0.0.0.0
        ether 28:ee:52:00:69:05  txqueuelen 1000  (Ethernet)
        RX packets 0  bytes 0 (0.0 B)
        RX errors 0  dropped 0  overruns 0  frame 0
        TX packets 10  bytes 1065 (1.0 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 1126  bytes 81367 (81.3 KB)
        RX errors 0  dropped 0  overruns 0  frame 0
        TX packets 1126  bytes 81367 (81.3 KB)
        TX errors 0  dropped 0 overruns 0  carrier 0  collisions 0
```

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

```
student@pesu-OptiPlex-3070:~$ ifconfig
enp1s0: flags=4163<UP,BROADCAST,RUNNING,MULTICAST>  mtu 1500
        ether 00:4e:01:a2:94:2d  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 1152  bytes 83047 (83.0 KB)
        RX errors 0  dropped 0  overruns 0  frame 0
        TX packets 1152  bytes 83047 (83.0 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 1  bytes 94 (94.0 B)
        RX errors 0  dropped 0  overruns 0  frame 0
        TX packets 9  bytes 1000 (1000.0 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 1246  bytes 90737 (90.7 KB)
        RX errors 0  dropped 0  overruns 0  frame 0
        TX packets 1246  bytes 90737 (90.7 KB)
        TX errors 0  dropped 0 overruns 0  carrier 0  collisions 0

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

On host machines Ha and Hd, issue the following command:

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

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

To have precautionary measures issue below command in router machines R1 and R2.

$ sudo sysctl –w net.ipv4.conf.all.send_redirects=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@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.

At Ha: $ ping 172.16.10.1 (Local network)

```
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:~$ 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=0.039 ms
64 bytes from 172.16.10.1: icmp_seq=2 ttl=64 time=0.046 ms
64 bytes from 172.16.10.1: icmp_seq=3 ttl=64 time=0.046 ms
64 bytes from 172.16.10.1: icmp_seq=4 ttl=64 time=0.047 ms
64 bytes from 172.16.10.1: icmp_seq=5 ttl=64 time=0.047 ms
64 bytes from 172.16.10.1: icmp_seq=6 ttl=64 time=0.048 ms
64 bytes from 172.16.10.1: icmp_seq=7 ttl=64 time=0.047 ms
64 bytes from 172.16.10.1: icmp_seq=8 ttl=64 time=0.048 ms
64 bytes from 172.16.10.1: icmp_seq=9 ttl=64 time=0.047 ms
64 bytes from 172.16.10.1: icmp_seq=10 ttl=64 time=0.047 ms
64 bytes from 172.16.10.1: icmp_seq=11 ttl=64 time=0.047 ms
^C
--- 172.16.10.1 ping statistics ---
11 packets transmitted, 11 received, 0% packet loss, time 10241ms
rtt min/avg/max/mdev = 0.039/0.046/0.048/0.002 ms
student@pesu-OptiPlex-3070:~$
```

At Hd: $ ping 172.16.12.201(Local network)

```
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=1.36 ms
64 bytes from 172.16.10.201: icmp_seq=2 ttl=63 time=1.37 ms
64 bytes from 172.16.10.201: icmp_seq=3 ttl=63 time=1.18 ms
64 bytes from 172.16.10.201: icmp_seq=4 ttl=63 time=1.28 ms
64 bytes from 172.16.10.201: icmp_seq=5 ttl=63 time=1.48 ms
64 bytes from 172.16.10.201: icmp_seq=6 ttl=63 time=1.43 ms
^C
--- 172.16.10.201 ping statistics ---
6 packets transmitted, 6 received, 0% packet loss, time 5009ms
rtt min/avg/max/mdev = 1.176/1.348/1.484/0.100 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@pesu-OptiPlex-3070:~$ sudo ip route add 172.16.12.0/24 via 172.16.10.201
student@pesu-OptiPlex-3070:~$ sudo ip route add 172.16.11.0/24 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
student@pesu-OptiPlex-3070:~$
```

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

```
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 enp1s0 scope link metric 1000
172.16.10.0/24 dev enp1s0 proto kernel scope link src 172.16.10.201
172.16.11.0/24 dev enxd037452cde3c proto kernel scope link src 172.16.11.1
172.16.12.0/24 via 172.16.11.201 dev enxd037452cde3c
student@pesu-OptiPlex-3070:~$
```

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

```
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 enp1s0 scope link metric 1000
172.16.10.0/24 via 172.16.11.1 dev enp1s0
172.16.11.0/24 dev enp1s0 proto kernel scope link src 172.16.11.201
172.16.12.0/24 dev enx28ee52006905 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

```
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
student@pesu-OptiPlex-3070:~$ ip route show
169.254.0.0/16 dev enp1s0 scope link metric 1000
172.16.10.0/24 via 172.16.12.1 dev enp1s0
172.16.11.0/24 via 172.16.12.1 dev enp1s0
172.16.12.0/24 dev enp1s0 proto kernel scope link src 172.16.12.201
```

Task 5: After adding routing table entries 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

```
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=63 time=2.39 ms
64 bytes from 172.16.12.1: icmp_seq=2 ttl=63 time=1.43 ms
64 bytes from 172.16.12.1: icmp_seq=3 ttl=63 time=1.45 ms
64 bytes from 172.16.12.1: icmp_seq=4 ttl=63 time=1.15 ms
^C
--- 172.16.12.1 ping statistics ---
4 packets transmitted, 4 received, 0% packet loss, time 3005ms
rtt min/avg/max/mdev = 1.148/1.605/2.388/0.467 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=1.86 ms
64 bytes from 172.16.12.201: icmp_seq=2 ttl=62 time=2.21 ms
64 bytes from 172.16.12.201: icmp_seq=3 ttl=62 time=2.25 ms
64 bytes from 172.16.12.201: icmp_seq=4 ttl=62 time=2.02 ms
64 bytes from 172.16.12.201: icmp_seq=5 ttl=62 time=2.26 ms
64 bytes from 172.16.12.201: icmp_seq=6 ttl=62 time=2.29 ms
64 bytes from 172.16.12.201: icmp_seq=7 ttl=62 time=1.98 ms
64 bytes from 172.16.12.201: icmp_seq=8 ttl=62 time=2.24 ms
64 bytes from 172.16.12.201: icmp_seq=9 ttl=62 time=2.26 ms
^C
--- 172.16.12.201 ping statistics ---
9 packets transmitted, 9 received, 0% packet loss, time 8014ms
rtt min/avg/max/mdev = 1.857/2.151/2.288/0.148 ms
student@pesu-OptiPlex-3070:~$
```

Step 2: Testing path from Hd and Ha

$ ping 172.16.12.1 and $ ping 172.16.12.201

```
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=1.12 ms
64 bytes from 172.16.12.1: icmp_seq=2 ttl=64 time=0.741 ms
64 bytes from 172.16.12.1: icmp_seq=3 ttl=64 time=0.723 ms
^C
--- 172.16.12.1 ping statistics ---
3 packets transmitted, 3 received, 0% packet loss, time 2023ms
rtt min/avg/max/mdev = 0.723/0.860/1.116/0.181 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=0.038 ms
64 bytes from 172.16.12.201: icmp_seq=2 ttl=64 time=0.048 ms
64 bytes from 172.16.12.201: icmp_seq=3 ttl=64 time=0.047 ms
^C
--- 172.16.12.201 ping statistics ---
3 packets transmitted, 3 received, 0% packet loss, time 2038ms
rtt min/avg/max/mdev = 0.038/0.044/0.048/0.004 ms
```

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

At Ha: $ ip neigh show

```
student@pesu-OptiPlex-3070:~$ ip neigh show
172.16.10.201 dev enp1s0 lladdr 00:4e:01:a2:94:78 STALE
student@pesu-OptiPlex-3070:~$
```

At R1: $ ip neigh show

```
student@pesu-OptiPlex-3070:~$ ip neigh show
172.16.11.201 dev enxd037452cde3c lladdr 00:4e:01:a2:82:bb STALE
172.16.10.1 dev enp1s0 lladdr 00:4e:01:a2:84:73 STALE
student@pesu-OptiPlex-3070:~$
```

At R2: $ ip neigh show

```
student@pesu-OptiPlex-3070:~$ ip neigh show
172.16.11.1 dev enp1s0 lladdr d0:37:45:2c:de:3c STALE
172.16.12.201 dev enx28ee52006905 lladdr 00:4e:01:a2:94:2d STALE
```

At Hd: $ ip neigh show

```
student@pesu-OptiPlex-3070:~$ ip neigh show
172.16.12.1 dev enp1s0 lladdr 28:ee:52:00:69:05 REACHABLE
```