Computer Networks Laboratory Week #7 IPv4 Addressing and Static Routing using Hardware

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

For Ha:

```
😵 🖨 📵 student@CSELAB: ~
student@CSELAB:~$ ifconfig
           Link encap:Ethernet HWaddr b8:ae:ed:a5:a6:53
enp2s0
           inet addr:172.16.10.1 Bcast:172.16.10.255 Mask:255.255.255.0
inet6 addr: fe80::99b2:d2bd:fb5e:b38b/64 Scope:Link
           UP BROADCAST RUNNING MULTICAST MTU:1500 Metric:1
           RX packets:358 errors:0 dropped:0 overruns:0 frame:0
           TX packets:351 errors:0 dropped:0 overruns:0 carrier:0
           collisions:0 txqueuelen:1000
           RX bytes:99474 (99.4 KB) TX bytes:41879 (41.8 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:335 errors:0 dropped:0 overruns:0 frame:0
           TX packets:335 errors:0 dropped:0 overruns:0 carrier:0
           collisions:0 txqueuelen:1
           RX bytes:23366 (23.3 KB) TX bytes:23366 (23.3 KB)
student@CSELAB:~$
```

For R1:

```
🖯 🗊 student@CSELAB: ~
student@CSELAB:~$ ifconfig
         Link encap:Ethernet HWaddr b8:ae:ed:a5:a6:70
enp2s0
          inet addr:172.16.10.201 Bcast:172.16.10.255 Mask:255.255.255.0
          inet6 addr: fe80::116e:60e7:a1b4:96d9/64 Scope:Link
         UP BROADCAST RUNNING MULTICAST MTU:1500 Metric:1
         RX packets:10969 errors:0 dropped:0 overruns:0 frame:0
          TX packets:3773 errors:0 dropped:0 overruns:0 carrier:0
         collisions:0 txqueuelen:1000
         RX bytes:8052174 (8.0 MB) TX bytes:571330 (571.3 KB)
enxd03745b8d975 Link encap:Ethernet HWaddr d0:37:45:b8:d9:75
          inet addr:172.16.11.1 Bcast:172.16.11.255 Mask:255.255.255.0
          inet6 addr: fe80::e7cd:b9a7:cf28:2a1f/64 Scope:Link
         UP BROADCAST RUNNING MULTICAST MTU:1500 Metric:1
         RX packets:26 errors:0 dropped:0 overruns:0 frame:0
          TX packets:53 errors:0 dropped:0 overruns:0 carrier:0
         collisions:0 txqueuelen:1000
RX bytes:4347 (4.3 KB) TX bytes:8214 (8.2 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:7189 errors:0 dropped:0 overruns:0 frame:0
          TX packets:7189 errors:0 dropped:0 overruns:0 carrier:0
         collisions:0 txqueuelen:1
          RX bytes:531121 (531.1 KB) TX bytes:531121 (531.1 KB)
```

For R2:

```
student@CSELAB:~$ ifconfig
         Link encap: Ethernet HWaddr b8:ae:ed:a5:a6:7a
enp2s0
          inet addr:172.16.12.1 Bcast:172.16.12.255 Mask:255.255.255.0
          inet6 addr: fe80::a6b:3f68:ffb7:7585/64 Scope:Link
          UP BROADCAST RUNNING MULTICAST MTU:1500 Metric:1
          RX packets:2508 errors:0 dropped:0 overruns:0 frame:0
          TX packets:439 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:1000
          RX bytes:258586 (258.5 KB) TX bytes:53964 (53.9 KB)
enxd03745b7b332 Link encap:Ethernet HWaddr d0:37:45:b7:b3:32
          inet addr:172.16.11.201 Bcast:172.16.11.255 Mask:255.255.255.0
          inet6 addr: fe80::8113:f0de:f59e:b7e/64 Scope:Link
          UP BROADCAST RUNNING MULTICAST MTU:1500 Metric:1
          RX packets:47 errors:0 dropped:0 overruns:0 frame:0
          TX packets:43 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:1000
          RX bytes:6298 (6.2 KB) TX bytes:6205 (6.2 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:353 errors:0 dropped:0 overruns:0 frame:0
          TX packets:353 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:1
          RX bytes:25880 (25.8 KB) TX bytes:25880 (25.8 KB)
```

For Hd:

```
student@CSELAB:~$ ip addr show
1: lo: <LOOPBACK,UP,LOWER_UP> mtu 65536 qdisc noqueue state UNKNOWN group defaul
t qlen 1
    link/loopback 00:00:00:00:00:00 brd 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:f5:90:30 brd ff:ff:ff:ff:
    inet 172.16.12.201/24 brd 172.16.12.255 scope global enp2s0
        valid_lft forever preferred_lft forever
inet6 fe80::d793:85c3:c289:c4e2/64 scope link
    valid_lft forever preferred_lft forever
```

Task 2: Convert machines B and C into Routers

For both R1 and R2:

```
student@CSELAB:~$ sudo sysctl -w net.ipv4.conf.all.send_redirects=0
net.ipv4.conf.all.send_redirects = 0
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 172.16.11.201
student@CSELAB:~$ sudo ip route add 172.16.12.0/24 via 172.16.11.201
RTNETLINK answers: File exists
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 enxd03745b8d975 proto kernel scope link src 172.16.11.1 metric 100
172.16.12.0/24 via 172.16.11.201 dev enxd03745b8d975
student@CSELAB:~$
```

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

At Ha:

```
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=0.738 ms
64 bytes from 172.16.10.1: icmp_seq=2 ttl=62 time=0.805 ms
64 bytes from 172.16.10.1: icmp_seq=3 ttl=62 time=0.819 ms
64 bytes from 172.16.10.1: icmp_seq=4 ttl=62 time=0.794 ms
^C
--- 172.16.10.1 ping statistics ---
4 packets transmitted, 4 received, 0% packet loss, time 2999ms
rtt min/avg/max/mdev = 0.738/0.789/0.819/0.030 ms
```

At Hd:

```
😰 🛑 📵 student@CSELAB: ~
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=1.23 ms
64 bytes from 172.16.12.201: icmp_seq=2 ttl=62 time=0.772 ms
64 bytes from 172.16.12.201: icmp_seq=2 ttl=62 time=0.774 ms
64 bytes from 172.16.12.201: icmp_seq=4 ttl=62 time=0.808 ms
64 bytes from 172.16.12.201: icmp_seq=5 ttl=62 time=0.853 ms
64 bytes from 172.16.12.201: icmp_seq=5 ttl=62 time=0.853 ms
64 bytes from 172.16.12.201: icmp_seq=6 ttl=62 time=0.892 ms
^C
--- 172.16.12.201 ping statistics
6 packets transmitted, 6 received, 0% packet loss, time 5001ms
rtt min/avg/max/mdev = 0.714/0.879/1.239/0.173 ms
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=0.528 ms
64 bytes from 172.16.12.1: icmp seq=2 ttl=63 time=0.615 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=0.496 ms
64 bytes from 172.16.12.1: icmp seq=5 ttl=63 time=0.633 ms
^C
--- 172.16.12.1 ping statistics ---
5 packets transmitted, 5 received, 0% packet loss, time 3999ms rtt min/avg/max/mdev = 0.496/0.581/0.634/0.059 ms
student@CSELAB:~$
```

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

At Ha:

```
student@CSELAB: ~
stude
```

At R1:

```
student@CSELAB:~$ sudo sysctl -w net.ipv4.conf.all.send_redirects=0
net.ipv4.conf.all.send_redirects = 0
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 172.16.11.201
student@CSELAB:~$ sudo ip route add 172.16.12.0/24 via 172.16.11.201
RTNETLINK answers: File exists
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 enxd03745b8d975 proto kernel scope link src 172.16.11.1 metric 100
172.16.12.0/24 via 172.16.11.201 dev enxd03745b8d975
student@CSELAB:~$
```

At R2:

```
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 enxd03745b7b332 scope link metric 1000
172.16.10.0/24 via 172.16.11.1 dev enxd03745b7b332
172.16.11.0/24 dev enxd03745b7b332 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:

```
student@CSELAB:~$ sudo ip route add 172.16.10.0/24 via 172.16.12.1
RTNETLINK answers: File exists
student@CSELAB:~$ sudo ip route add 172.16.11.0/24 via 172.16.12.1
RTNETLINK answers: File exists
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 1
00
```

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

1. Testing path from Ha and Hd

```
student@CSELAB:~

student@CSELAB:~

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=1.23 ms
64 bytes from 172.16.12.201: icmp_seq=2 ttl=62 time=0.772 ms
64 bytes from 172.16.12.201: icmp_seq=3 ttl=62 time=0.714 ms
64 bytes from 172.16.12.201: icmp_seq=3 ttl=62 time=0.808 ms
64 bytes from 172.16.12.201: icmp_seq=5 ttl=62 time=0.893 ms
64 bytes from 172.16.12.201: icmp_seq=5 ttl=62 time=0.892 ms
64 bytes from 172.16.12.201: icmp_seq=6 ttl=62 time=0.892 ms
65 bytes from 172.16.12.201: icmp_seq=6 ttl=62 time=0.892 ms
66 bytes from 172.16.12.101; icmp_seq=6 ttl=63 time=0.892 ms
67 bytes from 172.16.12.1 (172.16.12.1) 56(84) bytes of data.
68 bytes from 172.16.12.1: icmp_seq=1 ttl=63 time=0.528 ms
69 bytes from 172.16.12.1: icmp_seq=1 ttl=63 time=0.615 ms
60 bytes from 172.16.12.1: icmp_seq=2 ttl=63 time=0.634 ms
61 bytes from 172.16.12.1: icmp_seq=2 ttl=63 time=0.634 ms
62 bytes from 172.16.12.1: icmp_seq=4 ttl=63 time=0.633 ms
63 bytes from 172.16.12.1: icmp_seq=5 ttl=63 time=0.633 ms
64 bytes from 172.16.12.1: icmp_seq=5 ttl=63 time=0.633 ms
65 bytes from 172.16.12.1: icmp_seq=5 ttl=63 time=0.633 ms
66 bytes from 172.16.12.1: icmp_seq=5 ttl=63 time=0.633 ms
67 bytes from 172.16.12.1: icmp_seq=5 ttl=63 time=0.633 ms
68 bytes from 172.16.12.1: icmp_seq=5 ttl=63 time=0.633 ms
69 bytes from 172.16.12.1: icmp_seq=5 ttl=63 time=0.633 ms
60 bytes from 172.16.12.1: icmp_seq=5 ttl=63 time=0.633 ms
60 bytes from 172.16.12.1: icmp_seq=5 ttl=63 time=0.633 ms
61 bytes from 172.16.12.1: icmp_seq=5 ttl=63 time=0.633 ms
62 bytes from 172.16.12.1: icmp_seq=5 ttl=63 time=0.633 ms
64 bytes from 172.16.12.1: icmp_seq=5 ttl=63 time=0.633 ms
64 bytes from 172.16.12.1: icmp_seq=5 ttl=63 time=0.633 ms
65 bytes from 172.16.12.1: icmp_seq=5 ttl=63 time=0.633 ms
67 bytes from 172.16.12.1: icmp_seq=5 ttl=63 time=0.633 ms
68 bytes from 172.16.12.1: icmp_seq=5 ttl=63 time=0.633 ms
69 bytes from 172.16.12.1: icmp_seq=5 ttl=63 time=0.633 ms
61 bytes from 172.16.12.1: icmp_seq=5 ttl=63
```

2. Testing path from Hd and Ha

```
student@CSELAB:~$ ip neigh show^C
student@CSELAB:~$ 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=0.520 ms
64 bytes from 172.16.10.201: icmp_seq=2 ttl=63 time=0.479 ms
64 bytes from 172.16.10.201: icmp seq=3 ttl=63 time=0.569 ms
64 bytes from 172.16.10.201: icmp seq=4 ttl=63 time=0.460 ms
^C
--- 172.16.10.201 ping statistics ---
4 packets transmitted, 4 received, 0% packet loss, time 2999ms
rtt min/avg/max/mdev = 0.460/0.507/0.569/0.041 ms
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=0.738 ms
64 bytes from 172.16.10.1: icmp_seq=2 ttl=62 time=0.805 ms
64 bytes from 172.16.10.1: icmp seq=3 ttl=62 time=0.819 ms
64 bytes from 172.16.10.1: icmp seq=4 ttl=62 time=0.794 ms
^C
--- 172.16.10.1 ping statistics
4 packets transmitted, 4 received, 0% packet loss, time 2999ms
rtt min/avg/max/mdev = 0.738/0.789/0.819/0.030 ms
```

Task 6: Check each system neighbour to verify the connections

At Ha:

```
student@CSELAB:~

student@CSELAB:~$ ip neigh show

172.16.10.201 dev enp2s0 lladdr b8:ae:ed:a5:a6:70 STALE

student@CSELAB:~$
```

At R1:

```
student@CSELAB:~$ ip neigh show
172.16.10.1 dev enp2s0 lladdr b8:ae:ed:a5:a6:53 STALE
172.16.11.201 dev enxd03745b8d975 lladdr d0:37:45:b7:b3:32 STALE
student@CSELAB:~$
```

At R2:

```
student@CSELAB:~$ ip neigh show
L72.16.11.1 dev eth2 lladdr b8:a3:86:98:42:73 STALE
L72.16.12.201 dev eth1 lladdr 50:e5:49:1b:f0:c4 REACHABLE
```

At Hd:

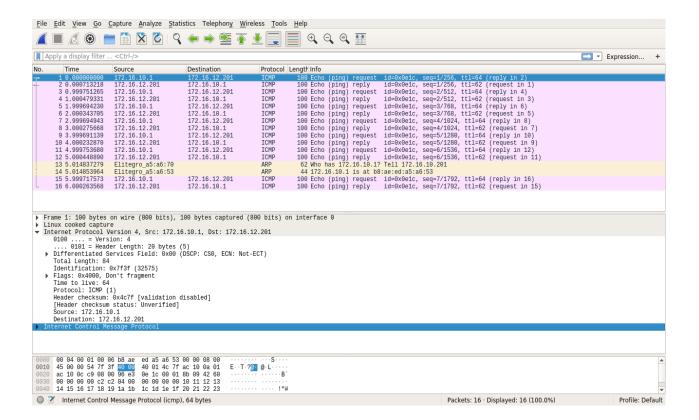
```
student@CSELAB:~$ ip neigh show
172.16.11.201 dev enp2s0 lladdr b8:ae:ed:a5:a6:7a STALE
172.16.12.1 dev enp2s0 lladdr b8:ae:ed:a5:a6:7a STALE
```

Task 7: Capture packets from Ha and Hd using Wireshark

At Ha:

Terminal 1: \$ sudo wireshark

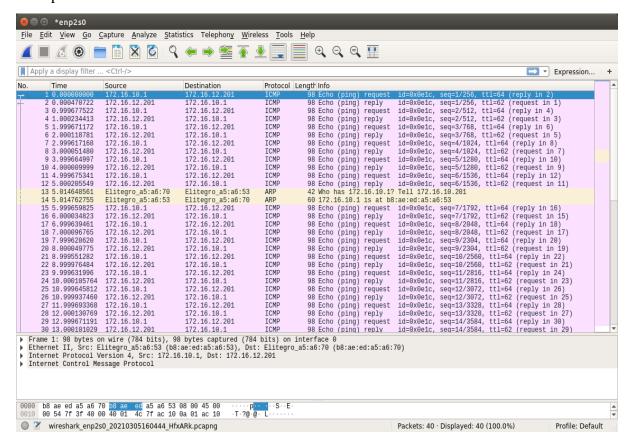
Terminal 2: \$ ping 172.16.12.201



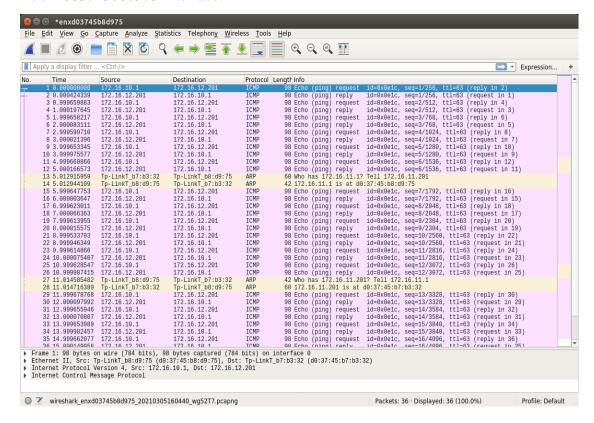
At R1:

\$ sudo wireshark

At enp2s0 interface:



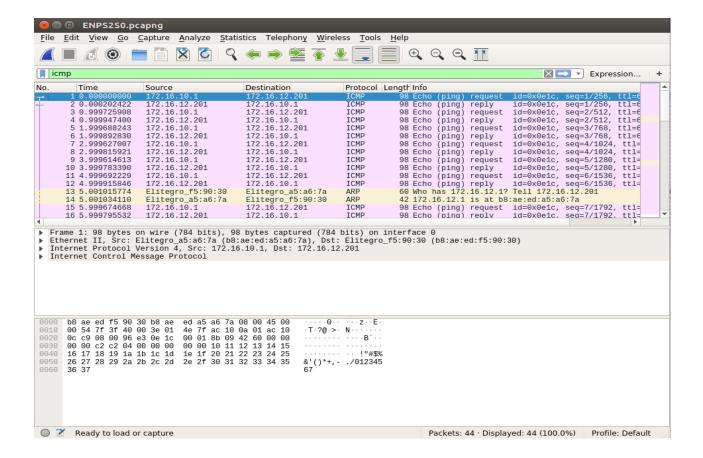
At enxd03745b8d975 interface:



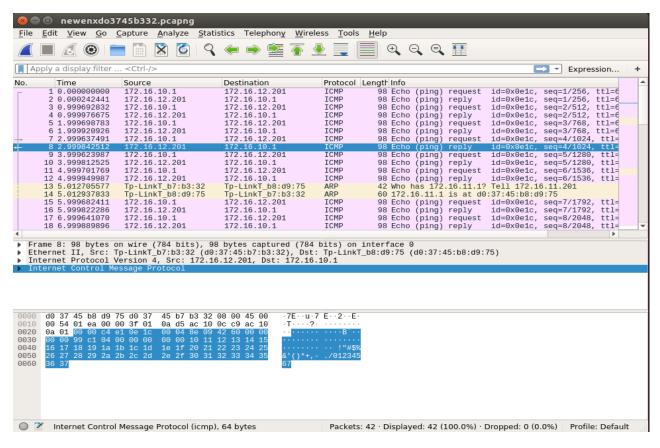
At R2:

\$ sudo wireshark

At enp2s0 interface:



At newenxdo3745b332 interface:



At Hd:

Terminal 1: \$ sudo wireshark

