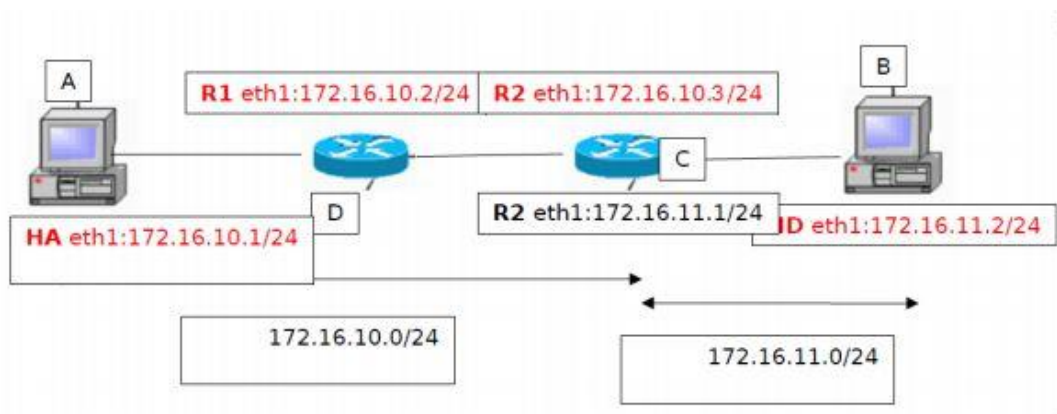


# Computer Networks Lab

## Week 10

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SRN : PES1UG19CS019  
Section : A

### Topology :



### Step 1: Assign IP addresses to each computer

At Ha:

```
$ sudo ip addr add 172.16.10.1/24 dev enp1s0  
$ ip addr show
```

```
student@pesu-OptiPlex-3070:~$ sudo ip addr add 172.16.10.1/24 dev enp1s0  
student@pesu-OptiPlex-3070:~$ ip addr show  
1: lo: <LOOPBACK,UP,LOWER_UP> mtu 65536 qdisc noqueue state UNKNOWN group default qlen 1000  
    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: enp1s0: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc pfifo_fast state UP group default qlen 1000  
    link/ether 00:4e:01:a0:b6:31 brd ff:ff:ff:ff:ff:ff  
    inet 172.16.10.1/24 scope global enp1s0  
        valid_lft forever preferred_lft forever  
student@pesu-OptiPlex-3070:~$
```

At Hd:

```
$ sudo ip addr add 172.16.11.2/24 dev enp1s0  
$ ip addr show
```

```

student@pesu-OptiPlex-3070:~$ sudo ip addr add 172.16.11.2/24 dev enp1s0
student@pesu-OptiPlex-3070:~$ ifconfig
enp1s0    Link encap:Ethernet  HWaddr 00:4e:01:a3:dc:b4
          inet addr:172.16.11.2  Bcast:0.0.0.0  Mask:255.255.255.0
          inet6 addr: fe80::bcee:9544:e810:966/64 Scope:Link
          UP BROADCAST RUNNING MULTICAST  MTU:1500  Metric:1
          RX packets:42153 errors:0 dropped:0 overruns:0 frame:0
          TX packets:9601 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:1000
          RX bytes:25182415 (25.1 MB)  TX bytes:967152 (967.1 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:3677 errors:0 dropped:0 overruns:0 frame:0
          TX packets:3677 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:1000
          RX bytes:338571 (338.5 KB)  TX bytes:338571 (338.5 KB)

```

**At R2:**

**\$ sudo ip addr add 172.16.11.1/24 dev enx4ce17342f08a**

**\$ sudo ip addr add 172.16.10.3 /24 dev enp1s0**

**\$ ip addr show**

```

student@pesu-OptiPlex-3070: ~
a
student@pesu-OptiPlex-3070:~$ sudo ip addr add 172.16.10.3 /24 dev enp1s0
Error: either "local" is duplicate, or "/24" is a garbage.
student@pesu-OptiPlex-3070:~$ sudo ip addr add 172.16.10.3/24 dev enp1s0
student@pesu-OptiPlex-3070:~$ ip addr show
1: lo: <LOOPBACK,UP,LOWER_UP> mtu 65536 qdisc noqueue state UNKNOWN group default qlen 1000
    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: enp1s0: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc pfifo_fast state UP group default qlen 1000
    link/ether 00:4e:01:9a:ae:6e brd ff:ff:ff:ff:ff:ff
    inet 172.16.10.3/24 scope global enp1s0
        valid_lft forever preferred_lft forever
    inet6 fe80::24e:1ff:fe9a:ae6e/64 scope link
        valid_lft forever preferred_lft forever
3: enx4ce17342f08a: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc pfifo_fast state UP group default qlen 1000
    link/ether 4c:e1:73:42:f0:8a brd ff:ff:ff:ff:ff:ff
    inet 172.16.11.1/24 scope global enx4ce17342f08a
        valid_lft forever preferred_lft forever
    inet6 fe80::4ee1:73ff:fe42:f08a/64 scope link
        valid_lft forever preferred_lft forever
student@pesu-OptiPlex-3070:~$

```

**At R1:**

**\$ sudo ip addr add 172.16.10.2/24 dev enp1s0**

**\$ ip addr show**

```

student@pesu-OptiPlex-3070: ~
student@pesu-OptiPlex-3070:~$ sudo ip addr add 172.16.10.2/24 dev enp1s0
[sudo] password for student:
student@pesu-OptiPlex-3070:~$ ip addr show
1: lo: <LOOPBACK,UP,LOWER_UP> mtu 65536 qdisc noqueue state UNKNOWN group default qlen 1000
    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: enp1s0: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc pfifo_fast state UP group default qlen 1000
    link/ether 00:4e:01:a3:dd:f1 brd ff:ff:ff:ff:ff:ff
    inet 172.16.10.2/24 scope global enp1s0
        valid_lft forever preferred_lft forever
    inet6 fe80::24e:1ff:fea3:ddf1/64 scope link
        valid_lft forever preferred_lft forever
student@pesu-OptiPlex-3070:~$

```

The machines are physically on the same LAN, thus you may get ICMP 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, the linux enables accepting the ICMP redirect packets. To have precautionary measures issue below the command line in Ha and Hd.

**\$ 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
student@pesu-OptiPlex-3070:~$

```

At Ha

```

student@pesu-OptiPlex-3070: ~
File Edit View Search Terminal Help
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:~$

```

At Hd

Since machines are on the same physical interface, the router is going to send ICMP redirect messages disturbing the routing decision by hosts. Thus, disable sending of the ICMP redirect packets by these routers with aliased interfaces. To have precautionary measures issued below command line in R1 and R2.

**\$ sudo sysctl -w net.ipv4.conf.all.send\_redirects=0**

```
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:~$
```

At R1

```
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:~$
```

At R2

## **Step 2: Convert C and D systems into routers R2 and R1 respectively by issuing below command.**

We need to query the sysctl kernel value net.ipv4.ip\_forward to see if forwarding is enabled or not.

**\$ sysctl net.ipv4.ip\_forward**

Other alternative to check out if IP forwarding is enabled or not through the value in the /proc system:

**\$ cat /proc/sys/net/ipv4/ip\_forward**

```
student@pesu-OptiPlex-3070:~$ sysctl net.ipv4.ip_forward
net.ipv4.ip_forward = 0
student@pesu-OptiPlex-3070:~$ cat /proc/sys/net/ipv4/ip_forward
0
```

The above command response states that forwarding is not enabled. So, we need to set ip\_forward=1 to carry out IP forwarding.

Command to set the value of net.ipv4.ip\_forward is as 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
student@pesu-OptiPlex-3070:~$
```

### Step 3: Verify the Local Network connection using ping command

At Ha:

**\$ ping 172.16.10.1(Local network)**

```
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=0.058 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=0.050 ms
64 bytes from 172.16.10.1: icmp_seq=4 ttl=64 time=0.050 ms
64 bytes from 172.16.10.1: icmp_seq=5 ttl=64 time=0.044 ms
64 bytes from 172.16.10.1: icmp_seq=6 ttl=64 time=0.050 ms
^C
--- 172.16.10.1 ping statistics ---
6 packets transmitted, 6 received, 0% packet loss, time 5117ms
rtt min/avg/max/mdev = 0.044/0.050/0.058/0.007 ms
```

At Hd:

**\$ ping 172.16.11.1(Local network)**

```
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=0.647 ms
64 bytes from 172.16.11.1: icmp_seq=2 ttl=64 time=0.769 ms
64 bytes from 172.16.11.1: icmp_seq=3 ttl=64 time=0.866 ms
64 bytes from 172.16.11.1: icmp_seq=4 ttl=64 time=0.764 ms
64 bytes from 172.16.11.1: icmp_seq=5 ttl=64 time=0.730 ms
64 bytes from 172.16.11.1: icmp_seq=6 ttl=64 time=0.861 ms
64 bytes from 172.16.11.1: icmp_seq=7 ttl=64 time=0.871 ms
64 bytes from 172.16.11.1: icmp_seq=8 ttl=64 time=0.847 ms
^C
--- 172.16.11.1 ping statistics ---
8 packets transmitted, 8 received, 0% packet loss, time 7161ms
rtt min/avg/max/mdev = 0.647/0.794/0.871/0.079 ms
```

### Step 4: Insert Routing Table entries on each system to direct ipv4 packets

At Ha:

**\$ sudo ip route add 172.16.11.0/24 via 172.16.10.2**

**\$ ip route show**

```
student@pesu-OptiPlex-3070:~$ sudo ip route add 172.16.11.0/24 via 172.16.10.2
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 172.16.10.2 dev enp1s0
student@pesu-OptiPlex-3070:~$
```

At R1:

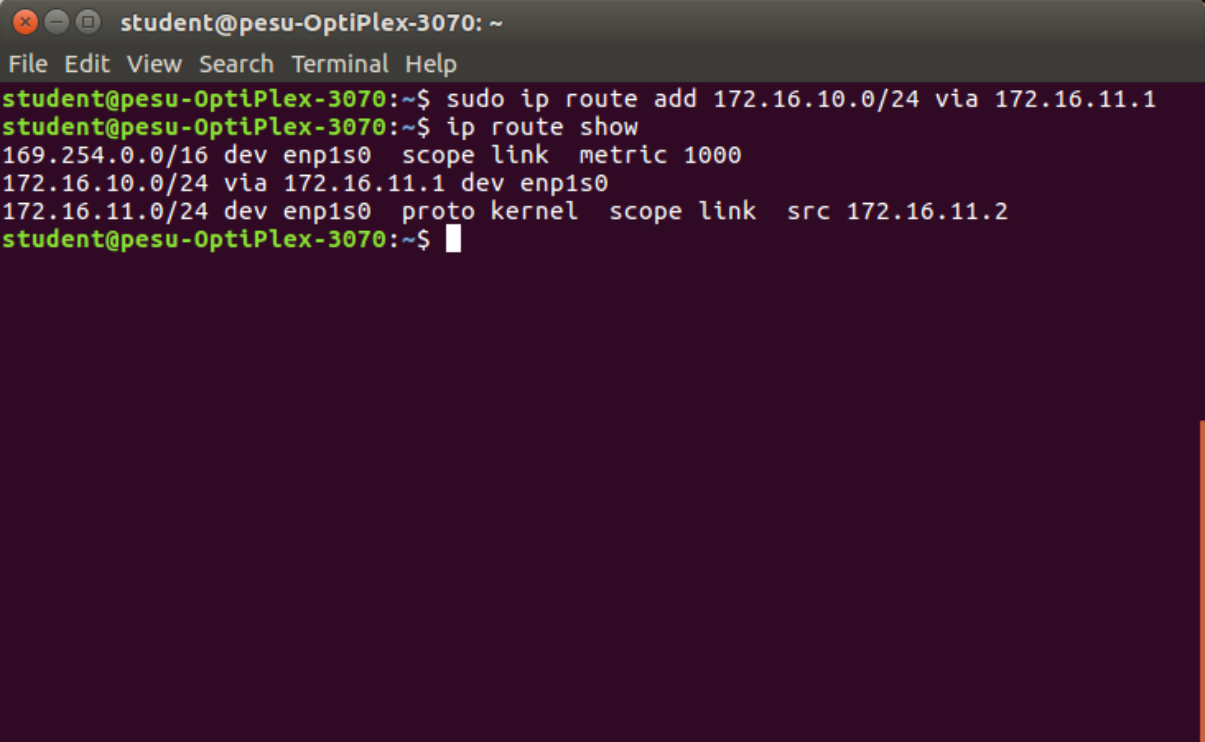
**\$ sudo ip route add 172.16.11.0/24 via 172.16.10.3**

**\$ ip route show**

```
student@pesu-OptiPlex-3070:~$ sudo ip route add 172.16.11.0/24 via 172.16.10.3
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 172.16.10.2
172.16.11.0/24 via 172.16.10.3 dev enp1s0
student@pesu-OptiPlex-3070:~$
```

**At Hd:**

```
$ sudo ip route add 172.16.10.0/24 via 172.16.11.1
$ ip route show
```



```
student@pesu-OptiPlex-3070: ~
File Edit View Search Terminal Help
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 172.16.11.2
student@pesu-OptiPlex-3070:~$
```

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

## **5.1 Testing path from Ha and Hd**

**From Ha:**

```
$ ping 172.16.11.2
```



```

student@pesu-OptiPlex-3070:~$ ping 172.16.11.2
PING 172.16.11.2 (172.16.11.2) 56(84) bytes of data.
64 bytes from 172.16.11.2: icmp_seq=1 ttl=63 time=1.03 ms
64 bytes from 172.16.11.2: icmp_seq=2 ttl=63 time=1.18 ms
64 bytes from 172.16.11.2: icmp_seq=3 ttl=63 time=1.25 ms
64 bytes from 172.16.11.2: icmp_seq=4 ttl=63 time=0.633 ms
64 bytes from 172.16.11.2: icmp_seq=5 ttl=63 time=1.30 ms
64 bytes from 172.16.11.2: icmp_seq=6 ttl=63 time=1.16 ms
64 bytes from 172.16.11.2: icmp_seq=7 ttl=63 time=1.49 ms
64 bytes from 172.16.11.2: icmp_seq=8 ttl=63 time=1.28 ms
64 bytes from 172.16.11.2: icmp_seq=9 ttl=63 time=1.22 ms
64 bytes from 172.16.11.2: icmp_seq=10 ttl=63 time=1.02 ms
64 bytes from 172.16.11.2: icmp_seq=11 ttl=63 time=1.09 ms
64 bytes from 172.16.11.2: icmp_seq=12 ttl=63 time=1.17 ms
64 bytes from 172.16.11.2: icmp_seq=13 ttl=63 time=1.28 ms
64 bytes from 172.16.11.2: icmp_seq=14 ttl=63 time=1.44 ms
64 bytes from 172.16.11.2: icmp_seq=15 ttl=63 time=1.06 ms
64 bytes from 172.16.11.2: icmp_seq=16 ttl=63 time=0.723 ms
64 bytes from 172.16.11.2: icmp_seq=17 ttl=63 time=1.15 ms
64 bytes from 172.16.11.2: icmp_seq=18 ttl=63 time=0.955 ms
64 bytes from 172.16.11.2: icmp_seq=19 ttl=63 time=1.46 ms
64 bytes from 172.16.11.2: icmp_seq=20 ttl=63 time=1.14 ms
64 bytes from 172.16.11.2: icmp_seq=21 ttl=63 time=1.09 ms
64 bytes from 172.16.11.2: icmp_seq=22 ttl=63 time=0.802 ms
64 bytes from 172.16.11.2: icmp_seq=23 ttl=63 time=1.21 ms
64 bytes from 172.16.11.2: icmp_seq=24 ttl=63 time=0.695 ms
64 bytes from 172.16.11.2: icmp_seq=25 ttl=63 time=0.928 ms
64 bytes from 172.16.11.2: icmp_seq=26 ttl=63 time=0.746 ms

```

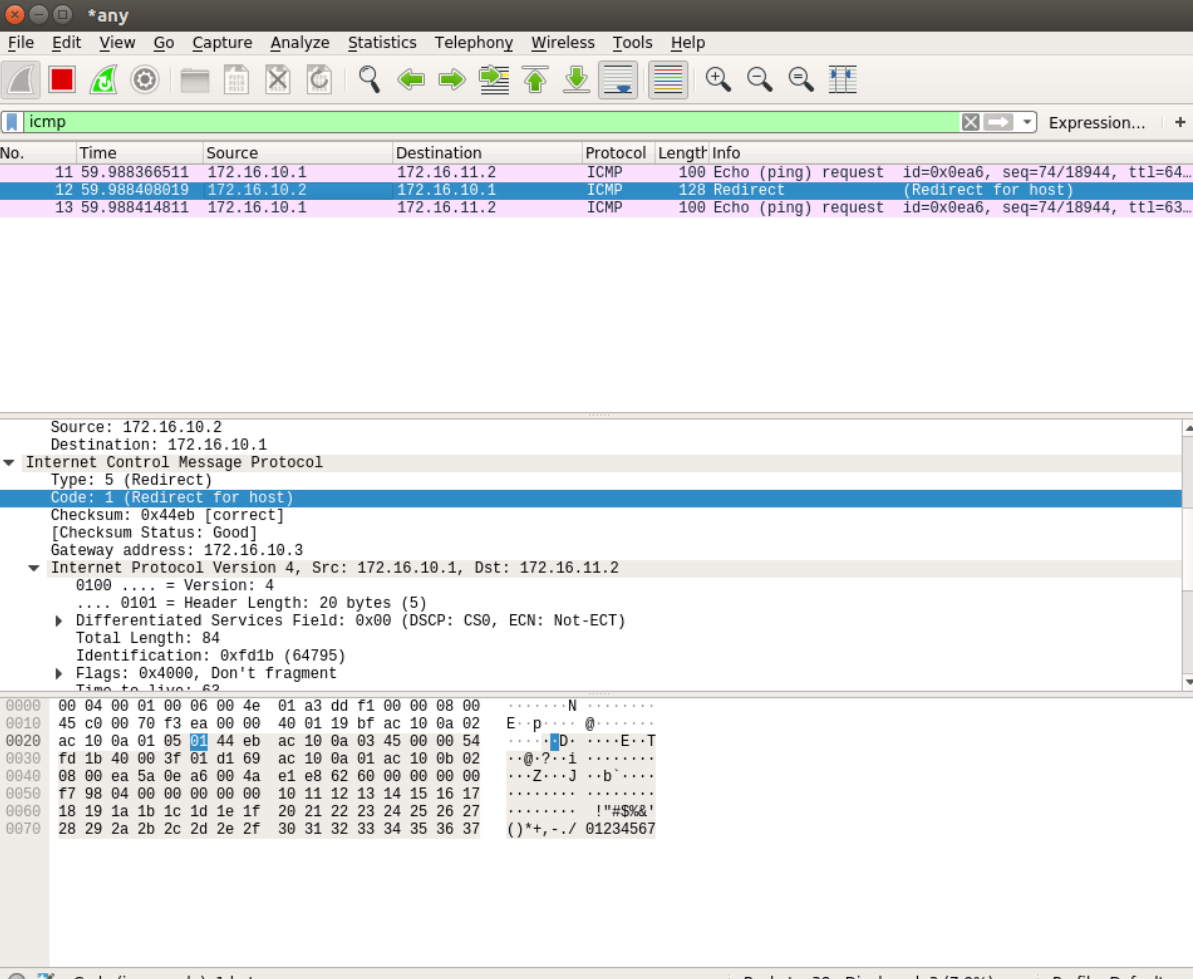
## 5.2 Capture packets in all systems using Wireshark

Ha:

The screenshot shows the Wireshark network protocol analyzer interface. The packet list pane displays 36 captured packets, all of which are ICMP Echo (ping) requests and replies between the source IP 172.16.10.1 and the destination IP 172.16.11.2. The packet details pane for the selected packet (No. 2) shows the following information:

- Frame 2:** 98 bytes on wire (784 bits), 98 bytes captured (784 bits) on interface 0
- Ethernet II:** Src: Dell\_9a:ae:6e (00:4e:01:9a:ae:6e), Dst: Dell\_a0:b6:31 (00:4e:01:a0:b6:31)
- Internet Protocol Version 4:** Src: 172.16.11.2, Dst: 172.16.10.1
- Internet Control Message Protocol:**
  - Type: 0 (Echo (ping) reply)
  - Code: 0
  - Checksum: 0x1676 [correct]
  - [Checksum Status: Good]
  - Identifier (BE): 3731 (0x0e93)
  - Identifier (LE): 37646 (0x930e)
  - Sequence number (BE): 1 (0x0001)
  - Sequence number (LE): 256 (0x0100)
  - [Request frame: 1]
  - [Response time: 0.945 ms]
  - Timestamp from icmp data: Mar 30, 2021 14:27:40.000000000 IST
  - [Timestamp from icmp data (relative): 0.646771969 seconds]
- Data (48 bytes)**

## R1:



The image shows a Wireshark packet capture of an ICMP Redirect for host. The packet list shows three packets: a ping request, a redirect, and another ping request. The packet details pane shows the structure of the ICMP Redirect for host, including the checksum, gateway address, and various fields. The packet bytes pane shows the raw data of the packet.

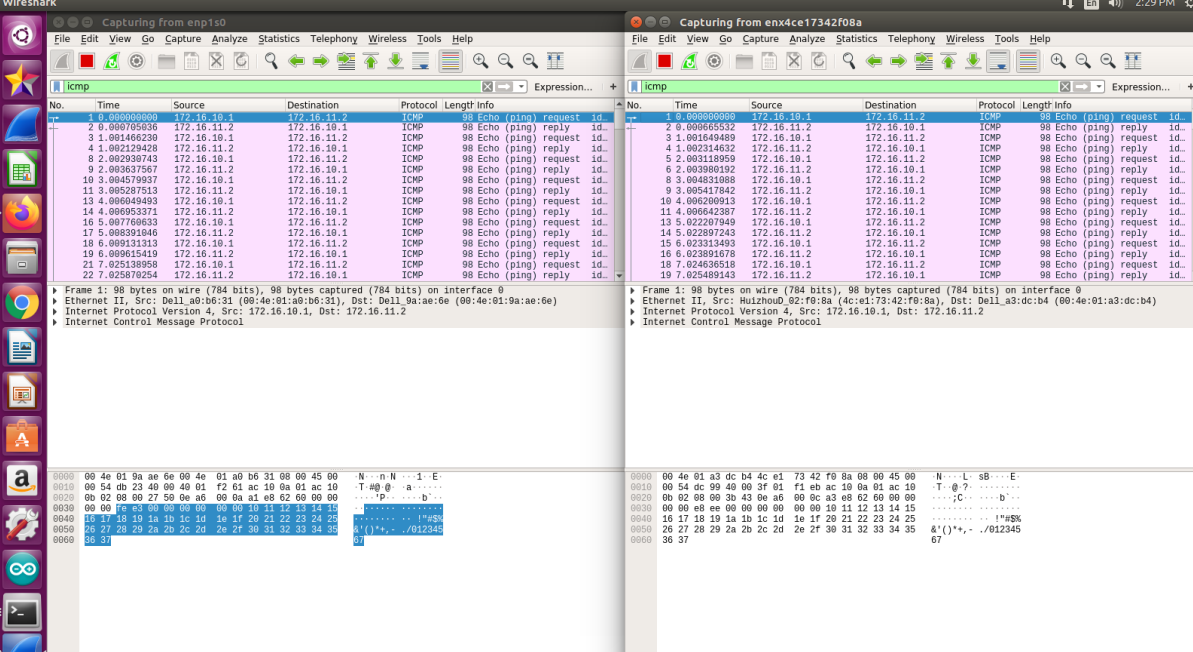
No.	Time	Source	Destination	Protocol	Length	Info
11	59.988366511	172.16.10.1	172.16.11.2	ICMP	100	Echo (ping) request id=0x0ea6, seq=74/18944, ttl=64..
12	59.988408019	172.16.10.2	172.16.10.1	ICMP	128	Redirect (Redirect for host)
13	59.988414811	172.16.10.1	172.16.11.2	ICMP	100	Echo (ping) request id=0x0ea6, seq=74/18944, ttl=63..

Source: 172.16.10.2  
Destination: 172.16.10.1  
▼ Internet Control Message Protocol  
Type: 5 (Redirect)  
Code: 1 (Redirect for host)  
Checksum: 0x44eb [correct]  
[Checksum Status: Good]  
Gateway address: 172.16.10.3  
▼ Internet Protocol Version 4, Src: 172.16.10.1, Dst: 172.16.11.2  
0100 .... = Version: 4  
.... 0101 = Header Length: 20 bytes (5)  
► Differentiated Services Field: 0x00 (DSCP: CS0, ECN: Not-ECT)  
Total Length: 84  
Identification: 0xfdb (64795)  
Flags: 0x4000, Don't fragment  
Time to live: 62

0000 00 04 00 01 00 06 00 4e 01 a3 d8 f1 00 00 08 00 .....N.....  
0010 45 c0 00 70 f3 ea 00 00 40 01 19 bf ac 10 0a 02 E..p...@.....  
0020 ac 10 0a 01 05 01 44 eb ac 10 0a 03 45 00 00 54 .....D...E..T  
0030 fd 1b 40 00 3f 01 d1 69 ac 10 0a 01 ac 10 0b 02 ...@.?..1.....  
0040 08 00 ea 5a 0e a6 00 4a e1 e8 62 60 00 00 00 00 ...Z...J...b`....  
0050 f7 98 04 00 00 00 00 00 10 11 12 13 14 15 16 17 .....!#\$%&'...  
0060 18 19 1a 1b 1c 1d 1e 1f 20 21 22 23 24 25 26 27 .....()\*+,-./01234567  
0070 28 29 2a 2b 2c 2d 2e 2f 30 31 32 33 34 35 36 37

Code (icmp.code), 1 byte      Packets: 38 · Displayed: 3 (7.9%)      Profile: Default

## R2:



The image shows two Wireshark packet captures. The left capture shows a series of ICMP Echo (ping) requests and replies. The right capture shows a single ICMP Echo (ping) request. Both captures show the packet list, packet details, and packet bytes panes.

No.	Time	Source	Destination	Protocol	Length	Info
1	0.000000000	172.16.10.1	172.16.11.2	ICMP	98	Echo (ping) request id..
2	0.000765036	172.16.11.2	172.16.10.1	ICMP	98	Echo (ping) reply id..
3	1.001460230	172.16.10.1	172.16.11.2	ICMP	98	Echo (ping) request id..
4	1.002129428	172.16.11.2	172.16.10.1	ICMP	98	Echo (ping) reply id..
8	2.002930743	172.16.10.1	172.16.11.2	ICMP	98	Echo (ping) request id..
9	2.003937567	172.16.11.2	172.16.10.1	ICMP	98	Echo (ping) reply id..
10	3.004579937	172.16.10.1	172.16.11.2	ICMP	98	Echo (ping) request id..
11	3.005287513	172.16.11.2	172.16.10.1	ICMP	98	Echo (ping) reply id..
13	4.006049403	172.16.10.1	172.16.11.2	ICMP	98	Echo (ping) request id..
14	4.006953371	172.16.11.2	172.16.10.1	ICMP	98	Echo (ping) reply id..
16	5.007760633	172.16.10.1	172.16.11.2	ICMP	98	Echo (ping) request id..
17	5.008391046	172.16.11.2	172.16.10.1	ICMP	98	Echo (ping) reply id..
18	6.009131313	172.16.10.1	172.16.11.2	ICMP	98	Echo (ping) request id..
19	6.009615419	172.16.11.2	172.16.10.1	ICMP	98	Echo (ping) reply id..
21	7.025130058	172.16.10.1	172.16.11.2	ICMP	98	Echo (ping) request id..
22	7.025870254	172.16.11.2	172.16.10.1	ICMP	98	Echo (ping) reply id..

Frame 1: 98 bytes on wire (784 bits), 98 bytes captured (784 bits) on interface 0  
Ethernet II, Src: Dell a0:b6:31 (00:a0:b6:31), Dst: Dell 9a:ae:6e (00:0a:01:9a:ae:6e)  
Internet Protocol Version 4, Src: 172.16.10.1, Dst: 172.16.11.2  
Internet Control Message Protocol

0000 00 4e 01 9a ae 00 4e 01 a0 b6 31 00 00 45 00 .....N...N...-1-E..  
0010 00 54 db 23 40 00 40 01 f2 61 ac 10 0a 01 ac 10 .....T.#@...a.....  
0020 00 02 08 00 27 50 0e a6 00 0a a1 e8 62 60 00 00 .....P.....b`....  
0030 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 .....  
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 &'()\*+,-./01234567  
0060 36 37

enp150: <live capture in progress>      Packets: 258 · Displayed: 232 (89.9%)      Profile: Default

No.	Time	Source	Destination	Protocol	Length	Info
1	0.000000000	172.16.10.1	172.16.11.2	ICMP	98	Echo (ping) request id..
2	0.000665532	172.16.11.2	172.16.10.1	ICMP	98	Echo (ping) reply id..
3	1.001640400	172.16.10.1	172.16.11.2	ICMP	98	Echo (ping) request id..
4	1.002314632	172.16.11.2	172.16.10.1	ICMP	98	Echo (ping) reply id..
5	2.003118959	172.16.10.1	172.16.11.2	ICMP	98	Echo (ping) request id..
6	2.003989192	172.16.11.2	172.16.10.1	ICMP	98	Echo (ping) reply id..
8	3.004831088	172.16.10.1	172.16.11.2	ICMP	98	Echo (ping) request id..
9	3.005417842	172.16.11.2	172.16.10.1	ICMP	98	Echo (ping) reply id..
10	4.006200913	172.16.10.1	172.16.11.2	ICMP	98	Echo (ping) request id..
11	4.006642387	172.16.11.2	172.16.10.1	ICMP	98	Echo (ping) reply id..
13	5.022207949	172.16.10.1	172.16.11.2	ICMP	98	Echo (ping) request id..
14	5.022897243	172.16.11.2	172.16.10.1	ICMP	98	Echo (ping) reply id..
15	6.023313493	172.16.10.1	172.16.11.2	ICMP	98	Echo (ping) request id..
16	6.023891678	172.16.11.2	172.16.10.1	ICMP	98	Echo (ping) reply id..
18	7.024630518	172.16.10.1	172.16.11.2	ICMP	98	Echo (ping) request id..
19	7.025489143	172.16.11.2	172.16.10.1	ICMP	98	Echo (ping) reply id..

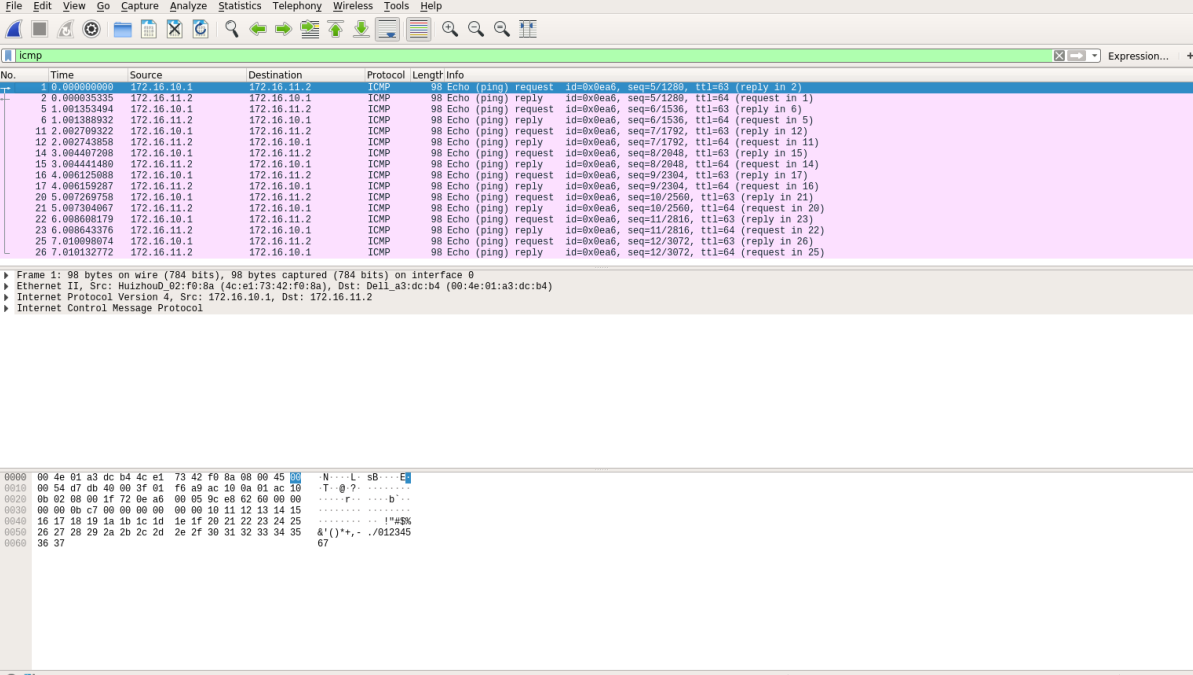
Frame 1: 98 bytes on wire (784 bits), 98 bytes captured (784 bits) on interface 0  
Ethernet II, Src: Huizhou0 92:f0:8a (4c:e1:73:42:f0:8a), Dst: Dell a3:dc:b4 (00:0a:01:a3:dc:b4)  
Internet Protocol Version 4, Src: 172.16.10.1, Dst: 172.16.11.2  
Internet Control Message Protocol

0000 00 4e 01 a3 dc b4 4c e1 73 42 f0 8a 00 00 45 00 .....L:sB...E..  
0010 00 54 dc 99 40 00 3f 01 f1 eb ac 10 0a 01 ac 10 .....T.@?.....  
0020 00 02 08 00 30 43 0e a6 00 0c a3 e8 62 60 00 00 .....C.....b`....  
0030 00 00 00 00 00 00 00 00 00 00 18 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 &'()\*+,-./01234567  
0060 36 37

enx4ce17342f08a: <live capture in progress>      Packets: 239 · Displayed: 228 (95.4%)      Profile: Default



Hd:



The image shows a Wireshark packet capture of ICMP Echo (ping) traffic. The packet list table is as follows:

No.	Time	Source	Destination	Protocol	Length	Info
1	0.000000000	172.16.10.1	172.16.11.2	ICMP	98	Echo (ping) request id=8x0ea6, seq=5/1280, ttl=63 (reply in 2)
2	0.000000335	172.16.11.2	172.16.10.1	ICMP	98	Echo (ping) reply id=8x0ea6, seq=5/1280, ttl=63 (request in 1)
5	1.001353404	172.16.10.1	172.16.11.2	ICMP	98	Echo (ping) request id=8x0ea6, seq=6/1536, ttl=63 (reply in 6)
6	1.001388932	172.16.11.2	172.16.10.1	ICMP	98	Echo (ping) reply id=8x0ea6, seq=6/1536, ttl=63 (request in 5)
11	2.002709322	172.16.10.1	172.16.11.2	ICMP	98	Echo (ping) request id=8x0ea6, seq=7/1792, ttl=63 (reply in 12)
12	2.002743858	172.16.11.2	172.16.10.1	ICMP	98	Echo (ping) reply id=8x0ea6, seq=7/1792, ttl=63 (request in 11)
14	3.004407208	172.16.10.1	172.16.11.2	ICMP	98	Echo (ping) request id=8x0ea6, seq=8/2048, ttl=63 (reply in 15)
15	3.004441480	172.16.11.2	172.16.10.1	ICMP	98	Echo (ping) reply id=8x0ea6, seq=8/2048, ttl=63 (request in 14)
16	4.006125088	172.16.10.1	172.16.11.2	ICMP	98	Echo (ping) request id=8x0ea6, seq=9/2304, ttl=63 (reply in 17)
17	4.006159287	172.16.11.2	172.16.10.1	ICMP	98	Echo (ping) reply id=8x0ea6, seq=9/2304, ttl=63 (request in 16)
20	5.007269758	172.16.10.1	172.16.11.2	ICMP	98	Echo (ping) request id=8x0ea6, seq=10/2560, ttl=63 (reply in 21)
21	5.007304067	172.16.11.2	172.16.10.1	ICMP	98	Echo (ping) reply id=8x0ea6, seq=10/2560, ttl=63 (request in 20)
22	6.008608179	172.16.10.1	172.16.11.2	ICMP	98	Echo (ping) request id=8x0ea6, seq=11/2816, ttl=63 (reply in 23)
23	6.008643376	172.16.11.2	172.16.10.1	ICMP	98	Echo (ping) reply id=8x0ea6, seq=11/2816, ttl=63 (request in 22)
25	7.010908074	172.16.10.1	172.16.11.2	ICMP	98	Echo (ping) request id=8x0ea6, seq=12/3072, ttl=63 (reply in 26)
26	7.010932772	172.16.11.2	172.16.10.1	ICMP	98	Echo (ping) reply id=8x0ea6, seq=12/3072, ttl=63 (request in 25)

Frame 1: 98 bytes on wire (784 bits), 98 bytes captured (784 bits) on interface 0  
Ethernet II, Src: HuiShou02:f0:8a (4c:e1:73:42:f0:8a), Dst: Dell\_a3:dc:b4 (00:4e:01:a3:dc:b4)  
Internet Protocol Version 4, Src: 172.16.10.1, Dst: 172.16.11.2  
Internet Control Message Protocol

0000 00 4e 01 a3 dc b4 4c e1 73 42 f0 8a 00 00 45 00 N....L..s0....E  
0010 00 54 d7 db 40 00 3f 01 f6 a9 ac 10 0a 01 ac 10 T..0?.....  
0020 00 62 08 00 1f 72 0e a0 00 05 9c e8 62 00 00 00 .....b....  
0030 00 00 0b c7 00 00 00 00 00 00 11 12 13 14 15 .....!%\$%  
0040 16 17 18 19 1a 1b 1c 1d 1e 1f 20 21 22 23 24 25 .....&'()\*+,-./012345  
0050 26 27 28 29 2a 2b 2c 2d 2e 2f 30 31 32 33 34 35  
0060 36 37 67

Step 6: Check each system neighbors to verify the connection

Ha: \$ ip neigh show

```
student@pesu-OptiPlex-3070:~$ ip neigh show
172.16.10.2 dev enp1s0 lladdr 00:4e:01:a3:dd:f1 STALE
172.16.10.3 dev enp1s0 lladdr 00:4e:01:9a:ae:6e STALE
student@pesu-OptiPlex-3070:~$
```

R1: \$ ip neigh show

```
student@pesu-OptiPlex-3070: ~
student@pesu-OptiPlex-3070:~$ ip neigh show
172.16.10.3 dev enp1s0 lladdr 00:4e:01:9a:ae:6e STALE
172.16.10.1 dev enp1s0 lladdr 00:4e:01:a0:b6:31 STALE
student@pesu-OptiPlex-3070:~$
```

## R2: \$ ip neigh show

```
student@pesu-OptiPlex-3070: ~  
student@pesu-OptiPlex-3070:~$ ip neigh show  
172.16.10.2 dev enp1s0 lladdr 00:4e:01:a3:dd:f1 STALE  
172.16.10.1 dev enp1s0 lladdr 00:4e:01:a0:b6:31 STALE  
172.16.11.2 dev enx4ce17342f08a lladdr 00:4e:01:a3:dc:b4 STALE  
student@pesu-OptiPlex-3070:~$
```

## Hd: \$ ip neigh show

```
student@pesu-OptiPlex-3070: ~  
File Edit View Search Terminal Help  
student@pesu-OptiPlex-3070:~$ ip neigh show  
172.16.11.1 dev enp1s0 lladdr 4c:e1:73:42:f0:8a STALE  
student@pesu-OptiPlex-3070:~$
```

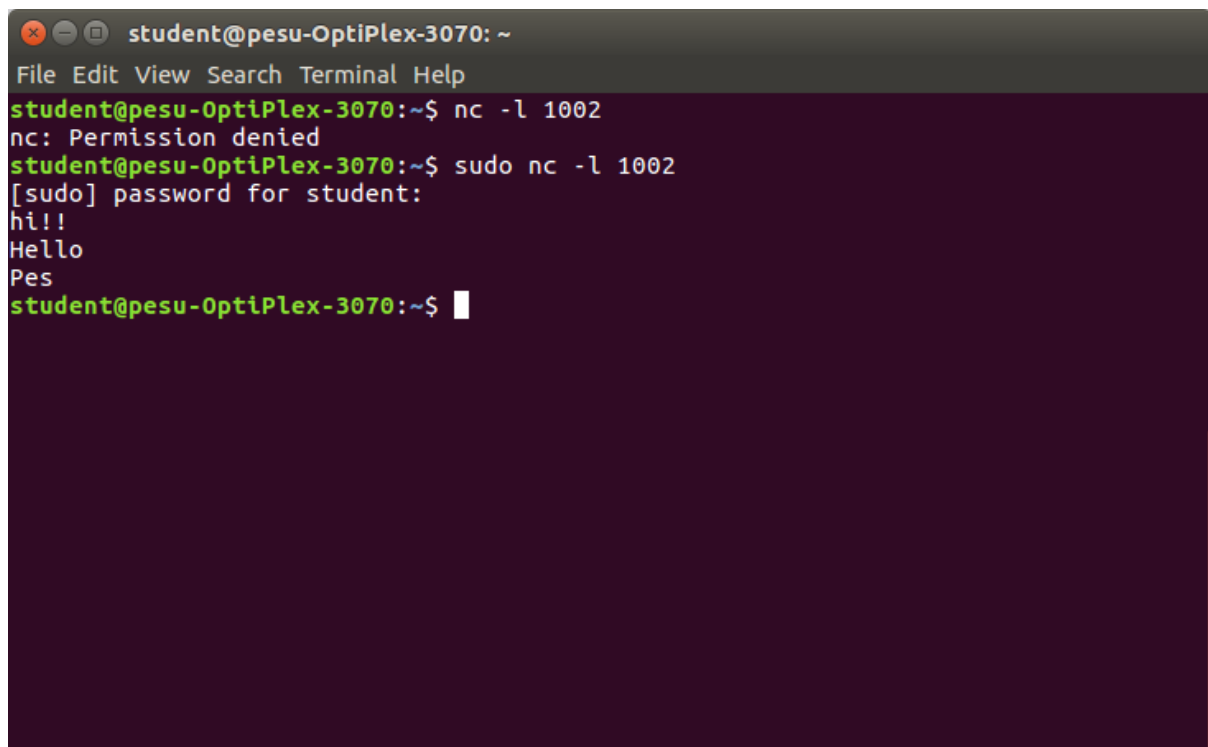
## PORT Unreachable

We are trying to send data from System Ha and Hb using nc command. nc (or netcat) utility is used for just about anything under the sun involving TCP or UDP. It can open TCP connections, send UDP packets, listen on arbitrary TCP and UDP ports, do port scanning, and deal with both IPv4 and IPv6.

**At Hb (172.16.11.2):**

**\$ nc -l 1002**

Here the Hd system acts as a server which is in listening mode through port 1002.

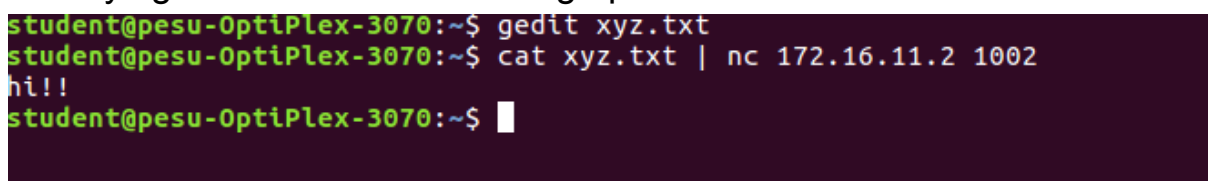
A terminal window titled 'student@pesu-OptiPlex-3070: ~' with a menu bar (File, Edit, View, Search, Terminal, Help). The terminal shows the following commands and output:

```
student@pesu-OptiPlex-3070:~$ nc -l 1002
nc: Permission denied
student@pesu-OptiPlex-3070:~$ sudo nc -l 1002
[sudo] password for student:
hi!!
Hello
Pes
student@pesu-OptiPlex-3070:~$
```

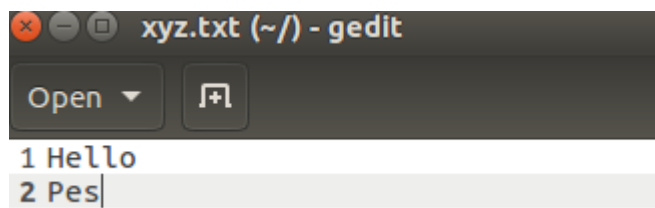
**At Ha (172.16.10.2):**

**\$ cat xyz.txt | nc 172.16.11.2 1002**

Here Ha system acts as a client which is sending a file xyz.txt by identifying host 172.16.11.2 through port 1002.

A terminal window titled 'student@pesu-OptiPlex-3070: ~' with a menu bar (File, Edit, View, Search, Terminal, Help). The terminal shows the following commands and output:

```
student@pesu-OptiPlex-3070:~$ gedit xyz.txt
student@pesu-OptiPlex-3070:~$ cat xyz.txt | nc 172.16.11.2 1002
hi!!
student@pesu-OptiPlex-3070:~$
```



Note: If we give the wrong port number which is not matching on both systems. Connection will fail and we get PORT UNREACHABLE error.