

CSE 232: Programming Assignment 1
Using command-line utilities for network debugging

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Github link : https://github.com/Muthuraj-Vairamuthu/CSE232_muthuraj

Q1)

a).

```
Last login: Mon Aug 19 14:11:46 on console
[muthuraj@mUTHURAJs-MacBook-Air ~ % ifconfig
lo0: flags=8049<UP,LOOPBACK,RUNNING,MULTICAST> mtu 16384
    options=1203<RXCSUM,TXCSUM,TXSTATUS,SW_TIMESTAMP>
    inet 127.0.0.1 netmask 0xff000000
        inet6 ::1 prefixlen 128
        inet6 fe80::1%lo0 prefixlen 64 scopeid 0x1
            nd6 options=201<PERFORMNUD,DAD>
gif0: flags=8010<POINTOPOINT,MULTICAST> mtu 1280
stf0: flags=0<> mtu 1280
anpi0: flags=8863<UP,BROADCAST,SMART,RUNNING,SIMPLEX,MULTICAST> mtu 1500
    options=400<CHANNEL_IO>
    ether 46:b7:5f:70:bc:aa
    media: none
    status: inactive
anpi1: flags=8863<UP,BROADCAST,SMART,RUNNING,SIMPLEX,MULTICAST> mtu 1500
    options=400<CHANNEL_IO>
    ether 46:b7:5f:70:bc:ab
    media: none
    status: inactive
en3: flags=8863<UP,BROADCAST,SMART,RUNNING,SIMPLEX,MULTICAST> mtu 1500
    options=400<CHANNEL_IO>
    ether 46:b7:5f:70:bc:8a
    nd6 options=201<PERFORMNUD,DAD>
    media: none
    status: inactive
en4: flags=8863<UP,BROADCAST,SMART,RUNNING,SIMPLEX,MULTICAST> mtu 1500
    options=400<CHANNEL_IO>
    ether 46:b7:5f:70:bc:8b
    nd6 options=201<PERFORMNUD,DAD>
    media: none
    status: inactive
en1: flags=8963<UP,BROADCAST,SMART,RUNNING,PROMISC,SIMPLEX,MULTICAST> mtu 1500
    options=460<TS04,TS06,CHANNEL_IO>
    ether 36:d3:81:a4:f6:00
    media: autoselect <full-duplex>
    status: inactive
en2: flags=8963<UP,BROADCAST,SMART,RUNNING,PROMISC,SIMPLEX,MULTICAST> mtu 1500
    options=460<TS04,TS06,CHANNEL_IO>
    ether 36:d3:81:a4:f6:04
    media: autoselect <full-duplex>
    status: inactive
ap1: flags=8802<BROADCAST,SIMPLEX,MULTICAST> mtu 1500
    options=400<CHANNEL_IO>
    ether 3e:a6:f6:56:30:82
    media: autoselect
en0: flags=8863<UP,BROADCAST,SMART,RUNNING,SIMPLEX,MULTICAST> mtu 1500
    options=400<CHANNEL_IO>
    ether 3c:a6:f6:56:30:82
    inet6 fe80::1012:b20:4168:1aa2%en0 prefixlen 64 secured scopeid 0xb
        inet 192.168.42.25 netmask 0xfffffe00 broadcast 192.168.63.255
            nd6 options=201<PERFORMNUD,DAD>
            media: autoselect
            status: active
awdl0: flags=8843<UP,BROADCAST,RUNNING,SIMPLEX,MULTICAST> mtu 1500
```

In accordance with this image above, my IP address as per my terminal is under en0: inet6
IP Address: 192.168.42.25
b).

What Is My IP?

My Public IPv4: [103.25.231.126](https://www.whatismyip.com/103.25.231.126)

My Public IPv6: Not Detected

My IP Location: Noida, UP IN

My ISP: Indraprastha Institute of Information Technology
Delhi

What is an IP address?

IP address According to this website:
103.25.231.126

Result: The IP Addresses are different.

The IP Address shown locally on my machine is the internal IP address, which is the IP address assigned locally by the LAN, it allows me to connect with computers within the local area network.

Whereas, the IP address displayed on websites like What is my IP? are external IP addresses, This is the IP address assigned by our Internet Service Provider to connect with external systems/computers. Network Address Translation method is used by our router to map the internal IP with the external IP and facilitate smooth connection between us and the external servers. Hence, what is my IP? The website utilises the external IP address assigned by our ISP to our routers.

Q2.)

a).

Lets change our current IP Address 192.168.42.25 to 192.168.42.28 and revert it back:

```
[muthuraj@mUTHURAJs-MacBook-Air ~ % sudo ifconfig en0 inet 192.168.42.28 netmask 255.255.224.0
[Password:
```

Now let's verify:

```
muthuraj@MUTHURAJs-MacBook-Air ~ % ifconfig
lo0: flags=8049<UP,LOOPBACK,RUNNING,MULTICAST> mtu 16384
    options=1203<RXCSUM,TXCSUM,TXSTATUS,SW_TIMESTAMP>
    inet 127.0.0.1 netmask 0xffff000000
        inet6 ::1 prefixlen 128
        inet6 fe80::1%lo0 prefixlen 64 scopeid 0x1
            nd6 options=201<PERFORMNUD,DAD>
gif0: flags=8010<POINTOPOINT,MULTICAST> mtu 1280
stf0: flags=0<> mtu 1280
anpi0: flags=8863<UP,BROADCAST,SMART,RUNNING,SIMPLEX,MULTICAST> mtu 1500
    options=400<CHANNEL_IO>
    ether 46:b7:5f:70:bc:aa
    media: none
    status: inactive
anpi1: flags=8863<UP,BROADCAST,SMART,RUNNING,SIMPLEX,MULTICAST> mtu 1500
    options=400<CHANNEL_IO>
    ether 46:b7:5f:70:bc:ab
    media: none
    status: inactive
en3: flags=8863<UP,BROADCAST,SMART,RUNNING,SIMPLEX,MULTICAST> mtu 1500
    options=400<CHANNEL_IO>
    ether 46:b7:5f:70:bc:8a
    nd6 options=201<PERFORMNUD,DAD>
    media: none
    status: inactive
en4: flags=8863<UP,BROADCAST,SMART,RUNNING,SIMPLEX,MULTICAST> mtu 1500
    options=400<CHANNEL_IO>
    ether 46:b7:5f:70:bc:8b
    nd6 options=201<PERFORMNUD,DAD>
    media: none
    status: inactive
en1: flags=8963<UP,BROADCAST,SMART,RUNNING,PROMISC,SIMPLEX,MULTICAST> mtu 1500
    options=460<TS04,TS06,CHANNEL_IO>
    ether 36:d3:81:a4:f6:00
    media: autoselect <full-duplex>
    status: inactive
en2: flags=8963<UP,BROADCAST,SMART,RUNNING,PROMISC,SIMPLEX,MULTICAST> mtu 1500
    options=460<TS04,TS06,CHANNEL_IO>
    ether 36:d3:81:a4:f6:04
    media: autoselect <full-duplex>
    status: inactive
ap1: flags=8843<UP,BROADCAST,RUNNING,SIMPLEX,MULTICAST> mtu 1500
    options=6460<TS04,TS06,CHANNEL_IO,PARTIAL_CSUM,ZEROINVERT_CSUM>
    ether 3e:a6:f6:56:30:82
    inet6 fe80::3ca6:f6ff:fe56:3082%ap1 prefixlen 64 scopeid 0xa
        nd6 options=201<PERFORMNUD,DAD>
        media: autoselect (<unknown type>)
        status: inactive
en0: flags=8863<UP,BROADCAST,SMART,RUNNING,SIMPLEX,MULTICAST> mtu 1500
    options=6460<TS04,TS06,CHANNEL_IO,PARTIAL_CSUM,ZEROINVERT_CSUM>
    ether 3c:a6:f6:56:30:82
    inet6 fe80::426:65fe:51d0:c2b8%en0 prefixlen 64 secured scopeid 0xb
        inet 192.168.42.28 netmask 0xfffffe000 broadcast 192.168.63.255
        nd6 options=201<PERFORMNUD,DAD>
        media: autoselect
        status: active
awdl0: flags=8843<UP,BROADCAST,RUNNING,SIMPLEX,MULTICAST> mtu 1500
    options=6460<TS04,TS06,CHANNEL_IO,PARTIAL_CSUM,ZEROINVERT_CSUM>
    ether d6:fd:40:2f:9f:80
    inet6 fe80::d4fd:40ff:fe2f:9f80%awdl0 prefixlen 64 scopeid 0xc
        nd6 options=201<PERFORMNUD,DAD>
        media: autoselect
        status: active
llw0: flags=8863<UP,BROADCAST,SMART,RUNNING,SIMPLEX,MULTICAST> mtu 1500
    options=400<CHANNEL_IO>
    ether d6:fd:40:2f:9f:80
```

Under eno0: we can see in inet our IP Address has been changed to 192.168.42.28
Now lets revert it back to the old IP Address

```
muthuraj@MUTHURAJs-MacBook-Air ~ % sudo ifconfig en0 inet 192.168.42.25 netmask 255.255.224.0
[muthuraj@MUTHURAJs-MacBook-Air ~ % ifconfig
lo0: flags=8049<UP,LOOPBACK,RUNNING,MULTICAST> mtu 16384
    options=1203<RXCSUM,TXCSUM,TXSTATUS,SW_TIMESTAMP>
    inet 127.0.0.1 netmask 0xff000000
        inet6 ::1 prefixlen 128
            inet6 fe80::1%lo0 prefixlen 64 scopeid 0x1
                nd6 options=201<PERFORMNUD,DAD>
gif0: flags=8010<POINTOPOINT,MULTICAST> mtu 1280
stf0: flags=0<> mtu 1280
anpi0: flags=8863<UP,BROADCAST,SMART,RUNNING,SIMPLEX,MULTICAST> mtu 1500
    options=400<CHANNEL_IO>
    ether 46:b7:5f:70:bc:aa
    media: none
    status: inactive
anpi1: flags=8863<UP,BROADCAST,SMART,RUNNING,SIMPLEX,MULTICAST> mtu 1500
    options=400<CHANNEL_IO>
    ether 46:b7:5f:70:bc:ab
    media: none
    status: inactive
en3: flags=8863<UP,BROADCAST,SMART,RUNNING,SIMPLEX,MULTICAST> mtu 1500
    options=400<CHANNEL_IO>
    ether 46:b7:5f:70:bc:8a
    nd6 options=201<PERFORMNUD,DAD>
    media: none
    status: inactive
en4: flags=8863<UP,BROADCAST,SMART,RUNNING,SIMPLEX,MULTICAST> mtu 1500
    options=400<CHANNEL_IO>
    ether 46:b7:5f:70:bc:8b
    nd6 options=201<PERFORMNUD,DAD>
    media: none
    status: inactive
en1: flags=8963<UP,BROADCAST,SMART,RUNNING,PROMISC,SIMPLEX,MULTICAST> mtu 1500
    options=460<TS04,TS06,CHANNEL_IO>
    ether 36:d3:81:a4:f6:00
    media: autoselect <full-duplex>
    status: inactive
en2: flags=8963<UP,BROADCAST,SMART,RUNNING,PROMISC,SIMPLEX,MULTICAST> mtu 1500
    options=460<TS04,TS06,CHANNEL_IO>
    ether 36:d3:81:a4:f6:04
    media: autoselect <full-duplex>
    status: inactive
ap1: flags=8843<UP,BROADCAST,RUNNING,SIMPLEX,MULTICAST> mtu 1500
    options=6460<TS04,TS06,CHANNEL_IO,PARTIAL_CSUM,ZEROINVERT_CSUM>
    ether 3e:a6:f6:56:30:82
    inet6 fe80::3ca6:f6ff:fe56:3082%ap1 prefixlen 64 scopeid 0xa
        nd6 options=201<PERFORMNUD,DAD>
        media: autoselect (<unknown type>)
        status: inactive
en0: flags=8863<UP,BROADCAST,SMART,RUNNING,SIMPLEX,MULTICAST> mtu 1500
    options=6460<TS04,TS06,CHANNEL_IO,PARTIAL_CSUM,ZEROINVERT_CSUM>
    ether 3c:a6:f6:56:30:82
    inet6 fe80::426:65fe:51d0:c2b8%en0 prefixlen 64 secured scopeid 0xb
        inet 192.168.42.25 netmask 0xffffffff broadcast 192.168.63.255
        nd6 options=201<PERFORMNUD,DAD>
        media: autoselect
        status: active
```

Here we can see we have reverted back to the Old IP address 192.168.42.25
Under en0 in inet section.

Q3.)

a.)

```
[muthuraj@MUTHURAJs-MacBook-Air ~ % nc -l 5050
hello
```

```
Last login: Fri Aug 30 19:04:51 on ttys000
[muthuraj@MUTHURAJs-MacBook-Air ~ % nc localhost 5050
hello
```

b.)

```
Last login: Fri Aug 30 19:59:19 on ttys001
[muthuraj@MUTHURAJs-MacBook-Air ~ % netstat -an | grep 5050
tcp4      0      0  127.0.0.1.5050          127.0.0.1.51344      ESTABLISHED
tcp4      0      0  127.0.0.1.51344        127.0.0.1.5050      ESTABLISHED
tcp4      0      0  *.5050                  *.*                  LISTEN
muthuraj@MUTHURAJs-MacBook-Air ~ %
```

Here, from the image, we can deduce that the client node has established a connection to the server on port 5050, and it is listening for incoming connections on port 5050.

Q4.)

a.)

```
nslookup -type=soa google.in
muthuraj@MUTHURAJs-MacBook-Air ~ % nslookup -type=soa google.in
Server:      192.168.1.7
Address:     192.168.1.7#53

Non-authoritative answer:
google.in
    origin = ns1.google.com
    mail addr = dns-admin.google.com
    serial = 668858537
    refresh = 900
    retry = 900
    expire = 1800
    minimum = 60

Authoritative answers can be found from:
ns1.google.com  internet address = 216.239.32.10
ns1.google.com  has AAAA address 2001:4860:4802:32::a
```

I have used the Linux man page to go through various commands for nslookup and have found soa- the description says that it provides technical information about the domain, including the authority.

Here is the reference link : <https://www.computerhope.com/unix/nslookup.htm>

Here, we can see the authoritative results for the website, including its internet address and AAAA address.

b).

```
muthuraj@MUTHURAJs-MacBook-Air ~ % nslookup -debug google.in
Server:      192.168.1.7
Address:     192.168.1.7#53

-----
QUESTIONS:
    google.in, type = A, class = IN
ANSWERS:
->  google.in
    internet address = 142.250.193.4
    ttl = 26
AUTHORITY RECORDS:
ADDITIONAL RECORDS:
-----
Non-authoritative answer:
Name:   google.in
Address: 142.250.193.4
```

I have taken the google.in the website for this task.

Here, we can see the Time-to-live is 26, which is 26 seconds.

Which means the DNS entry will expire from the local DNS server in 26 seconds.

Q5.)

a).

```
muthuraj@MUTHURAJs-MacBook-Air ~ % traceroute google.in

traceroute to google.in (142.250.193.4), 64 hops max, 52 byte packets
 1  192.168.32.254 (192.168.32.254)  144.633 ms  91.279 ms  29.275 ms
 2  auth.iiitd.edu.in (192.168.1.99)  5.651 ms  6.907 ms  18.641 ms
 3  103.25.231.1 (103.25.231.1)  7.737 ms  7.423 ms  6.185 ms
 4  * * *
 5  10.119.234.162 (10.119.234.162)  7.741 ms  8.466 ms  9.116 ms
 6  72.14.195.56 (72.14.195.56)  22.889 ms  8.686 ms  7.929 ms
 7  192.178.80.159 (192.178.80.159)  29.344 ms  30.509 ms  30.075 ms
 8  142.251.54.87 (142.251.54.87)  37.910 ms
    142.251.54.89 (142.251.54.89)  29.341 ms
    142.251.54.87 (142.251.54.87)  38.717 ms
 9  del11s14-in-f4.1e100.net (142.250.193.4)  55.692 ms  56.128 ms  104.949 ms
```

No. of Intermediate Hosts: I see 7 intermediate host excluding the 4th host since it is of form ***

The IP addresses are as follows:

1st host: 192.168.32.254

2nd host: 192.168.1.99

3rd Host: 103.25.231.1

4th Host: 10.119.234.162

5th Host: 72.14.195.56

6th Host: 192.178.80.159

7th Host: 142.251.54.87 and 142.251.54.89

We don't consider the last number 9 a host cause that is the final destination, not an intermediate host.

Average Latencies to each intermediate host:

1st host:

Latencies: 144.633 ms, 91.279 ms, 29.275 ms

Average: $(144.633 + 91.279 + 29.275) / 3 = 88.39$ ms

2nd host: 192.168.1.99

Latencies: 5.651 ms, 6.907 ms, 18.641 ms

Average: $(5.651 + 6.907 + 18.641) / 3 = 10.40$ ms

3rd Host: 103.25.231.1

Latencies: 7.737 ms, 7.423 ms, 6.185 ms

Average: $(7.737 + 7.423 + 6.185) / 3 = 7.12$ ms

4th Host: 10.119.234.162

Latencies: 7.741 ms, 8.466 ms, 9.116 ms

Average: $(7.741 + 8.466 + 9.116) / 3 = 8.44$ ms

5th Host: 72.14.195.56

Latencies: 22.889 ms, 8.686 ms, 7.929 ms

Average: $(22.889 + 8.686 + 7.929) / 3 = 13.83$ ms

6th Host: 192.178.80.159

Latencies: 29.344 ms, 30.509 ms, 30.075 ms

Average: $(29.344 + 30.509 + 30.075) / 3 = 29.98$ ms

7th Host: 142.251.54.87 and 142.251.54.89

Latencies: 37.910 ms, 29.341 ms, 38.717 ms (I have taken 142.251.54.87)

Average: $(37.910 + 29.341 + 38.717) / 3 = 35.32$ ms

b).

```
[muthuraj@MUTHURAJs-MacBook-Air ~ % ping -c 50 google.in
PING google.in (142.250.193.4): 56 data bytes
64 bytes from 142.250.193.4: icmp_seq=0 ttl=112 time=62.707 ms
64 bytes from 142.250.193.4: icmp_seq=1 ttl=112 time=59.402 ms
64 bytes from 142.250.193.4: icmp_seq=2 ttl=112 time=77.114 ms
64 bytes from 142.250.193.4: icmp_seq=3 ttl=112 time=55.705 ms
64 bytes from 142.250.193.4: icmp_seq=4 ttl=112 time=72.805 ms
64 bytes from 142.250.193.4: icmp_seq=5 ttl=112 time=98.784 ms
64 bytes from 142.250.193.4: icmp_seq=6 ttl=112 time=93.545 ms
Request timeout for icmp_seq 7
64 bytes from 142.250.193.4: icmp_seq=8 ttl=112 time=54.376 ms
64 bytes from 142.250.193.4: icmp_seq=9 ttl=112 time=58.368 ms
64 bytes from 142.250.193.4: icmp_seq=10 ttl=112 time=58.798 ms
64 bytes from 142.250.193.4: icmp_seq=11 ttl=112 time=54.639 ms
64 bytes from 142.250.193.4: icmp_seq=12 ttl=112 time=65.184 ms
64 bytes from 142.250.193.4: icmp_seq=13 ttl=112 time=55.308 ms
64 bytes from 142.250.193.4: icmp_seq=14 ttl=112 time=54.258 ms
64 bytes from 142.250.193.4: icmp_seq=15 ttl=112 time=70.453 ms
64 bytes from 142.250.193.4: icmp_seq=16 ttl=112 time=81.987 ms
64 bytes from 142.250.193.4: icmp_seq=17 ttl=112 time=110.989 ms
64 bytes from 142.250.193.4: icmp_seq=18 ttl=112 time=102.040 ms
64 bytes from 142.250.193.4: icmp_seq=19 ttl=112 time=54.284 ms
64 bytes from 142.250.193.4: icmp_seq=20 ttl=112 time=63.106 ms
64 bytes from 142.250.193.4: icmp_seq=21 ttl=112 time=54.488 ms
64 bytes from 142.250.193.4: icmp_seq=22 ttl=112 time=83.194 ms
64 bytes from 142.250.193.4: icmp_seq=23 ttl=112 time=54.469 ms
64 bytes from 142.250.193.4: icmp_seq=24 ttl=112 time=54.524 ms
64 bytes from 142.250.193.4: icmp_seq=25 ttl=112 time=93.176 ms
64 bytes from 142.250.193.4: icmp_seq=26 ttl=112 time=54.564 ms
64 bytes from 142.250.193.4: icmp_seq=27 ttl=112 time=54.387 ms
64 bytes from 142.250.193.4: icmp_seq=28 ttl=112 time=96.461 ms
64 bytes from 142.250.193.4: icmp_seq=29 ttl=112 time=132.412 ms
64 bytes from 142.250.193.4: icmp_seq=30 ttl=112 time=122.629 ms
64 bytes from 142.250.193.4: icmp_seq=31 ttl=112 time=72.382 ms
64 bytes from 142.250.193.4: icmp_seq=32 ttl=112 time=74.067 ms
64 bytes from 142.250.193.4: icmp_seq=33 ttl=112 time=55.149 ms
64 bytes from 142.250.193.4: icmp_seq=34 ttl=112 time=55.509 ms
64 bytes from 142.250.193.4: icmp_seq=35 ttl=112 time=55.556 ms
64 bytes from 142.250.193.4: icmp_seq=36 ttl=112 time=56.843 ms
64 bytes from 142.250.193.4: icmp_seq=37 ttl=112 time=66.335 ms
64 bytes from 142.250.193.4: icmp_seq=38 ttl=112 time=63.825 ms
64 bytes from 142.250.193.4: icmp_seq=39 ttl=112 time=60.089 ms
64 bytes from 142.250.193.4: icmp_seq=40 ttl=112 time=91.407 ms
64 bytes from 142.250.193.4: icmp_seq=41 ttl=112 time=163.814 ms
Request timeout for icmp_seq 42
64 bytes from 142.250.193.4: icmp_seq=43 ttl=112 time=86.909 ms
64 bytes from 142.250.193.4: icmp_seq=44 ttl=112 time=54.476 ms
64 bytes from 142.250.193.4: icmp_seq=45 ttl=112 time=56.723 ms
64 bytes from 142.250.193.4: icmp_seq=46 ttl=112 time=90.366 ms
64 bytes from 142.250.193.4: icmp_seq=47 ttl=112 time=53.897 ms
64 bytes from 142.250.193.4: icmp_seq=48 ttl=112 time=62.573 ms
64 bytes from 142.250.193.4: icmp_seq=49 ttl=112 time=54.476 ms

--- google.in ping statistics ---
50 packets transmitted, 48 packets received, 4.0% packet loss
round-trip min/avg/max/stddev = 53.897/72.470/163.814/23.756 ms
muthuraj@MUTHURAJs-MacBook-Air ~ %
```

The average latency given in the last row under round-trip is 72.470 ms.

c).

Adding up the average latencies for all intermediate hosts, we get :

$$88.39 + 10.40 + 7.12 + 8.44 + 13.83 + 29.98 + 35.32 = 193.48 \text{ms}$$

From the ping command, the average latency was 72.470 ms.

Result:

The latencies don't match and have a significant difference between them. The reason is that traceroute takes into account the time taken to transfer between each immediate hop, and it gets cumulated, whereas ping just takes into account the total round time from the starting and

reaching back without these cumulative hops hence, as a result, ping has lower latency time than traceroute.

d).The maximum ping latency among intermediate hosts is 88.39 ms from 192.168.32.254. And the average latency from ping is 72.470 ms.

Result:

They don't match the result being we get the maximum ping latency for one intermediate hop to be higher than the average latency in ping since ping shows the average latency across the entire path, which is the round trip time whereas the intermediate hop shows the latency for one particular hop where there was a high delay. The ping latency shows the average result in round trip time which is expected to be lower than a particular hop which experienced a slightly higher delay in the network traffic.

e)

We see multiple entries for a single hop when using the traceroute command,

```
8 142.251.54.87 (142.251.54.87) 37.910 ms  
142.251.54.89 (142.251.54.89) 29.341 ms  
142.251.54.87 (142.251.54.87) 38.717 ms
```

This is one such example we obtained in our previous tasks, the reason being load balancing, where the traffic is distributed across multiple networks to balance the load and hence regulate the network traffic. The other reason can be multiple interfaces the router can have different interfaces for data/packets to pass through and hence effectively balancing the load.

f)

```
muthuraj@MUTHURAJs-MacBook-Air ~ % ping stanford.edu -c 50
PING stanford.edu (171.67.215.200): 56 data bytes
64 bytes from 171.67.215.200: icmp_seq=0 ttl=242 time=337.469 ms
64 bytes from 171.67.215.200: icmp_seq=1 ttl=242 time=297.348 ms
64 bytes from 171.67.215.200: icmp_seq=2 ttl=242 time=289.512 ms
64 bytes from 171.67.215.200: icmp_seq=3 ttl=242 time=291.463 ms
64 bytes from 171.67.215.200: icmp_seq=4 ttl=242 time=325.812 ms
64 bytes from 171.67.215.200: icmp_seq=5 ttl=242 time=369.075 ms
64 bytes from 171.67.215.200: icmp_seq=6 ttl=242 time=411.642 ms
64 bytes from 171.67.215.200: icmp_seq=7 ttl=242 time=287.862 ms
64 bytes from 171.67.215.200: icmp_seq=8 ttl=242 time=304.022 ms
64 bytes from 171.67.215.200: icmp_seq=9 ttl=242 time=303.852 ms
64 bytes from 171.67.215.200: icmp_seq=10 ttl=242 time=362.769 ms
64 bytes from 171.67.215.200: icmp_seq=11 ttl=242 time=323.521 ms
64 bytes from 171.67.215.200: icmp_seq=12 ttl=242 time=287.538 ms
64 bytes from 171.67.215.200: icmp_seq=13 ttl=242 time=288.429 ms
64 bytes from 171.67.215.200: icmp_seq=14 ttl=242 time=287.278 ms
64 bytes from 171.67.215.200: icmp_seq=15 ttl=242 time=292.256 ms
64 bytes from 171.67.215.200: icmp_seq=16 ttl=242 time=343.061 ms
64 bytes from 171.67.215.200: icmp_seq=17 ttl=242 time=384.496 ms
64 bytes from 171.67.215.200: icmp_seq=18 ttl=242 time=287.323 ms
64 bytes from 171.67.215.200: icmp_seq=19 ttl=242 time=287.356 ms
64 bytes from 171.67.215.200: icmp_seq=20 ttl=242 time=287.558 ms
64 bytes from 171.67.215.200: icmp_seq=21 ttl=242 time=324.447 ms
64 bytes from 171.67.215.200: icmp_seq=22 ttl=242 time=364.188 ms
64 bytes from 171.67.215.200: icmp_seq=23 ttl=242 time=296.855 ms
64 bytes from 171.67.215.200: icmp_seq=24 ttl=242 time=289.332 ms
64 bytes from 171.67.215.200: icmp_seq=25 ttl=242 time=297.049 ms
64 bytes from 171.67.215.200: icmp_seq=26 ttl=242 time=292.952 ms
64 bytes from 171.67.215.200: icmp_seq=27 ttl=242 time=300.285 ms
64 bytes from 171.67.215.200: icmp_seq=28 ttl=242 time=345.277 ms
64 bytes from 171.67.215.200: icmp_seq=29 ttl=242 time=298.519 ms
64 bytes from 171.67.215.200: icmp_seq=30 ttl=242 time=437.011 ms
64 bytes from 171.67.215.200: icmp_seq=31 ttl=242 time=297.713 ms
64 bytes from 171.67.215.200: icmp_seq=32 ttl=242 time=333.668 ms
64 bytes from 171.67.215.200: icmp_seq=33 ttl=242 time=340.476 ms
64 bytes from 171.67.215.200: icmp_seq=34 ttl=242 time=452.012 ms
64 bytes from 171.67.215.200: icmp_seq=35 ttl=242 time=363.989 ms
64 bytes from 171.67.215.200: icmp_seq=36 ttl=242 time=287.132 ms
64 bytes from 171.67.215.200: icmp_seq=37 ttl=242 time=394.948 ms
64 bytes from 171.67.215.200: icmp_seq=38 ttl=242 time=287.707 ms
64 bytes from 171.67.215.200: icmp_seq=39 ttl=242 time=295.355 ms
64 bytes from 171.67.215.200: icmp_seq=40 ttl=242 time=295.548 ms
64 bytes from 171.67.215.200: icmp_seq=41 ttl=242 time=336.791 ms
64 bytes from 171.67.215.200: icmp_seq=42 ttl=242 time=298.886 ms
64 bytes from 171.67.215.200: icmp_seq=43 ttl=242 time=288.834 ms
64 bytes from 171.67.215.200: icmp_seq=44 ttl=242 time=325.827 ms
64 bytes from 171.67.215.200: icmp_seq=45 ttl=242 time=288.318 ms
64 bytes from 171.67.215.200: icmp_seq=46 ttl=242 time=318.744 ms
64 bytes from 171.67.215.200: icmp_seq=47 ttl=242 time=649.188 ms
64 bytes from 171.67.215.200: icmp_seq=48 ttl=242 time=291.049 ms
64 bytes from 171.67.215.200: icmp_seq=49 ttl=242 time=286.888 ms

--- stanford.edu ping statistics ---
50 packets transmitted, 50 packets received, 0.0% packet loss
round-trip min/avg/max/stddev = 286.888/326.412/649.188/61.522 ms
```

The average latency for round trip is given in the last row it is 326.412 ms.

g)

```
muthuraj@MUTHURAJs-MacBook-Air ~ % traceroute stanford.edu
traceroute to stanford.edu (171.67.215.200), 64 hops max, 52 byte packets
 1  192.168.32.254 (192.168.32.254)  18.221 ms  110.246 ms  93.089 ms
 2  auth.iitdt.edu.in (192.168.1.99)  15.944 ms  23.238 ms  5.144 ms
 3  103.25.231.1 (103.25.231.1)  5.483 ms  4.989 ms  8.032 ms
 4  10.1.209.201 (10.1.209.201)  34.176 ms  30.435 ms  46.972 ms
 5  10.1.200.137 (10.1.200.137)  29.279 ms  29.780 ms  29.119 ms
 6  * 10.255.238.254 (10.255.238.254)  81.841 ms  69.543 ms
 7  180.149.48.18 (180.149.48.18)  32.102 ms  176.670 ms  32.672 ms
 8  * * *
 9  * * *
10  * * *
11  * * *
12  * * *
13  * * *
14  * * *
15  * * *
16  * * *
17  * * *
18  * * *
19  * * *
20  * * *
21  * * *
22  * * *
23  * campus-ial-nets-a-vl1020.sunet (171.64.255.232)  443.702 ms *
24  campus-nw-rtr-vl1004.sunet (171.64.255.200)  285.436 ms
campus-nw-rtr-vl1104.sunet (171.66.255.200)  484.982 ms
campus-east-rtr-vl1120.sunet (171.66.255.232)  289.214 ms
25  web.stanford.edu (171.67.215.200)  290.594 ms  361.644 ms  289.471 ms
muthuraj@MUTHURAJs-MacBook-Air ~ %
```

The above shows the number of hops in stanford.edu here the total number of hops is 25 (which includes ***).

If we don't include ***, then the answer is 12 hops.

```
muthuraj@MUTHURAJs-MacBook-Air ~ % traceroute google.in

traceroute to google.in (142.250.193.4), 64 hops max, 52 byte packets
1  192.168.32.254 (192.168.32.254)  144.633 ms  91.279 ms  29.275 ms
2  auth.iiitd.edu.in (192.168.1.99)  5.651 ms  6.907 ms  18.641 ms
3  103.25.231.1 (103.25.231.1)  7.737 ms  7.423 ms  6.185 ms
4  * * *
5  10.119.234.162 (10.119.234.162)  7.741 ms  8.466 ms  9.116 ms
6  72.14.195.56 (72.14.195.56)  22.889 ms  8.686 ms  7.929 ms
7  192.178.80.159 (192.178.80.159)  29.344 ms  30.509 ms  30.075 ms
8  142.251.54.87 (142.251.54.87)  37.910 ms
   142.251.54.89 (142.251.54.89)  29.341 ms
   142.251.54.87 (142.251.54.87)  38.717 ms
9  del11s14-in-f4.1e100.net (142.250.193.4)  55.692 ms  56.128 ms  104.949 ms
```

And for google.in we had 8 hops, the difference in number of hops refers to a longer route where the data has to pass through more routers, a possible reason would be the greater distance geographically from my local machine to stanford.edu than google.in.

h)

Average Latency for stanford.edu : 326.412ms

Average Latency for google.in 72.470 ms

As we can observe stanford.edu has a higher average latency than google.in, the reason can be due to multiple factors the main being greater distance geographically from my local machine to stanford.edu than google.in.

Also, more number of hops in stanford.edu indicates a more complex and longer path to travel than google.in(8 hops), hence a higher latency.

Q6)

To utilise the ping command and make it fail for 127.0.0.1 (with 100% packet loss), we need to first disable the feature named ICMP- Internet Control Message Protocol since ping depends on ICMP for echo requests/replies blocking ICMP will help prevent 127.0.0.1 from responding back to ping requests and we can achieve our task easily.

In my Mac system, to disable ICMP, we have to use pfctl we add the following line in our configuration file to block ICMP requests.

```
muthuraj@MUTHURAJs-MacBook-Air ~ % sudo nano /etc/pf.anchors/block_icmp
```

```
Password:
```

```
UW PICO 5.09                                         File: /etc/pf.anchors/block_icmp  
block drop in proto icmp from any to any
```

After doing it, we have to load the rule into our pf configuration.

```
muthuraj@MUTHURAJs-MacBook-Air ~ % sudo nano /etc/pf.conf
```

```
muthuraj@MUTHURAJs-MacBook-Air ~ % sudo pfctl -f /etc/pf.conf  
sudo pfctl -e
```

```
pfctl: Use of -f option, could result in flushing of rules  
present in the main ruleset added by the system at startup.  
See /etc/pf.conf for further details.
```

```
No ALTQ support in kernel  
ALTQ related functions disabled  
No ALTQ support in kernel  
ALTQ related functions disabled  
pf enabled
```

After performing the following steps and applying the following steps, we can finally run our command ping 127.0.0.1

And this is the output.

```
muthuraj@MUTHURAJs-MacBook-Air ~ % ping 127.0.0.1

PING 127.0.0.1 (127.0.0.1): 56 data bytes
Request timeout for icmp_seq 0
Request timeout for icmp_seq 1
Request timeout for icmp_seq 2
Request timeout for icmp_seq 3
Request timeout for icmp_seq 4
Request timeout for icmp_seq 5
Request timeout for icmp_seq 6
Request timeout for icmp_seq 7
Request timeout for icmp_seq 8
Request timeout for icmp_seq 9
Request timeout for icmp_seq 10
Request timeout for icmp_seq 11
Request timeout for icmp_seq 12
Request timeout for icmp_seq 13
Request timeout for icmp_seq 14
Request timeout for icmp_seq 15
Request timeout for icmp_seq 16
Request timeout for icmp_seq 17
Request timeout for icmp_seq 18
Request timeout for icmp_seq 19
Request timeout for icmp_seq 20
Request timeout for icmp_seq 21
Request timeout for icmp_seq 22
Request timeout for icmp_seq 23
Request timeout for icmp_seq 24
Request timeout for icmp_seq 25
Request timeout for icmp_seq 26
Request timeout for icmp_seq 27
Request timeout for icmp_seq 28
Request timeout for icmp_seq 29
Request timeout for icmp_seq 30
Request timeout for icmp_seq 31
Request timeout for icmp_seq 32
Request timeout for icmp_seq 33
Request timeout for icmp_seq 34
Request timeout for icmp_seq 35
Request timeout for icmp_seq 36
Request timeout for icmp_seq 37
Request timeout for icmp_seq 38
Request timeout for icmp_seq 39
Request timeout for icmp_seq 40
Request timeout for icmp_seq 41
Request timeout for icmp_seq 42
Request timeout for icmp_seq 43
Request timeout for icmp_seq 44
Request timeout for icmp_seq 45
Request timeout for icmp_seq 46
Request timeout for icmp_seq 47
Request timeout for icmp_seq 48
Request timeout for icmp_seq 49
Request timeout for icmp_seq 50
Request timeout for icmp_seq 51
Request timeout for icmp_seq 52
Request timeout for icmp_seq 53
```

```
Request timeout for icmp_seq 53
Request timeout for icmp_seq 54
Request timeout for icmp_seq 55
Request timeout for icmp_seq 56
Request timeout for icmp_seq 57
Request timeout for icmp_seq 58
Request timeout for icmp_seq 59
Request timeout for icmp_seq 60
Request timeout for icmp_seq 61
Request timeout for icmp_seq 62
Request timeout for icmp_seq 63
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Request timeout for icmp_seq 65
Request timeout for icmp_seq 66
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Request timeout for icmp_seq 68
Request timeout for icmp_seq 69
Request timeout for icmp_seq 70
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Request timeout for icmp_seq 77
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Request timeout for icmp_seq 85
Request timeout for icmp_seq 86
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Request timeout for icmp_seq 90
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Request timeout for icmp_seq 93
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Request timeout for icmp_seq 95
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Request timeout for icmp_seq 97
Request timeout for icmp_seq 98
Request timeout for icmp_seq 99
Request timeout for icmp_seq 100
Request timeout for icmp_seq 101
Request timeout for icmp_seq 102
Request timeout for icmp_seq 103
Request timeout for icmp_seq 104
Request timeout for icmp_seq 105
Request timeout for icmp_seq 106
Request timeout for icmp_seq 107
Request timeout for icmp_seq 108
Request timeout for icmp_seq 109
Request timeout for icmp_seq 110
Request timeout for icmp_seq 111
^C
--- 127.0.0.1 ping statistics ---
113 packets transmitted, 0 packets received, 100.0% packet loss
```

From this output, we can see the multiple request timeout, which highlights that a reply wasn't received and that the time ended.

In the last row, we can see the line where it shows 113 packets transmitted but none of them were received, resulting in 100% packet loss.
Hence, this indicates that it has failed.

References Used in This Assignment :

Q4 a) <https://www.computerhope.com/unix/unslookup.htm>

Q6)

<https://man.openbsd.org/pfctl>

<https://www.openbsd.org/faq/pf/>

<https://www.rfc-editor.org/info/rfc792>

<https://linux.die.net/man/8/ping>

<https://www.unix.com/man-page/ultrix/8/ping/>