CSE 232: Computer Networks
PA-1 Solutions (Sec - A)
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Q1. a. Using the `ifconfig` command, I got my IP address (assigned to by my device by the local network) as `192.168.43.30` which is shown by the en0 which is the primary wifi interface for mac device

```
Last login: Wed Aug 28 09:58:17 on ttys000
varun@Varuns-MacBook-Air-2 ~ % 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
ap1: flags=8843<UP,BROADCAST,RUNNING,SIMPLEX,MULTICAST> mtu 1500
        options=6463<RXCSUM,TXCSUM,TSO4,TSO6,CHANNEL_IO,PARTIAL_CSUM,ZEROINVERT_CSUM>
        ether 3e:57:dc:5d:9c:f3
        inet6 fe80::3c57:dcff:fe5d:9cf3%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=6463<RXCSUM,TXCSUM,TSO4,TSO6,CHANNEL_IO,PARTIAL_CSUM,ZEROINVERT_CSUM>
        ether 1c:57:dc:5d:9c:f3
        inet6 fe80::1462:e92d:fad3:d7c2%en0 prefixlen 64 secured scopeid 0xb
        inet 192.168.43.30 netmask 0xffffe000 broadcast 192.168.63.255
        nd6 options=201<PERFORMNUD,DAD>
        media: autoselect
        status: active
```

b. Using https://www.whatismyip.com , I got my IP address as `103.25.231.125`

What Is My IP?

My Public IPv4: 103.25.231.125

My Public IPv6: Not Detected

My IP Location: Noida, UP IN

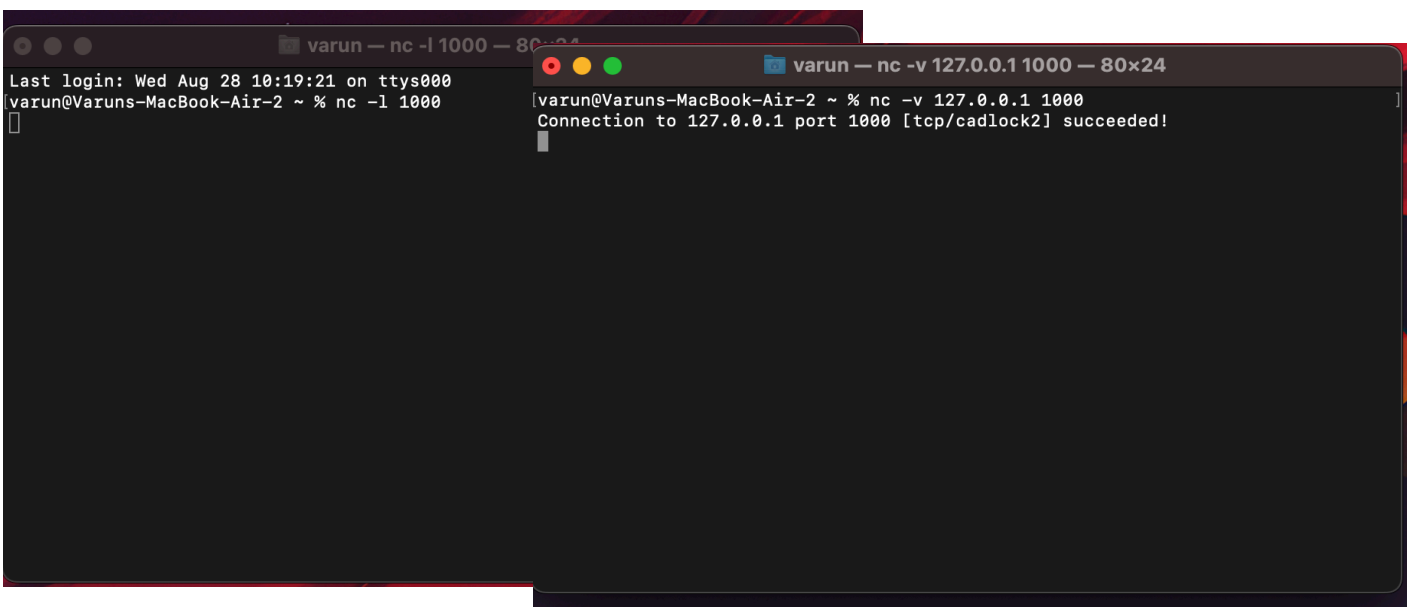### My ISP: Indraprastha Institute of Information Technology Delhi

Both the addresses are different as the en0 IP address is a private IP address which is assigned to the device on the local network while the Ip address `103.25.231.125` is the address of the router assigned by ISP. This is being done through process of NAT (Network Address translation)

Q2. I changed the IP address `192.168.231.28` and then reverted back to the original IP address `192.168.43.30` using sudo ifconfig command
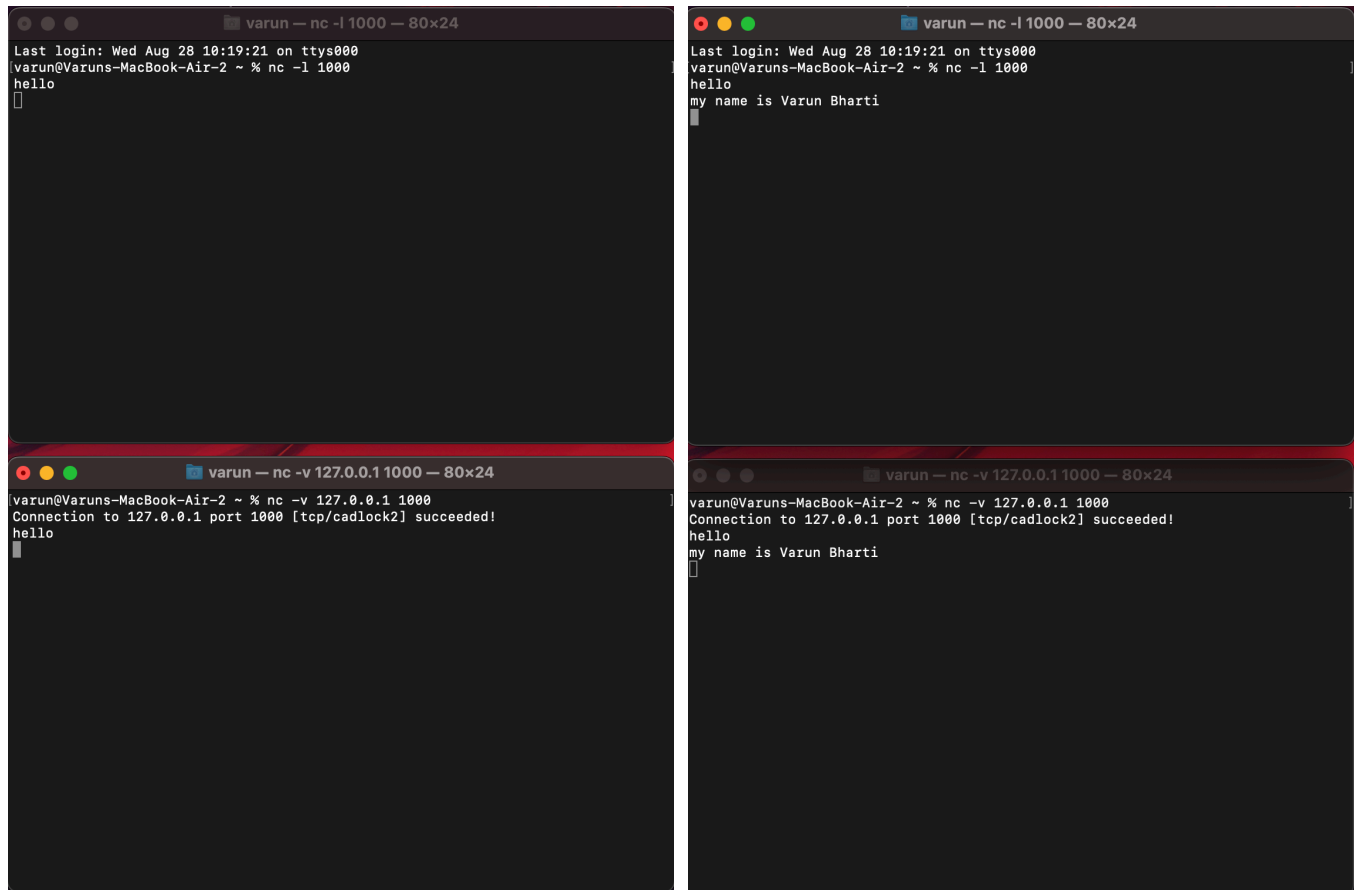
```
[varun@Varuns-MacBook-Air-2 ~ % sudo ifconfig en0 192.168.231.28
[Password:
[varun@Varuns-MacBook-Air-2 ~ % ifconfig en0
en0: flags=8863<UP,BROADCAST,SMART,RUNNING,SIMPLEX,MULTICAST> mtu 1500
        options=6463<RXCSUM,TXCSUM,TSO4,TSO6,CHANNEL_IO,PARTIAL_CSUM,ZEROINVERT_CSUM>
        ether 1c:57:dc:5d:9c:f3
        inet6 fe80::1462:e92d:fad3:d7c2%en0 prefixlen 64 secured scopeid 0xb
        inet 192.168.231.28 netmask 0xffffff00 broadcast 192.168.231.255
        nd6 options=201<PERFORMNUD,DAD>
        media: autoselect
        status: active
[varun@Varuns-MacBook-Air-2 ~ % sudo ifconfig en0 192.168.43.30
[varun@Varuns-MacBook-Air-2 ~ % ifconfig en0
en0: flags=8863<UP,BROADCAST,SMART,RUNNING,SIMPLEX,MULTICAST> mtu 1500
        options=6463<RXCSUM,TXCSUM,TSO4,TSO6,CHANNEL_IO,PARTIAL_CSUM,ZEROINVERT_CSUM>
        ether 1c:57:dc:5d:9c:f3
        inet6 fe80::1462:e92d:fad3:d7c2%en0 prefixlen 64 secured scopeid 0xb
        inet 192.168.43.30 netmask 0xffffe000 broadcast 192.168.63.255
        nd6 options=201<PERFORMNUD,DAD>
        media: autoselect
        status: active
```

Q3. a. Since I am using a Mac, I don't have a VM and hence I have established a connection with my localhost. I am doing using `netcat` command which involves running `nc` command on two terminals one acting as the server and another acting as the client

Connection successful between server and client :

```
varun — nc -l 1000 — 80x24
Last login: Wed Aug 28 10:19:21 on ttys000
[varun@Varuns-MacBook-Air-2 ~ % nc -l 1000
```
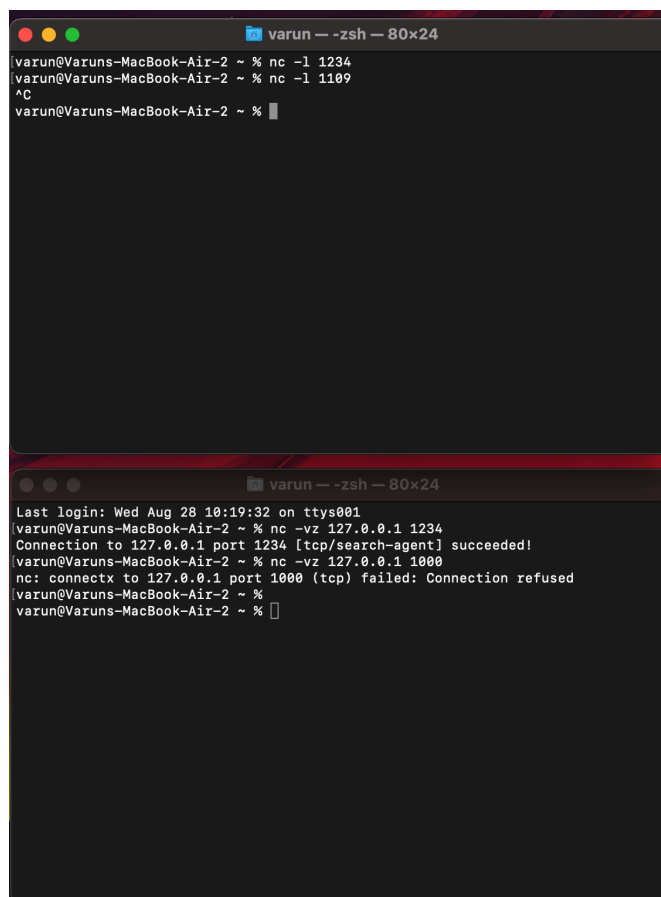
```
varun — nc -v 127.0.0.1 1000 — 80x24
[varun@Varuns-MacBook-Air-2 ~ % nc -v 127.0.0.1 1000
Connection to 127.0.0.1 port 1000 [tcp/cadlock2] succeeded!
```

Sending messages between them :


```
Last login: Wed Aug 28 10:19:21 on ttys000
[varun@Varuns-MacBook-Air-2 ~ % nc -l 1000
hello
```

```
Last login: Wed Aug 28 10:19:21 on ttys000
varun@Varuns-MacBook-Air-2 ~ % nc -l 1000
hello
my name is Varun Bharti
```

```
[varun@Varuns-MacBook-Air-2 ~ % nc -v 127.0.0.1 1000
Connection to 127.0.0.1 port 1000 [tcp/cadlock2] succeeded!
hello
```

```
varun@Varuns-MacBook-Air-2 ~ % nc -v 127.0.0.1 1000
Connection to 127.0.0.1 port 1000 [tcp/cadlock2] succeeded!
hello
my name is Varun Bharti
```

b. The state of TCP server can be found using `-z command with ns` command.


```
[varun@Varuns-MacBook-Air-2 ~ % nc -l 1234
[varun@Varuns-MacBook-Air-2 ~ % nc -l 1109
^C
varun@Varuns-MacBook-Air-2 ~ %
```

```
Last login: Wed Aug 28 10:19:32 on ttys001
[varun@Varuns-MacBook-Air-2 ~ % nc -vz 127.0.0.1 1234
Connection to 127.0.0.1 port 1234 [tcp/search-agent] succeeded!
[varun@Varuns-MacBook-Air-2 ~ % nc -vz 127.0.0.1 1000
nc: connectx to 127.0.0.1 port 1000 (tcp) failed: Connection refused
[varun@Varuns-MacBook-Air-2 ~ %
varun@Varuns-MacBook-Air-2 ~ %
```

Q4. a. I used the `nslookup` command andused the `set type = soa` command to find the Start of Authority(SOA) record for a domain to find the Authoritative answers.

```
varun@Varuns-MacBook-Air-2 ~ % nslookup
> set 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 = 667912540
        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
>
```

b. The time to live the server is TTL which can be found using `-debug command` with the nslookup `command.`

```
varun@Varuns-MacBook-Air-2 ~ % 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 = 299
    AUTHORITY RECORDS:
    ADDITIONAL RECORDS:
------------
Non-authoritative answer:
Name:   google.in
Address: 142.250.193.4

varun@Varuns-MacBook-Air-2 ~ % nslookup -debug iiitd.ac.in
Server:         192.168.1.7
Address:        192.168.1.7#53

------------
    QUESTIONS:
        iiitd.ac.in, type = A, class = IN
    ANSWERS:
    ->  iiitd.ac.in
        internet address = 192.168.2.127
        ttl = 3600
    AUTHORITY RECORDS:
    ADDITIONAL RECORDS:
------------
Name:   iiitd.ac.in
Address: 192.168.2.127
```

For google.in, time is `229 seconds or 3.817(approx) mins`
For iiitd.ac.in, time is `3600 seconds or 1 hr`

Q5. a.

```
Last login: Wed Aug 28 10:38:59 on ttys000
varun@Varuns-MacBook-Air-2 ~ % 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)  20.356 ms  126.220 ms  45.100 ms
 2  auth.iiitd.edu.in (192.168.1.99)  4.540 ms  4.045 ms  3.768 ms
 3  103.25.231.1 (103.25.231.1)  5.472 ms  3.897 ms  5.583 ms
 4  * * *
 5  10.119.234.162 (10.119.234.162)  8.683 ms  8.911 ms  7.561 ms
 6  72.14.195.56 (72.14.195.56)  10.790 ms
    72.14.194.160 (72.14.194.160)  8.429 ms  7.725 ms
 7  192.178.80.159 (192.178.80.159)  29.500 ms  35.105 ms
    142.251.54.111 (142.251.54.111)  28.162 ms
 8  142.251.54.87 (142.251.54.87)  28.805 ms  29.293 ms  31.204 ms
 9  del11s14-in-f4.1e100.net (142.250.193.4)  28.263 ms  31.560 ms  29.626 ms
varun@Varuns-MacBook-Air-2 ~ % ▊
```

There are total of 9 intermediate hosts :

a. `192.168.32.254` : avg latency: 63.892 ms

b. `192.168.1.99` : avg latency : 4.117ms

c. `103.25.231.1` : avg latency : 4.984ms

d. Timed out, no latency data available

e. `10.119.234.162` : avg latency : 8.385ms

f. `72.14.195.56 or 72.14.194.160` : avg latency : 8.981ms

g. `192.178.80.159 or 142.251.54.111` : avg latency : 30.922ms

h. `142.251.54.87` : avg latency : 29.767ms

i. `142.250.193.4` : avg latency: 29.816ms

Avg Total Latency : 67.824ms

b.

```
[varun@Varuns-MacBook-Air-2 ~ % 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=56 time=29.379 ms
64 bytes from 142.250.193.4: icmp_seq=1 ttl=56 time=42.222 ms
64 bytes from 142.250.193.4: icmp_seq=2 ttl=56 time=29.763 ms
64 bytes from 142.250.193.4: icmp_seq=3 ttl=56 time=32.539 ms
64 bytes from 142.250.193.4: icmp_seq=4 ttl=56 time=63.397 ms
64 bytes from 142.250.193.4: icmp_seq=5 ttl=56 time=53.849 ms
64 bytes from 142.250.193.4: icmp_seq=6 ttl=56 time=28.944 ms
64 bytes from 142.250.193.4: icmp_seq=7 ttl=56 time=28.204 ms
64 bytes from 142.250.193.4: icmp_seq=8 ttl=56 time=29.975 ms
64 bytes from 142.250.193.4: icmp_seq=9 ttl=56 time=31.232 ms

64 bytes from 142.250.193.4: icmp_seq=44 ttl=56 time=28.079 ms
64 bytes from 142.250.193.4: icmp_seq=45 ttl=56 time=30.113 ms
64 bytes from 142.250.193.4: icmp_seq=46 ttl=56 time=27.659 ms
64 bytes from 142.250.193.4: icmp_seq=47 ttl=56 time=27.692 ms
64 bytes from 142.250.193.4: icmp_seq=48 ttl=56 time=28.227 ms
64 bytes from 142.250.193.4: icmp_seq=49 ttl=56 time=28.081 ms

--- google.in ping statistics ---
50 packets transmitted, 50 packets received, 0.0% packet loss
round-trip min/avg/max/stddev = 27.425/32.323/63.397/8.245 ms
```

Avg Latency : 32.323ms

c. No, both the avg latency from traceroute and ping are not the same as the `traceroute` command calculates the latency to each intermediate host and back to the source host, while the `ping` command calculates the round-trip time for each packet to the destination host. The `traceroute` command only sends 3 packets while the `ping` commands sends 50 packets. As a result, the ping command is much faster than the traceroute command.

d. The maximum latency for traceroute command is 63.892 ms which is much higher than (b) . By definition. Maximum latency is obtained as the max of the three attempts made by the command. There might be issues like network congestion, packet loss etc. which may cause delay in the network. On the other hand, `avg latency by ping` command is avg round trip time for each packet which minimizes the effect of issues like network congestion and packet loss

e. Multiple entries for a single hop in traceroute typically indicate that there are multiple routers or paths that traffic can take to reach that hop. The reasons for this may be things like network redundancy or load balancing, where packets may take different routes to reach the same destination.

f.

```
varun@Varuns-MacBook-Air-2 ~ %  ping -c 50 stanford.edu
PING stanford.edu (171.67.215.200): 56 data bytes
64 bytes from 171.67.215.200: icmp_seq=0 ttl=242 time=288.501 ms
64 bytes from 171.67.215.200: icmp_seq=1 ttl=242 time=422.072 ms
64 bytes from 171.67.215.200: icmp_seq=2 ttl=242 time=288.347 ms
64 bytes from 171.67.215.200: icmp_seq=3 ttl=242 time=324.067 ms
64 bytes from 171.67.215.200: icmp_seq=4 ttl=242 time=290.938 ms
64 bytes from 171.67.215.200: icmp_seq=5 ttl=242 time=296.586 ms
64 bytes from 171.67.215.200: icmp_seq=6 ttl=242 time=408.301 ms
64 bytes from 171.67.215.200: icmp_seq=7 ttl=242 time=327.485 ms
64 bytes from 171.67.215.200: icmp_seq=8 ttl=242 time=288.417 ms
64 bytes from 171.67.215.200: icmp_seq=9 ttl=242 time=350.134 ms
64 bytes from 171.67.215.200: icmp_seq=47 ttl=242 time=289.281 ms
64 bytes from 171.67.215.200: icmp_seq=48 ttl=242 time=287.593 ms
64 bytes from 171.67.215.200: icmp_seq=49 ttl=242 time=288.190 ms

--- stanford.edu ping statistics ---
50 packets transmitted, 50 packets received, 0.0% packet loss
round-trip min/avg/max/stddev = 287.593/329.290/422.072/43.514 ms
```

Avg latency : 329.290ms

g.
```
varun@Varuns-MacBook-Air-2 ~ % 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)  5.557 ms  10.329 ms  5.259 ms
 2  auth.iiitd.edu.in (192.168.1.99)  3.988 ms  3.179 ms  3.126 ms
 3  103.25.231.1 (103.25.231.1)  3.496 ms  3.867 ms  3.151 ms
 4  10.1.209.201 (10.1.209.201)  28.509 ms  29.102 ms  28.892 ms
 5  10.1.200.137 (10.1.200.137)  33.150 ms  34.834 ms  37.781 ms
 6  10.255.238.122 (10.255.238.122)  32.509 ms
    10.255.238.254 (10.255.238.254)  35.070 ms  28.196 ms
 7  180.149.48.18 (180.149.48.18)  27.990 ms  29.151 ms  29.039 ms
 8  * * *
 9  * * *
10  * * *
11  * * *
12  * * *
13  * * *
14  * * *
15  * * *
16  * * *
17  * * *
18  * * *
19  * * *
20  * * *
21  * * *
22  * * *
23  campus-nw-rtr-vl1104.sunet (171.66.255.200)  375.686 ms *  288.704 ms
24  * campus-nw-rtr-vl1104.sunet (171.66.255.200)  288.382 ms *
25  * * web.stanford.edu (171.67.215.200)  387.313 ms
```

 No of intermediate hosts = 25

h. The number of hops for `stanford.edu` is 25. This is much greater than `google.in` which had 9 hops. This can be accounted for by their servers being located in disparate geographical locations. The `stanford server` is located far as compared to the `google server` due to which packers have to travel a longer distance hence increasing the latency

Q6. `127.0.0.1` is the IP address associated with the loopback interface (shown as lo0 on my device, used to test the network stack of the device.

```
varun@Varuns-MacBook-Air-2 ~ % ifconfig lo0
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>
varun@Varuns-MacBook-Air-2 ~ % ping -c 10 127.0.01
PING 127.0.01 (127.0.0.1): 56 data bytes
64 bytes from 127.0.0.1: icmp_seq=0 ttl=64 time=0.113 ms
64 bytes from 127.0.0.1: icmp_seq=1 ttl=64 time=0.163 ms
64 bytes from 127.0.0.1: icmp_seq=2 ttl=64 time=0.117 ms
64 bytes from 127.0.0.1: icmp_seq=3 ttl=64 time=0.116 ms
64 bytes from 127.0.0.1: icmp_seq=4 ttl=64 time=0.123 ms
64 bytes from 127.0.0.1: icmp_seq=5 ttl=64 time=0.107 ms
64 bytes from 127.0.0.1: icmp_seq=6 ttl=64 time=0.138 ms
64 bytes from 127.0.0.1: icmp_seq=7 ttl=64 time=0.163 ms
64 bytes from 127.0.0.1: icmp_seq=8 ttl=64 time=0.118 ms
64 bytes from 127.0.0.1: icmp_seq=9 ttl=64 time=0.125 ms

--- 127.0.01 ping statistics ---
10 packets transmitted, 10 packets received, 0.0% packet loss
round-trip min/avg/max/stddev = 0.107/0.128/0.163/0.019 ms
```

To make ping command fail with 100% packet loss , we can do it by changing the address of lo0. Hence , we can see in the screenshot below that the ping command failed with 100% packet loss.

```
[varun@Varuns-MacBook-Air-2 ~ % sudo ifconfig lo0 23.10.23.10
[Password:
[varun@Varuns-MacBook-Air-2 ~ % ifconfig lo0
lo0: flags=8049<UP,LOOPBACK,RUNNING,MULTICAST> mtu 16384
        options=1203<RXCSUM,TXCSUM,TXSTATUS,SW_TIMESTAMP>
        inet6 ::1 prefixlen 128
        inet6 fe80::1%lo0 prefixlen 64 scopeid 0x1
        inet 23.10.23.10 netmask 0xff000000
        nd6 options=201<PERFORMNUD,DAD>
```

```
varun@Varuns-MacBook-Air-2 ~ % ping -c 10 127.0.0.1
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

--- 127.0.0.1 ping statistics ---
10 packets transmitted, 0 packets received, 100.0% packet loss
```

Then finally reverted back to original IP address and the ping command works fine.

```
varun@Varuns-MacBook-Air-2 ~ % sudo ifconfig lo0 127.0.0.1
varun@Varuns-MacBook-Air-2 ~ % ping -c 10 127.0.0.1
PING 127.0.0.1 (127.0.0.1): 56 data bytes
64 bytes from 127.0.0.1: icmp_seq=0 ttl=64 time=0.083 ms
64 bytes from 127.0.0.1: icmp_seq=1 ttl=64 time=0.114 ms
64 bytes from 127.0.0.1: icmp_seq=2 ttl=64 time=0.117 ms
64 bytes from 127.0.0.1: icmp_seq=3 ttl=64 time=0.134 ms
64 bytes from 127.0.0.1: icmp_seq=4 ttl=64 time=0.165 ms
64 bytes from 127.0.0.1: icmp_seq=5 ttl=64 time=0.145 ms
64 bytes from 127.0.0.1: icmp_seq=6 ttl=64 time=0.095 ms
64 bytes from 127.0.0.1: icmp_seq=7 ttl=64 time=0.108 ms
64 bytes from 127.0.0.1: icmp_seq=8 ttl=64 time=0.160 ms
64 bytes from 127.0.0.1: icmp_seq=9 ttl=64 time=0.125 ms

--- 127.0.0.1 ping statistics ---
10 packets transmitted, 10 packets received, 0.0% packet loss
round-trip min/avg/max/stddev = 0.083/0.125/0.165/0.025 ms
varun@Varuns-MacBook-Air-2 ~ %
```