

CSE232: Programming Assignment 1

Using command-line utilities for network debugging

Q1.

a) Using `ifconfig` command

```
anish@LAPTOP:~$ ifconfig
eth1: flags=4163<UP,BROADCAST,RUNNING,MULTICAST> mtu 1500
    inet 169.254.74.75 netmask 255.255.0.0 broadcast 169.254.255.255
    inet6 fe80::8043:8008:7373:972c prefixlen 64 scopeid 0xfd<compat,link,site,host>
    ether 0a:00:27:00:00:0f (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

eth5: flags=4163<UP,BROADCAST,RUNNING,MULTICAST> mtu 1500
    inet 169.254.152.39 netmask 255.255.0.0 broadcast 169.254.255.255
    inet6 fe80::7bcc:3f0f:800f:c6eb prefixlen 64 scopeid 0xfd<compat,link,site,host>
    ether 0a:00:27:00:00:0d (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 1500
    inet 127.0.0.1 netmask 255.0.0.0
    inet6 ::1 prefixlen 128 scopeid 0xfe<compat,link,site,host>
    loop (Local Loopback)
    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

wifi0: flags=4163<UP,BROADCAST,RUNNING,MULTICAST> mtu 1500
    inet 192.168.1.41 netmask 255.255.255.0 broadcast 192.168.1.255
    inet6 fe80::8d25:c0e7:8214:339c prefixlen 64 scopeid 0xfd<compat,link,site,host>
    ether 38:d5:7a:37:1b:a5 (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

anish@LAPTOP:~$
```

From the above output of the command `ifconfig`, we see many outputs, but **wifi0** shows our IPv4 address, and we have to note this address and now check with the website <https://www.whatismyip.com/> to see whether we have same IP address or not .

b) Below is the output from <https://www.whatismyip.com/> .

What Is My IP?

My Public IPv4: [103.69.15.115](#) 🌐

My Public IPv6: Not Detected

My IP Location: Azadpur, DL IN 🌐

My ISP: Candor InfoSolution Pvt Ltd 🌐

We note that the IPv4 address in both `ifconfig` and the <https://www.whatismyip.com/> are different. Because

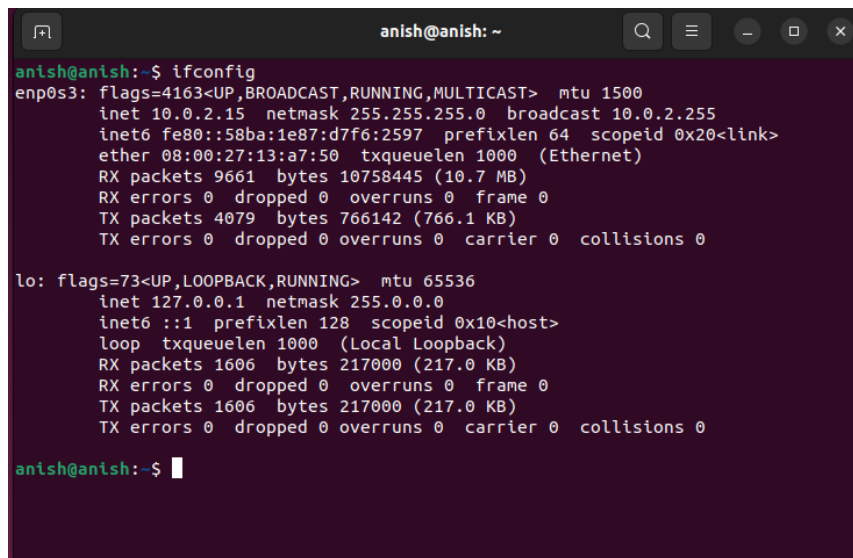
1. IPv4 address shown using `ifconfig` is a Private IP address assigned to our local device by router and not visible to the outside world.
2. IPv4 address shown in <https://www.whatismyip.com/> is a Public IP address that is assigned by our ISP to the router and is visible to the outside world.

Q2.

To change the IP address, we can use the following command:

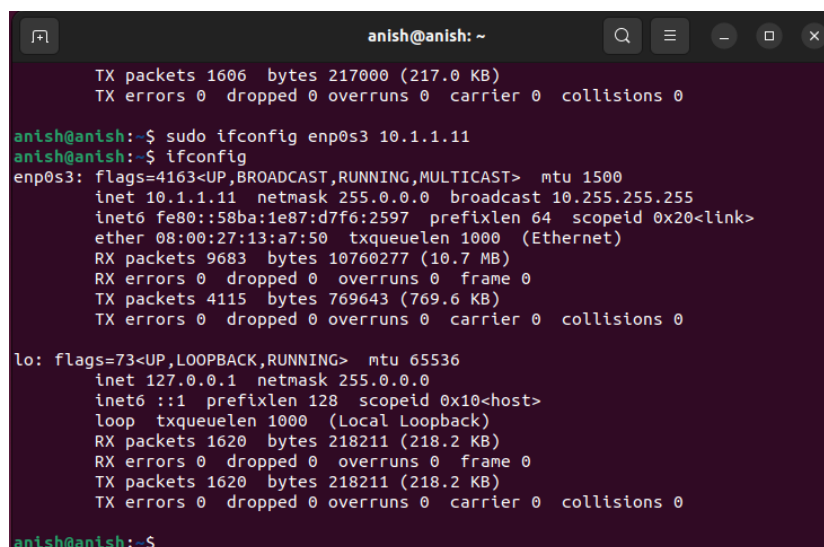
```
sudo ifconfig <if_name> <new_ip_Address>
```

- a. First we remember the old IP address and see which network interface we want to change.



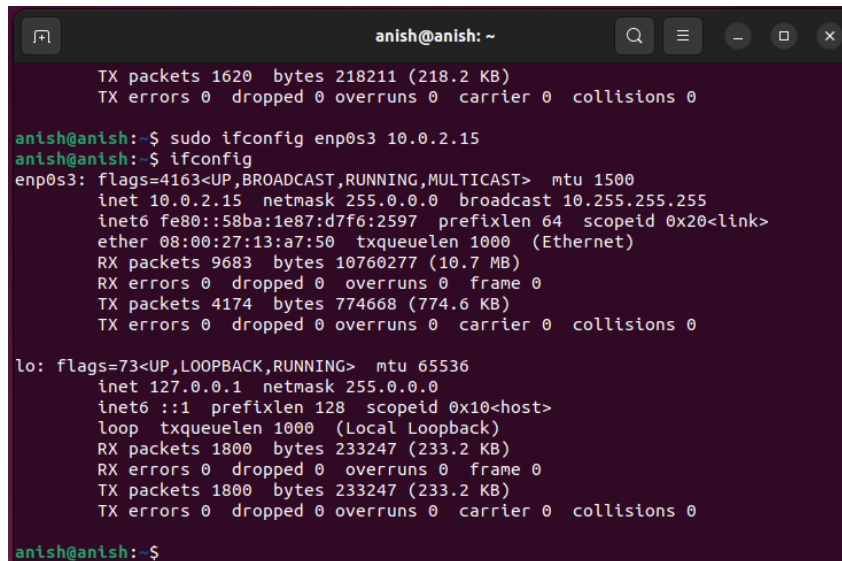
```
anish@anish: ~  
anish@anish:~$ ifconfig  
enp0s3: flags=4163<UP,BROADCAST,RUNNING,MULTICAST> mtu 1500  
    inet 10.0.2.15 netmask 255.255.255.0 broadcast 10.0.2.255  
    inet6 fe80::58ba:1e87:d7f6:2597 prefixlen 64 scopeid 0x20<link>  
    ether 08:00:27:13:a7:50 txqueuelen 1000 (Ethernet)  
    RX packets 9661 bytes 10758445 (10.7 MB)  
    RX errors 0 dropped 0 overruns 0 frame 0  
    TX packets 4079 bytes 766142 (766.1 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 1606 bytes 217000 (217.0 KB)  
    RX errors 0 dropped 0 overruns 0 frame 0  
    TX packets 1606 bytes 217000 (217.0 KB)  
    TX errors 0 dropped 0 overruns 0 carrier 0 collisions 0  
  
anish@anish:~$
```

- b. Now, Lets say, we are going to change the IP address for network interface `enp0s3` with new IP (let = 10.1.1.11).
- c. So, we just have to write `sudo ifconfig enp0s3 10.1.1.11`



```
anish@anish: ~  
TX packets 1606 bytes 217000 (217.0 KB)  
TX errors 0 dropped 0 overruns 0 carrier 0 collisions 0  
  
anish@anish:~$ sudo ifconfig enp0s3 10.1.1.11  
anish@anish:~$ ifconfig  
enp0s3: flags=4163<UP,BROADCAST,RUNNING,MULTICAST> mtu 1500  
    inet 10.1.1.11 netmask 255.0.0.0 broadcast 10.255.255.255  
    inet6 fe80::58ba:1e87:d7f6:2597 prefixlen 64 scopeid 0x20<link>  
    ether 08:00:27:13:a7:50 txqueuelen 1000 (Ethernet)  
    RX packets 9683 bytes 10760277 (10.7 MB)  
    RX errors 0 dropped 0 overruns 0 frame 0  
    TX packets 4115 bytes 769643 (769.6 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 1620 bytes 218211 (218.2 KB)  
    RX errors 0 dropped 0 overruns 0 frame 0  
    TX packets 1620 bytes 218211 (218.2 KB)  
    TX errors 0 dropped 0 overruns 0 carrier 0 collisions 0  
  
anish@anish:~$
```

- d. We note that our IP address for `enp0s3` is changed, and our original IP address for `enp0s3` was (10.0.2.15).
- e. Therefore, to revert to the original IP address, we just write `sudo ifconfig enp0s3 10.0.2.15`.

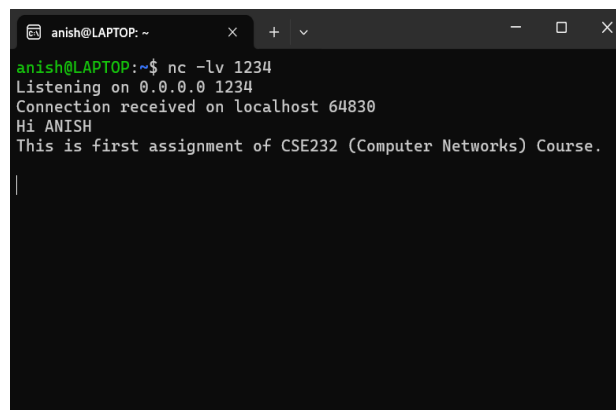


```
anish@anish: ~  
TX packets 1620  bytes 218211 (218.2 KB)  
TX errors 0  dropped 0 overruns 0  carrier 0  collisions 0  
  
anish@anish:~$ sudo ifconfig enp0s3 10.0.2.15  
anish@anish:~$ ifconfig  
enp0s3: flags=4163<UP,BROADCAST,RUNNING,MULTICAST>  mtu 1500  
    inet 10.0.2.15  netmask 255.0.0.0  broadcast 10.255.255.255  
    inet6 fe80::58ba:1e87:d7f6:2597  prefixlen 64  scopeid 0x20<link>  
    ether 08:00:27:13:a7:50  txqueuelen 1000  (Ethernet)  
    RX packets 9683  bytes 10760277 (10.7 MB)  
    RX errors 0  dropped 0  overruns 0  frame 0  
    TX packets 4174  bytes 774668 (774.6 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 1800  bytes 233247 (233.2 KB)  
    RX errors 0  dropped 0  overruns 0  frame 0  
    TX packets 1800  bytes 233247 (233.2 KB)  
    TX errors 0  dropped 0 overruns 0  carrier 0  collisions 0  
  
anish@anish:~$
```

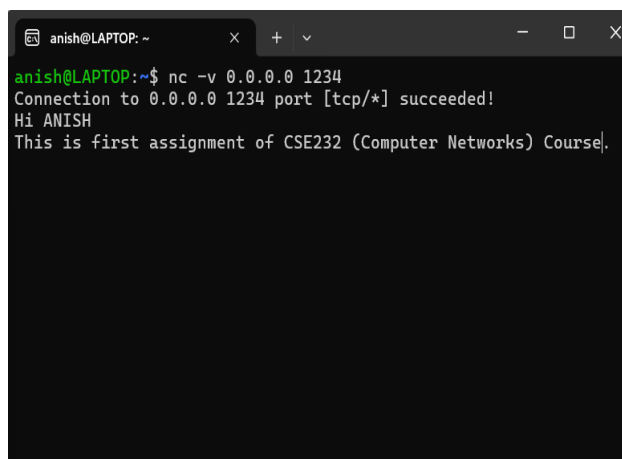
- f. We see, our IP address is changed back to the original one.

Q3.

- a.



```
anish@LAPTOP: ~  
anish@LAPTOP:~$ nc -lv 1234  
Listening on 0.0.0.0 1234  
Connection received on localhost 64830  
Hi ANISH  
This is first assignment of CSE232 (Computer Networks) Course.  
|
```



```
anish@LAPTOP: ~  
anish@LAPTOP:~$ nc -v 0.0.0.0 1234  
Connection to 0.0.0.0 1234 port [tcp/*] succeeded!  
Hi ANISH  
This is first assignment of CSE232 (Computer Networks) Course|
```

If we have to setup a connection between our VM and Host Machine, therefore, instead of writing (0.0.0.0) to the client machine, we have to write <ip_Addr> of our server machine.

Client: `nc -lv 1234`

Server: `nc -v <ip_addr_client> 1234`

- b. Use the command `netstat -a` to see the status of all TCP connections.

```
PS C:\Users\anish> netstat -a

Active Connections

Proto Local Address           Foreign Address         State
TCP   0.0.0.0:135             LAPTOP:0                LISTENING
TCP   0.0.0.0:445             LAPTOP:0                LISTENING
TCP   0.0.0.0:1234            LAPTOP:0                LISTENING
TCP   0.0.0.0:1978            LAPTOP:0                LISTENING
TCP   0.0.0.0:1979            LAPTOP:0                LISTENING
TCP   0.0.0.0:1980            LAPTOP:0                LISTENING
TCP   0.0.0.0:2869            LAPTOP:0                LISTENING
TCP   0.0.0.0:3306            LAPTOP:0                LISTENING
TCP   0.0.0.0:5040            LAPTOP:0                LISTENING
TCP   0.0.0.0:6646            LAPTOP:0                LISTENING
TCP   0.0.0.0:6881            LAPTOP:0                LISTENING
TCP   0.0.0.0:7070            LAPTOP:0                LISTENING
TCP   0.0.0.0:7680            LAPTOP:0                LISTENING
TCP   0.0.0.0:19575           LAPTOP:0                LISTENING
TCP   0.0.0.0:19576           LAPTOP:0                LISTENING
TCP   0.0.0.0:19577           LAPTOP:0                LISTENING
TCP   0.0.0.0:28451           LAPTOP:0                LISTENING
TCP   0.0.0.0:28459           LAPTOP:0                LISTENING
TCP   0.0.0.0:33060           LAPTOP:0                LISTENING
TCP   0.0.0.0:49664           LAPTOP:0                LISTENING
TCP   0.0.0.0:49665           LAPTOP:0                LISTENING
TCP   0.0.0.0:49666           LAPTOP:0                LISTENING
TCP   0.0.0.0:49667           LAPTOP:0                LISTENING
TCP   0.0.0.0:49668           LAPTOP:0                LISTENING
TCP   0.0.0.0:49687           LAPTOP:0                LISTENING
TCP   0.0.0.0:56891           LAPTOP:0                LISTENING
TCP   127.0.0.1:1234          kubernetes:49575        TIME_WAIT
TCP   127.0.0.1:1234          kubernetes:57862        ESTABLISHED
TCP   127.0.0.1:2015          LAPTOP:0                LISTENING
TCP   127.0.0.1:8053          LAPTOP:0                LISTENING
TCP   127.0.0.1:49679         kubernetes:49680        ESTABLISHED
TCP   127.0.0.1:49680         kubernetes:49679        ESTABLISHED
TCP   127.0.0.1:49681         kubernetes:49682        ESTABLISHED
TCP   127.0.0.1:49682         kubernetes:49681        ESTABLISHED
TCP   127.0.0.1:51533         LAPTOP:0                LISTENING
TCP   127.0.0.1:56181         kubernetes:56182        ESTABLISHED
TCP   127.0.0.1:56182         kubernetes:56181        ESTABLISHED
TCP   127.0.0.1:56183         kubernetes:56205        ESTABLISHED
TCP   127.0.0.1:56200         LAPTOP:0                LISTENING
TCP   127.0.0.1:56205         kubernetes:56183        ESTABLISHED
TCP   127.0.0.1:56253         LAPTOP:0                LISTENING
TCP   127.0.0.1:57841         kubernetes:1234         TIME_WAIT
TCP   127.0.0.1:57862         kubernetes:1234         ESTABLISHED
TCP   169.254.74.75:139       LAPTOP:0                LISTENING
TCP   169.254.152.39:139      LAPTOP:0                LISTENING
TCP   192.168.0.104:139       LAPTOP:0                LISTENING
TCP   192.168.0.104:49500     172.64.155.209:https    ESTABLISHED
TCP   192.168.0.104:49502     104.18.32.47:https      ESTABLISHED
TCP   192.168.0.104:49536     52.123.253.81:https     ESTABLISHED
TCP   192.168.0.104:49552     1:https                 ESTABLISHED
TCP   192.168.0.104:49570     server-54-192-142-18:https ESTABLISHED

PS C:\Users\anish> |
```

Q4.

a.

1. To get an authoritative answer from google.in, first we have to find the address of google.in, and that can be found using the command: `nslookup -type=ns google.in`

```
anish@LAPTOP:~$ nslookup -type=ns google.in
Server:      192.168.1.7
Address:     192.168.1.7#53

Non-authoritative answer:
google.in    nameserver = ns3.google.com.
google.in    nameserver = ns2.google.com.
google.in    nameserver = ns1.google.com.
google.in    nameserver = ns4.google.com.

Authoritative answers can be found from:
ns3.google.com internet address = 216.239.36.10
ns2.google.com internet address = 216.239.34.10
ns1.google.com internet address = 216.239.32.10
ns1.google.com has AAAA address 2001:4860:4802:32::a
ns4.google.com internet address = 216.239.38.10
```

2. And notice the above output, that we can get an authoritative answer at addresses.
3. So, for that, we just have to query DNS server of google using: `nslookup google.in 216.239.36.10` (we can use any of the authoritative addresses).

```
anish@LAPTOP:~$ nslookup www.google.in 216.239.32.10
Server:      216.239.32.10
Address:     216.239.32.10#53

Name:   www.google.in
Address: 142.250.207.227
Name:   www.google.in
Address: 2404:6800:4002:82f::2003
```

4. And we got an authoritative answer from google.in.

b.

1. **TTL (Time to Live):** Maximum number of hops the data packet can pass before being discarded.
2. To find value of TTL, we use the debug option present in `nslookup` command with the website we want to find the TTL, i.e. `nslookup -debug google.in`

```
anish@LAPTOP:~$ 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 = 188
AUTHORITY RECORDS:
ADDITIONAL RECORDS:
-----
Non-authoritative answer:
Name:   google.in
Address: 142.250.193.4
-----
QUESTIONS:
  google.in, type = AAAA, class = IN
ANSWERS:
-> google.in
  has AAAA address 2404:6800:4002:819::2004
  ttl = 188
AUTHORITY RECORDS:
ADDITIONAL RECORDS:
-----
Name:   google.in
Address: 2404:6800:4002:819::2004
anish@LAPTOP:~$
```

3. And we notice, we got the TTL = 188 (i.e. packet can pass through 188 routers/hops before it is discarded).

Q5.

a.

```
C:\Windows\System32>tracert google.in

Tracing route to google.in [142.250.193.4]
over a maximum of 30 hops:

  0  23 ms  22 ms  13 ms  192.168.32.254
  1 1226 ms   5 ms   1 ms  auth.iiitd.edu.in [192.168.1.99]
  2  34 ms  10 ms   3 ms  103.25.231.1
  3  *      *      *      Request timed out.
  4  4 ms   6 ms   9 ms  10.119.234.162
  5  4 ms   4 ms   4 ms  72.14.195.56
  6 51 ms  46 ms  46 ms  142.251.54.111
  7 41 ms  51 ms  41 ms  142.251.54.89
  8 54 ms  45 ms  44 ms  del11s14-in-f4.1e100.net [142.250.193.4]

Trace complete.
```

Number of Intermediate hosts = 7

Hop 1: 192.168.32.254, Avg Latency: $(23 + 22 + 13) / 3 = 19.3$ ms

Hop 2: 192.168.1.99, Avg Latency: $(1226 + 5 + 1) / 3 = 410.7$ ms

Hop 3: 103.25.231.1, Avg Latency: $(34 + 10 + 3) / 3 = 15.7$ ms

Hop 5: 10.119.234.162, Avg Latency: $(4 + 6 + 9) / 3 = 6.3$ ms

Hop 6: 72.14.195.56, Avg Latency: $(4 + 4 + 4) / 3 = 4.0$ ms

Hop 7: 142.251.54.111, Avg Latency: $(51 + 46 + 46) / 3 = 47.7$ ms

Hop 8: 142.251.54.89, Avg Latency: $(41 + 51 + 41) / 3 = 44.3$ ms

Hop 9 (Destination): 142.250.193.4, Avg Latency: $(54 + 45 + 44) / 3 = 47.7$ ms

b. **Average Latency:** 51ms

```
C:\Windows\System32>ping google.in -n 50

Pinging google.in [142.250.193.4] with 32 bytes of data:
Reply from 142.250.193.4: bytes=32 time=59ms TTL=112
Reply from 142.250.193.4: bytes=32 time=46ms TTL=112
Reply from 142.250.193.4: bytes=32 time=48ms TTL=112
Reply from 142.250.193.4: bytes=32 time=55ms TTL=112
Reply from 142.250.193.4: bytes=32 time=55ms TTL=112
Reply from 142.250.193.4: bytes=32 time=45ms TTL=112
Reply from 142.250.193.4: bytes=32 time=48ms TTL=112
Reply from 142.250.193.4: bytes=32 time=45ms TTL=112
Reply from 142.250.193.4: bytes=32 time=45ms TTL=112
Reply from 142.250.193.4: bytes=32 time=45ms TTL=112
Reply from 142.250.193.4: bytes=32 time=55ms TTL=112
Reply from 142.250.193.4: bytes=32 time=48ms TTL=112
Reply from 142.250.193.4: bytes=32 time=45ms TTL=112
Reply from 142.250.193.4: bytes=32 time=45ms TTL=112
Reply from 142.250.193.4: bytes=32 time=55ms TTL=112
Reply from 142.250.193.4: bytes=32 time=44ms TTL=112
Reply from 142.250.193.4: bytes=32 time=50ms TTL=112
Reply from 142.250.193.4: bytes=32 time=45ms TTL=112
Reply from 142.250.193.4: bytes=32 time=55ms TTL=112
Reply from 142.250.193.4: bytes=32 time=55ms TTL=112
Reply from 142.250.193.4: bytes=32 time=45ms TTL=112
Reply from 142.250.193.4: bytes=32 time=45ms TTL=112
Reply from 142.250.193.4: bytes=32 time=45ms TTL=112
Reply from 142.250.193.4: bytes=32 time=153ms TTL=112
Reply from 142.250.193.4: bytes=32 time=57ms TTL=112
Reply from 142.250.193.4: bytes=32 time=55ms TTL=112
```

```

Reply from 142.250.193.4: bytes=32 time=54ms TTL=112
Reply from 142.250.193.4: bytes=32 time=45ms TTL=112
Reply from 142.250.193.4: bytes=32 time=55ms TTL=112
Reply from 142.250.193.4: bytes=32 time=45ms TTL=112
Reply from 142.250.193.4: bytes=32 time=46ms TTL=112
Reply from 142.250.193.4: bytes=32 time=45ms TTL=112
Reply from 142.250.193.4: bytes=32 time=55ms TTL=112
Reply from 142.250.193.4: bytes=32 time=55ms TTL=112
Reply from 142.250.193.4: bytes=32 time=54ms TTL=112
Reply from 142.250.193.4: bytes=32 time=45ms TTL=112
Reply from 142.250.193.4: bytes=32 time=45ms TTL=112
Reply from 142.250.193.4: bytes=32 time=54ms TTL=112
Reply from 142.250.193.4: bytes=32 time=55ms TTL=112
Reply from 142.250.193.4: bytes=32 time=46ms TTL=112
Reply from 142.250.193.4: bytes=32 time=46ms TTL=112
Reply from 142.250.193.4: bytes=32 time=55ms TTL=112
Reply from 142.250.193.4: bytes=32 time=53ms TTL=112
Reply from 142.250.193.4: bytes=32 time=54ms TTL=112
Reply from 142.250.193.4: bytes=32 time=45ms TTL=112

Ping statistics for 142.250.193.4:
    Packets: Sent = 50, Received = 50, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 44ms, Maximum = 153ms, Average = 51ms

```

c. **Sum of latencies of all intermediate hops in part(a):**

$19.3 + 410.7 + 15.7 + 6.3 + 4.0 + 47.7 + 44.3 = \underline{548ms}$

And, Average Latency obtained in part(B): 51ms

Sum of latencies obtained in part(a) is greater than overall ping latency because ping latency represents the complete round trip to the destination and back and might use optimised/best paths, but in case of latencies of intermediate hops, they include multiple packets and some of which overlap due to multiple paths, and they might not use best/optimised path.

d. **Maximum Latency among intermediate hops: 1276ms**

Average Ping Latency to google.in: **51ms**

The maximum latency observed among intermediate hops is much higher, and there might be a possibility of network congestion at a specific hop, and Ping cmd uses a more stable path and thus shows a lower average latency.

e. **Multiple entries for a single hop indicate that there might be multiple routes/paths to reach the same destination, possibly due to routing changes within the network.**

f.

```

C:\Windows\System32>ping stanford.edu -n 50

Pinging stanford.edu [171.67.215.200] with 32 bytes of data:
Reply from 171.67.215.200: bytes=32 time=292ms TTL=242
Reply from 171.67.215.200: bytes=32 time=292ms TTL=242
Reply from 171.67.215.200: bytes=32 time=292ms TTL=242
Reply from 171.67.215.200: bytes=32 time=292ms TTL=242
Reply from 171.67.215.200: bytes=32 time=292ms TTL=242
Reply from 171.67.215.200: bytes=32 time=292ms TTL=242
Reply from 171.67.215.200: bytes=32 time=293ms TTL=242
Reply from 171.67.215.200: bytes=32 time=291ms TTL=242
Reply from 171.67.215.200: bytes=32 time=292ms TTL=242
Reply from 171.67.215.200: bytes=32 time=292ms TTL=242
Reply from 171.67.215.200: bytes=32 time=291ms TTL=242
Reply from 171.67.215.200: bytes=32 time=292ms TTL=242
Reply from 171.67.215.200: bytes=32 time=292ms TTL=242
Reply from 171.67.215.200: bytes=32 time=296ms TTL=242
Reply from 171.67.215.200: bytes=32 time=292ms TTL=242
Reply from 171.67.215.200: bytes=32 time=291ms TTL=242
Reply from 171.67.215.200: bytes=32 time=292ms TTL=242
Reply from 171.67.215.200: bytes=32 time=292ms TTL=242
Reply from 171.67.215.200: bytes=32 time=291ms TTL=242
Reply from 171.67.215.200: bytes=32 time=293ms TTL=242

```



```

Reply from 171.67.215.200: bytes=32 time=293ms TTL=242
Reply from 171.67.215.200: bytes=32 time=292ms TTL=242
Reply from 171.67.215.200: bytes=32 time=292ms TTL=242
Reply from 171.67.215.200: bytes=32 time=292ms TTL=242
Reply from 171.67.215.200: bytes=32 time=292ms TTL=242
Reply from 171.67.215.200: bytes=32 time=292ms TTL=242
Reply from 171.67.215.200: bytes=32 time=680ms TTL=242
Reply from 171.67.215.200: bytes=32 time=292ms TTL=242
Reply from 171.67.215.200: bytes=32 time=291ms TTL=242
Reply from 171.67.215.200: bytes=32 time=292ms TTL=242
Reply from 171.67.215.200: bytes=32 time=291ms TTL=242
Reply from 171.67.215.200: bytes=32 time=293ms TTL=242
Reply from 171.67.215.200: bytes=32 time=292ms TTL=242
Reply from 171.67.215.200: bytes=32 time=287ms TTL=242
Reply from 171.67.215.200: bytes=32 time=291ms TTL=242
Reply from 171.67.215.200: bytes=32 time=293ms TTL=242
Reply from 171.67.215.200: bytes=32 time=282ms TTL=242
Reply from 171.67.215.200: bytes=32 time=282ms TTL=242
Reply from 171.67.215.200: bytes=32 time=292ms TTL=242
Reply from 171.67.215.200: bytes=32 time=282ms TTL=242
Reply from 171.67.215.200: bytes=32 time=282ms TTL=242
Reply from 171.67.215.200: bytes=32 time=293ms TTL=242
Reply from 171.67.215.200: bytes=32 time=292ms TTL=242
Reply from 171.67.215.200: bytes=32 time=282ms TTL=242
Reply from 171.67.215.200: bytes=32 time=282ms TTL=242
Reply from 171.67.215.200: bytes=32 time=288ms TTL=242
Reply from 171.67.215.200: bytes=32 time=282ms TTL=242
Reply from 171.67.215.200: bytes=32 time=293ms TTL=242

Ping statistics for 171.67.215.200:
    Packets: Sent = 50, Received = 50, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 282ms, Maximum = 680ms, Average = 298ms

```

Average Ping Latency: **298ms**

g.

```

C:\Windows\System32>tracert stanford.edu

Tracing route to stanford.edu [171.67.215.200]
over a maximum of 30 hops:

  0  38 ms  60 ms  34 ms  192.168.32.254
  1  11 ms  11 ms  1 ms  auth.iiitd.edu.in [192.168.1.99]
  2  13 ms  18 ms  4 ms  103.25.231.1
  3  37 ms  28 ms  28 ms  10.1.209.201
  4  28 ms  28 ms  25 ms  10.1.200.137
  5  47 ms  46 ms  51 ms  10.255.238.254
  6  30 ms  29 ms  30 ms  180.149.48.18
  7  *      *      *      Request timed out.
  8  *      *      *      Request timed out.
  9  *      *      *      Request timed out.
 10  *      *      *      Request timed out.
 11  *      *      *      Request timed out.
 12  *      *      *      Request timed out.
 13  *      *      *      Request timed out.
 14  *      *      *      Request timed out.
 15  *      *      *      Request timed out.
 16  *      *      *      Request timed out.
 17  *      *      *      Request timed out.
 18  *      *      *      Request timed out.
 19  *      *      *      Request timed out.
 20  *      *      *      Request timed out.
 21  *      *      *      Request timed out.
 22  *      *      *      Request timed out.
 23 283 ms 285 ms 282 ms campus-east-rtr-v1020.SUNet [171.64.255.232]
 24  *      *      *      Request timed out.
 25 284 ms 282 ms 292 ms web.stanford.edu [171.67.215.200]

Trace complete.

```

Number of hops in reaching **google.in**: 9

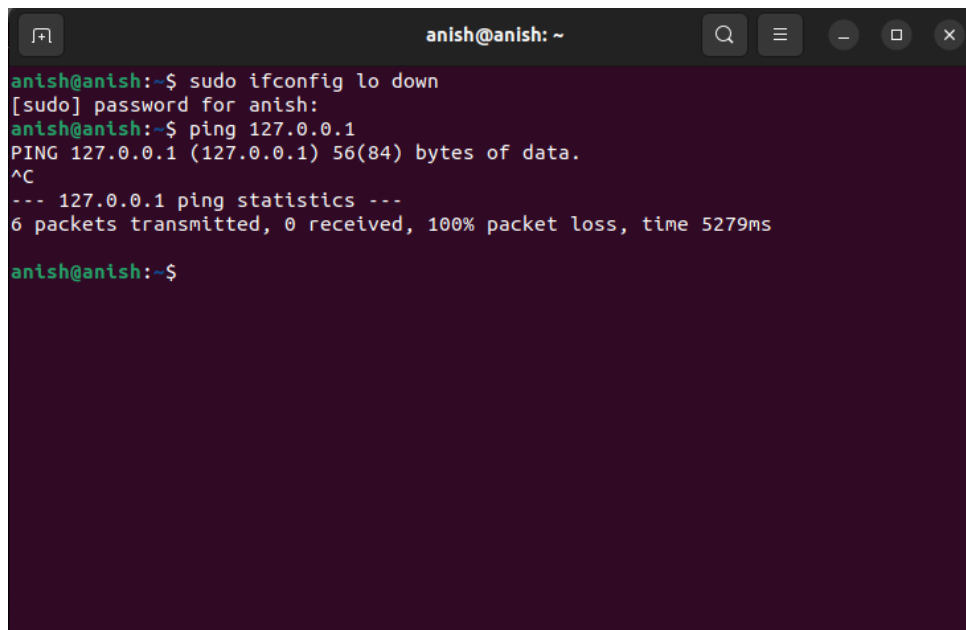
Number of hops in reaching **Stanford.edu**: 25

Traceroute to Stanford has significantly more hops compared to Google, suggesting a longer or more complex route to reach Stanford's servers.

- h. The difference in latency between google and Stanford is due to the distance and network path chosen. We might say that, as latency in reaching google server is less than reaching to Stanford servers because google servers might be closer to us than the Stanford servers.

Q6.

1. To make a ping command fail and 100% packet fail, we have to down our port.
2. Then we can simply use the ping command and notice the 100% packet loss.
3. And, after that, we up the down port.

A terminal window titled 'anish@anish: ~' with standard window controls. The user enters 'sudo ifconfig lo down' and provides a password. Then, they enter 'ping 127.0.0.1'. The output shows 'PING 127.0.0.1 (127.0.0.1) 56(84) bytes of data.' followed by a carriage return '^C'. Then, it shows '--- 127.0.0.1 ping statistics ---' and '6 packets transmitted, 0 received, 100% packet loss, time 5279ms'. The prompt returns to 'anish@anish:~\$'.

```
anish@anish:~$ sudo ifconfig lo down
[sudo] password for anish:
anish@anish:~$ ping 127.0.0.1
PING 127.0.0.1 (127.0.0.1) 56(84) bytes of data.
^C
--- 127.0.0.1 ping statistics ---
6 packets transmitted, 0 received, 100% packet loss, time 5279ms
anish@anish:~$
```

Thank You