

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

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Q1. [1 + 1]

a) Learn to use the `ifconfig` command, and figure out the IP address of your network interface. Put a screenshot.

b) Go to the webpage <https://www.whatismyip.com> and find out what IP is shown for your machine. Are they identical or different? Why?

Ans 1. a)

```
sidhartha@LAPTOP-VM0EA2TI:/mnt/c/Users/Sidhartha Garg$ ifconfig
eth0: flags=4163<UP,BROADCAST,RUNNING,MULTICAST> mtu 1492
    inet 172.20.45.228 netmask 255.255.240.0 broadcast 172.20.47.255
    inet6 fe80::215:5dff:fe90:d581 prefixlen 64 scopeid 0x20<link>
    ether 00:15:5d:90:d5:81 txqueuelen 1000 (Ethernet)
    RX packets 342 bytes 63101 (63.1 KB)
    RX errors 0 dropped 0 overruns 0 frame 0
    TX packets 16 bytes 1336 (1.3 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 77 bytes 7737 (7.7 KB)
    RX errors 0 dropped 0 overruns 0 frame 0
    TX packets 77 bytes 7737 (7.7 KB)
    TX errors 0 dropped 0 overruns 0 carrier 0 collisions 0
```

One can figure out the IP address from the `inet` in `eth0` network interface. Here, for the WSL, we see that the IPv4 IP address is `172.20.45.228`. Similarly, the IPv6 address can be found by observing the `inet6` in the `eth0` interface.

****this is for the wsl2 instance on my windows laptop**

b)

What Is My IP?

My Public IPv4: [122.161.53.245](#) 

My Public IPv6: [2401:4900:1c5b:5030:21ce:941f:ccd7:d536](#) 

My IP Location: Noida, UP IN 

My ISP: Bharti Airtel Ltd. 

We can observe that the IP addresses are different because the IP address displayed by `ifconfig` corresponds to the local (private) IP address, while the IP address shown on the website represents the public IP address.

Q.2. [1+1+1]

a) Change the IP address of your network interface using the command line. Put a screenshot that shows the change. Revert to the original IP address.

Ans2. a) We can change the IP address of the network interface using the command `ifconfig <interface_name> <new_ip_address>`. As we can see sudo permission was required at my station before implementing this.

```
sidhartha@LAPTOP-VM0EA2TI:/mnt/c/Users/Sidhartha Garg$ sudo ifconfig eth0 172.20.45.1
[sudo] password for sidhartha:
sidhartha@LAPTOP-VM0EA2TI:/mnt/c/Users/Sidhartha Garg$ ifconfig
eth0: flags=4163<UP,BROADCAST,RUNNING,MULTICAST> mtu 1492
    inet 172.20.45.1 netmask 255.255.0.0 broadcast 172.20.255.255
    inet6 fe80::215:5dff:fe90:d581 prefixlen 64 scopeid 0x20<link>
    ether 00:15:5d:90:d5:81 txqueuelen 1000 (Ethernet)
    RX packets 545 bytes 126699 (126.6 KB)
    RX errors 0 dropped 0 overruns 0 frame 0
    TX packets 17 bytes 1406 (1.4 KB)
    TX errors 0 dropped 0 overruns 0 carrier 0 collisions 0
```

We can revert back to the original IP address now using the same command:

```
sidhartha@LAPTOP-VM0EA2TI:/mnt/c/Users/Sidhartha Garg$ sudo ifconfig eth0 172.20.45.228
sidhartha@LAPTOP-VM0EA2TI:/mnt/c/Users/Sidhartha Garg$ ifconfig
eth0: flags=4163<UP,BROADCAST,RUNNING,MULTICAST> mtu 1492
    inet 172.20.45.228 netmask 255.255.0.0 broadcast 172.20.255.255
    inet6 fe80::215:5dff:fe90:d581 prefixlen 64 scopeid 0x20<link>
    ether 00:15:5d:90:d5:81 txqueuelen 1000 (Ethernet)
    RX packets 614 bytes 146865 (146.8 KB)
    RX errors 0 dropped 0 overruns 0 frame 0
    TX packets 17 bytes 1406 (1.4 KB)
    TX errors 0 dropped 0 overruns 0 carrier 0 collisions 0
```

Q.3. [4]

a) Use `netcat` to set up a TCP client/server connection between your VM and host machine. If you are not using a VM, you can set up the connection with localhost. Put a screenshot. [1+1]

b) Determine the state of this TCP connection(s) at the client node. Put a screenshot. [1 + 1]

Ans3. a) I establish a server-client connection between Windows and WSL using Telnet and Netcat:

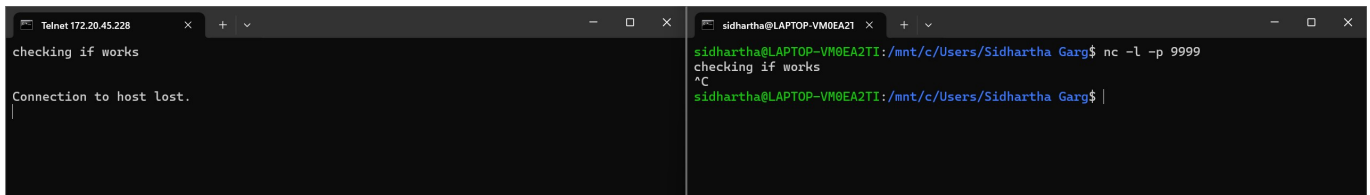
On my WSL terminal:

1. Open the terminal.
2. Type `nc -l -p <PORT_NUMBER>` using the same as a user defined port number.

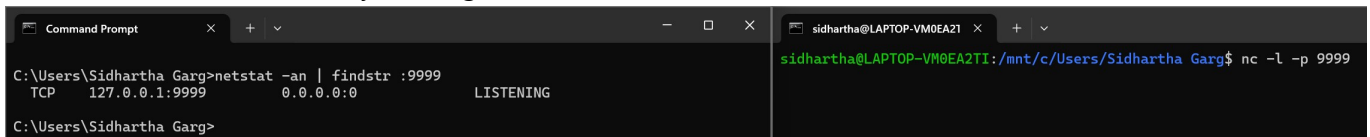
On my Windows machine:

1. Open Command Prompt or PowerShell.
2. Type `telnet <WSL_IP_ADDRESS> <PORT_NUMBER>` (replacing the placeholders with my WSL IP and port) and press Enter to connect.

This sets up the connection, allowing me to communicate between Windows and WSL. When I'm finished, I close the Telnet connection and stop the Netcat server.



b) Using the `nc -l -p 9999` command on WSL to listen on port 9999 is actively reflected on the Windows host, as verified by the `netstat -an | findstr :9999` command. This demonstrates that the Netcat listener on WSL is successfully running and can be monitored from the Windows environment.



Further, connecting to the port using the WSL IP and port number will lead to establishing the connection.

Q.4. nslookup ([2 + 1] + [1 + 1])

a) Get an authoritative result for "google.in" using nslookup. Put a screenshot. Explain how you did it.

b) Find out the time to live for any website on the local DNS. Put a screenshot. Explain in words (with unit) after how much time this entry would expire from the local DNS server.

Ans4. a) In the screenshot, I used the `nslookup` command to query DNS information for the domain `google.in`.

First Command: By running `nslookup -type=soa google.in`, I retrieved the Start of Authority (SOA) record for `google.in`, which provides details about the primary DNS server responsible for the domain, along with timing parameters like refresh, retry, expire, and minimum TTL.

Second Command: I then used `nslookup google.in ns1.google.com` to query the domain `google.in` specifically from the DNS server `ns1.google.com`, which is one of Google's authoritative name servers. By querying directly from an authoritative name server, I ensured that the response was authoritative, meaning it came directly from the source responsible for the domain.

```
sidhartha@LAPTOP-VM0EA2TI:/mnt/c/Users/Sidhartha Garg$ nslookup -type=soa google.in
Server:      10.255.255.254
Address:     10.255.255.254#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:
google.in      nameserver = ns1.google.com.
google.in      nameserver = ns3.google.com.
google.in      nameserver = ns4.google.com.
google.in      nameserver = ns2.google.com.

sidhartha@LAPTOP-VM0EA2TI:/mnt/c/Users/Sidhartha Garg$ nslookup google.in ns1.google.com
Server:      ns1.google.com
Address:     216.239.32.10#53

Name:   google.in
Address: 172.217.167.196
Name:   google.in
Address: 2404:6800:4002:80d::2004
```

b)

- TTL stands for "Time to Live".
- It is a value that is used to determine the maximum amount of time the packet can remain in the network before it is discarded.
- We can find it using `nslookup -debug <domain_name>`.
- It is measured in **seconds**.

```

sidhartha@LAPTOP-VM0EA2TI:/mnt/c/Users/Sidhartha Garg$ nslookup -debug google.com
Server:      10.255.255.254
Address:     10.255.255.254#53

-----
QUESTIONS:
  google.com, type = A, class = IN
ANSWERS:
-> google.com
  internet address = 142.250.193.238
  ttl = 279
AUTHORITY RECORDS:
ADDITIONAL RECORDS:
-----
Non-authoritative answer:
Name:   google.com
Address: 142.250.193.238
-----
QUESTIONS:
  google.com, type = AAAA, class = IN
ANSWERS:
-> google.com
  has AAAA address 2404:6800:4002:823::200e
  ttl = 279
AUTHORITY RECORDS:
ADDITIONAL RECORDS:
-----
Name:   google.com
Address: 2404:6800:4002:823::200e

```

Here, we see the ttl is 279 seconds.

Q.5. [13]

a) Run the command, `tracert google.in`. How many intermediate hosts do you see? What are the IP addresses? Compute the average latency to each intermediate host. Put a screenshot. [1+2+1] Note that some of the intermediate hosts might not be visible; their IP addresses will come as `***`, ignore those hosts for this assignment.

Ans) There are a total 8 intermediate hosts which can be seen in the picture, one of which is `***` which will be excluded while doing the calculation of average latency.

```

sidhartha@LAPTOP-VM0EA2TI:/mnt/c/Users/Sidhartha Garg$ traceroute google.in
traceroute to google.in (142.250.193.228), 30 hops max, 60 byte packets
 1 LAPTOP-VM0EA2TI.mshome.net (172.20.32.1)  0.401 ms  0.380 ms  0.370 ms
 2 192.168.1.1 (192.168.1.1)  12.600 ms  12.591 ms  12.581 ms
 3 abts-north-static-068.127.176.122.airtelbroadband.in (122.176.127.68)  14.242 ms  14.232 ms  14.219 ms
 4 182.79.117.225 (182.79.117.225)  22.986 ms  182.79.117.229 (182.79.117.229)  14.179 ms  182.79.117.225 (182.79.117.225)  22.969 ms
 5 * * 116.119.73.220 (116.119.73.220)  14.143 ms
 6 72.14.222.126 (72.14.222.126)  22.952 ms  21.585 ms  21.567 ms
 7 * * *
 8 172.253.73.194 (172.253.73.194)  10.923 ms  142.251.76.198 (142.251.76.198)  14.890 ms  172.253.67.98 (172.253.67.98)  14.853 ms
 9 216.239.50.22 (216.239.50.22)  14.840 ms  142.251.54.101 (142.251.54.101)  12.904 ms  142.251.54.99 (142.251.54.99)  14.729 ms
10 del11s18-in-f4.1e100.net (142.250.193.228)  12.843 ms  192.178.82.237 (192.178.82.237)  49.252 ms  14.683 ms

```

Hop	IP Addresses	Average Latency (ms)
2	192.168.1.1	12.502
3	122.176.127.68	14.231
4	182.79.117.225, 182.79.117.229	20.045

Hop	IP Addresses	Average Latency (ms)
5	116.119.73.220	14.143
6	72.14.222.126	22.035
7	* (No response)	-
8	172.253.73.194, 142.251.76.198, 172.253.67.98	13.555
9	216.239.50.121, 142.251.54.101, 142.251.54.99	14.158

b) Send 50 ping messages to google.in, Determine the average latency. Put a screenshot. [1]

Ans) We can do this by using the command `ping -c 50 google.in`. Here the flag `-c`, specifies the count of packets to be sent. In this case the number is 50. As can be seen in the screenshot the average latency is `12.982 ms`.


```

sidhartha@LAPTOP-VM0EA2TI:/mnt/c/Users/Sidhartha Garg$ ping -c 50 google.in
PING google.in (142.250.194.228) 56(84) bytes of data:
64 bytes from del12s08-in-f4.1e100.net (142.250.194.228): icmp_seq=1 ttl=118 time=10.9 ms
64 bytes from del12s08-in-f4.1e100.net (142.250.194.228): icmp_seq=2 ttl=118 time=13.9 ms
64 bytes from del12s08-in-f4.1e100.net (142.250.194.228): icmp_seq=3 ttl=118 time=9.95 ms
64 bytes from del12s08-in-f4.1e100.net (142.250.194.228): icmp_seq=4 ttl=118 time=10.2 ms
64 bytes from del12s08-in-f4.1e100.net (142.250.194.228): icmp_seq=5 ttl=118 time=11.9 ms
64 bytes from del12s08-in-f4.1e100.net (142.250.194.228): icmp_seq=6 ttl=118 time=12.6 ms
64 bytes from del12s08-in-f4.1e100.net (142.250.194.228): icmp_seq=7 ttl=118 time=10.6 ms
64 bytes from del12s08-in-f4.1e100.net (142.250.194.228): icmp_seq=8 ttl=118 time=11.0 ms
64 bytes from del12s08-in-f4.1e100.net (142.250.194.228): icmp_seq=9 ttl=118 time=10.5 ms
64 bytes from del12s08-in-f4.1e100.net (142.250.194.228): icmp_seq=10 ttl=118 time=9.65 ms
64 bytes from del12s08-in-f4.1e100.net (142.250.194.228): icmp_seq=11 ttl=118 time=13.6 ms
64 bytes from del12s08-in-f4.1e100.net (142.250.194.228): icmp_seq=12 ttl=118 time=10.0 ms
64 bytes from del12s08-in-f4.1e100.net (142.250.194.228): icmp_seq=13 ttl=118 time=10.5 ms
64 bytes from del12s08-in-f4.1e100.net (142.250.194.228): icmp_seq=14 ttl=118 time=11.7 ms
64 bytes from del12s08-in-f4.1e100.net (142.250.194.228): icmp_seq=15 ttl=118 time=10.9 ms
64 bytes from del12s08-in-f4.1e100.net (142.250.194.228): icmp_seq=16 ttl=118 time=9.46 ms
64 bytes from del12s08-in-f4.1e100.net (142.250.194.228): icmp_seq=17 ttl=118 time=10.2 ms
64 bytes from del12s08-in-f4.1e100.net (142.250.194.228): icmp_seq=18 ttl=118 time=9.99 ms
64 bytes from del12s08-in-f4.1e100.net (142.250.194.228): icmp_seq=19 ttl=118 time=12.7 ms
64 bytes from del12s08-in-f4.1e100.net (142.250.194.228): icmp_seq=20 ttl=118 time=10.7 ms
64 bytes from del12s08-in-f4.1e100.net (142.250.194.228): icmp_seq=21 ttl=118 time=11.6 ms
64 bytes from del12s08-in-f4.1e100.net (142.250.194.228): icmp_seq=22 ttl=118 time=10.8 ms
64 bytes from del12s08-in-f4.1e100.net (142.250.194.228): icmp_seq=23 ttl=118 time=27.4 ms
64 bytes from del12s08-in-f4.1e100.net (142.250.194.228): icmp_seq=24 ttl=118 time=10.2 ms
64 bytes from del12s08-in-f4.1e100.net (142.250.194.228): icmp_seq=25 ttl=118 time=14.6 ms
64 bytes from del12s08-in-f4.1e100.net (142.250.194.228): icmp_seq=26 ttl=118 time=10.6 ms
64 bytes from del12s08-in-f4.1e100.net (142.250.194.228): icmp_seq=27 ttl=118 time=27.8 ms
64 bytes from del12s08-in-f4.1e100.net (142.250.194.228): icmp_seq=28 ttl=118 time=11.3 ms
64 bytes from del12s08-in-f4.1e100.net (142.250.194.228): icmp_seq=29 ttl=118 time=23.7 ms
64 bytes from del12s08-in-f4.1e100.net (142.250.194.228): icmp_seq=30 ttl=118 time=24.2 ms
64 bytes from del12s08-in-f4.1e100.net (142.250.194.228): icmp_seq=31 ttl=118 time=11.4 ms
64 bytes from del12s08-in-f4.1e100.net (142.250.194.228): icmp_seq=32 ttl=118 time=14.1 ms
64 bytes from del12s08-in-f4.1e100.net (142.250.194.228): icmp_seq=33 ttl=118 time=27.0 ms
64 bytes from del12s08-in-f4.1e100.net (142.250.194.228): icmp_seq=34 ttl=118 time=10.3 ms
64 bytes from del12s08-in-f4.1e100.net (142.250.194.228): icmp_seq=35 ttl=118 time=11.0 ms
64 bytes from del12s08-in-f4.1e100.net (142.250.194.228): icmp_seq=36 ttl=118 time=13.2 ms
64 bytes from del12s08-in-f4.1e100.net (142.250.194.228): icmp_seq=37 ttl=118 time=11.7 ms
64 bytes from del12s08-in-f4.1e100.net (142.250.194.228): icmp_seq=38 ttl=118 time=11.1 ms
64 bytes from del12s08-in-f4.1e100.net (142.250.194.228): icmp_seq=39 ttl=118 time=10.9 ms
64 bytes from del12s08-in-f4.1e100.net (142.250.194.228): icmp_seq=40 ttl=118 time=12.2 ms
64 bytes from del12s08-in-f4.1e100.net (142.250.194.228): icmp_seq=41 ttl=118 time=11.9 ms
64 bytes from del12s08-in-f4.1e100.net (142.250.194.228): icmp_seq=42 ttl=118 time=10.3 ms
64 bytes from del12s08-in-f4.1e100.net (142.250.194.228): icmp_seq=43 ttl=118 time=11.1 ms
64 bytes from del12s08-in-f4.1e100.net (142.250.194.228): icmp_seq=44 ttl=118 time=17.9 ms
64 bytes from del12s08-in-f4.1e100.net (142.250.194.228): icmp_seq=45 ttl=118 time=10.7 ms
64 bytes from del12s08-in-f4.1e100.net (142.250.194.228): icmp_seq=46 ttl=118 time=13.6 ms
64 bytes from del12s08-in-f4.1e100.net (142.250.194.228): icmp_seq=47 ttl=118 time=16.3 ms
64 bytes from del12s08-in-f4.1e100.net (142.250.194.228): icmp_seq=48 ttl=118 time=10.4 ms
64 bytes from del12s08-in-f4.1e100.net (142.250.194.228): icmp_seq=49 ttl=118 time=10.6 ms
64 bytes from del12s08-in-f4.1e100.net (142.250.194.228): icmp_seq=50 ttl=118 time=10.3 ms

--- google.in ping statistics ---
50 packets transmitted, 50 received, 0% packet loss, time 49081ms
rtt min/avg/max/mdev = 9.458/12.982/27.805/4.680 ms

```

c) Add up the ping latency of all the intermediate hosts obtained in (a) and compare with (b). Are they matching, explain? [1+1]

The sum of ping latency of all the intermediate hosts in (a) comes out to be **110.699 ms**. The average latency calculated in (b) is **12.982 ms**. We see both of them don't match and even the average of the sum in the first part which is **13.83 ms** doesn't match with the calculation of (b). Two reason which I think effect this:

- Network conditions can change between tests, affecting latency.
- Traceroute may take a different path than direct pings, potentially involving more hops or less optimal routes.

d) Take the maximum ping latency amongst the intermediate hosts (in (a)) and compare it with (b). Are they matching, explain? [1+1]

Ans) The maximum ping latency in (a) is **22.035 ms**. We see this does not match with the average calculated in (b) which is **12.982 ms**.

This happens mainly because of network conditions which can fluctuate due to various factors like traffic congestion, routing changes, or temporary interference.

e) You may see multiple entries for a single hop while using the traceroute command. What do these entries mean? [1]

Ans) Multiple hops typically indicates that the router at that hop has multiple routes to the destination and is performing per-packet load balancing.

f) Send 50 ping messages to stanford.edu, Determine the average latency. Put a screenshot.[1]

Ans) We can see the average latency is 306.686 ms.

```
sidhartha@LAPTOP-VM0EA2TI:/mnt/c/Users/Sidhartha Garg$ ping -c 50 stanford.edu
PING stanford.edu (171.67.215.200) 56(84) bytes of data:
64 bytes from web.stanford.edu (171.67.215.200): icmp_seq=1 ttl=246 time=344 ms
64 bytes from web.stanford.edu (171.67.215.200): icmp_seq=2 ttl=246 time=321 ms
64 bytes from web.stanford.edu (171.67.215.200): icmp_seq=3 ttl=246 time=349 ms
64 bytes from web.stanford.edu (171.67.215.200): icmp_seq=4 ttl=246 time=254 ms
64 bytes from web.stanford.edu (171.67.215.200): icmp_seq=5 ttl=246 time=255 ms
64 bytes from web.stanford.edu (171.67.215.200): icmp_seq=6 ttl=246 time=253 ms
64 bytes from web.stanford.edu (171.67.215.200): icmp_seq=7 ttl=246 time=257 ms
64 bytes from web.stanford.edu (171.67.215.200): icmp_seq=8 ttl=246 time=331 ms
64 bytes from web.stanford.edu (171.67.215.200): icmp_seq=9 ttl=246 time=392 ms
64 bytes from web.stanford.edu (171.67.215.200): icmp_seq=10 ttl=246 time=275 ms
64 bytes from web.stanford.edu (171.67.215.200): icmp_seq=11 ttl=246 time=325 ms
64 bytes from web.stanford.edu (171.67.215.200): icmp_seq=12 ttl=246 time=257 ms
64 bytes from web.stanford.edu (171.67.215.200): icmp_seq=13 ttl=246 time=361 ms
64 bytes from web.stanford.edu (171.67.215.200): icmp_seq=14 ttl=246 time=283 ms
64 bytes from web.stanford.edu (171.67.215.200): icmp_seq=15 ttl=246 time=303 ms
64 bytes from web.stanford.edu (171.67.215.200): icmp_seq=16 ttl=246 time=327 ms
64 bytes from web.stanford.edu (171.67.215.200): icmp_seq=17 ttl=246 time=345 ms
64 bytes from web.stanford.edu (171.67.215.200): icmp_seq=18 ttl=246 time=371 ms
64 bytes from web.stanford.edu (171.67.215.200): icmp_seq=19 ttl=246 time=291 ms
64 bytes from web.stanford.edu (171.67.215.200): icmp_seq=20 ttl=246 time=321 ms
64 bytes from web.stanford.edu (171.67.215.200): icmp_seq=21 ttl=246 time=257 ms
64 bytes from web.stanford.edu (171.67.215.200): icmp_seq=22 ttl=246 time=257 ms
64 bytes from web.stanford.edu (171.67.215.200): icmp_seq=23 ttl=246 time=390 ms
64 bytes from web.stanford.edu (171.67.215.200): icmp_seq=24 ttl=246 time=257 ms
64 bytes from web.stanford.edu (171.67.215.200): icmp_seq=25 ttl=246 time=272 ms
64 bytes from web.stanford.edu (171.67.215.200): icmp_seq=26 ttl=246 time=255 ms
64 bytes from web.stanford.edu (171.67.215.200): icmp_seq=27 ttl=246 time=254 ms
64 bytes from web.stanford.edu (171.67.215.200): icmp_seq=28 ttl=246 time=255 ms
64 bytes from web.stanford.edu (171.67.215.200): icmp_seq=29 ttl=246 time=319 ms
64 bytes from web.stanford.edu (171.67.215.200): icmp_seq=30 ttl=246 time=338 ms
64 bytes from web.stanford.edu (171.67.215.200): icmp_seq=31 ttl=246 time=357 ms
64 bytes from web.stanford.edu (171.67.215.200): icmp_seq=32 ttl=246 time=275 ms
64 bytes from web.stanford.edu (171.67.215.200): icmp_seq=33 ttl=246 time=306 ms
64 bytes from web.stanford.edu (171.67.215.200): icmp_seq=34 ttl=246 time=335 ms
64 bytes from web.stanford.edu (171.67.215.200): icmp_seq=35 ttl=246 time=351 ms
64 bytes from web.stanford.edu (171.67.215.200): icmp_seq=36 ttl=246 time=363 ms
64 bytes from web.stanford.edu (171.67.215.200): icmp_seq=37 ttl=246 time=285 ms
64 bytes from web.stanford.edu (171.67.215.200): icmp_seq=38 ttl=246 time=258 ms
64 bytes from web.stanford.edu (171.67.215.200): icmp_seq=39 ttl=246 time=321 ms
64 bytes from web.stanford.edu (171.67.215.200): icmp_seq=40 ttl=246 time=356 ms
64 bytes from web.stanford.edu (171.67.215.200): icmp_seq=41 ttl=246 time=372 ms
64 bytes from web.stanford.edu (171.67.215.200): icmp_seq=42 ttl=246 time=298 ms
64 bytes from web.stanford.edu (171.67.215.200): icmp_seq=43 ttl=246 time=274 ms
64 bytes from web.stanford.edu (171.67.215.200): icmp_seq=44 ttl=246 time=258 ms
64 bytes from web.stanford.edu (171.67.215.200): icmp_seq=45 ttl=246 time=350 ms
64 bytes from web.stanford.edu (171.67.215.200): icmp_seq=46 ttl=246 time=273 ms
64 bytes from web.stanford.edu (171.67.215.200): icmp_seq=47 ttl=246 time=274 ms
64 bytes from web.stanford.edu (171.67.215.200): icmp_seq=48 ttl=246 time=329 ms
64 bytes from web.stanford.edu (171.67.215.200): icmp_seq=49 ttl=246 time=256 ms
64 bytes from web.stanford.edu (171.67.215.200): icmp_seq=50 ttl=246 time=375 ms

--- stanford.edu ping statistics ---
50 packets transmitted, 50 received, 0% packet loss, time 49330ms
rtt min/avg/max/mdev = 253.343/306.686/392.299/43.668 ms
```

g) Run the command, `tracert stanford.edu`. Compare the number of hops between google.in and stanford.edu (between the traceroute result of google.in and stanford.edu).[1]

Ans) As we can see using the command `tracert stanford.edu` gives the below picture which clearly shows **13 hops**.

```
sidhartha@LAPTOP-VM0EA2TI:/mnt/c/Users/Sidhartha Garg$ tracert stanford.edu
tracert to stanford.edu (171.67.215.200), 30 hops max, 60 byte packets
 1 LAPTOP-VM0EA2TI.mshome.net (172.20.32.1) 0.525 ms 0.494 ms 1.021 ms
 2 192.168.1.1 (192.168.1.1) 34.496 ms 30.024 ms 30.011 ms
 3 abts-north-static-068.127.176.122.airtelbroadband.in (122.176.127.68) 39.833 ms 39.821 ms 39.809 ms
 4 182.79.117.225 (182.79.117.225) 36.122 ms 36.101 ms 182.79.117.229 (182.79.117.229) 36.089 ms
 5 182.79.146.238 (182.79.146.238) 277.367 ms 116.119.44.132 (116.119.44.132) 270.171 ms 116.119.112.98 (116.119.112.98) 277.335 ms
 6 * * *
 7 port-channel8.core2.lax1.he.net (184.104.197.109) 278.681 ms 245.019 ms 250.872 ms
 8 * * *
 9 port-channel9.core2.pao1.he.net (184.105.81.101) 306.835 ms * *
10 stanford-university.e0-62.core2.pao1.he.net (184.105.177.238) 306.809 ms 254.169 ms 259.802 ms
11 campus-ial-nets-b-vl1118.SUNet (171.66.255.228) 249.333 ms 265.888 ms campus-nw-rtr-vl1002.SUNet (171.64.255.196) 259.698 ms
12 * * *
13 web.stanford.edu (171.67.215.200) 254.128 ms 246.543 ms 250.637 ms
```

whereas, in

```
sidhartha@LAPTOP-VM0EA2TI:/mnt/c/Users/Sidhartha Garg$ tracert google.in
tracert to google.in (142.250.193.228), 30 hops max, 60 byte packets
 1 LAPTOP-VM0EA2TI.mshome.net (172.20.32.1) 0.401 ms 0.380 ms 0.370 ms
 2 192.168.1.1 (192.168.1.1) 12.600 ms 12.591 ms 12.581 ms
 3 abts-north-static-068.127.176.122.airtelbroadband.in (122.176.127.68) 14.242 ms 14.232 ms 14.219 ms
 4 182.79.117.225 (182.79.117.225) 22.986 ms 182.79.117.229 (182.79.117.229) 14.179 ms 182.79.117.225 (182.79.117.225) 22.969 ms
 5 * * 116.119.73.220 (116.119.73.220) 14.143 ms
 6 72.14.222.126 (72.14.222.126) 22.952 ms 21.585 ms 21.567 ms
 7 * * *
 8 172.253.73.194 (172.253.73.194) 10.923 ms 142.251.76.198 (142.251.76.198) 14.890 ms 172.253.67.98 (172.253.67.98) 14.853 ms
 9 216.239.50.22 (216.239.50.22) 14.840 ms 142.251.54.101 (142.251.54.101) 12.904 ms 142.251.54.99 (142.251.54.99) 14.729 ms
10 dell1s18-in-f4.1e100.net (142.250.193.228) 12.843 ms 192.178.82.237 (192.178.82.237) 49.252 ms 14.683 ms
```

we see **10 hops** while doing the command `tracert google.in`.

h) Can you explain the reason for the latency difference between google.in and stanford.edu (see (b) & (f))? [1]

Google.in: This domain is likely hosted on servers within India or nearby regions. Since the physical distance between my location and the server is relatively short, the time taken for data packets to travel back and forth (latency) is lower.

Stanford.edu: This domain is hosted on servers located at Stanford University in the United States. The physical distance between my location (in India) and Stanford's servers is much greater. This increased distance results in higher latency because data packets have to travel a longer distance, which takes more time.

Q.6.[2+1] Make your ping command fail for 127.0.0.1 (with 100% packet loss). Explain how you do it. Put a screenshot that it failed.

We can make the ping command fail for the 127.0.0.1 (localhost) by simply downing the lo interface, which is the loop back interface. We can do this by using the command `sudo ifconfig lo down`.

Now when we use `ping 127.0.0.1` we see that 100 % loss of packets as we downed lo.

```
sidhartha@LAPTOP-VM0EA2TI:/mnt/c/Users/Sidhartha Garg$ sudo ifconfig lo down
[sudo] password for sidhartha:
sidhartha@LAPTOP-VM0EA2TI:/mnt/c/Users/Sidhartha Garg$ ifconfig
eth0: flags=4163<UP,BROADCAST,RUNNING,MULTICAST>  mtu 1492
    inet 172.20.45.228  netmask 255.255.240.0  broadcast 172.20.47.255
    inet6 fe80::215:5dff:fe90:d334  prefixlen 64  scopeid 0x20<link>
    ether 00:15:5d:90:d3:34  txqueuelen 1000  (Ethernet)
    RX packets 3081  bytes 883259 (883.2 KB)
    RX errors 0  dropped 0  overruns 0  frame 0
    TX packets 412  bytes 72049 (72.0 KB)
    TX errors 0  dropped 0 overruns 0  carrier 0  collisions 0

sidhartha@LAPTOP-VM0EA2TI:/mnt/c/Users/Sidhartha Garg$ 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 ---
66 packets transmitted, 0 received, 100% packet loss, time 67596ms
```