

CSE 232: Programming Assignment 1

Using command-line utilities for network debugging

Name : Vipul

Roll no: 2022576

Q1. [1 + 1]

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

Ans.

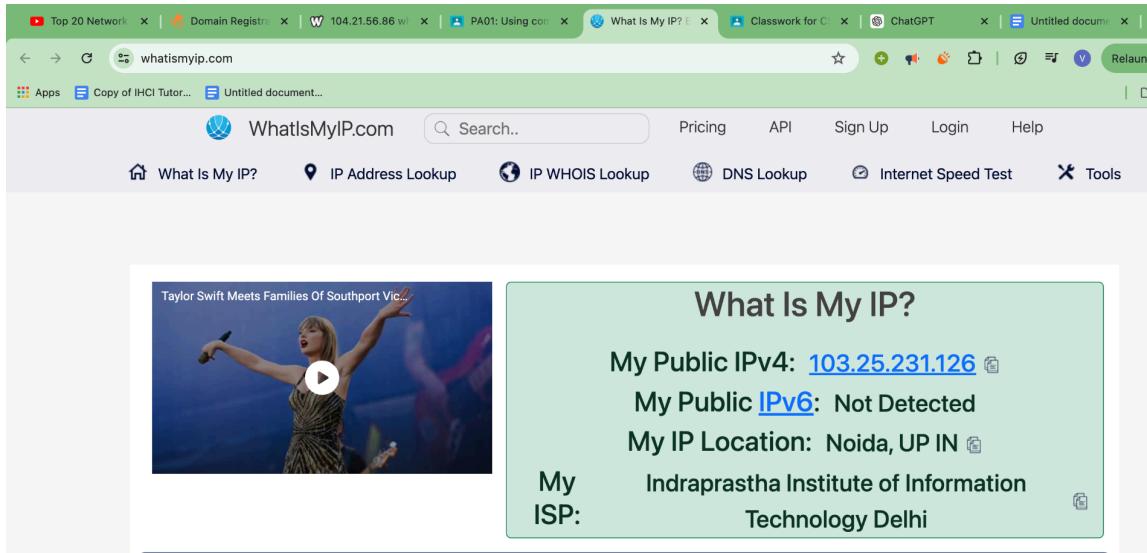
```
Last login: Sat Aug 24 15:36:46 on ttys001
vipul@vipul-MacBook-Air-2 ~ % ifconfig
lo0: flags=8049UP,BROADCAST,RUNNING,MULTICAST mtu 16384
    options=68<NOFCS,NOMTU,XTSTATOS,SU_TIMESTAMP>
    ether 00:0c:29:1d:00:00
    netmask 00:00:00:00:00:00
    inet6 ::1 prefixlen 128
        inet6 fe80::1%lo0 prefixlen 64 scopid 0x1
    nd6 options=201<PERFORMNUD,DAD>
gi0: flags=8049UP,BROADCAST,RUNNING,MULTICAST mtu 1280
    options=68<NOFCS,NOMTU>
    ether 00:0c:29:1d:00:00
    netmask 00:00:00:00:00:00
    nd6 options=201<PERFORMNUD,DAD>
    nd6 options=201<PERFORMNUD,DAD>
    nd6 options=201<PERFORMNUD,DAD>
anp0: flags=8043UP,BROADCAST,SMART,RUNNING,SIMPLEX,MULTICAST mtu 1500
    options=400<CHANNEL_ID>
    ether 12:18:a0:b3:a6:e6
    media: autoselect
    status: inactive
anp1: flags=8043UP,BROADCAST,SMART,RUNNING,SIMPLEX,MULTICAST mtu 1500
    options=400<CHANNEL_ID>
    ether 12:18:a0:b3:a6:e7
    media: autoselect
    status: inactive
en3: flags=8043UP,BROADCAST,SMART,RUNNING,SIMPLEX,MULTICAST mtu 1500
    options=400<CHANNEL_ID>
    ether 12:18:a0:b3:a6:c7
    media: autoselect
    status: inactive
en4: flags=8043UP,BROADCAST,SMART,RUNNING,SIMPLEX,MULTICAST mtu 1500
    options=400<CHANNEL_ID>
    ether 12:18:a0:b3:a6:c8
    media: autoselect
    status: inactive
bridge0: flags=8043UP,BROADCAST,SMART,RUNNING,PROMISC,SIMPLEX,MULTICAST mtu 1500
    options=46<TSQA,TSQA,CHANNEL_ID>
    ether 36:63:59:15:44:c8
    media: autoselect <full-duplex>
    status: active
en2: flags=8043UP,BROADCAST,SMART,RUNNING,PROMISC,SIMPLEX,MULTICAST mtu 1500
    options=46<TSQA,TSQA,CHANNEL_ID>
    ether 36:63:59:15:44:c4
    media: autoselect <full-duplex>
    status: active
bridge0: flags=8043UP,BROADCAST,SMART,RUNNING,SIMPLEX,MULTICAST mtu 1500
    options=63<RXCSUM,TXCSUM,TSQA,TSQA>
    ether 36:63:59:15:44:c8
    Configuration:
        id 0:0:0:0:0:0 priority 0 hellotime 0 fwddelay 0
        maxage 0 holdtime 0 proto stp maxaddr 100 timeout 1200
        root id 0:0:0:0:0:0 priority 0 ifcost 0 port 0
        ipfilter disabled flags 0x0
    member: en1 flags=3<LEARNING,DISCOVER>
        ifmaxaddr 0 port 8 priority 0 path cost 0
    member: en2 flags=3<LEARNING,DISCOVER>
        ifmaxaddr 0 port 9 priority 0 path cost 0
    nd6 options=201<PERFORMNUD,DAD>
    media: unknown type>
    status: inactive
en0: flags=8043UP,BROADCAST,RUNNING,SIMPLEX,MULTICAST mtu 1500
    options=640<TSQA,TSQA,CHANNEL_IO,PARTIAL_CSUM,ZEROINVERT_CSUM>
    ether 66:3e:5f:2e:30:58
    inet6 fe80::663e:5fffe:2e30:58%en0 prefixlen 64 scopid 0xc
    nd6 options=201<PERFORMNUD,DAD>
    nd6 options=201<PERFORMNUD,DAD>
    media: autoselect (unknown type)
    status: active
en0: flags=8043UP,BROADCAST,SMART,RUNNING,SIMPLEX,MULTICAST mtu 1500
    options=640<TSQA,TSQA,CHANNEL_IO,PARTIAL_CSUM,ZEROINVERT_CSUM>
    ether 66:3e:5f:2e:30:58
    inet6 fe80::663e:5fffe:2e30:58%en0 prefixlen 64 secured scopid 0xc
        linklayer 66:3e:5f:2e:30:58 broadcast 0xffffffff
    nd6 options=201<PERFORMNUD,DAD>
    nd6 options=201<PERFORMNUD,DAD>
    nd6 options=201<PERFORMNUD,DAD>
    nd6 options=201<PERFORMNUD,DAD>
    media: autoselect
    status: active
```

Ethernet IP address: 192.168.27.190

(Virtual Network Interface) IP address: 127.0.0.1

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. Public IP address: 103.25.231.126



What Is My IP?

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

My Public IPv6: Not Detected

My IP Location: Noida, UP IN

My ISP: Indraprastha Institute of Information Technology Delhi

REASON FOR DIFFERENCE

A public IP address, like 103.25.231.126, is a unique identifier assigned to your network router by your Internet Service Provider (ISP) that can be accessed directly over the Internet. A private IP address is assigned by your router to individual devices within your network, enabling secure communication between them. Each device on the same network receives a unique private IP address, allowing them to connect with one another.

The **ifconfig** command displays the list of private IP addresses on your network, while tools like "**whatismyip**" or the command **curl ifconfig.me** reveal your public IP address.

The difference between the IP address shown in my terminal and the one displayed on [WhatIsMyIP.com](<https://www.whatismyip.com/>) occurs because my terminal shows the **inet 127.0.0.1** (used within the college LAN), while the website displays the **103.25.231.126** (used for internet communication). The college's router, managed by our ISP **Indraprastha Institute of Information Technology Delhi**, assigns the private IP to my device and uses **Network Address Translation (NAT)** to map this to a single public IP, which is visible to the outside world. This setup allows all devices on the college network to share the same public IP when accessing the internet.

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.

Ans.

```

media: none
status: inactive
en3: flags=8863<UP,BROADCAST,SMART,RUNNING,SIMPLEX,MULTICAST> mtu 1500
options=400<CHANNEL_IO>
ether 12:10:ab:b3:a6:c6
ndo options=201<PERFORMNUD,DAD>
media: none
status: inactive
en4: flags=8863<UP,BROADCAST,SMART,RUNNING,SIMPLEX,MULTICAST> mtu 1500
options=400<CHANNEL_IO>
ether 12:10:ab:b3:a6:c7
ndo 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 36:63:59:15:44:c8
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 36:63:59:15:44:c4
media: autoselect <full-duplex>
status: inactive
br0: flags=8863<UP,BROADCAST,SMART,RUNNING,SIMPLEX,MULTICAST> mtu 1500
options=460<CHANNEL_IO>
ether 36:63:59:15:44:c0
ndo options=201<PERFORMNUD,DAD>
Configuration:
    id 0:0:0:0:0:0 priority 0 hellotime 0 fwddelay 0
        maxage 0 holdcnt 0 proto stp maxaddr 100 timeout 1200
    root id 0:0:0:0:0:0 priority 0 ifcost 0 port 0
    ipfilter disabled flags 0x8
member: en1 flags=3<LEARNING,DISCOVER>
    ifmaxaddr 0 port 9 priority 0 path cost 0
member: en2 flags=3<LEARNING,DISCOVER>
    ifmaxaddr 0 port 9 priority 0 path cost 0
ndo options=201<PERFORMNUD,DAD>
media: unknown type
status: inactive
ap1: flags=8863<UP,BROADCAST,RUNNING,SIMPLEX,MULTICAST> mtu 1500
options=6468<TS04,TS06,CHANNEL_IO,PARTIAL_CSUM,ZEROINVERT_CSUM>
ether 52:3e:5f:2c:13:b9
inet6 fe80::683e:5fffe2e:3b58%ap1 prefixlen 64 scopeid 0xb
ndo options=201<PERFORMNUD,DAD>
media: autoselect (unknown type)
status: inactive
en0: flags=8863<UP,BROADCAST,SMART,RUNNING,SIMPLEX,MULTICAST> mtu 1500
options=6468<TS04,TS06,CHANNEL_IO,PARTIAL_CSUM,ZEROINVERT_CSUM>
ether 8c:28:dc:91:fa:d0
inet6 fe80::8c28:dcff:fea1:fa:d0 prefixlen 64 secured scopeid 0xc
inet6 2489:40d0:2015:729c:aa1:f71:3c27:140d prefixlen 64 autoconf secured
inet6 2489:40d0:2015:729c:6416:8b7c:f732:43f3 prefixlen 64 autoconf temporary
inet 192.136.34.98 netmask 0xffffffff broadcast 192.136.34.255
nat64 prefix 64:f90:: prefixlen 96
ndo options=201<PERFORMNUD,DAD>
media: autoselect
status: active
awdl0: flags=8863<UP,BROADCAST,RUNNING,SIMPLEX,MULTICAST> mtu 1500
options=6468<TS04,TS06,CHANNEL_IO,PARTIAL_CSUM,ZEROINVERT_CSUM>
ether 86:07:37:56:68:7c
inet6 fe80::8607:37ff:fe56:687c%awdl0 prefixlen 64 scopeid 0xd
ndo options=201<PERFORMNUD,DAD>
media: autoselect

```

To change the IP address Use the below command:

```
sudo ifconfig <interface-name> <new-ip-address> netmask <subnet-mask>
```

As my previous IP address is 192.168.27.190 as seen in Question1 part (a)

Revert this to 1st one:

```

inet6 fe80::8c28:dcff:fea1:fa:d0 prefixlen 64 secured scopeid 0xc
ndo options=32<PERFORMNUD,DAD>
utun3: flags=43<UP,NOPOINT,POINT> mtu 1000
inet6 fe80::ca81:b1c:8d2c:49a%utun3 prefixlen 64 scopeid 0x12
ndo options=201<PERFORMNUD,DAD>
vipul@vipul-MacBook-Air-2 ~ % sudo ifconfig en0 192.168.27.190 netmask 255.255.255.0
vipul@vipul-MacBook-Air-2 ~ % ifconfig en0
en0: flags=8863<UP,BROADCAST,SMART,RUNNING,SIMPLEX,MULTICAST> mtu 1500
options=6468<TS04,TS06,CHANNEL_IO,PARTIAL_CSUM,ZEROINVERT_CSUM>
ether 8c:28:dc:91:fa:d0
inet6 fe80::8c28:dcff:fea1:fa:d0 prefixlen 64 secured scopeid 0xc
inet6 2489:40d0:2015:729c:aa1:f71:3c27:140d prefixlen 64 deprecated autoconf secured
inet6 2489:40d0:2015:729c:6416:8b7c:f732:43f3 prefixlen 64 deprecated autoconf temporary
inet6 2489:40d0:1024:eff3:466:a0e8:9926:1482 prefixlen 64 autoconf secured
inet6 2489:40d0:1024:eff3:7c01:f0d7:13a1:33d6 prefixlen 64 autoconf temporary
inet 192.168.27.190 netmask 0xffffffff broadcast 192.168.27.255
nat64 prefix 64:f90:: prefixlen 96
ndo options=201<PERFORMNUD,DAD>
media: autoselect
status: active
vipul@vipul-MacBook-Air-2 ~ %

```

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]

Start the server with the following command:

```
nc -l 1234
```

where **-l**: Puts the **netcat** in listen mode, acting as a server.
-p 1234: Specifies the port number 1234 for the server to Listen on.

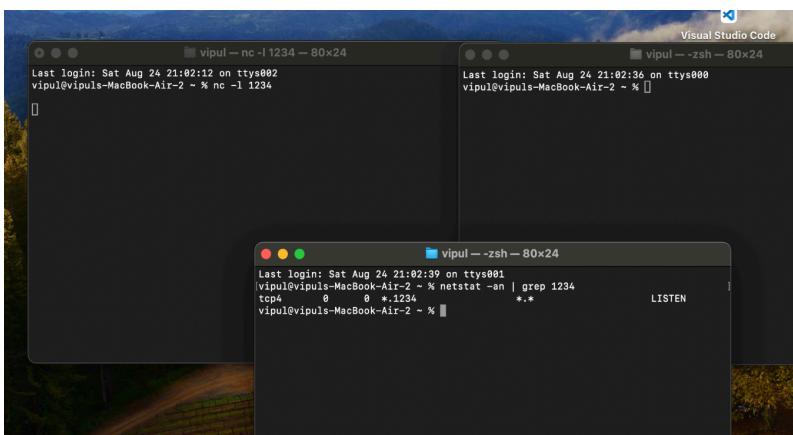
Now I am going to Open another WSL terminal:

Connect to the TCP server using the following command:

```
nc localhost 1234
```

where **localhost**: Refers to the local machine (the WSL Instance)
1234: Port number on which the TCP server is listening.

-----WAITING FOR CONNECTION-----



<<<<<-CONNECTION ESTABLISHED->>>>>>>

The screenshot shows three terminal windows on a Mac OS X desktop. The top-left window is titled 'vipul - nc -l 1234 - 80x24' and displays the message 'Your name is #####'. The top-right window is titled 'vipul - nc localhost 1234 - 80x24' and also displays 'Your name is #####'. The bottom window is titled 'vipul -- zsh - 80x24' and shows the output of the 'netstat -an | grep 1234' command. It lists several TCP connections, with one entry for port 1234 being highlighted in blue: 'tcp4 0 0 127.0.0.1.1234 127.0.0.1.66512 ESTABLISHED'. This indicates an established connection between the client and server.

```
Last login: Sat Aug 24 21:07:49 on ttys002
vipul@ipuls-MacBook-Air-2 ~ % nc -l 1234
Your name is #####
Last login: Sat Aug 24 21:09:31 on ttys008
vipul@ipuls-MacBook-Air-2 ~ % nc localhost 1234
Your name is #####
Last login: Sat Aug 24 21:02:43 on ttys002
|vipul@ipuls-MacBook-Air-2 ~ % netstat -an | grep 1234
tcp4      0      0    *.*.1234          *.*                  LISTEN
tcp4      0      0    127.0.0.1.1234        127.0.0.1.66512      ESTABLISHED
tcp4      0      0    127.0.0.1.66512        127.0.0.1.1234      ESTABLISHED
tcp4      0      0    *.*.1234          *.*                  LISTEN
vipul@ipuls-MacBook-Air-2 ~ %
```

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

Ans. **ESTABLISHED**: The connection between the client and server is active and ongoing.
Screenshot is above in part a.

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.

Ans.

The screenshot shows a terminal window with two nslookup commands. The first command, 'nslookup -type=ns google.in', returns non-authoritative answers for the nameservers ns1.google.com, ns2.google.com, ns3.google.com, and ns4.google.com. The second command, 'nslookup google.in ns1.google.com', queries the authoritative server ns1.google.com for the IP address of google.in, which is 142.258.194.228.

```
[vipul@ipuls-MacBook-Air-2 ~ % nslookup -type=ns google.in
Server:  192.168.1.7
Address: 192.168.1.7#53
Non-authoritative answer:
google.in  nameserver = ns2.google.com.
google.in  nameserver = ns4.google.com.
google.in  nameserver = ns3.google.com.
google.in  nameserver = ns1.google.com.

Authoritative answers can be found from:
ns1.google.com  internet address = 216.239.36.10
ns4.google.com  internet address = 216.239.38.10
ns3.google.com  internet address = 216.239.36.10
ns2.google.com  internet address = 216.239.32.10
[vipul@ipuls-MacBook-Air-2 ~ % nslookup google.in ns1.google.com
Server:  ns1.google.com
Address: 216.239.32.10#53
Name:  google.in
Address: 142.258.194.228
vipul@ipuls-MacBook-Air-2 ~ % ]
```

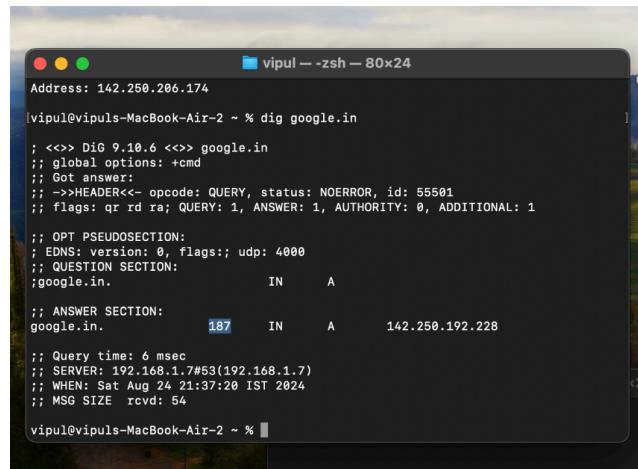
- Run `nslookup -type=ns google.in` to identify the authoritative nameservers.
- Query an authoritative server with `nslookup google.in <nameserver>` to get an

authoritative response.

- 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.

Ans. TTL value is 187 seconds, this DNS entry will expire from the local DNS server's cache after 187 seconds. After this period, the DNS server will need to make a new query to the authoritative DNS server to refresh the record and obtain the latest information.

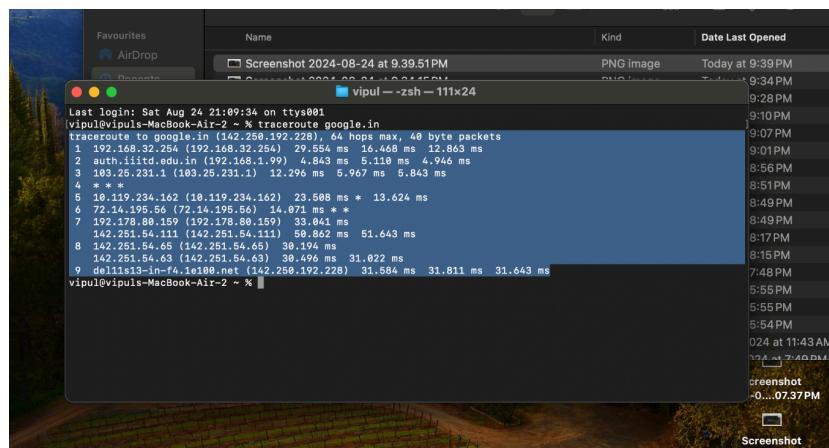
Attached Below Screenshot



```
vipul@vipuls-MacBook-Air-2 ~ % dig google.in
; <>> DiG 9.10.6 <>> google.in
;; global options: +cmd
;; Got answer:
;; ->>HEADER<- opcode: QUERY, status: NOERROR, id: 55501
;; flags: qr rd ra; QUERY: 1, ANSWER: 1, AUTHORITY: 0, ADDITIONAL: 1
;; OPT PSEUDOSECTION:
; EDNS: version: 0, flags: udp: 4000
;; QUESTION SECTION:
;google.in.           IN      A
;; ANSWER SECTION:
google.in.        187    IN      A       142.250.192.228
;; Query time: 6 msec
;; SERVER: 192.168.1.7#53(192.168.1.7)
;; WHEN: Sat Aug 24 21:37:20 IST 2024
;; MSG SIZE rcvd: 54
vipul@vipuls-MacBook-Air-2 ~ %
```

Q.5. [13]

- a) Run the command, *traceroute 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]



```
Last login: Sat Aug 24 21:09:34 on ttys001
vipul@vipuls-MacBook-Air-2 ~ % traceroute google.in
traceroute to google.in (142.250.192.228), 44 hops max, 40 byte packets
1  192.168.32.254 (192.168.32.254)  29.554 ms  16.468 ms  12.863 ms
2  auth.jilt.du.edu.in (192.168.1.99)  4.843 ms  5.110 ms  4.946 ms
3  103.25.231.1 (103.25.231.1)  12.296 ms  5.967 ms  5.843 ms
4  * *
5  10.119.224.162 (10.119.224.162)  23.508 ms *  13.624 ms
6  10.119.224.172 (10.119.224.172)  24.156 ms *  13.624 ms
7  192.178.88.150 (192.178.88.150)  93.041 ms
8  142.251.54.111 (142.251.54.111)  50.862 ms  51.643 ms
9  142.251.54.65 (142.251.54.65)  30.194 ms
10  142.251.54.63 (142.251.54.63)  30.496 ms  31.822 ms
11  dell1st13-in-f4.1e100.net (142.250.192.228)  31.584 ms  31.811 ms  31.643 ms
vipul@vipuls-MacBook-Air-2 ~ %
```

Average Latency Calculation:

1. **Host 1: 192.168.32.254**
 - o Latencies: 29.554 ms, 16.468 ms, 12.863 ms
 - o Average Latency = $(29.554 + 16.468 + 12.863) / 3 \approx 19.295$ ms
2. **Host 2: auth.iiitd.edu.in (192.168.1.99)**
 - o Latencies: 4.843 ms, 5.110 ms, 4.946 ms
 - o Average Latency = $(4.843 + 5.110 + 4.946) / 3 \approx 4.966$ ms
3. **Host 3: 103.25.231.1**
 - o Latencies: 12.296 ms, 5.967 ms, 5.843 ms
 - o Average Latency = $(12.296 + 5.967 + 5.843) / 3 \approx 8.369$ ms
4. **Host 4: * * ***
 - o No latency values to compute for this host.
5. **Host 5: 10.119.234.162**
 - o Latencies: 23.508 ms, *, 13.624 ms
 - o Average Latency = $(23.508 + 13.624) / 2 \approx 18.566$ ms (Ignoring *)
6. **Host 6: 72.14.195.56**
 - o Latency: 14.071 ms
 - o Average Latency = 14.071 ms (Only one value)
7. **Host 7: 192.178.80.159 and 142.251.54.111**
 - o Latencies: 33.041 ms, 50.862 ms, 51.643 ms
 - o Average Latency = $(33.041 + 50.862 + 51.643) / 3 \approx 45.182$ ms
8. **Host 8: 142.251.54.65 and 142.251.54.63**
 - o Latencies: 30.194 ms, 30.496 ms, 31.022 ms
 - o Average Latency = $(30.194 + 30.496 + 31.022) / 3 \approx 30.571$ ms
9. **Host 9: del11s13-in-f4.1e100.net (142.250.192.228)**
 - o Latencies: 31.584 ms, 31.811 ms, 31.643 ms
 - o Average Latency = $(31.584 + 31.811 + 31.643) / 3 \approx 31.679$ ms

Summary:

- **Host 1: 19.295 ms**
- **Host 2: 4.966 ms**
- **Host 3: 8.369 ms**
- **Host 5: 18.566 ms**
- **Host 6: 14.071 ms**
- **Host 7: 45.182 ms**
- **Host 8: 30.571 ms**
- **Host 9: 31.679 ms**

b) Send 50 ping messages to google.in, Determine the average latency. Put a screenshot.
 Ans. Average Latency is **41.977**

```

7 192.178.80.159 (192.178.80.159) 33.041 ms
142.251.54.111 (142.251.54.111) 50.862 ms 51.643 ms
8 142.251.54.63 (142.251.54.63) 30.996 ms 31.022 ms
9 dell113-in-f4.1e100.net (142.250.192.228) 31.584 ms 31.811 ms 31.643 ms
vipul@vipul-MacBook-Air-2 ~ % ping -c 50 google.in

PING google.in (142.250.192.228): 56 data bytes
64 bytes from 142.250.192.228: icmp_seq=0 ttl=55 time=36.183 ms
64 bytes from 142.250.192.228: icmp_seq=1 ttl=55 time=40.380 ms
64 bytes from 142.250.192.228: icmp_seq=2 ttl=55 time=37.724 ms
64 bytes from 142.250.192.228: icmp_seq=3 ttl=55 time=37.587 ms
64 bytes from 142.250.192.228: icmp_seq=4 ttl=55 time=44.681 ms
64 bytes from 142.250.192.228: icmp_seq=5 ttl=55 time=60.501 ms
64 bytes from 142.250.192.228: icmp_seq=6 ttl=55 time=40.454 ms
64 bytes from 142.250.192.228: icmp_seq=7 ttl=55 time=39.004 ms
64 bytes from 142.250.192.228: icmp_seq=8 ttl=55 time=51.000 ms
64 bytes from 142.250.192.228: icmp_seq=9 ttl=55 time=40.778 ms
64 bytes from 142.250.192.228: icmp_seq=10 ttl=55 time=72.778 ms
64 bytes from 142.250.192.228: icmp_seq=11 ttl=55 time=36.817 ms
64 bytes from 142.250.192.228: icmp_seq=12 ttl=55 time=36.402 ms
64 bytes from 142.250.192.228: icmp_seq=13 ttl=55 time=37.681 ms
64 bytes from 142.250.192.228: icmp_seq=14 ttl=55 time=46.451 ms
64 bytes from 142.250.192.228: icmp_seq=15 ttl=55 time=44.661 ms
64 bytes from 142.250.192.228: icmp_seq=16 ttl=55 time=40.716 ms
64 bytes from 142.250.192.228: icmp_seq=17 ttl=55 time=55.262 ms
64 bytes from 142.250.192.228: icmp_seq=18 ttl=55 time=38.444 ms
64 bytes from 142.250.192.228: icmp_seq=19 ttl=55 time=39.288 ms
64 bytes from 142.250.192.228: icmp_seq=20 ttl=55 time=43.937 ms
64 bytes from 142.250.192.228: icmp_seq=21 ttl=55 time=36.241 ms
64 bytes from 142.250.192.228: icmp_seq=22 ttl=55 time=35.993 ms
64 bytes from 142.250.192.228: icmp_seq=23 ttl=55 time=40.305 ms
64 bytes from 142.250.192.228: icmp_seq=24 ttl=55 time=36.288 ms
64 bytes from 142.250.192.228: icmp_seq=25 ttl=55 time=42.213 ms
64 bytes from 142.250.192.228: icmp_seq=26 ttl=55 time=43.914 ms
64 bytes from 142.250.192.228: icmp_seq=27 ttl=55 time=44.783 ms
64 bytes from 142.250.192.228: icmp_seq=28 ttl=55 time=37.804 ms
64 bytes from 142.250.192.228: icmp_seq=29 ttl=55 time=37.347 ms
64 bytes from 142.250.192.228: icmp_seq=30 ttl=55 time=36.015 ms
64 bytes from 142.250.192.228: icmp_seq=31 ttl=55 time=40.822 ms
64 bytes from 142.250.192.228: icmp_seq=32 ttl=55 time=44.822 ms
64 bytes from 142.250.192.228: icmp_seq=33 ttl=55 time=37.963 ms
64 bytes from 142.250.192.228: icmp_seq=34 ttl=55 time=42.795 ms
64 bytes from 142.250.192.228: icmp_seq=35 ttl=55 time=43.869 ms
64 bytes from 142.250.192.228: icmp_seq=36 ttl=55 time=44.661 ms
64 bytes from 142.250.192.228: icmp_seq=37 ttl=55 time=36.144 ms
64 bytes from 142.250.192.228: icmp_seq=38 ttl=55 time=40.100 ms
64 bytes from 142.250.192.228: icmp_seq=39 ttl=55 time=41.493 ms
64 bytes from 142.250.192.228: icmp_seq=40 ttl=55 time=35.916 ms
64 bytes from 142.250.192.228: icmp_seq=41 ttl=55 time=45.351 ms
64 bytes from 142.250.192.228: icmp_seq=42 ttl=55 time=42.426 ms
64 bytes from 142.250.192.228: icmp_seq=43 ttl=55 time=40.041 ms
64 bytes from 142.250.192.228: icmp_seq=44 ttl=55 time=36.301 ms
64 bytes from 142.250.192.228: icmp_seq=45 ttl=55 time=40.000 ms
64 bytes from 142.250.192.228: icmp_seq=46 ttl=55 time=46.215 ms
64 bytes from 142.250.192.228: icmp_seq=47 ttl=55 time=42.368 ms
64 bytes from 142.250.192.228: icmp_seq=48 ttl=55 time=39.299 ms
64 bytes from 142.250.192.228: icmp_seq=49 ttl=55 time=37.718 ms
--- google.in ping statistics ---
50 packets transmitted, 50 packets received, 0.0% packet loss
round-trip min/avg/max/stddev = 34.942/41.977/72.778/6.860 ms
vipul@vipul-MacBook-Air-2 ~ %

```

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

Ans.

Sum of Latencies from Intermediate Hosts (Part a): $19.295 \text{ ms} + 4.966 \text{ ms} + 8.369 \text{ ms} + 18.566 \text{ ms} + 14.071 \text{ ms} + 45.182 \text{ ms} + 30.571 \text{ ms} + 31.679 \text{ ms} = 171.699 \text{ ms}$

Total Latency for 50 Packets (Part b) : $41.977 \text{ ms} \times 50 \text{ packets} = 2098.85 \text{ ms}$

Comparison:

- The sum of the latencies from intermediate hosts (171.699 ms) is not directly comparable to the total latency for 50 packets (2098.85 ms) because one reflects the cumulative sum of latencies from several hosts, while the other reflects the total latency over multiple packets for a single endpoint. (Not Matching)

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

Ans. **Maximum Latency among Intermediate Hosts (Part (a)) :** 51.643 ms (Host 7)

Maximum Latency from google.in (Part (b)): 72.778 ms

Comparison: The maximum latency among the intermediate hosts (51.643 ms) is

lower than the maximum latency recorded for google.in (72.778 ms). (Not Matching)

Explanation: This difference is expected because the ping latency to google.in reflects the round-trip time over a longer and potentially more complex network path involving multiple intermediate hops, which can introduce higher delays compared to the latencies of the individual intermediate hosts.

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

Ans. In traceroute, multiple entries for a single hop represent the latencies of three separate probes sent to that hop. These entries show the consistency and variability in network performance. If there are significant differences between them, it may indicate network congestion or variability.

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

Ans . Average Latency = 303.338 ms

```
PING stanford.edu (171.67.215.200): 56 data bytes
64 bytes from 171.67.215.200: icmp_seq=0 ttl=242 time=298.488 ms
64 bytes from 171.67.215.200: icmp_seq=1 ttl=242 time=289.126 ms
64 bytes from 171.67.215.200: icmp_seq=2 ttl=242 time=289.126 ms
64 bytes from 171.67.215.200: icmp_seq=3 ttl=242 time=285.428 ms
64 bytes from 171.67.215.200: icmp_seq=4 ttl=242 time=281.694 ms
64 bytes from 171.67.215.200: icmp_seq=5 ttl=242 time=293.459 ms
64 bytes from 171.67.215.200: icmp_seq=6 ttl=242 time=386.013 ms
64 bytes from 171.67.215.200: icmp_seq=7 ttl=242 time=287.822 ms
64 bytes from 171.67.215.200: icmp_seq=8 ttl=242 time=301.958 ms
64 bytes from 171.67.215.200: icmp_seq=9 ttl=242 time=282.379 ms
64 bytes from 171.67.215.200: icmp_seq=10 ttl=242 time=284.983 ms
64 bytes from 171.67.215.200: icmp_seq=11 ttl=242 time=382.928 ms
64 bytes from 171.67.215.200: icmp_seq=12 ttl=242 time=304.337 ms
64 bytes from 171.67.215.200: icmp_seq=13 ttl=242 time=322.723 ms
64 bytes from 171.67.215.200: icmp_seq=14 ttl=242 time=335.546 ms
64 bytes from 171.67.215.200: icmp_seq=15 ttl=242 time=284.998 ms
64 bytes from 171.67.215.200: icmp_seq=16 ttl=242 time=284.998 ms
64 bytes from 171.67.215.200: icmp_seq=17 ttl=242 time=284.467 ms
64 bytes from 171.67.215.200: icmp_seq=18 ttl=242 time=318.375 ms
64 bytes from 171.67.215.200: icmp_seq=19 ttl=242 time=294.278 ms
64 bytes from 171.67.215.200: icmp_seq=20 ttl=242 time=289.599 ms
64 bytes from 171.67.215.200: icmp_seq=21 ttl=242 time=285.956 ms
64 bytes from 171.67.215.200: icmp_seq=22 ttl=242 time=289.629 ms
64 bytes from 171.67.215.200: icmp_seq=23 ttl=242 time=285.839 ms
64 bytes from 171.67.215.200: icmp_seq=24 ttl=242 time=285.405 ms
64 bytes from 171.67.215.200: icmp_seq=25 ttl=242 time=286.687 ms
64 bytes from 171.67.215.200: icmp_seq=26 ttl=242 time=285.996 ms
64 bytes from 171.67.215.200: icmp_seq=27 ttl=242 time=289.256 ms
64 bytes from 171.67.215.200: icmp_seq=28 ttl=242 time=285.413 ms
64 bytes from 171.67.215.200: icmp_seq=29 ttl=242 time=285.446 ms
64 bytes from 171.67.215.200: icmp_seq=30 ttl=242 time=285.446 ms
64 bytes from 171.67.215.200: icmp_seq=31 ttl=242 time=285.446 ms
64 bytes from 171.67.215.200: icmp_seq=32 ttl=242 time=385.985 ms
64 bytes from 171.67.215.200: icmp_seq=33 ttl=242 time=303.593 ms
64 bytes from 171.67.215.200: icmp_seq=34 ttl=242 time=323.985 ms
64 bytes from 171.67.215.200: icmp_seq=35 ttl=242 time=292.649 ms
64 bytes from 171.67.215.200: icmp_seq=36 ttl=242 time=294.372 ms
64 bytes from 171.67.215.200: icmp_seq=37 ttl=242 time=285.695 ms
64 bytes from 171.67.215.200: icmp_seq=38 ttl=242 time=285.681 ms
64 bytes from 171.67.215.200: icmp_seq=39 ttl=242 time=285.683 ms
64 bytes from 171.67.215.200: icmp_seq=40 ttl=242 time=286.065 ms
64 bytes from 171.67.215.200: icmp_seq=41 ttl=242 time=285.977 ms
64 bytes from 171.67.215.200: icmp_seq=42 ttl=242 time=284.997 ms
64 bytes from 171.67.215.200: icmp_seq=43 ttl=242 time=296.882 ms
64 bytes from 171.67.215.200: icmp_seq=44 ttl=242 time=288.342 ms
64 bytes from 171.67.215.200: icmp_seq=45 ttl=242 time=286.379 ms
64 bytes from 171.67.215.200: icmp_seq=46 ttl=242 time=286.379 ms
64 bytes from 171.67.215.200: icmp_seq=47 ttl=242 time=284.239 ms
64 bytes from 171.67.215.200: icmp_seq=48 ttl=242 time=292.597 ms
64 bytes from 171.67.215.200: icmp_seq=49 ttl=242 time=286.917 ms

--- stanford.edu ping statistics ---
50 packets transmitted, 50 packets received, 0.0% packet loss
round-trip min/avg/max/stddev = 284.996/303.338/386.013/28.956 ms
vipul@vipuls-MacBook-Air-2 ~ %
```

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

```

round-trip min/avg/max/stddev = 284.997/303.339/366.013/28.954 ms
vipul@vipuls-MacBook-Air-2 ~ % traceroute stanford.edu
traceroute to stanford.edu (171.67.215.200), 64 hops max, 40 byte packets
1 192.168.32.254 (192.168.32.254) 15.913 ms 6.768 ms 7.348 ms
2 auth.iitd.edu.in (192.168.1.99) 5.858 ms 6.131 ms 4.963 ms
3 103.25.231.1 (103.25.231.1) 6.474 ms 8.015 ms 6.353 ms
4 10.255.238.121 (10.255.238.121) 30.787 ms 36.873 ms
5 10.1.208.137 (10.1.208.137) 29.694 ms 30.621 ms 29.961 ms
6 10.255.238.122 (10.255.238.122) 50.750 ms
10.255.238.254 (10.255.238.254) 50.056 ms 51.248 ms
7 180.149.48.18 (180.149.48.18) 33.969 ms 38.141 ms 34.375 ms
8 * *
9 * *
10 * *
11 * *
12 * *
13 * *
14 * *
15 * *
16 * *
17 * *
18 * *
19 * *
20 * *
21 * *
22 * *
23 * *
24 campus-nw-rtr-vl1104.sunet (171.66.255.200) 295.498 ms *
25 web.stanford.edu (171.67.215.200) 298.784 ms 297.198 ms *
vipul@vipuls-MacBook-Air-2 ~ %

```

Count the Hops for google.in: The result shows up to **9 hops**, with some hops not responding but still counted up to hop 9.

Count the Hops for stanford.edu: The result shows up to **25 hops**, with several hops not responding but still counted up to hop 25.

Explanation: The number of hops for stanford.edu is significantly higher compared to google.in. This difference indicates that the path to stanford.edu involves more intermediate network devices or routers, which could be due to the different network routes and infrastructure involved in reaching the two destinations.

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

Ans. The latency difference between google.in and stanford.edu is mainly due to their geographic distance; Stanford is much farther away, leading to higher latency. The network path to Stanford likely involves more hops and potential congestion, contributing to the higher delay. In contrast, google.in is closer and benefits from a more direct and optimized network route, resulting in lower and more consistent latency.

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.

Ans. The command **sudo ifconfig lo down** is used to disable the loopback interface (**lo**) on your system. The loopback interface is a virtual network interface that the system uses to communicate with itself. Disabling it can disrupt local services and applications that rely on it for inter-process communication.

```

vipul@vipuls-MacBook-Air-2 ~ % sudo ifconfig lo down
vipul@vipuls-MacBook-Air-2 ~ % 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 ---
33 packets transmitted, 0 received, 100% packet loss, time 22146ms

```

Disabling Local Communication: The loopback interface (usually `127.0.0.1`) is used for local communication within your machine. Disabling it will stop all services that rely on local loopback, like database connections, local testing servers, and other inter-process communications.