EXPERIMENT 2

Ping Command –

The command ping <host> sends a series of packets and expects to receive a response to each packet. When a return packet is received, ping reports the round-trip time (the time between sending the packet and receiving the response).

ping -n 10 -l 64 cs.stanford.edu

```
C:\WINDOWS\system32>type ping1.log

Pinging cs.stanford.edu [171.64.64.64] with 64 bytes of data:
Reply from 171.64.64.64: bytes=64 time=250ms TTL=47
Reply from 171.64.64.64: bytes=64 time=250ms TTL=47
Reply from 171.64.64.64: bytes=64 time=255ms TTL=47
Reply from 171.64.64.64: bytes=64 time=261ms TTL=47
Reply from 171.64.64.64: bytes=64 time=250ms TTL=47
Reply from 171.64.64.64: bytes=64 time=264ms TTL=47
Reply from 171.64.64.64: bytes=64 time=252ms TTL=47
Reply from 171.64.64.64: bytes=64 time=253ms TTL=47
Reply from 171.64.64.64: bytes=64 time=252ms TTL=47
Reply from 171.64.64.64: bytes=64 time=250ms TTL=47

Ping statistics for 171.64.64.64:
    Packets: Sent = 10, Received = 10, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 250ms, Maximum = 264ms, Average = 253ms
```

ping -n 10 -l 100 cs.stanford.edu

```
C:\WINDOWS\system32>type ping2.log

Pinging cs.stanford.edu [171.64.64.64] with 100 bytes of data:
Reply from 171.64.64.64: bytes=100 time=250ms TTL=47
Reply from 171.64.64.64: bytes=100 time=256ms TTL=47
Reply from 171.64.64.64: bytes=100 time=256ms TTL=47
Reply from 171.64.64.64: bytes=100 time=250ms TTL=47
Reply from 171.64.64.64: bytes=100 time=253ms TTL=47
Reply from 171.64.64.64: bytes=100 time=251ms TTL=47
Reply from 171.64.64.64: bytes=100 time=251ms TTL=47
Reply from 171.64.64.64: bytes=100 time=252ms TTL=47
Reply from 171.64.64.64: bytes=100 time=250ms TTL=47
Reply from 171.64.64.64: bytes=100 time=250ms TTL=47

Ping statistics for 171.64.64.64:
    Packets: Sent = 10, Received = 10, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 250ms, Maximum = 256ms, Average = 251ms
```

ping -n 10 -l 500 cs.stanford.edu

```
C:\WINDOWS\system32>type ping3.log

Pinging cs.stanford.edu [171.64.64.64] with 500 bytes of data:
Reply from 171.64.64.64: bytes=500 time=251ms TTL=47
Reply from 171.64.64.64: bytes=500 time=250ms TTL=47
Reply from 171.64.64.64: bytes=500 time=252ms TTL=47
Reply from 171.64.64.64: bytes=500 time=252ms TTL=47
Reply from 171.64.64.64: bytes=500 time=257ms TTL=47
Reply from 171.64.64.64: bytes=500 time=259ms TTL=47
Reply from 171.64.64.64: bytes=500 time=260ms TTL=47
Reply from 171.64.64.64: bytes=500 time=254ms TTL=47
Reply from 171.64.64.64: bytes=500 time=263ms TTL=47
Reply from 171.64.64.64: bytes=500 time=270ms TTL=47

Ping statistics for 171.64.64.64:
    Packets: Sent = 10, Received = 10, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 250ms, Maximum = 270ms, Average = 256ms
```

ping -n 10 -l 1000 cs.stanford.edu

```
C:\WINDOWS\system32>type ping4.log

Pinging cs.stanford.edu [171.64.64.64] with 1000 bytes of data:
Reply from 171.64.64.64: bytes=1000 time=252ms TTL=47
Reply from 171.64.64.64: bytes=1000 time=251ms TTL=47
Reply from 171.64.64.64: bytes=1000 time=252ms TTL=47
Reply from 171.64.64.64: bytes=1000 time=272ms TTL=47
Reply from 171.64.64.64: bytes=1000 time=250ms TTL=47
Reply from 171.64.64.64: bytes=1000 time=300ms TTL=47
Reply from 171.64.64.64: bytes=1000 time=253ms TTL=47
Reply from 171.64.64.64: bytes=1000 time=250ms TTL=47
Reply from 171.64.64.64: bytes=1000 time=253ms TTL=47
Reply from 171.64.64.64: bytes=1000 time=272ms TTL=47

Ping statistics for 171.64.64.64:
    Packets: Sent = 10, Received = 10, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 250ms, Maximum = 300ms, Average = 260ms
```

ping -n 10 -l 1400 cs.stanford.edu

```
C:\WINDOWS\system32>type ping5.log

Pinging cs.stanford.edu [171.64.64.64] with 1400 bytes of data:
Reply from 171.64.64.64: bytes=1400 time=251ms TTL=47
Reply from 171.64.64.64: bytes=1400 time=259ms TTL=47
Reply from 171.64.64.64: bytes=1400 time=263ms TTL=47
Reply from 171.64.64.64: bytes=1400 time=251ms TTL=47
Reply from 171.64.64.64: bytes=1400 time=251ms TTL=47
Reply from 171.64.64.64: bytes=1400 time=251ms TTL=47
Reply from 171.64.64.64: bytes=1400 time=251ms TTL=47
Reply from 171.64.64.64: bytes=1400 time=251ms TTL=47
Reply from 171.64.64.64: bytes=1400 time=251ms TTL=47
Reply from 171.64.64.64: bytes=1400 time=252ms TTL=47

Ping statistics for 171.64.64.64:
    Packets: Sent = 10, Received = 10, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 251ms, Maximum = 263ms, Average = 253ms
```

Round-trip time (RTT) is the duration, measured in milliseconds, from when a browser sends a request to when it receives a response from a server. It's a key performance metric for web applications and one of the main factors, along with Time to First Byte (TTFB), when measuring page load time and network latency.

Questions on Latency:

1. Does the average RTT vary between different hosts? What aspects of latency (transmit, propagation, and queueing delay) might impact this and why?

```
C:\WINDOWS\system32>ping -n 10 -l 64 google.com

Pinging google.com [216.58.203.14] with 64 bytes of data:
Reply from 216.58.203.14: bytes=64 time=5ms TTL=120
Reply from 216.58.203.14: bytes=64 time=3ms TTL=120
Reply from 216.58.203.14: bytes=64 time=4ms TTL=120
Reply from 216.58.203.14: bytes=64 time=6ms TTL=120
Reply from 216.58.203.14: bytes=64 time=5ms TTL=120
Reply from 216.58.203.14: bytes=64 time=3ms TTL=120
Reply from 216.58.203.14: bytes=64 time=3ms TTL=120
Reply from 216.58.203.14: bytes=64 time=20ms TTL=120
Reply from 216.58.203.14: bytes=64 time=12ms TTL=120
Reply from 216.58.203.14: bytes=64 time=3ms TTL=120

Ping statistics for 216.58.203.14:
    Packets: Sent = 10, Received = 10, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 3ms, Maximum = 20ms, Average = 6ms
```

```
C:\WINDOWS\system32>ping -n 10 -l 64 cs.stanford.edu

Pinging cs.stanford.edu [171.64.64.64] with 64 bytes of data:
Reply from 171.64.64.64: bytes=64 time=252ms TTL=52
Reply from 171.64.64.64: bytes=64 time=251ms TTL=52
Reply from 171.64.64.64: bytes=64 time=259ms TTL=52
Reply from 171.64.64.64: bytes=64 time=253ms TTL=52
Reply from 171.64.64.64: bytes=64 time=271ms TTL=52
Reply from 171.64.64.64: bytes=64 time=279ms TTL=52
Reply from 171.64.64.64: bytes=64 time=270ms TTL=52
Reply from 171.64.64.64: bytes=64 time=253ms TTL=52
Reply from 171.64.64.64: bytes=64 time=263ms TTL=52
Reply from 171.64.64.64: bytes=64 time=286ms TTL=52

Ping statistics for 171.64.64.64:
    Packets: Sent = 10, Received = 10, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 251ms, Maximum = 286ms, Average = 263ms
```

We can see that RTT depends upon the host(destination) on which the ping command is used. RTT is affect due to **Transmission delay, Propagation delay, Queueing delay etc.**

2. Does the average RTT vary with different packet sizes? What aspects of latency (transmit, propagation, and queueing delay) might impact this and why?

```
C:\WINDOWS\system32>ping -n 10 -l 100 google.com

Pinging google.com [216.58.203.14] with 100 bytes of data:
Reply from 216.58.203.14: bytes=68 (sent 100) time=6ms TTL=120
Reply from 216.58.203.14: bytes=68 (sent 100) time=3ms TTL=120
Reply from 216.58.203.14: bytes=68 (sent 100) time=4ms TTL=120
Reply from 216.58.203.14: bytes=68 (sent 100) time=6ms TTL=120
Reply from 216.58.203.14: bytes=68 (sent 100) time=5ms TTL=120
Reply from 216.58.203.14: bytes=68 (sent 100) time=5ms TTL=120
Reply from 216.58.203.14: bytes=68 (sent 100) time=3ms TTL=120
Reply from 216.58.203.14: bytes=68 (sent 100) time=3ms TTL=120
Reply from 216.58.203.14: bytes=68 (sent 100) time=4ms TTL=120
Reply from 216.58.203.14: bytes=68 (sent 100) time=4ms TTL=120

Ping statistics for 216.58.203.14:
    Packets: Sent = 10, Received = 10, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 3ms, Maximum = 6ms, Average = 4ms

C:\WINDOWS\system32>ping -n 10 -l 1000 google.com

Pinging google.com [216.58.203.14] with 1000 bytes of data:
Reply from 216.58.203.14: bytes=68 (sent 1000) time=45ms TTL=120
Reply from 216.58.203.14: bytes=68 (sent 1000) time=6ms TTL=120
Reply from 216.58.203.14: bytes=68 (sent 1000) time=12ms TTL=120
Reply from 216.58.203.14: bytes=68 (sent 1000) time=23ms TTL=120
Reply from 216.58.203.14: bytes=68 (sent 1000) time=14ms TTL=120
Reply from 216.58.203.14: bytes=68 (sent 1000) time=8ms TTL=120
Reply from 216.58.203.14: bytes=68 (sent 1000) time=5ms TTL=120
Reply from 216.58.203.14: bytes=68 (sent 1000) time=7ms TTL=120
Reply from 216.58.203.14: bytes=68 (sent 1000) time=4ms TTL=120
Reply from 216.58.203.14: bytes=68 (sent 1000) time=8ms TTL=120

Ping statistics for 216.58.203.14:
    Packets: Sent = 10, Received = 10, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 4ms, Maximum = 45ms, Average = 13ms
```

The RTT is impacted due to difference in size of packets because Transmission delay and Queueing Delay depend on size of packets.

Exercise:

Experiment with ping to find the round-trip times to a variety of destinations.
Write up any interesting observations, including in particular how the round-trip time compares to the physical distance.

ANS-
The length a signal has to travel correlates with the time taken for a request to reach a server and a response to reach a browser.

Intermediate routers or servers take time to process a signal, increasing g RTT. The more hops a signal has to travel through, the higher the RTT.

RTT typically increases when a network is congested with high levels of traffic. Conversely, low traffic times can result in decreased RTT

A longer server response time increases RTT.

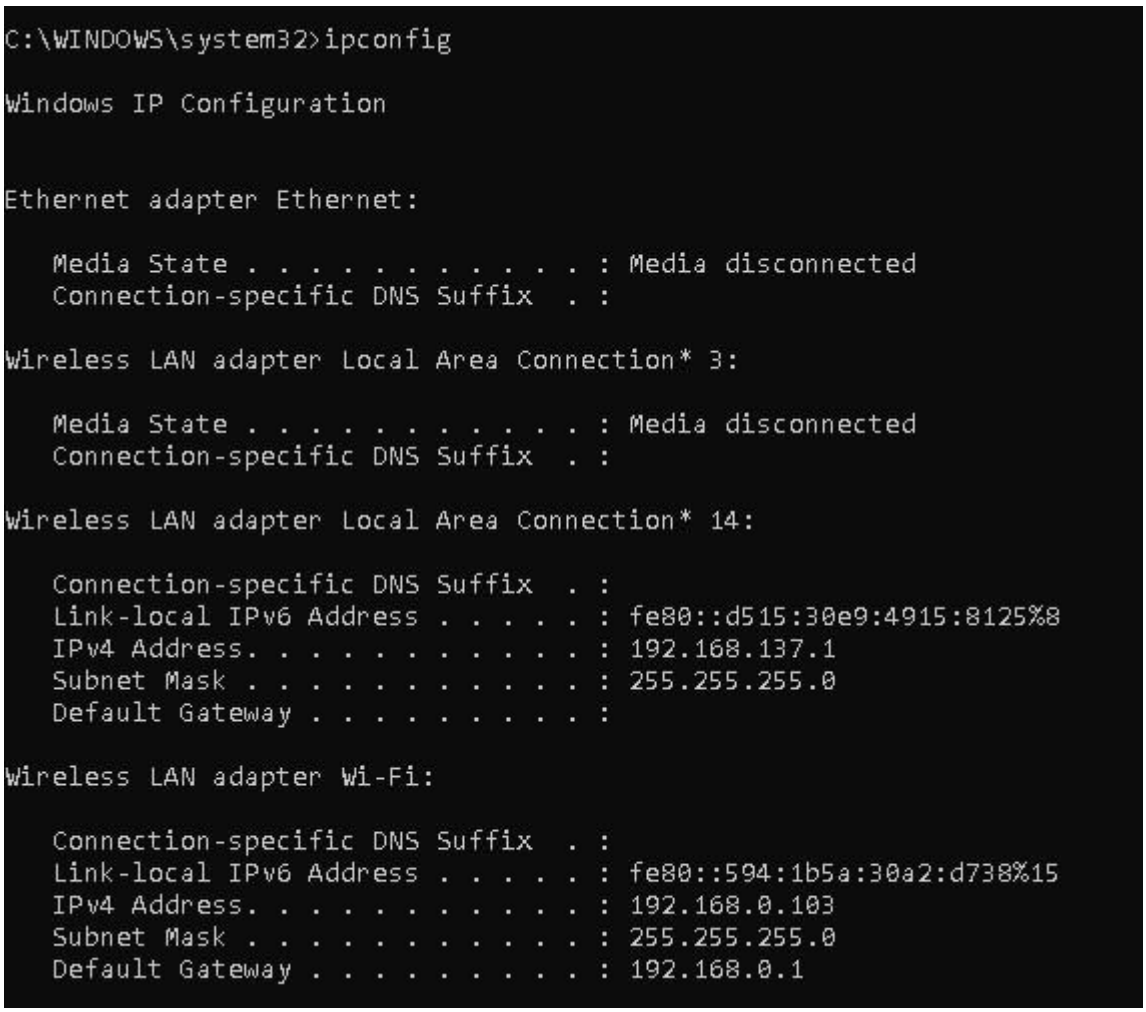
NSLOOKUP –

The command nslookup <host> will do a DNS query to find and report the IP address (or addresses) for a domain name or the domain name corresponding to an IP address. To do this, it contacts a "DNS server." Default DNS servers are part of a computer's network configuration.

```
C:\WINDOWS\system32>nslookup www.google.com
Server:  UnKnown
Address:  192.168.0.1

Non-authoritative answer:
Name:    www.google.com
Addresses:  2404:6800:4009:812::2004
          142.250.67.164
```

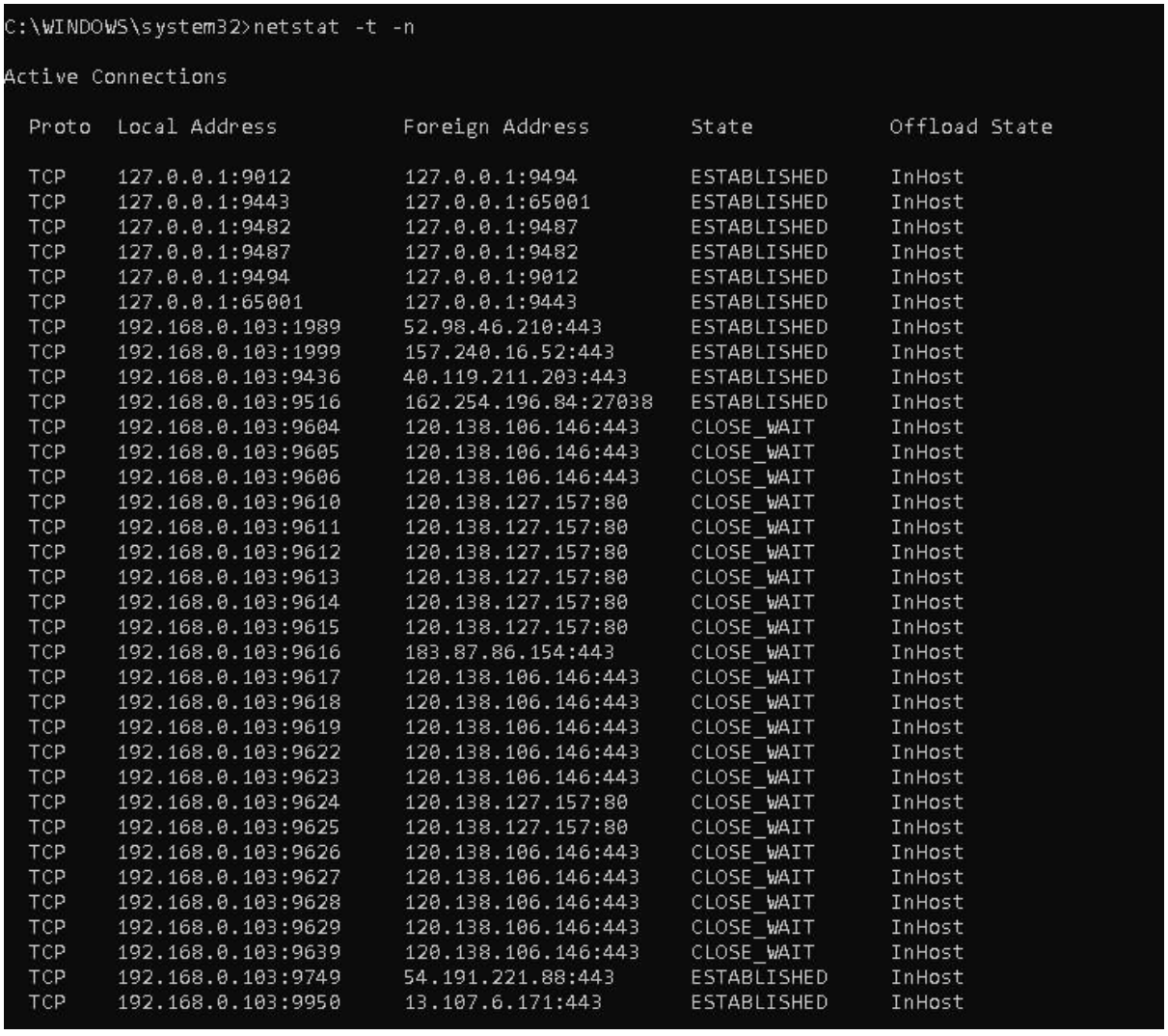
IPCONFIG –

You used ifconfig in the previous lab. When used with no parameters, ifconfig reports some information about the computer's network interfaces. This usually includes lo which stands for localhost; it can be used for communication between programs running on the same computer.



Netstat –

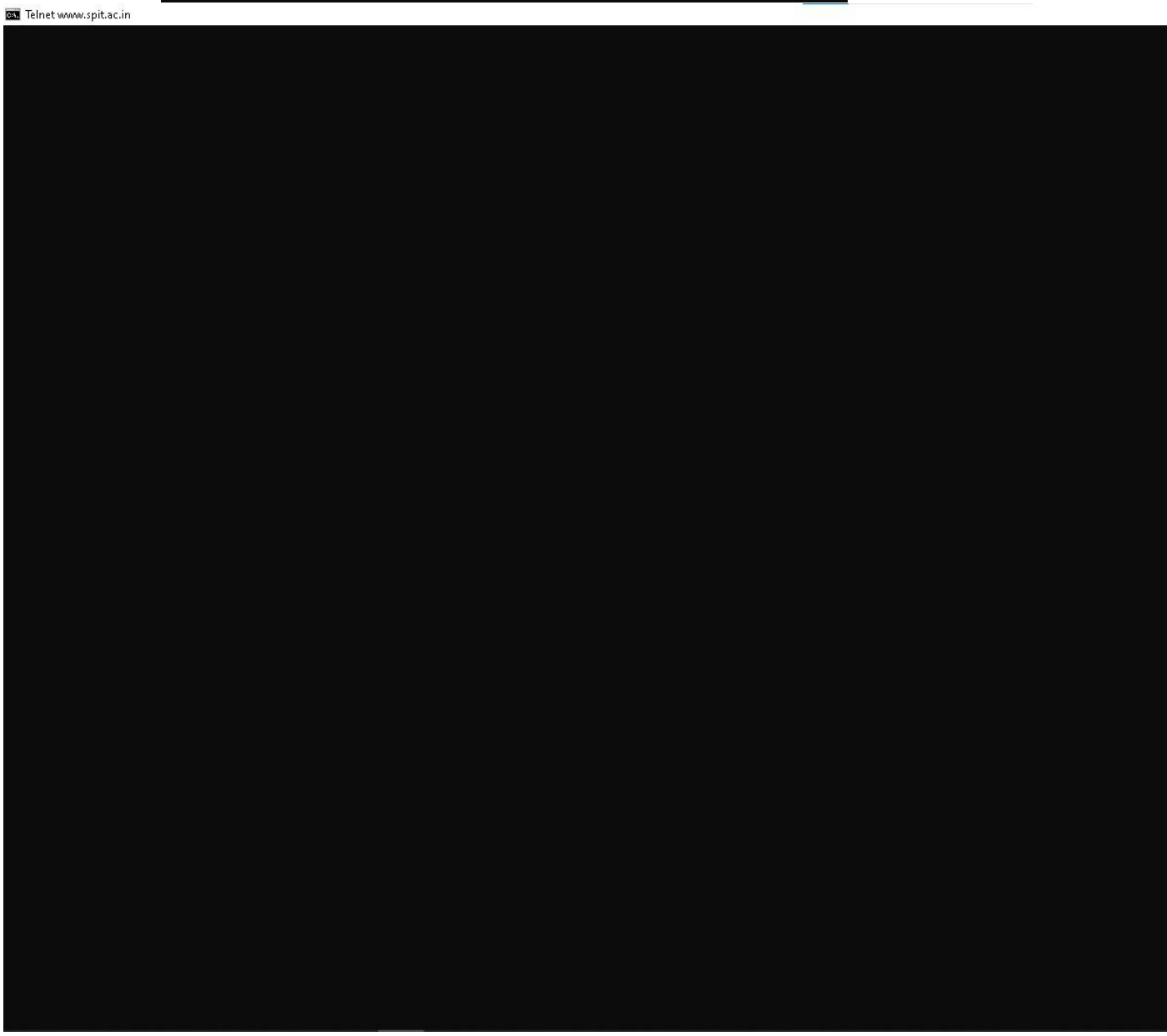
The netstat command gives information about network connections. I often use netstat -t -n which lists currently open TCP connections (that's the "-t" option) by IP address rather than domain name (that's the "-n" option)



```
C:\WINDOWS\system32>netstat -t -n

Active Connections

  Proto  Local Address          Foreign Address        State           Offload State

  TCP    127.0.0.1:9012         127.0.0.1:9494         ESTABLISHED     InHost
  TCP    127.0.0.1:9443         127.0.0.1:65001        ESTABLISHED     InHost
  TCP    127.0.0.1:9482         127.0.0.1:9487         ESTABLISHED     InHost
  TCP    127.0.0.1:9487         127.0.0.1:9482         ESTABLISHED     InHost
  TCP    127.0.0.1:9494         127.0.0.1:9012         ESTABLISHED     InHost
  TCP    127.0.0.1:65001        127.0.0.1:9443         ESTABLISHED     InHost
  TCP    192.168.0.103:1989     52.98.46.210:443       ESTABLISHED     InHost
  TCP    192.168.0.103:1999     157.240.16.52:443      ESTABLISHED     InHost
  TCP    192.168.0.103:9436     40.119.211.203:443     ESTABLISHED     InHost
  TCP    192.168.0.103:9516     162.254.196.84:27038   ESTABLISHED     InHost
  TCP    192.168.0.103:9604     120.138.106.146:443    CLOSE_WAIT      InHost
  TCP    192.168.0.103:9605     120.138.106.146:443    CLOSE_WAIT      InHost
  TCP    192.168.0.103:9606     120.138.106.146:443    CLOSE_WAIT      InHost
  TCP    192.168.0.103:9610     120.138.127.157:80     CLOSE_WAIT      InHost
  TCP    192.168.0.103:9611     120.138.127.157:80     CLOSE_WAIT      InHost
  TCP    192.168.0.103:9612     120.138.127.157:80     CLOSE_WAIT      InHost
  TCP    192.168.0.103:9613     120.138.127.157:80     CLOSE_WAIT      InHost
  TCP    192.168.0.103:9614     120.138.127.157:80     CLOSE_WAIT      InHost
  TCP    192.168.0.103:9615     120.138.127.157:80     CLOSE_WAIT      InHost
  TCP    192.168.0.103:9616     183.87.86.154:443      CLOSE_WAIT      InHost
  TCP    192.168.0.103:9617     120.138.106.146:443    CLOSE_WAIT      InHost
  TCP    192.168.0.103:9618     120.138.106.146:443    CLOSE_WAIT      InHost
  TCP    192.168.0.103:9619     120.138.106.146:443    CLOSE_WAIT      InHost
  TCP    192.168.0.103:9622     120.138.106.146:443    CLOSE_WAIT      InHost
  TCP    192.168.0.103:9623     120.138.106.146:443    CLOSE_WAIT      InHost
  TCP    192.168.0.103:9624     120.138.127.157:80     CLOSE_WAIT      InHost
  TCP    192.168.0.103:9625     120.138.127.157:80     CLOSE_WAIT      InHost
  TCP    192.168.0.103:9626     120.138.106.146:443    CLOSE_WAIT      InHost
  TCP    192.168.0.103:9627     120.138.106.146:443    CLOSE_WAIT      InHost
  TCP    192.168.0.103:9628     120.138.106.146:443    CLOSE_WAIT      InHost
  TCP    192.168.0.103:9629     120.138.106.146:443    CLOSE_WAIT      InHost
  TCP    192.168.0.103:9639     120.138.106.146:443    CLOSE_WAIT      InHost
  TCP    192.168.0.103:9749     54.191.221.88:443      ESTABLISHED     InHost
  TCP    192.168.0.103:9950     13.107.6.171:443       ESTABLISHED     InHost
```

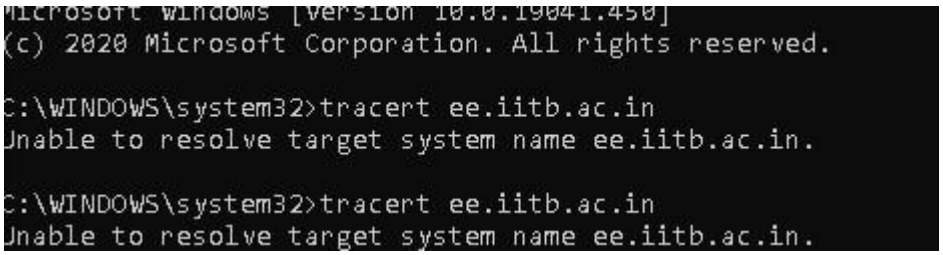
Telnet –

Telnet is an old program for remote login. It's not used so much for that any more, since it has no security features. But basically, all it does is open a connection to a server and allow server and client to send lines of plain text to each other. It can be used to check that it's possible to connect to a server and, if the server communicates in plain text, even to interact with the server by hand. Since the Web uses a plain text protocol, you can use telnet to connect to a web client and play the part of the web browser.



Exercise 1-

From your machine traceroute to the following hosts :
1. ee.iitb.ac.in
2. mscs.mu.edu
3. www.cs.grinnell.edu
4. csail.mit.edu
5. cs.stanford.edu
6. cs.manchester.ac.uk
Store the output of each traceroute command in a separate file named traceroute_HOSTNAME.log, replacing HOSTNAME with the hostname fo r end-host you pinged
(e.g., traceroute_ee.iitb.ac.in.log).



```
C:\WINDOWS\system32>type 1.log

Tracing route to mscs.mu.edu [134.48.4.5]
over a maximum of 30 hops:

  1     1 ms     3 ms     1 ms  192.168.0.1
  2     2 ms     2 ms     5 ms  18-200.59.103.n4uspl.net [103.59.200.18]
  3     3 ms     3 ms     3 ms  13-200.59.103.n4uspl.net [103.59.200.13]
  4     4 ms     4 ms     4 ms  182.73.199.157
  5   199 ms   199 ms   200 ms  116.119.52.163
  6   197 ms   198 ms   204 ms  core1.nyc4.he.net [198.32.118.57]
  7     *      223 ms   224 ms  100ge2-1.core2.chi1.he.net [184.104.193.173]
  8     *        *        *     Request timed out.
  9   223 ms   224 ms   223 ms  r-222wwash-isp-ae6-3926.wiscnet.net [140.189.8.126]
 10   226 ms   226 ms   223 ms  r-milwaukeeci-809-isp-ae3-0.wiscnet.net [140.189.8.230]
 11   224 ms   222 ms   223 ms  MarquetteUniv.site.wiscnet.net [216.56.1.202]
 12   219 ms   219 ms   218 ms  134.48.10.26
 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     *        *        *     Request timed out.
 24     *        *        *     Request timed out.
 25     *        *        *     Request timed out.
 26     *        *        *     Request timed out.
 27     *        *        *     Request timed out.
 28     *        *        *     Request timed out.
 29     *        *        *     Request timed out.
 30     *        *        *     Request timed out.

Trace complete.
```

```
C:\WINDOWS\system32>type 2.txt

Tracing route to www.cs.grinnell.edu [132.161.132.159]
over a maximum of 30 hops:

  1    11 ms     1 ms     1 ms  192.168.0.1
  2     4 ms     3 ms    10 ms  18-200.59.103.n4uspl.net [103.59.200.18]
  3     3 ms     3 ms     5 ms  13-200.59.103.n4uspl.net [103.59.200.13]
  4     5 ms     5 ms     7 ms  182.73.199.157
  5   219 ms   219 ms   225 ms  182.79.245.6
  6   214 ms   217 ms   214 ms  core1.nyc4.he.net [198.32.118.57]
  7   237 ms     *        *     100ge9-1.core2.chi1.he.net [184.105.223.161]
  8   246 ms   245 ms   244 ms  100ge14-2.core1.msp1.he.net [184.105.223.178]
  9   251 ms     *      251 ms  aureon-network-services-inc.e0-26.switch1.msp1.he.net [216.66.77.218]
 10   251 ms   251 ms   251 ms  peer-as5056.br02.msp1.tfbnw.net [157.240.76.37]
 11   252 ms     *      252 ms  167.142.58.40
 12   251 ms   249 ms   250 ms  167.142.219.32
 13   250 ms   254 ms   251 ms  grinnellcollege1.desm.netins.net [167.142.65.43]
 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     *        *        *     Request timed out.
 24     *        *        *     Request timed out.
 25     *        *        *     Request timed out.
 26     *        *        *     Request timed out.
 27     *        *        *     Request timed out.
 28     *        *        *     Request timed out.
 29     *        *        *     Request timed out.
 30     *        *        *     Request timed out.

Trace complete.
```

```
C:\WINDOWS\system32>type 3.txt

Tracing route to csail.mit.edu [128.30.2.109]
over a maximum of 30 hops:

  1     3 ms     1 ms     1 ms  192.168.0.1
  2     3 ms     6 ms    10 ms  18-200.59.103.n4uspl.net [103.59.200.18]
  3     *        3 ms     *     13-200.59.103.n4uspl.net [103.59.200.13]
  4     4 ms     4 ms     5 ms  182.73.199.157
  5   237 ms   228 ms   229 ms  182.79.243.25
  6   240 ms   232 ms   233 ms  ae58.edge1.LosAngeles6.Level3.net [4.26.0.17]
  7     *        *        *     Request timed out.
  8   254 ms   257 ms   254 ms  MASSACHUSET.bear1.Boston1.Level3.net [4.53.48.98]
  9   253 ms   253 ms   256 ms  dmz-rtr-1-external-rtr-1.mit.edu [18.0.161.17]
 10   255 ms   255 ms   253 ms  dmz-rtr-2-dmz-rtr-1-1.mit.edu [18.0.161.6]
 11   266 ms   253 ms   257 ms  mitnet.core-1-ext.csail.mit.edu [18.4.7.65]
 12     *        *      260 ms  core-1-ext.bdr.csail.mit.edu [128.30.13.26]
 13   256 ms   260 ms   258 ms  bdr.core-1.csail.mit.edu [128.30.0.246]
 14   257 ms   258 ms   255 ms  inquir-3ld.csail.mit.edu [128.30.2.109]

Trace complete.
```

```
C:\WINDOWS\system32>type 4.txt

Tracing route to cs.stanford.edu [171.64.64.64]
over a maximum of 30 hops:

  1     2 ms    24 ms     2 ms  192.168.0.1
  2     7 ms     2 ms     3 ms  18-200.59.103.n4uspl.net [103.59.200.18]
  3     4 ms     *        3 ms  13-200.59.103.n4uspl.net [103.59.200.13]
  4     5 ms     5 ms     5 ms  182.73.199.157
  5   187 ms   194 ms   187 ms  182.79.222.233
  6   199 ms   198 ms   200 ms  core1.nyc4.he.net [198.32.118.57]
  7   246 ms     *      251 ms  100ge8-1.core1.sjc2.he.net [184.105.81.218]
  8   259 ms   249 ms   249 ms  10ge4-5.core1.pao1.he.net [72.52.92.69]
  9   246 ms   246 ms   246 ms  stanford-university.100gigabitethernet5-1.core1.pao1.he.net [184.105.177.238]
 10   250 ms   250 ms   252 ms  csee-west-rtr-vl3.SUNet [171.66.255.140]
 11   251 ms   253 ms   251 ms  CS.stanford.edu [171.64.64.64]

Trace complete.
```

```
C:\WINDOWS\system32>type 5.txt

Tracing route to cs.manchester.ac.uk [130.88.101.49]
over a maximum of 30 hops:

  1     1 ms     5 ms     2 ms  192.168.0.1
  2     2 ms     1 ms     2 ms  18-200.59.103.n4uspl.net [103.59.200.18]
  3    20 ms     5 ms     3 ms  13-200.59.103.n4uspl.net [103.59.200.13]
  4     4 ms     5 ms     4 ms  182.73.199.157
  5   132 ms   136 ms   133 ms  182.79.154.0
  6   326 ms   133 ms     *     ldn-b4-link.telia.net [62.115.162.232]
  7   133 ms   137 ms   133 ms  jisc-ic-345131-ldn-b4.c.telia.net [62.115.175.131]
  8   133 ms   133 ms   132 ms  ae24.londhx-sbr1.ja.net [146.97.35.197]
  9   133 ms   136 ms   135 ms  ae29.londpg-sbr2.ja.net [146.97.33.2]
 10   139 ms   141 ms   139 ms  ae31.erdiss-sbr2.ja.net [146.97.33.22]
 11   154 ms   140 ms   138 ms  ae29.manckh-sbr2.ja.net [146.97.33.42]
 12   151 ms   142 ms   141 ms  ae23.mancrh-rbr1.ja.net [146.97.38.42]
 13   143 ms     *      140 ms  universityofmanchester.ja.net [146.97.169.2]
 14   143 ms   145 ms   142 ms  130.88.249.194
 15     *        *        *     Request timed out.
 16     *        *        *     Request timed out.
 17   144 ms   140 ms   142 ms  eps.its.man.ac.uk [130.88.101.49]

Trace complete.
```

Exercise 2-

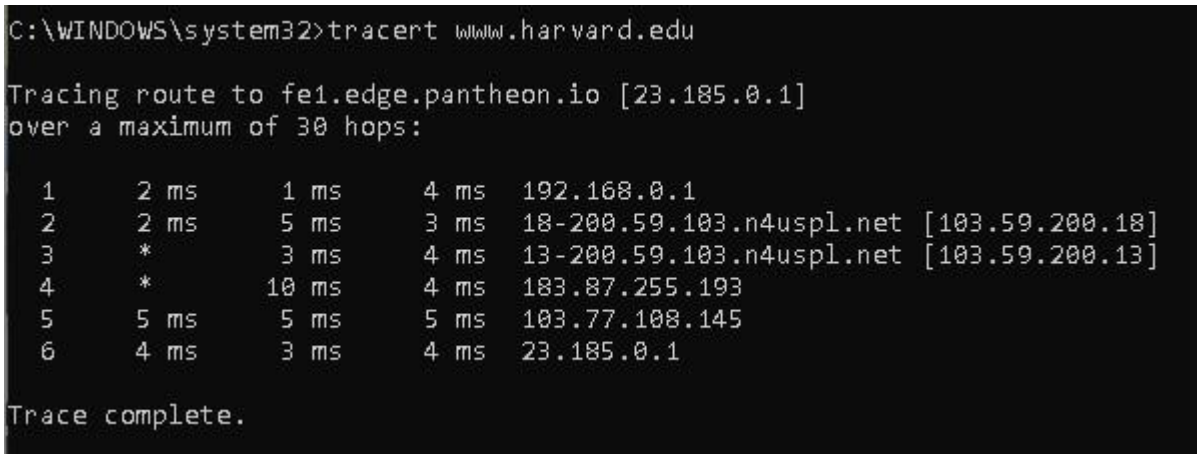
Use traceroute to trace the route from your computer to math.hws.edu and to www.hws.edu. Explain the difference in the results.

```
C:\WINDOWS\system32>tracert math.hws.edu > a.txt

C:\WINDOWS\system32>type a.txt

Tracing route to math.hws.edu [64.89.144.237]
over a maximum of 30 hops:

  1     3 ms     4 ms     1 ms  192.168.0.1
  2     2 ms     2 ms     2 ms  18-200.59.103.n4uspl.net [103.59.200.18]
  3     *        2 ms     3 ms  13-200.59.103.n4uspl.net [103.59.200.13]
  4     5 ms     6 ms     5 ms  182.73.199.157
  5   225 ms   228 ms   224 ms  182.79.217.217
  6   231 ms   236 ms   231 ms  ae58.edge1.LosAngeles6.Level3.net [4.26.0.17]
  7     *        *        *     Request timed out.
  8     *        *        *     Request timed out.
  9   253 ms   250 ms   247 ms  roc1-ar5-xe-0-0-0-0.us.twtelecom.net [35.248.1.158]
 10   256 ms   249 ms   249 ms  66-195-65-170.static.ctl.one [66.195.65.170]
 11   249 ms   249 ms   254 ms  nat.hws.edu [64.89.144.100]
 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     *        *        *     Request timed out.
 24     *        *        *     Request timed out.
 25     *        *        *     Request timed out.
 26     *        *        *     Request timed out.
 27     *        *        *     Request timed out.
 28     *        *        *     Request timed out.
 29     *        *        *     Request timed out.
 30     *        *        *     Request timed out.

Trace complete.
```

```
C:\WINDOWS\system32>tracert www.hws.edu > b.txt

C:\WINDOWS\system32>type b.txt

Tracing route to www.hws.edu [64.89.145.159]
over a maximum of 30 hops:

  1     1 ms     1 ms     1 ms  192.168.0.1
  2     2 ms     2 ms     2 ms  18-200.59.103.n4uspl.net [103.59.200.18]
  3     *        6 ms     7 ms  13-200.59.103.n4uspl.net [103.59.200.13]
  4     6 ms     5 ms     4 ms  182.73.199.157
  5   230 ms   255 ms   234 ms  182.79.222.25
  6   247 ms   233 ms   232 ms  xe-9-1-0.edge1.LosAngeles6.Level3.net [4.26.0.61]
  7     *        *        *     Request timed out.
  8     *        *        *     Request timed out.
  9   258 ms   259 ms   257 ms  roc1-ar5-xe-0-0-0-0.us.twtelecom.net [35.248.1.158]
 10   262 ms   260 ms   262 ms  66-195-65-170.static.ctl.one [66.195.65.170]
 11   300 ms   281 ms   260 ms  nat.hws.edu [64.89.144.100]
 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     *        *        *     Request timed out.
 24     *        *        *     Request timed out.
 25     *        *        *     Request timed out.
 26     *        *        *     Request timed out.
 27     *        *        *     Request timed out.
 28     *        *        *     Request timed out.
 29     *        *        *     Request timed out.
 30     *        *        *     Request timed out.

Trace complete.
```

Exercise 3

Two packets sent from the same source to the same destination do not necessarily follow the same path through the net. Experiment with some sources that are fairly far away. Can you find cases where packets sent to the same destination follow different paths? How likely does it seem to be? What about when the packets are sent at very different times? Save some of the outputs from traceroute. Come back sometime next week, try the same destinations again, and compare the results with the results from today. Report your observations.



Exercise 4: (Short.) Use Whois to investigate a well-known web site such as google.com or amazon.com, and write a couple of sentences about what you find out.

```
Domain Name: google.com
Registry Domain ID: 2138514_DOMAIN_COM-VRSN
Registrar WHOIS Server: whois.markmonitor.com
Registrar URL: http://www.markmonitor.com
Updated Date: 2019-09-09T08:39:04-0700
Creation Date: 1997-09-15T00:00:00-0700
Registrar Registration Expiration Date: 2028-09-13T00:00:00-0700
Registrar: MarkMonitor, Inc.
Registrar IANA ID: 292
Registrar Abuse Contact Email: abusecomplaints@markmonitor.com
Registrar Abuse Contact Phone: +1.2083895770
Domain Status: clientUpdateProhibited (https://www.icann.org/epp#clientUpdateProhibited)
Domain Status: clientTransferProhibited (https://www.icann.org/epp#clientTransferProhibited)
Domain Status: clientDeleteProhibited (https://www.icann.org/epp#clientDeleteProhibited)
Domain Status: serverUpdateProhibited (https://www.icann.org/epp#serverUpdateProhibited)
Domain Status: serverTransferProhibited (https://www.icann.org/epp#serverTransferProhibited)
Domain Status: serverDeleteProhibited (https://www.icann.org/epp#serverDeleteProhibited)
Registrant Organization: Google LLC
Registrant State/Province: CA
Registrant Country: US
Registrant Email: Select Request Email Form at https://domains.markmonitor.com/whois/google.com
Admin Organization: Google LLC
Admin State/Province: CA
Admin Country: US
Admin Email: Select Request Email Form at https://domains.markmonitor.com/whois/google.com
Tech Organization: Google LLC
Tech State/Province: CA
Tech Country: US
Tech Email: Select Request Email Form at https://domains.markmonitor.com/whois/google.com
Name Server: ns2.google.com
Name Server: ns4.google.com
Name Server: ns3.google.com
Name Server: ns1.google.com
DNSSEC: unsigned
URL of the ICANN WHOIS Data Problem Reporting System: http://wdprs.internic.net/
>>> Last update of WHOIS database: 2020-08-17T00:41:16-0700 <<<
```

A Whois record contains all of the contact information associated with the person, group, or company that registers a particular domain name. It is a widely used Internet record listing that identifies who owns a domain and how to get in contact with them.