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💻 EXPERIMENT 2 💻

AIM: To study the basic command line networking utilities.

THEORY:

Some Basic command line Networking utilities

Start with a few of the most basic command line tools. These commands are available on Unix, including Linux (and the first two, at least, are also for Windows). Some parameters or options might differ on different operating systems. Remember that you can use man <command> to get information about a command and its options.

ping — The command ping <host> sends a series of packets and expects to receieve 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). Some routers and firewalls block ping requests, so you might get no reponse at all. Ping can be used to check whether a computer is up and running, to measure network delay time, and to check for dropped packets indicating network congestion. Note that <host> can be either a domain name or an IP address. By default, ping will send a packet every second indefinitely; stop it with Control-C

Network latency, specifically round trip time (RTT), can be measured using `ping`, which sends ICMP packets. The syntax for the command in Linux or Mac OS is:

```
ping [-c <count>] [-s <packetsize>] <hostname>
```

The syntax in Windows is:

```
ping [-n <count>] [-l <packetsize>] <hostname>
```

The default number of ICMP packets to send is either infinite (in Linux and Mac OS) or 4 (in Windows). The default packet size is either 64 bytes (in Linux) or 32 bytes (in Windows). You can specify either a hostname (e.g., `spit.ac.in`) or an IP address.

To save the output from `ping` to a file, include a greater than symbol and a file name at the end of the command. For example:

```
ping -c 10 google.com > ping_c10_s64_google.log
```

EXPERIMENTS WITH PING

1. Ping the any hosts 10 times (i.e., packet count is 10) with a packet size of 64 bytes, 100 bytes, 500 bytes, 1000 bytes, 1400 bytes

```
Microsoft Windows [Version 10.0.18363.1016]
(c) 2019 Microsoft Corporation. All rights reserved.

C:\Users\Ankeet>ping -n 10 -l 64 www.google.com

Pinging www.google.com [172.217.174.228] with 64 bytes of data:
Reply from 172.217.174.228: bytes=64 time=4ms TTL=117
Reply from 172.217.174.228: bytes=64 time=4ms TTL=117
Reply from 172.217.174.228: bytes=64 time=4ms TTL=117
Reply from 172.217.174.228: bytes=64 time=4ms TTL=117
Reply from 172.217.174.228: bytes=64 time=7ms TTL=117
Reply from 172.217.174.228: bytes=64 time=4ms TTL=117
Reply from 172.217.174.228: bytes=64 time=4ms TTL=117
Reply from 172.217.174.228: bytes=64 time=4ms TTL=117
Reply from 172.217.174.228: bytes=64 time=4ms TTL=117
Reply from 172.217.174.228: bytes=64 time=4ms TTL=117

Ping statistics for 172.217.174.228:
    Packets: Sent = 10, Received = 10, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 4ms, Maximum = 7ms, Average = 4ms

C:\Users\Ankeet>ping -n 10 -l 100 www.google.com

Pinging www.google.com [172.217.174.228] with 100 bytes of data:
Reply from 172.217.174.228: bytes=68 (sent 100) time=4ms TTL=117
Reply from 172.217.174.228: bytes=68 (sent 100) time=4ms TTL=117
Reply from 172.217.174.228: bytes=68 (sent 100) time=4ms TTL=117
Reply from 172.217.174.228: bytes=68 (sent 100) time=4ms TTL=117
Reply from 172.217.174.228: bytes=68 (sent 100) time=4ms TTL=117
Reply from 172.217.174.228: bytes=68 (sent 100) time=4ms TTL=117
Reply from 172.217.174.228: bytes=68 (sent 100) time=4ms TTL=117
Reply from 172.217.174.228: bytes=68 (sent 100) time=4ms TTL=117
Reply from 172.217.174.228: bytes=68 (sent 100) time=4ms TTL=117
Reply from 172.217.174.228: bytes=68 (sent 100) time=4ms TTL=117

Ping statistics for 172.217.174.228:
    Packets: Sent = 10, Received = 10, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 4ms, Maximum = 4ms, Average = 4ms
```

```
C:\Users\Ankeet>ping -n 10 -l 500 www.google.com

Pinging www.google.com [172.217.174.228] with 500 bytes of data:
Reply from 172.217.174.228: bytes=68 (sent 500) time=4ms TTL=117
Reply from 172.217.174.228: bytes=68 (sent 500) time=5ms TTL=117
Reply from 172.217.174.228: bytes=68 (sent 500) time=4ms TTL=117
Reply from 172.217.174.228: bytes=68 (sent 500) time=4ms TTL=117
Reply from 172.217.174.228: bytes=68 (sent 500) time=5ms TTL=117
Reply from 172.217.174.228: bytes=68 (sent 500) time=5ms TTL=117
Reply from 172.217.174.228: bytes=68 (sent 500) time=4ms TTL=117
Reply from 172.217.174.228: bytes=68 (sent 500) time=5ms TTL=117
Reply from 172.217.174.228: bytes=68 (sent 500) time=4ms TTL=117
Reply from 172.217.174.228: bytes=68 (sent 500) time=5ms TTL=117

Ping statistics for 172.217.174.228:
    Packets: Sent = 10, Received = 10, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 4ms, Maximum = 5ms, Average = 4ms

C:\Users\Ankeet>ping -n 10 -l 1000 www.google.com

Pinging www.google.com [172.217.174.228] with 1000 bytes of data:
Reply from 172.217.174.228: bytes=68 (sent 1000) time=4ms TTL=117
Reply from 172.217.174.228: bytes=68 (sent 1000) time=4ms TTL=117
Reply from 172.217.174.228: bytes=68 (sent 1000) time=5ms TTL=117
Reply from 172.217.174.228: bytes=68 (sent 1000) time=4ms TTL=117
Reply from 172.217.174.228: bytes=68 (sent 1000) time=5ms TTL=117
Reply from 172.217.174.228: bytes=68 (sent 1000) time=4ms TTL=117
Reply from 172.217.174.228: bytes=68 (sent 1000) time=4ms TTL=117
Reply from 172.217.174.228: bytes=68 (sent 1000) time=4ms TTL=117
Reply from 172.217.174.228: bytes=68 (sent 1000) time=4ms TTL=117
Reply from 172.217.174.228: bytes=68 (sent 1000) time=5ms TTL=117

Ping statistics for 172.217.174.228:
    Packets: Sent = 10, Received = 10, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 4ms, Maximum = 5ms, Average = 4ms
```

QUESTIONS ABOUT LATENCY

Now look at the results you gathered and answer the following questions about latency. Store your answers in a file named `ping.txt`.

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

>> Yes the average RTT varies between different hosts.
Processing delay – time it takes a router to process the packet header, depends on the processing speed of the switch.
Queuing delay – time the packet spends in routing queues depends on the number of packets, size of the packet and bandwidth
Transmission delay – time it takes to push the packet's bits onto the link depends on size of the packet and bandwidth
Propagation delay – time for a signal to reach its destination depends on size of the packet and the bandwidth

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

>> Yes the average RTT varies with different packet sizes. The differences are likely caused by transmit delay

Exercise 1: 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. Here are few places from who to get replies: www.uw.edu, www.cornell.edu, berkeley.edu, www.uchicago.edu, www.ox.ac.uk (England), www.u-tokyo.ac.jp (Japan).

>> Infrastructure components, network traffic, and physical distance along the path between a source and a destination are all potential factors that can affect RTT.

Physical distance – although a connection optimized by a CDN can often reduce the number of hops required to reach a destination, there is no way of getting around the limitation imposed by the speed of light; the distance between a start and end point is a limiting factor in network connectivity that can only be reduced by moving content closer to the requesting users. To overcome this obstacle, a CDN will cache content closer to the requesting users, thereby reducing RTT.

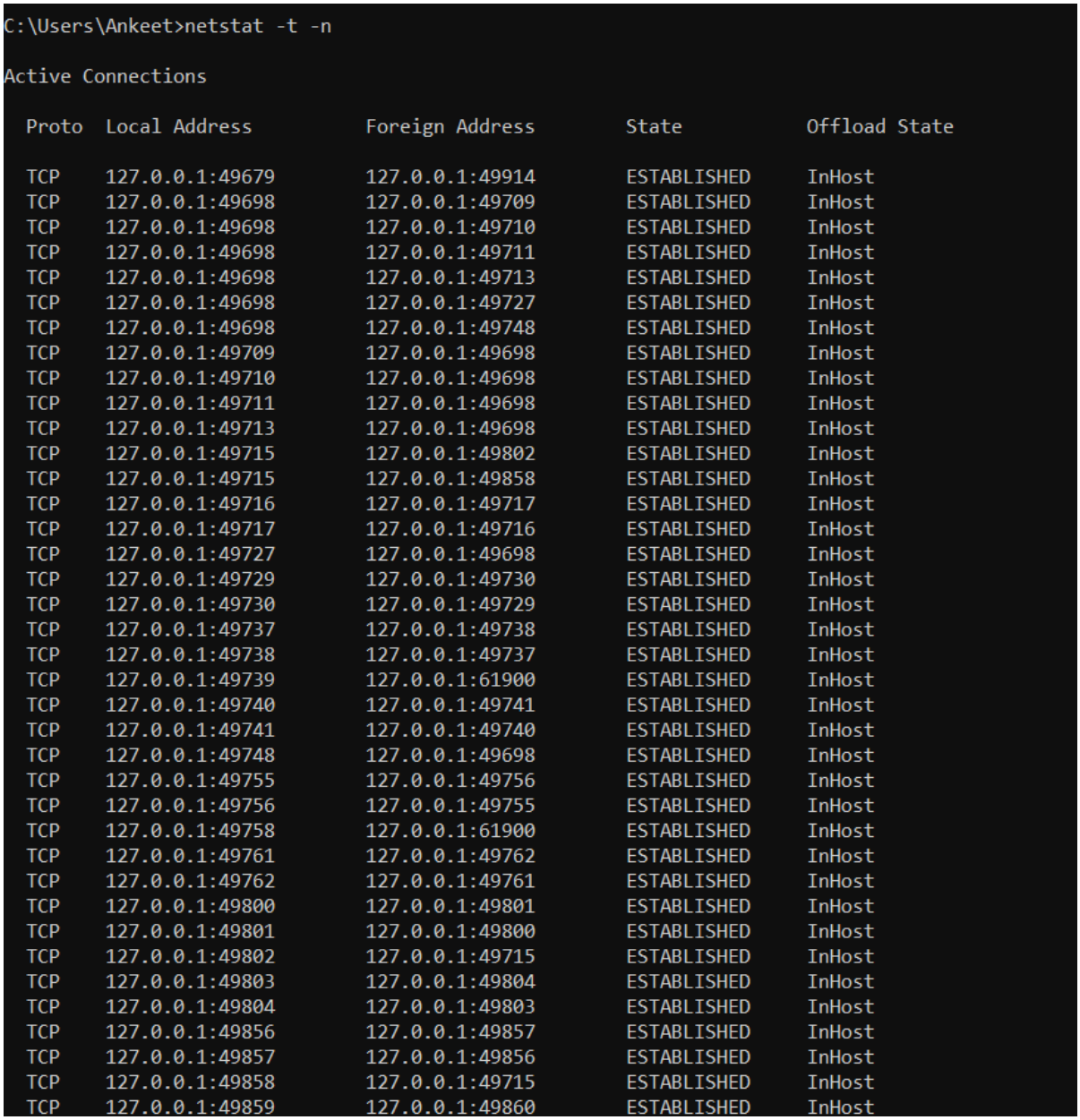
nslookup — The command nslookup <host> will do a DNS query to find and report the IP address (or addresses) for a domain name or the domain name corresponding to an IP address. To do this, it contacts a "DNS server." Default DNS servers are part of a computer's network configuration. (For a static IP address in Linux, they are configured in the file /etc/network/interfaces that you encountered in the last lab.) You can specify a different DNS server to be used by nslokup by adding the server name or IP address to the command: nslookup <host> <server>

```
C:\Users\Ankeet>nslookup youtube.com
Server:  beetel-04177
Address:  192.168.1.1

Non-authoritative answer:
Name:    youtube.com
Addresses:  2404:6800:4009:80c::200e
          172.217.166.46
```

ifconfig — 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. Linux often has an interface named eth0, which is the first ethernet card. The information is different on Mac OS and Linux, but includes the IP or "inet" address and ethernet or "hardware" address for an ethernet card. On Linux, you get the number of packets received (RX) and sent (TX), as well as the number of bytes transmitted and received. (A better place to monitor network bytes on our Linux computers is in the GUI program System Monitor, if it is installed!!!.)

```
C:\Users\Ankeet>ipconfig

Windows IP Configuration


Ethernet adapter Ethernet:

   Media State . . . . . . . . . . . : Media disconnected
   Connection-specific DNS Suffix  . :

Wireless LAN adapter Local Area Connection* 1:

   Media State . . . . . . . . . . . : Media disconnected
   Connection-specific DNS Suffix  . :

Wireless LAN adapter Local Area Connection* 2:

   Media State . . . . . . . . . . . : Media disconnected
   Connection-specific DNS Suffix  . :

Wireless LAN adapter Wi-Fi:

   Connection-specific DNS Suffix  . :
   Link-local IPv6 Address . . . . . : fe80::5cb8:126f:e31c:fe6a%21
   IPv4 Address. . . . . . . . . . . : 192.168.1.2
   Subnet Mask . . . . . . . . . . . : 255.255.255.0
   Default Gateway . . . . . . . . . : 192.168.1.1

Ethernet adapter Bluetooth Network Connection:

   Media State . . . . . . . . . . . : Media disconnected
   Connection-specific DNS Suffix  . :

C:\Users\Ankeet>
```

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). Add the option "-l" (lower case ell) to list listening sockets, that is sockets that have been opened by server programs to wait for connection requests from clients: netstat -t -n -l. (On Mac, use netstat -p tcp to list tcp connections, and add "-a" to include listening sockets in the list.)



```
C:\Users\Ankeet>netstat -t -n

Active Connections

  Proto  Local Address          Foreign Address        State           Offload State

  TCP    127.0.0.1:49679        127.0.0.1:49914        ESTABLISHED     InHost
  TCP    127.0.0.1:49698        127.0.0.1:49709        ESTABLISHED     InHost
  TCP    127.0.0.1:49698        127.0.0.1:49710        ESTABLISHED     InHost
  TCP    127.0.0.1:49698        127.0.0.1:49711        ESTABLISHED     InHost
  TCP    127.0.0.1:49698        127.0.0.1:49713        ESTABLISHED     InHost
  TCP    127.0.0.1:49698        127.0.0.1:49727        ESTABLISHED     InHost
  TCP    127.0.0.1:49698        127.0.0.1:49748        ESTABLISHED     InHost
  TCP    127.0.0.1:49709        127.0.0.1:49698        ESTABLISHED     InHost
  TCP    127.0.0.1:49710        127.0.0.1:49698        ESTABLISHED     InHost
  TCP    127.0.0.1:49711        127.0.0.1:49698        ESTABLISHED     InHost
  TCP    127.0.0.1:49713        127.0.0.1:49698        ESTABLISHED     InHost
  TCP    127.0.0.1:49715        127.0.0.1:49802        ESTABLISHED     InHost
  TCP    127.0.0.1:49715        127.0.0.1:49858        ESTABLISHED     InHost
  TCP    127.0.0.1:49716        127.0.0.1:49717        ESTABLISHED     InHost
  TCP    127.0.0.1:49717        127.0.0.1:49716        ESTABLISHED     InHost
  TCP    127.0.0.1:49727        127.0.0.1:49698        ESTABLISHED     InHost
  TCP    127.0.0.1:49729        127.0.0.1:49730        ESTABLISHED     InHost
  TCP    127.0.0.1:49730        127.0.0.1:49729        ESTABLISHED     InHost
  TCP    127.0.0.1:49737        127.0.0.1:49738        ESTABLISHED     InHost
  TCP    127.0.0.1:49738        127.0.0.1:49737        ESTABLISHED     InHost
  TCP    127.0.0.1:49739        127.0.0.1:61900        ESTABLISHED     InHost
  TCP    127.0.0.1:49740        127.0.0.1:49741        ESTABLISHED     InHost
  TCP    127.0.0.1:49741        127.0.0.1:49740        ESTABLISHED     InHost
  TCP    127.0.0.1:49748        127.0.0.1:49698        ESTABLISHED     InHost
  TCP    127.0.0.1:49755        127.0.0.1:49756        ESTABLISHED     InHost
  TCP    127.0.0.1:49756        127.0.0.1:49755        ESTABLISHED     InHost
  TCP    127.0.0.1:49758        127.0.0.1:61900        ESTABLISHED     InHost
  TCP    127.0.0.1:49761        127.0.0.1:49762        ESTABLISHED     InHost
  TCP    127.0.0.1:49762        127.0.0.1:49761        ESTABLISHED     InHost
  TCP    127.0.0.1:49800        127.0.0.1:49801        ESTABLISHED     InHost
  TCP    127.0.0.1:49801        127.0.0.1:49800        ESTABLISHED     InHost
  TCP    127.0.0.1:49802        127.0.0.1:49715        ESTABLISHED     InHost
  TCP    127.0.0.1:49803        127.0.0.1:49804        ESTABLISHED     InHost
  TCP    127.0.0.1:49804        127.0.0.1:49803        ESTABLISHED     InHost
  TCP    127.0.0.1:49856        127.0.0.1:49857        ESTABLISHED     InHost
  TCP    127.0.0.1:49857        127.0.0.1:49856        ESTABLISHED     InHost
  TCP    127.0.0.1:49858        127.0.0.1:49715        ESTABLISHED     InHost
  TCP    127.0.0.1:49859        127.0.0.1:49860        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. I will suggest that you to do this with your own web server when you write it, but you might want to try it now. When you use telnet in this way, you need to specify both the host and the port number to which you want to connect: telent <host> <port>. For example, to connect to the web server on www.spit.ac.in: telnet spit.ac.in 80

traceroute — Traceroute is discussed in man utility. The command traceroute <host> will show routers encountered by packets on their way from your computer to a specified <host>. For each n = 1, 2, 3,..., traceroute sends a packet with "time-to-live" (ttl) equal to n. Every time a router forwards a packet, it decreases the ttl of the packet by one. If the ttl drops to zero, the router discards the packet and sends an error message back to the sender of the packet. (Again, as with ping, the packets might be blocked or might not even be sent, so that the error messages will never be received.) The sender gets the identity of the router from the source of the error message. Traceroute will send packets until n reaches some set upper bound or until a packet actually gets through to the destination. It actually does this three times for each n. In this way, it identifies routers that are one step, two steps, three steps, ... away from the source computer. A packet for which no response is received is indicated in the output as a *.

Traceroute is installed on the computers. If was not installed in your virtual server last week, but you can install it with the command sudo apt-get install traceroute

The path taken through a network, can be measured using `traceroute`. The syntax for the command in Linux is:

```
traceroute <hostname>
```

The syntax in Windows is:

```
tracert <hostname>
```

You can specify either a hostname (e.g., `cs.iitb.ac.in`) or an IP address (e.g., `128.105.2.6`).

1.2.1 EXPERIMENTS WITH TRACEROUTE

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 for end-host you pinged(e.g., `traceroute_ee.iitb.ac.in.log`).

```
C:\Users\Ankeet>tracert mscs.mu.edu

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

  1     2 ms     1 ms     2 ms  beetel-04177 [192.168.1.1]
  2     2 ms     1 ms     1 ms  csp1.zte.com.cn [192.168.5.1]
  3     4 ms     2 ms     2 ms  172.22.1.194 [172.22.1.194]
  4     *        *        *     Request timed out.
  5    84 ms    33 ms   107 ms  73-192-119-111.mysipl.com [111.119.192.73]
  6    15 ms    15 ms    14 ms  46-97-87-183.mysipl.com [183.87.97.46]
  7   105 ms    23 ms    20 ms  172.23.78.233 [172.23.78.233]
  8    23 ms    22 ms    22 ms  ix-ae-0-100.tcore1.mlv-mumbai.as6453.net [180.87.38.5]
  9     *      174 ms   170 ms  if-ae-5-2.tcore1.wyn-marseille.as6453.net [80.231.217.29]
 10   168 ms   166 ms   167 ms  if-ae-21-2.tcore1.pye-paris.as6453.net [80.231.154.208]
 11   186 ms   174 ms   168 ms  if-ae-11-2.tcore1.pvu-paris.as6453.net [80.231.153.49]
 12   169 ms   177 ms   178 ms  80.231.153.66
 13     *        *      236 ms  ae-2-3603.ear3.Chicago2.Level3.net [4.69.159.186]
 14   237 ms     *      237 ms  MARQUETTE-U.ear3.Chicago2.Level3.net [4.16.38.70]
 15   237 ms   238 ms   237 ms  134.48.10.26
 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:\Users\Ankeet>tracert www.cs.grinnell.edu

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

  1     4 ms    13 ms     1 ms  beetel-04177 [192.168.1.1]
  2     2 ms     1 ms     1 ms  csp3.zte.com.cn [192.168.5.1]
  3     3 ms     2 ms     2 ms  172.22.1.194 [172.22.1.194]
  4     *        *        *     Request timed out.
  5     6 ms     4 ms    81 ms  73-192-119-111.mysipl.com [111.119.192.73]
  6    21 ms    17 ms    14 ms  46-97-87-183.mysipl.com [183.87.97.46]
  7    32 ms    13 ms    14 ms  172.23.78.233 [172.23.78.233]
  8    44 ms    41 ms    41 ms  172.31.244.45 [172.31.244.45]
  9    43 ms    43 ms    46 ms  ix-ae-4-2.tcore2.cxr-chennai.as6453.net [180.87.37.1]
 10   282 ms   302 ms   296 ms  if-ae-9-2.tcore2.mlv-mumbai.as6453.net [180.87.37.10]
 11   306 ms   285 ms   282 ms  if-ae-2-2.tcore1.mlv-mumbai.as6453.net [180.87.38.1]
 12   301 ms   301 ms     *     if-ae-5-2.tcore1.wyn-marseille.as6453.net [80.231.217.29]
 13   297 ms   280 ms   281 ms  if-ae-2-2.tcore2.wyn-marseille.as6453.net [80.231.217.2]
 14   301 ms     *      317 ms  if-ae-9-2.tcore2.l78-london.as6453.net [80.231.200.14]
 15   312 ms   300 ms   300 ms  if-ae-15-2.tcore2.ldn-london.as6453.net [80.231.131.118]
 16   305 ms   306 ms   362 ms  if-ae-32-3.tcore2.nto-newyork.as6453.net [80.231.20.107]
 17   321 ms   311 ms   335 ms  if-ae-26-2.tcore1.ct8-chicago.as6453.net [216.6.81.29]
 18   302 ms   306 ms   307 ms  63.243.129.121
 19     *        *        *     Request timed out.
 20   311 ms   301 ms   297 ms  et3-1-0-0.agr03.desm01-ia.us.windstream.net [40.128.250.43]
 21   324 ms   309 ms   305 ms  ae4-0.pe04.grnl01-ia.us.windstream.net [40.128.248.35]
 22   316 ms   315 ms   304 ms  ae7-0.pe05.grnl01-ia.us.windstream.net [40.138.127.29]
 23   293 ms   280 ms   277 ms  grnl-static-grinnellcollege0-0001.flex.iowatelecom.net [69.66.111.181]
 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:\Users\Ankeet>tracert csail.mit.edu

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

  1     1 ms     1 ms     1 ms  beetel-04177 [192.168.1.1]
  2     3 ms     7 ms     1 ms  csp1.zte.com.cn [192.168.5.1]
  3     4 ms     3 ms     2 ms  172.22.1.194 [172.22.1.194]
  4     *        4 ms     *     172.22.1.193 [172.22.1.193]
  5    52 ms   103 ms    13 ms  73-192-119-111.mysipl.com [111.119.192.73]
  6    16 ms    12 ms    11 ms  46-97-87-183.mysipl.com [183.87.97.46]
  7     6 ms     5 ms     9 ms  172.23.78.233 [172.23.78.233]
  8     5 ms     5 ms     5 ms  ix-ae-0-100.tcore1.mlv-mumbai.as6453.net [180.87.38.5]
  9   268 ms   264 ms     *     if-ae-5-2.tcore1.wyn-marseille.as6453.net [80.231.217.29]
 10   266 ms     *      263 ms  if-ae-2-2.tcore2.wyn-marseille.as6453.net [80.231.217.2]
 11   248 ms     *      262 ms  if-ae-9-2.tcore2.l78-london.as6453.net [80.231.200.14]
 12   276 ms   282 ms   271 ms  if-ae-15-2.tcore2.ldn-london.as6453.net [80.231.131.118]
 13   260 ms   251 ms   251 ms  if-ae-32-2.tcore2.nto-newyork.as6453.net [63.243.216.22]
 14   278 ms   268 ms   280 ms  if-ae-12-2.tcore1.n75-newyork.as6453.net [66.110.96.5]
 15   269 ms   258 ms   256 ms  66.110.96.150
 16   270 ms   264 ms   263 ms  be-10390-cr02.newyork.ny.ibone.comcast.net [68.86.83.89]
 17   251 ms   254 ms   253 ms  be-1302-cs03.newyork.ny.ibone.comcast.net [96.110.38.41]
 18   266 ms   225 ms   225 ms  96.110.42.10
 19   225 ms   312 ms   225 ms  ae0-0-eg-bstpmall74w.boston.ma.boston.comcast.net [68.86.238.34]
 20   274 ms   269 ms   281 ms  50-201-57-174-static.hfc.comcastbusiness.net [50.201.57.174]
 21   294 ms   281 ms   276 ms  dmz-rtr-1-external-rtr-3.mit.edu [18.0.161.13]
 22   344 ms   267 ms   275 ms  dmz-rtr-2-dmz-rtr-1-1.mit.edu [18.0.161.6]
 23   265 ms   264 ms   281 ms  mitnet.core-1-ext.csail.mit.edu [18.4.7.65]
 24     *        *        *     Request timed out.
 25   271 ms   282 ms   281 ms  bdr.core-1.csail.mit.edu [128.30.0.246]
 26   273 ms   274 ms   275 ms  inquir-3ld.csail.mit.edu [128.30.2.109]

Trace complete.
```

```
C:\Users\Ankeet>tracert cs.stanford.edu

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

  1     1 ms     1 ms     1 ms  beetel-04177 [192.168.1.1]
  2     4 ms     1 ms     1 ms  csp3.zte.com.cn [192.168.5.1]
  3     4 ms     2 ms     2 ms  172.22.1.194 [172.22.1.194]
  4     *        *        4 ms  172.22.1.193 [172.22.1.193]
  5     4 ms    15 ms     5 ms  73-192-119-111.mysipl.com [111.119.192.73]
  6     6 ms     4 ms     5 ms  38-97-87-183.mysipl.com [183.87.97.38]
  7    19 ms    18 ms    17 ms  172.23.78.237 [172.23.78.237]
  8    24 ms    26 ms    25 ms  172.31.244.45 [172.31.244.45]
  9    30 ms    29 ms    30 ms  ix-ae-4-2.tcore2.cxr-chennai.as6453.net [180.87.37.1]
 10   245 ms   241 ms   240 ms  if-ae-10-4.tcore2.svw-singapore.as6453.net [180.87.67.16]
 11   252 ms   242 ms   236 ms  if-ae-7-2.tcore2.lvw-losangeles.as6453.net [180.87.15.26]
 12   228 ms   226 ms   228 ms  if-ae-2-2.tcore1.lvw-losangeles.as6453.net [66.110.59.1]
 13   261 ms   266 ms   266 ms  las-b24-link.telia.net [80.239.128.214]
 14   261 ms   256 ms   262 ms  palo-b24-link.telia.net [62.115.119.90]
 15   269 ms   267 ms   274 ms  palo-b1-link.telia.net [62.115.122.169]
 16   254 ms   270 ms   274 ms  hurricane-ic-308019-palo-b1.c.telia.net [80.239.167.174]
 17   269 ms   263 ms   260 ms  stanford-university.100gigabitethernet5-1.core1.pao1.he.net [184.105.177.238]
 18   274 ms   273 ms   273 ms  csee-west-rtr-vl3.SUNet [171.66.255.140]
 19   267 ms   283 ms   273 ms  CS.stanford.edu [171.64.64.64]

Trace complete.
```

Exercise 2: (Very short.) Use traceroute to trace the route from your computer to math.hws.edu and to www.hws.edu. Explain the difference in the results.

>> There is difference in the 12th hop in the above mentioned sites

```
C:\Users\Ankeet>tracert math.hws.edu

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

  1     3 ms     1 ms     1 ms  beetel-04177 [192.168.1.1]
  2     2 ms     3 ms     2 ms  csp1.zte.com.cn [192.168.5.1]
  3     *        3 ms     5 ms  172.22.1.194 [172.22.1.194]
  4     *       14 ms     9 ms  172.22.1.193 [172.22.1.193]
  5   270 ms   199 ms    99 ms  73-192-119-111.mysipl.com [111.119.192.73]
  6     6 ms    24 ms    21 ms  46-97-87-183.mysipl.com [183.87.97.46]
  7    17 ms    12 ms    18 ms  172.23.78.233 [172.23.78.233]
  8     5 ms     7 ms     7 ms  ix-ae-0-100.tcore1.mlv-mumbai.as6453.net [180.87.38.5]
  9   160 ms   162 ms   181 ms  if-ae-5-2.tcore1.wyn-marseille.as6453.net [80.231.217.29]
 10   169 ms   164 ms   165 ms  if-ae-21-2.tcore1.pye-paris.as6453.net [80.231.154.208]
 11   163 ms   161 ms   162 ms  if-ae-11-2.tcore1.pvu-paris.as6453.net [80.231.153.49]
 12   164 ms   163 ms   164 ms  80.231.153.66
 13   163 ms   164 ms   164 ms  ae-2-3204.edge3.Paris1.Level3.net [4.69.161.114]
 14   169 ms   171 ms   166 ms  global-crossing-xe-level3.paris1.level3.net [4.68.63.230]
 15   252 ms   257 ms   260 ms  roc1-ar5-xe-11-0-0-0.us.twtelecom.net [35.248.1.162]
 16   254 ms   254 ms   254 ms  66-195-65-170.static.ctl.one [66.195.65.170]
 17   268 ms   265 ms   267 ms  nat.hws.edu [64.89.144.100]
 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:\Users\Ankeet>tracert www.hws.edu

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

  1    11 ms     4 ms     3 ms  beetel-04177 [192.168.1.1]
  2     5 ms     2 ms     1 ms  csp3.zte.com.cn [192.168.5.1]
  3     5 ms     3 ms     2 ms  172.22.1.194 [172.22.1.194]
  4     *        4 ms     *     172.22.1.193 [172.22.1.193]
  5     5 ms     4 ms     9 ms  73-192-119-111.mysipl.com [111.119.192.73]
  6    17 ms     5 ms     9 ms  42-97-87-183.mysipl.com [183.87.97.42]
  7     8 ms     5 ms     6 ms  172.23.78.237 [172.23.78.237]
  8     5 ms     5 ms     5 ms  ix-ae-0-100.tcore1.mlv-mumbai.as6453.net [180.87.38.5]
  9   166 ms   161 ms   160 ms  if-ae-5-2.tcore1.wyn-marseille.as6453.net [80.231.217.29]
 10   161 ms   161 ms   175 ms  if-ae-8-1600.tcore1.pye-paris.as6453.net [80.231.217.6]
 11   166 ms   162 ms   164 ms  if-ae-11-2.tcore1.pvu-paris.as6453.net [80.231.153.49]
 12     *        *        *     Request timed out.
 13   169 ms     *      163 ms  114.161.69.4.in-addr.arpa [4.69.161.114]
 14   164 ms   164 ms   164 ms  global-crossing-xe-level3.paris1.level3.net [4.68.63.230]
 15   255 ms   256 ms   257 ms  roc1-ar5-xe-11-0-0-0.us.twtelecom.net [35.248.1.162]
 16   261 ms   261 ms   264 ms  66-195-65-170.static.ctl.one [66.195.65.170]
 17   261 ms   263 ms   260 ms  nat.hws.edu [64.89.144.100]
 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. (You can copy them from the Terminal window by highlighting and right-clicking, then paste into a text editor.) Come back sometime next week, try the same destinations again, and compare the results with the results from today. Report your observations.

20th August 2020:

```
C:\Users\Ankeet>tracert csail.mit.edu

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

  1     1 ms     1 ms     1 ms  beetel-04177 [192.168.1.1]
  2     3 ms     7 ms     1 ms  csp1.zte.com.cn [192.168.5.1]
  3     4 ms     3 ms     2 ms  172.22.1.194 [172.22.1.194]
  4     *        4 ms     *     172.22.1.193 [172.22.1.193]
  5    52 ms   103 ms    13 ms  73-192-119-111.mysipl.com [111.119.192.73]
  6    16 ms    12 ms    11 ms  46-97-87-183.mysipl.com [183.87.97.46]
  7     6 ms     5 ms     9 ms  172.23.78.233 [172.23.78.233]
  8     5 ms     5 ms     5 ms  ix-ae-0-100.tcore1.mlv-mumbai.as6453.net [180.87.38.5]
  9   268 ms   264 ms     *     if-ae-5-2.tcore1.wyn-marseille.as6453.net [80.231.217.29]
 10   266 ms     *      263 ms  if-ae-2-2.tcore2.wyn-marseille.as6453.net [80.231.217.2]
 11   248 ms     *      262 ms  if-ae-9-2.tcore2.l78-london.as6453.net [80.231.200.14]
 12   276 ms   282 ms   271 ms  if-ae-15-2.tcore2.ldn-london.as6453.net [80.231.131.118]
 13   260 ms   251 ms   251 ms  if-ae-32-2.tcore2.nto-newyork.as6453.net [63.243.216.22]
 14   278 ms   268 ms   280 ms  if-ae-12-2.tcore1.n75-newyork.as6453.net [66.110.96.5]
 15   269 ms   258 ms   256 ms  66.110.96.150
 16   270 ms   264 ms   263 ms  be-10390-cr02.newyork.ny.ibone.comcast.net [68.86.83.89]
 17   251 ms   254 ms   253 ms  be-1302-cs03.newyork.ny.ibone.comcast.net [96.110.38.41]
 18   266 ms   225 ms   225 ms  96.110.42.10
 19   225 ms   312 ms   225 ms  ae0-0-eg-bstpmall74w.boston.ma.boston.comcast.net [68.86.238.34]
 20   274 ms   269 ms   281 ms  50-201-57-174-static.hfc.comcastbusiness.net [50.201.57.174]
 21   294 ms   281 ms   276 ms  dmz-rtr-1-external-rtr-3.mit.edu [18.0.161.13]
 22   344 ms   267 ms   275 ms  dmz-rtr-2-dmz-rtr-1-1.mit.edu [18.0.161.6]
 23   265 ms   264 ms   281 ms  mitnet.core-1-ext.csail.mit.edu [18.4.7.65]
 24     *        *        *     Request timed out.
 25   271 ms   282 ms   281 ms  bdr.core-1.csail.mit.edu [128.30.0.246]
 26   273 ms   274 ms   275 ms  inquir-3ld.csail.mit.edu [128.30.2.109]

Trace complete.
```

27th August 2020:

```
C:\Users\Ankeet>tracert csail.mit.edu

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

  1     1 ms     1 ms     1 ms  beetel-04177 [192.168.1.1]
  2     2 ms     *        2 ms  csp3.zte.com.cn [192.168.5.1]
  3     *        6 ms     2 ms  172.22.1.194 [172.22.1.194]
  4     *        *        8 ms  172.22.1.193 [172.22.1.193]
  5    53 ms     7 ms     5 ms  73-192-119-111.mysipl.com [111.119.192.73]
  6     5 ms     5 ms     5 ms  46-97-87-183.mysipl.com [183.87.97.46]
  7     5 ms     5 ms     4 ms  172.23.78.233 [172.23.78.233]
  8     5 ms     5 ms     5 ms  ix-ae-0-100.tcore1.mlv-mumbai.as6453.net [180.87.38.5]
  9   256 ms   254 ms   254 ms  if-ae-5-2.tcore1.wyn-marseille.as6453.net [80.231.217.29]
 10   246 ms   244 ms   245 ms  if-ae-2-2.tcore2.wyn-marseille.as6453.net [80.231.217.2]
 11   247 ms   247 ms     *     if-ae-9-2.tcore2.l78-london.as6453.net [80.231.200.14]
 12   245 ms   244 ms   244 ms  if-ae-15-2.tcore2.ldn-london.as6453.net [80.231.131.118]
 13   254 ms   253 ms   252 ms  if-ae-32-2.tcore2.nto-newyork.as6453.net [63.243.216.22]
 14   252 ms   252 ms   253 ms  if-ae-12-2.tcore1.n75-newyork.as6453.net [66.110.96.5]
 15   254 ms   253 ms   253 ms  66.110.96.150
 16   255 ms   255 ms   254 ms  be-10390-cr02.newyork.ny.ibone.comcast.net [68.86.83.89]
 17   255 ms   255 ms   256 ms  be-1302-cs03.newyork.ny.ibone.comcast.net [96.110.38.41]
 18   210 ms   209 ms   209 ms  96.110.42.10
 19   270 ms   209 ms   209 ms  ae0-0-eg-bstpmall74w.boston.ma.boston.comcast.net [68.86.238.34]
 20   257 ms   256 ms   257 ms  50-201-57-174-static.hfc.comcastbusiness.net [50.201.57.174]
 21     *        *        *     Request timed out.
 22     *        *      261 ms  dmz-rtr-2-dmz-rtr-1-1.mit.edu [18.0.161.6]
 23   262 ms   264 ms   262 ms  mitnet.core-1-ext.csail.mit.edu [18.4.7.65]
 24     *        *        *     Request timed out.
 25   265 ms   264 ms   265 ms  bdr.core-1.csail.mit.edu [128.30.0.246]
 26   265 ms   265 ms   265 ms  inquir-3ld.csail.mit.edu [128.30.2.109]

Trace complete.
```

QUESTIONS ABOUT PATHS

Now look at the results you gathered and answer the following questions about the paths taken by your packets. Store your answers in a file named `traceroute.txt`.

1. Is any part of the path common for all hosts you tracerouted?

>> Yes some part of the path is common for all hosts that I tracerouted.

2. Is there a relationship between the number of nodes that show up in the traceroute and the location of the host? If so, what is this relationship?

>> No there is no relationship between number of nodes and location.

3. Is there a relationship between the number of nodes that show up in the traceroute and latency of the host (from your ping results above)? Does the same relationship hold for all hosts?

>> Number of nodes has direct relationship to the latency for all hosts.

Whois — The *whois* command can give detailed information about domain names and IP addresses. If it is not installed on the computers then install it with command sudo apt-get install whois in. *Whois* can tell you what organization owns or is responsible for the name or address and where to contact them. It often includes a list of domain name servers for the organization.
When using *whois* to look up a domain name, use the simple two-part network name, not an individual computer name (for example, *whois spit.ac.in*).

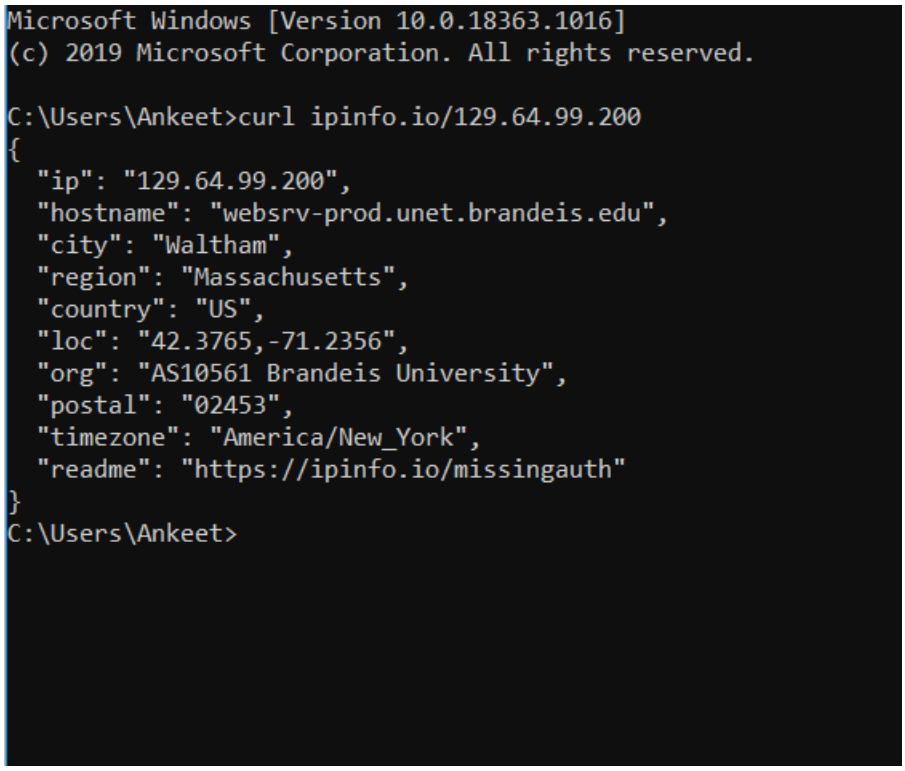
Exercise 4: (Short.) Use *whois* to investigate a well-known web site such as google.com or amazon.com, and write a couple of sentences about what you find out.

```
c:\tools> whois techbuzzonline.com

Whois v1.14 - Domain information lookup
Copyright (C) 2005-2016 Mark Russinovich
Sysinternals - www.sysinternals.com

Connecting to COM.whois-servers.net...

Domain ID: 1663819488_DOMAIN_COM-VRSN
   Registrar WHOIS Server: whois.godaddy.com
   Registrar URL: http://www.godaddy.com
   Updated Date: 2017-10-26T16:55:43Z
   Creation Date: 2011-06-26T05:36:06Z
   Registry Expiry Date: 2022-06-26T05:36:06Z
   Registrar: GoDaddy.com, LLC
   Registrar IANA ID: 146
   Registrar Abuse Contact Email: abuse@godaddy.com
   Registrar Abuse Contact Phone: 480-624-2505
   Domain Status: clientDeleteProhibited https://icann.org/epp#clientDeleteProhibited
   Domain Status: clientRenewProhibited https://icann.org/epp#clientRenewProhibited
   Domain Status: clientTransferProhibited https://icann.org/epp#clientTransferProhibitec
   Domain Status: clientUpdateProhibited https://icann.org/epp#clientUpdateProhibited
   Name Server: JIM.NS.CLOUDFLARE.COM
   Name Server: MARY.NS.CLOUDFLARE.COM
   DNSSEC: unsigned
   URL of the ICANN Whois Inaccuracy Complaint Form: https://www.icann.org/wicf/
>>> Last update of whois database: 2017-11-20T07:52:52Z <<<
```

Exercise 5: (Should be short.) Because of NAT, the domain name *spit.ac.in* has a different IP address outside of SPIT than it does on campus. Using information in this lab and working on a home computer, find the outside IP address for spit.ac.in. Explain how you did it.

Geolocation — A geolocation service tries to tell, approximately, where a given IP address is located physically. They can't be completely accurate—but they probably get at least the country right most of the time.

This geolocation program is not installed on our computers, but you can access one on the command line using the *curl* command, which can send HTTP requests and display the



CONCLUSION:

Got to learn about different types of IP addresses in my laptop and some of the basic network commands like ping, ipconfig, tracert.

REFERENCES:

1) cloudflare.com/learning/cdn/glossary/round-trip-time-rtt/
2) https://www.geeksforgeeks.org/traceroute-in-network-layer/