

## CEL 51, DCCN, Monsoon 2020

### Lab 2: Basic Network Utilities

This lab introduces some basic network monitoring/analysis tools. There are a few exercises along the way. You should write up answers to the *ping* and *traceroute* exercises and turn them in next lab. (You should try out each tool, whether it is needed for an exercise or not!).

Prerequisite: Basic understanding of command line utilities of Linux Operating system.

#### 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.

**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!!!.)

**Experiment 0:** Experiment with ifconfig and write details about the information returned.

```
C:\Users\Ritik>ipconfig

Windows IP Configuration

Ethernet adapter Ethernet:

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

Ethernet adapter VirtualBox Host-Only Network:

    Connection-specific DNS Suffix  . :
    Link-local IPv6 Address . . . . . : fe80::84cb:547e:9a9c:196c%42
    IPv4 Address. . . . . : 192.168.56.1
    Subnet Mask . . . . . : 255.255.255.0
    Default Gateway . . . . . :

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::ed0c:f629:947c:4538%14
    IPv4 Address. . . . . : 192.168.0.106
    Subnet Mask . . . . . : 255.255.255.0
    Default Gateway . . . . . : 192.168.0.1
```

- lo is a special virtual network interface called loopback device. Loopback is used mainly for diagnostics and troubleshooting, and to connect to services running on local host.
- gif0 is Software Network Interface
- stf0 is 6to4 tunnel interface
- en0 is a physical interface representing Ethernet network card. It's used for communication with other computers on the network and on the Internet.
- Ether is the MAC address which is globally unique.

- mtu stands for Maximum Transmission Units is the size of each packet received by the ethernet card. The value of MTU is set to 1500 by default. The loopback device has a higher MTU value than the ethernet device
- INET 192.168.0.100 is the ipv4 address
- INET6 is the ipv6 address.
- bridge0 is a software bridge between other interfaces
- p2p0 is a point to point interface for wireless services.

### **FLAGS:**

- UP indicates that kernel modules related to the interface have been loaded and interface is activated.
- BROADCAST indicates that interface is configured to handle broadcast packets, which is required for obtaining IP address via DHCP.
- RUNNING indicates that interface is ready to accept data.
- MULTICAST indicates that interface supports multicasting.

---

### END OF IFCONFIG

---

**ping** — 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). Some routers and firewalls block ping requests, so you might get no response 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

```
C:\Users\Ritik>ping -n 10 -l 64 google.com

Pinging google.com [142.250.67.238] with 64 bytes of data:
Reply from 142.250.67.238: bytes=64 time=4ms TTL=118
Reply from 142.250.67.238: bytes=64 time=9ms TTL=118
Reply from 142.250.67.238: bytes=64 time=5ms TTL=118
Reply from 142.250.67.238: bytes=64 time=4ms TTL=118
Reply from 142.250.67.238: bytes=64 time=7ms TTL=118
Reply from 142.250.67.238: bytes=64 time=8ms TTL=118
Reply from 142.250.67.238: bytes=64 time=4ms TTL=118
Reply from 142.250.67.238: bytes=64 time=4ms TTL=118
Reply from 142.250.67.238: bytes=64 time=7ms TTL=118
Reply from 142.250.67.238: bytes=64 time=6ms TTL=118

Ping statistics for 142.250.67.238:
    Packets: Sent = 10, Received = 10, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 4ms, Maximum = 9ms, Average = 5ms
```

Fig.1 Ping google.com with 64 packet size with packet count 10

```
C:\Users\Ritik>ping -n 10 -l 100 google.com

Pinging google.com [142.250.67.238] with 100 bytes of data:
Reply from 142.250.67.238: bytes=68 (sent 100) time=23ms TTL=118
Reply from 142.250.67.238: bytes=68 (sent 100) time=4ms TTL=118
Reply from 142.250.67.238: bytes=68 (sent 100) time=5ms TTL=118
Reply from 142.250.67.238: bytes=68 (sent 100) time=8ms TTL=118
Reply from 142.250.67.238: bytes=68 (sent 100) time=7ms TTL=118
Reply from 142.250.67.238: bytes=68 (sent 100) time=93ms TTL=118
Reply from 142.250.67.238: bytes=68 (sent 100) time=5ms TTL=118
Reply from 142.250.67.238: bytes=68 (sent 100) time=5ms TTL=118
Reply from 142.250.67.238: bytes=68 (sent 100) time=7ms TTL=118
Reply from 142.250.67.238: bytes=68 (sent 100) time=6ms TTL=118

Ping statistics for 142.250.67.238:
    Packets: Sent = 10, Received = 10, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 4ms, Maximum = 93ms, Average = 16ms

C:\Users\Ritik>
```

Fig.2 Ping google.com with 100 packet size with packet count 10



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

Pinging google.com [142.250.67.238] with 500 bytes of data:
Reply from 142.250.67.238: bytes=68 (sent 500) time=131ms TTL=118
Reply from 142.250.67.238: bytes=68 (sent 500) time=109ms TTL=118
Reply from 142.250.67.238: bytes=68 (sent 500) time=8ms TTL=118
Reply from 142.250.67.238: bytes=68 (sent 500) time=7ms TTL=118
Reply from 142.250.67.238: bytes=68 (sent 500) time=7ms TTL=118
Reply from 142.250.67.238: bytes=68 (sent 500) time=6ms TTL=118
Reply from 142.250.67.238: bytes=68 (sent 500) time=8ms TTL=118
Reply from 142.250.67.238: bytes=68 (sent 500) time=4ms TTL=118
Reply from 142.250.67.238: bytes=68 (sent 500) time=6ms TTL=118
Reply from 142.250.67.238: bytes=68 (sent 500) time=5ms TTL=118

Ping statistics for 142.250.67.238:
    Packets: Sent = 10, Received = 10, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 4ms, Maximum = 131ms, Average = 29ms

C:\Users\Ritik>
```

Fig.3 Ping google.com with 500 packet size 10 times

```
C:\Users\Ritik>ping -n 10 -l 1400 google.com

Pinging google.com [142.250.67.238] with 1400 bytes of data:
Reply from 142.250.67.238: bytes=68 (sent 1400) time=5ms TTL=118
Reply from 142.250.67.238: bytes=68 (sent 1400) time=15ms TTL=118
Reply from 142.250.67.238: bytes=68 (sent 1400) time=69ms TTL=118
Reply from 142.250.67.238: bytes=68 (sent 1400) time=7ms TTL=118
Reply from 142.250.67.238: bytes=68 (sent 1400) time=45ms TTL=118
Reply from 142.250.67.238: bytes=68 (sent 1400) time=9ms TTL=118
Reply from 142.250.67.238: bytes=68 (sent 1400) time=5ms TTL=118
Reply from 142.250.67.238: bytes=68 (sent 1400) time=59ms TTL=118
Reply from 142.250.67.238: bytes=68 (sent 1400) time=17ms TTL=118
Reply from 142.250.67.238: bytes=68 (sent 1400) time=9ms TTL=118

Ping statistics for 142.250.67.238:
    Packets: Sent = 10, Received = 10, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 5ms, Maximum = 69ms, Average = 24ms
```

Fig.4 Ping google.com with 1400 packet size with a packet count of 10

```
C:\Users\Ritik>ping -n 10 -l 1000 google.com

Pinging google.com [142.250.67.238] with 1000 bytes of data:
Reply from 142.250.67.238: bytes=68 (sent 1000) time=34ms TTL=118
Reply from 142.250.67.238: bytes=68 (sent 1000) time=19ms TTL=118
Reply from 142.250.67.238: bytes=68 (sent 1000) time=48ms TTL=118
Reply from 142.250.67.238: bytes=68 (sent 1000) time=6ms TTL=118
Reply from 142.250.67.238: bytes=68 (sent 1000) time=5ms TTL=118
Reply from 142.250.67.238: bytes=68 (sent 1000) time=7ms TTL=118
Reply from 142.250.67.238: bytes=68 (sent 1000) time=45ms TTL=118
Reply from 142.250.67.238: bytes=68 (sent 1000) time=12ms TTL=118
Reply from 142.250.67.238: bytes=68 (sent 1000) time=67ms TTL=118
Reply from 142.250.67.238: bytes=68 (sent 1000) time=9ms TTL=118

Ping statistics for 142.250.67.238:
    Packets: Sent = 10, Received = 10, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 5ms, Maximum = 67ms, Average = 25ms
```

Fig.5 Ping google.com with 1000 packet size with a packet count of 10

```
Minimum = 5ms, Maximum = 67ms, Average = 25ms

C:\Users\Ritik>ping -n 10 -l 1000 yahoo.com

Pinging yahoo.com [98.137.11.164] with 1000 bytes of data:
Reply from 98.137.11.164: bytes=1000 time=340ms TTL=46
Reply from 98.137.11.164: bytes=1000 time=268ms TTL=46
Reply from 98.137.11.164: bytes=1000 time=359ms TTL=46
Reply from 98.137.11.164: bytes=1000 time=324ms TTL=46
Reply from 98.137.11.164: bytes=1000 time=296ms TTL=46
Reply from 98.137.11.164: bytes=1000 time=308ms TTL=46
Reply from 98.137.11.164: bytes=1000 time=287ms TTL=46
Reply from 98.137.11.164: bytes=1000 time=296ms TTL=46
Reply from 98.137.11.164: bytes=1000 time=298ms TTL=46
Reply from 98.137.11.164: bytes=1000 time=269ms TTL=46

Ping statistics for 98.137.11.164:
    Packets: Sent = 10, Received = 10, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 268ms, Maximum = 359ms, Average = 304ms
```

Fig.6 Ping yahoo.com with 1000 packet size with a packet count of 10

## 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?

Round-trip time (RTT) is the duration in milliseconds (ms) it takes for a network request to go from a starting point to a destination and back again to the starting point. RTT is an important metric in determining the health of a connection on a local network or the larger Internet, and is commonly utilised by network administrators to diagnose the speed and reliability of network connections.

Delay may differ slightly, depending on the location of the specific pair of communicating endpoints. Engineers usually report both the maximum and average delay, and they divide the delay into several parts:

- 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 the bandwidth of the network.
- Propagation delay – time for a signal to reach its destination depends on distance and propagation speed.

A certain minimum level of delay is experienced by signals due to the time it takes to transmit a packet serially through a link. This delay is extended by more variable levels of delay due to network congestion. IP network delays can range from a few milliseconds to several hundred milliseconds.

So yes , Average RTT does vary between different hosts due to queuing delay as we can see in above example the average RTT was calculated for google.com and yahoo.com differs .This is due to propagation delay as it depends on distance and due to queuing delay as the packet may be in queue.

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 increases with packet size as Queuing delay and Transmission delay increases as they both rely on size of packets eventually increasing the average RTT's.

**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](http://www.uw.edu), [www.cornell.edu](http://www.cornell.edu), [berkeley.edu](http://berkeley.edu), [www.uchicago.edu](http://www.uchicago.edu), [www.ox.ac.uk](http://www.ox.ac.uk) (England), [www.u-tokyo.ac.jp](http://www.u-tokyo.ac.jp) (Japan).



```
C:\Users\Ritik>ping www.uw.edu

Pinging www.washington.edu [128.95.155.135] with 32 bytes of data:
Reply from 128.95.155.135: bytes=32 time=259ms TTL=50
Reply from 128.95.155.135: bytes=32 time=294ms TTL=50
Reply from 128.95.155.135: bytes=32 time=248ms TTL=50
Reply from 128.95.155.135: bytes=32 time=266ms TTL=50

Ping statistics for 128.95.155.135:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 248ms, Maximum = 294ms, Average = 266ms
```

Fig.7 Ping [uw.edu](http://uw.edu) with 64 packet size with packet count 10

```
C:\Users\Ritik>ping cornell.edu

Pinging cornell.edu [128.253.173.247] with 32 bytes of data:
Request timed out.
Request timed out.
Request timed out.
Request timed out.

Ping statistics for 128.253.173.247:
    Packets: Sent = 4, Received = 0, Lost = 4 (100% loss),

C:\Users\Ritik>
```

Fig.8 Ping [cornell.edu](http://cornell.edu) with 64 packet size with packet count 10



```
C:\Users\Ritik>ping berkeley.edu

Pinging berkeley.edu [35.163.72.93] with 32 bytes of data:
Reply from 35.163.72.93: bytes=32 time=365ms TTL=37
Reply from 35.163.72.93: bytes=32 time=265ms TTL=37
Reply from 35.163.72.93: bytes=32 time=271ms TTL=37
Reply from 35.163.72.93: bytes=32 time=263ms TTL=37

Ping statistics for 35.163.72.93:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 263ms, Maximum = 365ms, Average = 291ms
```

Fig.9 Ping [berkeley.edu](http://berkeley.edu) with 64 packet size with packet count 10

```
C:\Users\Ritik>ping www.u-tokyo.ac.jp

Pinging www.u-tokyo.ac.jp [210.152.243.234] with 32 bytes of data:
Request timed out.
Request timed out.
Request timed out.
Request timed out.

Ping statistics for 210.152.243.234:
    Packets: Sent = 4, Received = 0, Lost = 4 (100% loss),
```

Fig.10 Ping [u-tokyo.ac.jp](http://u-tokyo.ac.jp) with 64 packet size with packet count 10

```
C:\Users\Ritik>ping uchicago.edu

Pinging uchicago.edu [34.200.129.209] with 32 bytes of data:
Request timed out.
Request timed out.
Request timed out.
Request timed out.

Ping statistics for 34.200.129.209:
    Packets: Sent = 4, Received = 0, Lost = 4 (100% loss),
```

Fig.11 Ping uchicago.edu with 64 packet size with packet count 10

### Interesting Observations:

The average RTT varies for different destinations for the same packet size.

The reasons for this are:

Nature of the transmission medium - the way in which connections are made affects how fast the connection moves; connections made over optical fiber will behave differently than connections made over copper. Likewise, a connection made over a wireless frequency will behave differently than that of a satellite communication.

Physical Distance: Physical distance between two hosts is defined as the length of the great circle arc connecting their locations on the surface of the Earth. The sum of per-hop distances would not significantly diverge from the actual distance between hosts. However, several studies have shown that the sum of per-hop distances may greatly exceed the great circle distance between two end hosts. The only solution to this is to get the content closer to the users.

Server response time – the amount of time it takes a server to process and respond to a request is a potential bottleneck in network latency. When a server is overwhelmed with requests, such as during a DDoS attack, its ability to respond efficiently can be inhibited, resulting in increased 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 `nslookup` by adding the server name or IP address to the command: `nslookup <host> <server>`

**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.)

**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: `telnet <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  $n = 1, 2, 3, \dots$ , `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. `mcs.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\Ritik>tracert www.iitb.ac.in

Tracing route to www.iitb.ac.in [103.21.127.114]
over a maximum of 30 hops:

  1      5 ms      7 ms      1 ms    192.168.0.1
  2      2 ms      3 ms      3 ms    103.209.38.170
  3      *          6 ms      *       237-62-106-27.mysipl.com [27.106.62.237]
  4     77 ms     47 ms      5 ms    42-97-87-183.mysipl.com [183.87.97.42]
  5      *          *          *       Request timed out.
  6      *          *          *       Request timed out.
  7     32 ms      6 ms      5 ms    115.110.234.170.static.Mumbai.vsnl.net
  8      *          *          *       Request timed out.
  9      *          *          *       Request timed out.
 10     *          *          *       Request timed out.
 11     *          *          *       Request timed out.
 12     *          *          *       Request timed out.
 13     *          *          *       Request timed out.
 14     *          *          *       Request timed out.
 15     *          *          *       Request timed out.
 16     *          *          *       Request timed out.
 17     *          *          *       Request timed out.
 18     *          *          *       Request timed out.
 19     *          *          *       Request timed out.
 20     *          *          *       Request timed out.
 21     *          *          *       Request timed out.
 22     *          *          *       Request timed out.
 23     *          *          *       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.
```

Fig.12 traceroute for iitb.ac.in



```

C:\Users\Ritik>tracert mscs.mu.edu

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

  1    13 ms    7 ms    3 ms  192.168.0.1
  2     3 ms    8 ms    4 ms  103.209.38.170
  3     *      *      *      Request timed out.
  4     5 ms   11 ms    3 ms  38-97-87-183.mysipl.com [183.87.97.38]
  5     *      *      *      Request timed out.
  6     5 ms    4 ms    4 ms  ix-ae-0-100.tcore1.mlv-mumbai.as6453.net [180.87.38.5]
  7   161 ms   123 ms    *      if-ae-29-8.tcore1.wyn-marseille.as6453.net [80.231.217.110]
  8   113 ms   244 ms   125 ms  if-ae-21-2.tcore1.pye-paris.as6453.net [80.231.154.208]
  9   116 ms   188 ms   183 ms  if-ae-11-2.tcore1.pvu-paris.as6453.net [80.231.153.49]
 10     *      *      *      Request timed out.
 11     *      *      *      Request timed out.
 12   360 ms   226 ms   268 ms  MARQUETTE-U.ear3.Chicago2.Level3.net [4.16.38.70]
 13   224 ms   232 ms   343 ms  134.48.10.26
 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.

```

Fig.13 traceroute for [mscs.mu.edu](http://mscs.mu.edu)

```

C:\Users\Ritik>tracert www.cs.grinnell.edu

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

  1     1 ms    1 ms    1 ms  192.168.0.1
  2     4 ms   11 ms    4 ms  103.209.38.170
  3     *      *      *      Request timed out.
  4    25 ms    8 ms    3 ms  38-97-87-183.mysipl.com [183.87.97.38]
  5     *      *      *      Request timed out.
  6     *      *      *      Request timed out.
  7    48 ms   48 ms   23 ms  ix-ae-4-2.tcore2.cxr-chennai.as6453.net [180.87.37.1]
  8   329 ms   236 ms   242 ms  if-ae-9-2.tcore2.mlv-mumbai.as6453.net [180.87.37.10]
  9   290 ms   322 ms   243 ms  if-ae-2-2.tcore1.mlv-mumbai.as6453.net [180.87.38.1]
 10     *      *      *      Request timed out.
 11   275 ms   391 ms   310 ms  if-ae-2-2.tcore2.wyn-marseille.as6453.net [80.231.217.2]
 12   416 ms    *      *      if-ae-9-2.tcore2.l78-london.as6453.net [80.231.200.14]
 13   483 ms   513 ms   238 ms  if-ae-15-2.tcore2.ldn-london.as6453.net [80.231.131.118]
 14   265 ms   302 ms   304 ms  if-ae-32-2.tcore2.nto-newyork.as6453.net [63.243.216.22]
 15   333 ms   299 ms   239 ms  if-ae-26-2.tcore1.ct8-chicago.as6453.net [216.6.81.29]
 16     *      *      *      Request timed out.
 17     *      *      *      Request timed out.
 18   274 ms   250 ms   250 ms  et3-1-0-0.agr03.desm01-ia.us.windstream.net [40.128.250.43]
 19   272 ms   263 ms   275 ms  ae4-0.pe04.grnl01-ia.us.windstream.net [40.128.248.35]
 20   345 ms   303 ms   248 ms  ae7-0.pe05.grnl01-ia.us.windstream.net [40.138.127.29]
 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.

```

Fig.14 traceroute for [cs.grinnell.edu](http://cs.grinnell.edu)

```

C:\Users\Ritik>tracert cs.manchester.ac.uk

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

  1     1 ms     1 ms     1 ms  192.168.0.1
  2    115 ms     6 ms     2 ms  103.209.38.170
  3      *         *         *    Request timed out.
  4     11 ms     3 ms     4 ms  38-97-87-183.mysipl.com [183.87.97.38]
  5      *         *         *    Request timed out.
  6     22 ms    23 ms     4 ms  ix-ae-0-100.tcore1.mlv-mumbai.as6453.net [180.87.38.5]
  7    162 ms    112 ms    130 ms  if-ae-29-8.tcore1.wyn-marseille.as6453.net [80.231.217.110]
  8    198 ms    110 ms    190 ms  if-ae-8-1600.tcore1.pye-paris.as6453.net [80.231.217.6]
  9    112 ms    170 ms    213 ms  if-ae-11-2.tcore1.pvu-paris.as6453.net [80.231.153.49]
 10      *         *         *    Request timed out.
 11      *         *         *    Request timed out.
 12    184 ms    201 ms    223 ms  JANET.bear1.Manchester1.Level3.net [212.187.174.238]
 13    278 ms    127 ms    126 ms  ae22.manckh-sbr2.ja.net [146.97.35.189]
 14    173 ms    200 ms    205 ms  ae23.mancrh-rbr1.ja.net [146.97.38.42]
 15      *         *         *    Request timed out.
 16    218 ms    194 ms    130 ms  130.88.249.194
 17      *         *         *    Request timed out.
 18    135 ms    127 ms    127 ms  gw-jh.its.manchester.ac.uk [130.88.250.32]
 19    214 ms    238 ms    165 ms  eps.its.man.ac.uk [130.88.101.49]

Trace complete.
C:\Users\Ritik>

```

Fig.15 traceroute for [cs.manchester.ac.uk](http://cs.manchester.ac.uk)

```

C:\Users\Ritik>tracert csail.mit.edu

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

  1      5 ms     2 ms     1 ms  192.168.0.1
  2      4 ms    20 ms     2 ms  103.209.38.170
  3      *         *         *    Request timed out.
  4      4 ms    41 ms     3 ms  38-97-87-183.mysipl.com [183.87.97.38]
  5      *         *         *    Request timed out.
  6      6 ms     9 ms    46 ms  ix-ae-0-100.tcore1.mlv-mumbai.as6453.net [180.87.38.5]
  7    198 ms    199 ms     *    if-ae-5-2.tcore1.wyn-marseille.as6453.net [80.231.217.29]
  8    204 ms    198 ms    197 ms  if-ae-2-2.tcore2.wyn-marseille.as6453.net [80.231.217.2]
  9      *         *         *    Request timed out.
 10    223 ms    200 ms    211 ms  if-ae-18-2.tcore1.nto-newyork.as6453.net [80.231.131.73]
 11    358 ms    197 ms    310 ms  if-ae-9-2.tcore1.n75-newyork.as6453.net [63.243.128.122]
 12    285 ms    198 ms    199 ms  66.110.96.134
 13    202 ms    303 ms    200 ms  be-10390-cr02.newyork.ny.ibone.comcast.net [68.86.83.89]
 14    285 ms    201 ms    712 ms  be-1102-cs01.newyork.ny.ibone.comcast.net [96.110.38.33]
 15    209 ms    203 ms    211 ms  96.110.42.2
 16    217 ms   1023 ms   407 ms  ae0-0-eg-bstpmall74w.boston.ma.boston.comcast.net [68.86.238.34]
 17    375 ms    315 ms    303 ms  50-201-57-174-static.hfc.comcastbusiness.net [50.201.57.174]
 18    289 ms    227 ms    204 ms  dmz-rtr-1-external-rtr-3.mit.edu [18.0.161.13]
 19    250 ms    302 ms    303 ms  dmz-rtr-2-dmz-rtr-1-1.mit.edu [18.0.161.6]
 20    317 ms    411 ms    294 ms  mitnet.core-1-ext.csail.mit.edu [18.4.7.65]
 21      *         *         *    Request timed out.
 22    206 ms    211 ms    208 ms  bdr.core-1.csail.mit.edu [128.30.0.246]
 23    336 ms    273 ms    304 ms  inquire-3ld.csail.mit.edu [128.30.2.109]

Trace complete.

```

Fig.16 traceroute for [csail.mit.edu](http://csail.mit.edu)



**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.

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

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

  1    37 ms    3 ms    3 ms    192.168.0.1
  2     5 ms    14 ms    4 ms    103.209.38.170
  3     *      *      *      Request timed out.
  4     4 ms    4 ms    13 ms    38-97-87-183.mysipl.com [183.87.97.38]
  5     *      *      *      Request timed out.
  6     3 ms    5 ms    4 ms    ix-ae-0-100.tcore1.mlv-mumbai.as6453.net [180.87.38.5]
  7    124 ms   137 ms   174 ms    if-ae-5-6.tcore1.wyn-marseille.as6453.net [180.87.38.126]
  8    123 ms   120 ms   111 ms    if-ae-8-1600.tcore1.pye-paris.as6453.net [80.231.217.6]
  9    198 ms   227 ms   148 ms    if-ae-11-2.tcore1.pvu-paris.as6453.net [80.231.153.49]
 10     *      *      *      Request timed out.
 11    127 ms   110 ms   121 ms    ae-2-3204.edge3.Paris1.Level3.net [4.69.161.114]
 12    135 ms   111 ms   166 ms    global-crossing-xe-level3.paris1.level3.net [4.68.63.230]
 13    244 ms   307 ms   212 ms    roc1-ar5-xe-11-0-0-0.us.twtelecom.net [35.248.1.162]
 14    292 ms   218 ms   285 ms    66-195-65-170.static.ctl.one [66.195.65.170]
 15    276 ms   208 ms   208 ms    nat.hws.edu [64.89.144.100]
 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.
```

Fig.17 traceroute for [math.hws.edu](http://math.hws.edu)

```
C:\Users\Ritik>tracert www.hws.edu

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

  1     23 ms    7 ms    4 ms    192.168.0.1
  2     23 ms    22 ms   19 ms    103.209.38.170
  3     *      134 ms   *      237-62-106-27.mysipl.com [27.106.62.237]
  4     19 ms    10 ms   15 ms    42-97-87-183.mysipl.com [183.87.97.42]
  5     *      *      *      Request timed out.
  6     3 ms    4 ms    3 ms    ix-ae-0-100.tcore1.mlv-mumbai.as6453.net [180.87.38.5]
  7    111 ms   113 ms   119 ms    if-ae-5-2.tcore1.wyn-marseille.as6453.net [80.231.217.29]
  8    111 ms   135 ms   112 ms    if-ae-8-1600.tcore1.pye-paris.as6453.net [80.231.217.6]
  9    249 ms   174 ms   150 ms    if-ae-11-2.tcore1.pvu-paris.as6453.net [80.231.153.49]
 10     *      *      *      Request timed out.
 11    364 ms   169 ms   228 ms    ae-1-3104.edge3.Paris1.Level3.net [4.69.161.110]
 12    133 ms   114 ms   110 ms    global-crossing-xe-level3.paris1.level3.net [4.68.63.230]
 13    205 ms   217 ms   206 ms    roc1-ar5-xe-11-0-0-0.us.twtelecom.net [35.248.1.162]
 14    207 ms   208 ms   207 ms    66-195-65-170.static.ctl.one [66.195.65.170]
 15    216 ms   215 ms   208 ms    nat.hws.edu [64.89.144.100]
 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.
```

Fig.18 traceroute for [www.hws.edu](http://www.hws.edu)

**Traceroute:** When we connect to another computer, traffic does not go directly to the machine we are attempting to connect to. Instead it goes through multiple machines on the Internet known as routers. These machines serve the sole purpose of controlling how your traffic gets to your destination. If any one connection fails, we will not be able to connect to the intended destination. Hence it is used for diagnostics. Each hop displays the time taken for each hop during its route to the destination. If a hop comes back with request timed out it denotes network congestion.

**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.

```
C:\Users\Ritik>tracert www.hws.edu

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

  1    23 ms    7 ms    4 ms    192.168.0.1
  2    23 ms    22 ms   19 ms    103.209.38.170
  3    *        134 ms   *        237-62-106-27.mysipl.com [27.106.62.237]
  4    19 ms    10 ms    15 ms    42-97-87-183.mysipl.com [183.87.97.42]
  5    *        *        *        Request timed out.
  6    3 ms     4 ms     3 ms     ix-ae-0-100.tcore1.mlv-mumbai.as6453.net [180.87.38.5]
  7   111 ms    113 ms   119 ms    if-ae-5-2.tcore1.wyn-marseille.as6453.net [80.231.217.29]
  8   111 ms    135 ms   112 ms    if-ae-8-1600.tcore1.pye-paris.as6453.net [80.231.217.6]
  9   249 ms    174 ms   150 ms    if-ae-11-2.tcore1.pvu-paris.as6453.net [80.231.153.49]
 10    *        *        *        Request timed out.
 11   364 ms    169 ms   228 ms    ae-1-3104.edge3.Paris1.Level3.net [4.69.161.110]
 12   133 ms    114 ms   110 ms    global-crossing-xe-level3.paris1.level3.net [4.68.63.230]
 13   205 ms    217 ms   206 ms    roc1-ar5-xe-11-0-0-0.us.twtelecom.net [35.248.1.162]
 14   207 ms    208 ms   207 ms    66-195-65-170.static.clt.one [66.195.65.170]
 15   216 ms    215 ms   208 ms    nat.hws.edu [64.89.144.100]
 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.
```

Fig.19 traceroute for hws.edu



```

C:\Users\Ritik>tracert math.hws.edu

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

  1    37 ms    3 ms    3 ms    192.168.0.1
  2     5 ms   14 ms    4 ms   103.209.38.170
  3     *      *      *      Request timed out.
  4     4 ms    4 ms   13 ms   38-97-87-183.mysipl.com [183.87.97.38]
  5     *      *      *      Request timed out.
  6     3 ms    5 ms    4 ms   ix-ae-0-100.tcore1.mlv-mumbai.as6453.net [180.87.38.5]
  7   124 ms   137 ms   174 ms   if-ae-5-6.tcore1.wyn-marseille.as6453.net [180.87.38.126]
  8   123 ms   120 ms   111 ms   if-ae-8-1600.tcore1.pye-paris.as6453.net [80.231.217.6]
  9   198 ms   227 ms   148 ms   if-ae-11-2.tcore1.pvu-paris.as6453.net [80.231.153.49]
 10     *      *      *      Request timed out.
 11   127 ms   110 ms   121 ms   ae-2-3204.edge3.Paris1.Level3.net [4.69.161.114]
 12   135 ms   111 ms   166 ms   global-crossing-xe-level3.paris1.level3.net [4.68.63.230]
 13   244 ms   307 ms   212 ms   roc1-ar5-xe-11-0-0-0.us.twtelecom.net [35.248.1.162]
 14   292 ms   218 ms   285 ms   66-195-65-170.static.ctl.one [66.195.65.170]
 15   276 ms   208 ms   208 ms   nat.hws.edu [64.89.144.100]
 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.

```

Fig.20 traceroute for [math.hws.edu](http://math.hws.edu)

```

Select Command Prompt

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

  1    97 ms    1 ms    1 ms    192.168.0.1
  2     2 ms    1 ms    1 ms   103.5.187.30
  3     4 ms    3 ms    5 ms   103.5.187.13
  4     3 ms    4 ms    3 ms   dhcp-192-196-101.in2cable.com [203.192.196.101]
  5     *      *      10 ms   dhcp-192-196-29.in2cable.com [203.192.196.29]
  6     4 ms    3 ms    4 ms   115.113.165.121.static-mumbai.vsnl.net.in [115.113.165.121]
  7     3 ms    4 ms    3 ms   172.23.78.237
  8     8 ms    3 ms    5 ms   ix-ae-0-100.tcore1.mlv-mumbai.as6453.net [180.87.38.5]
  9     *      159 ms    *      if-ae-5-2.tcore1.wyn-marseille.as6453.net [80.231.217.29]
 10     *      *      *      Request timed out.
 11   131 ms   130 ms   133 ms   if-ae-11-2.tcore1.pvu-paris.as6453.net [80.231.153.49]
 12     *      131 ms   137 ms   80.231.153.66
 13   134 ms   127 ms   125 ms   ae-2-3204.edge3.Paris1.Level3.net [4.69.161.114]
 14   127 ms   131 ms   133 ms   global-crossing-xe-level3.paris1.level3.net [4.68.63.230]
 15   206 ms   205 ms   208 ms   roc1-ar5-xe-11-0-0-0.us.twtelecom.net [35.248.1.162]
 16   214 ms   210 ms   212 ms   66-195-65-170.static.ctl.one [66.195.65.170]
 17   215 ms   212 ms   213 ms   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\yashc>

```

Fig.21 traceroute for [math.hws.edu](http://math.hws.edu) on 11/08/2020

```
Command Prompt
Trace complete.

C:\Users\yashc>tracert www.hws.edu

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

 1  2272 ms    1 ms    <1 ms    192.168.0.1
 2      2 ms    2 ms    1 ms    103.5.187.30
 3      6 ms    7 ms    3 ms    103.5.187.13
 4      2 ms    2 ms    30 ms    dhcp-192-196-101.in2cable.com [203.192.196.101]
 5      *      *      *      Request timed out.
 6     18 ms    4 ms    5 ms    115.113.165.121.static-mumbai.vsnl.net.in [115.113.165.121]
 7      4 ms    3 ms    3 ms    172.23.78.237
 8     23 ms    4 ms    3 ms    ix-ae-0-100.tcore1.mlv-mumbai.as6453.net [180.87.38.5]
 9    132 ms   133 ms   129 ms    if-ae-5-2.tcore1.wyn-marseille.as6453.net [80.231.217.29]
10    127 ms   135 ms    *      if-ae-21-2.tcore1.pye-paris.as6453.net [80.231.154.208]
11    126 ms   126 ms   125 ms    if-ae-11-2.tcore1.pvu-paris.as6453.net [80.231.153.49]
12    128 ms   131 ms    *      80.231.153.66
13    129 ms   130 ms   128 ms    ae-1-3104.edge3.Paris1.level3.net [4.69.161.110]
14    127 ms   136 ms   125 ms    global-crossing-xe-level3.paris1.level3.net [4.68.63.230]
15    210 ms   227 ms   213 ms    roc1-ar5-xe-11-0-0-0.us.twtelecom.net [35.248.1.162]
16    310 ms   209 ms   293 ms    66-195-65-170.static.ctl.one [66.195.65.170]
17    347 ms   331 ms   280 ms    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.
```

Fig.24 traceroute for [www.hws.edu](http://www.hws.edu) on 18/08/2020

From the above experiments, I can conclude that for the same source and same destination, the packets sent at different times have different RTT's and take different paths through the net, which is clear from figure 22 and 23.

## 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, the path to my ISP is always the same, and then the path depends on which access point is ready to respond.

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.

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?

There is a direct relationship between the number of nodes and the latency of the host. The amount of latency is largely dependent on how far the visitor is from the server location and how many nodes the signal has to travel through.

**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`. *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.

**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 response. The following command uses *curl* to contact a public web service that will look up an IP address for you: `curl ipinfo.io/<IP-address>`. For a specific example:

```
curl ipinfo.io/129.64.99.200
```

(As you can see, you get back more than just the location.)

**Exercise 6:** Find a few IP addresses that are connected to the web server on spit.ac.in right now, and determine where those IP addresses are located. (I'm expecting that there will be several; if not, try again in a few minutes or sometime later.) Find one that is far from Geneva, NY. Explain how you did it.

References : StackOverflow, Wikipedia, StackPath

References:

1. <https://stackoverflow.com/questions/17868153/propagation-delay-vs-transmission-delay>
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