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Data Communication and Computer Networks

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.

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

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

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).

```
ubuntu@ip-172-31-40-210:~$ ping -c 10 -s 100 berkeley.edu
PING berkeley.edu (35.163.72.93) 100(128) bytes of data.
108 bytes from ec2-35-163-72-93.us-west-2.compute.amazonaws.com (35.163.72.93): icmp_seq=1 ttl=35 time=225 ms
108 bytes from ec2-35-163-72-93.us-west-2.compute.amazonaws.com (35.163.72.93): icmp_seq=2 ttl=35 time=224 ms
108 bytes from ec2-35-163-72-93.us-west-2.compute.amazonaws.com (35.163.72.93): icmp_seq=3 ttl=35 time=224 ms
108 bytes from ec2-35-163-72-93.us-west-2.compute.amazonaws.com (35.163.72.93): icmp_seq=4 ttl=35 time=225 ms
108 bytes from ec2-35-163-72-93.us-west-2.compute.amazonaws.com (35.163.72.93): icmp_seq=5 ttl=35 time=224 ms
108 bytes from ec2-35-163-72-93.us-west-2.compute.amazonaws.com (35.163.72.93): icmp_seq=6 ttl=35 time=224 ms
108 bytes from ec2-35-163-72-93.us-west-2.compute.amazonaws.com (35.163.72.93): icmp_seq=7 ttl=35 time=224 ms
108 bytes from ec2-35-163-72-93.us-west-2.compute.amazonaws.com (35.163.72.93): icmp_seq=8 ttl=35 time=225 ms
108 bytes from ec2-35-163-72-93.us-west-2.compute.amazonaws.com (35.163.72.93): icmp_seq=9 ttl=35 time=224 ms
108 bytes from ec2-35-163-72-93.us-west-2.compute.amazonaws.com (35.163.72.93): icmp_seq=10 ttl=35 time=224 ms

--- berkeley.edu ping statistics ---
10 packets transmitted, 10 received, 0% packet loss, time 9009ms
rtt min/avg/max/mdev = 224.832/225.007/225.584/0.475 ms
ubuntu@ip-172-31-40-210:~$ ping -c 10 -s 100 www.uchicago.edu
```

```
ubuntu@ip-172-31-40-210:~$ ping -c 10 -s 100 www.ox.ac.uk
PING www.ox.ac.uk (151.101.66.133) 100(128) bytes of data.
108 bytes from 151.101.66.133 (151.101.66.133): icmp_seq=1 ttl=52 time=1.08 ms
108 bytes from 151.101.66.133 (151.101.66.133): icmp_seq=2 ttl=52 time=1.15 ms
108 bytes from 151.101.66.133 (151.101.66.133): icmp_seq=3 ttl=52 time=1.14 ms
108 bytes from 151.101.66.133 (151.101.66.133): icmp_seq=4 ttl=52 time=1.13 ms
108 bytes from 151.101.66.133 (151.101.66.133): icmp_seq=5 ttl=52 time=1.16 ms
108 bytes from 151.101.66.133 (151.101.66.133): icmp_seq=6 ttl=52 time=1.15 ms
108 bytes from 151.101.66.133 (151.101.66.133): icmp_seq=7 ttl=52 time=1.10 ms
108 bytes from 151.101.66.133 (151.101.66.133): icmp_seq=8 ttl=52 time=1.15 ms
108 bytes from 151.101.66.133 (151.101.66.133): icmp_seq=9 ttl=52 time=1.14 ms
108 bytes from 151.101.66.133 (151.101.66.133): icmp_seq=10 ttl=52 time=1.14 ms

--- www.ox.ac.uk ping statistics ---
10 packets transmitted, 10 received, 0% packet loss, time 9012ms
rtt min/avg/max/mdev = 1.087/1.138/1.162/0.048 ms
ubuntu@ip-172-31-40-210:~$ ping -c 10 -s 100 www.u-tokyo.ac.jp
```

```
ubuntu@ip-172-31-40-210:~$ ping -c 10 -s 100 www.uw.edu
PING www.washington.edu (128.95.155.135) 100(128) bytes of data.
108 bytes from www2.cac.washington.edu (128.95.155.135): icmp_seq=1 ttl=35 time=240 ms
108 bytes from www2.cac.washington.edu (128.95.155.135): icmp_seq=2 ttl=35 time=241 ms
108 bytes from www2.cac.washington.edu (128.95.155.135): icmp_seq=3 ttl=35 time=241 ms
108 bytes from www2.cac.washington.edu (128.95.155.135): icmp_seq=4 ttl=35 time=241 ms
108 bytes from www2.cac.washington.edu (128.95.155.135): icmp_seq=5 ttl=35 time=240 ms
108 bytes from www2.cac.washington.edu (128.95.155.135): icmp_seq=6 ttl=35 time=241 ms
108 bytes from www2.cac.washington.edu (128.95.155.135): icmp_seq=7 ttl=35 time=241 ms
108 bytes from www2.cac.washington.edu (128.95.155.135): icmp_seq=8 ttl=35 time=241 ms
108 bytes from www2.cac.washington.edu (128.95.155.135): icmp_seq=9 ttl=35 time=240 ms
108 bytes from www2.cac.washington.edu (128.95.155.135): icmp_seq=10 ttl=35 time=241 ms

--- www.washington.edu ping statistics ---
10 packets transmitted, 10 received, 0% packet loss, time 9008ms
rtt min/avg/max/mdev = 240.972/241.107/241.902/0.639 ms
ubuntu@ip-172-31-40-210:~$ ping -c 10 -s 100 www.cornell.edu
```

As seen from the above we see that as the distance from my location to the pinged place location increases the TTL time also increases. Like getting response from www.uk.edu (in United Kingdom) is faster then getting response from www.uw.edu (University of Washington). Hence it can be concluded that distance is a major factor in getting in the response and has good impact on the response time.

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>`

```
ubuntu@ip-172-31-40-210:~$ nslookup google.com
Server:      127.0.0.53
Address:     127.0.0.53#53

Non-authoritative answer:
Name:   google.com
Address: 216.58.203.206
Name:   google.com
Address: 2404:6800:4009:80c::200e

ubuntu@ip-172-31-40-210:~$ nslookup spit.ac.in
Server:      127.0.0.53
Address:     127.0.0.53#53

Non-authoritative answer:
Name:   spit.ac.in
Address: 43.252.193.19

ubuntu@ip-172-31-40-210:~$ |
```

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!!!.)

```
ubuntu@ip-172-31-40-210:~$ ifconfig
eth0: flags=4163<UP,BROADCAST,RUNNING,MULTICAST> mtu 9001
    inet 172.31.40.210 netmask 255.255.240.0 broadcast 172.31.47.255
    inet6 fe80::f6:87ff:fe34:3de8 prefixlen 64 scopeid 0x20<link>
    ether 02:f6:87:34:3d:e8 txqueuelen 1000 (Ethernet)
    RX packets 5433 bytes 6148403 (6.1 MB)
    RX errors 0 dropped 0 overruns 0 frame 0
    TX packets 3183 bytes 293273 (293.2 KB)
    TX errors 0 dropped 0 overruns 0 carrier 0 collisions 0

lo: flags=73<UP,LOOPBACK,RUNNING> mtu 65536
    inet 127.0.0.1 netmask 255.0.0.0
    inet6 ::1 prefixlen 128 scopeid 0x10<host>
    loop txqueuelen 1000 (Local Loopback)
    RX packets 208 bytes 17021 (17.0 KB)
    RX errors 0 dropped 0 overruns 0 frame 0
    TX packets 208 bytes 17021 (17.0 KB)
    TX errors 0 dropped 0 overruns 0 carrier 0 collisions 0
```

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.)

```

ubuntu@ip-172-31-40-210:~$ netstat -t -n
Active Internet connections (w/o servers)
Proto Recv-Q Send-Q Local Address           Foreign Address         State
tcp      0      0 172.31.40.210:22       49.32.58.139:58083     ESTABLISHED
tcp      0      300 172.31.40.210:22       49.32.58.139:58180     ESTABLISHED
ubuntu@ip-172-31-40-210:~$ netstat -t -n -l
Active Internet connections (only servers)
Proto Recv-Q Send-Q Local Address           Foreign Address         State
tcp      0      0 0.0.0.0:80             0.0.0.0:*              LISTEN
tcp      0      0 127.0.0.53:53           0.0.0.0:*              LISTEN
tcp      0      0 0.0.0.0:22             0.0.0.0:*              LISTEN
tcp6     0      0 :::80                  :::*                    LISTEN
tcp6     0      0 :::22                   :::*                    LISTEN
ubuntu@ip-172-31-40-210:~$ |

```

```

ubuntu@ip-172-31-40-210:~$ netstat
Active Internet connections (w/o servers)
Proto Recv-Q Send-Q Local Address           Foreign Address         State
tcp      0      0 ip-172-31-40-210.ap:ssh 49.32.58.139:58083     ESTABLISHED
tcp      0      300 ip-172-31-40-210.ap:ssh 49.32.58.139:58180     ESTABLISHED
Active UNIX domain sockets (w/o servers)
Proto RefCnt Flags       Type        State         I-Node    Path
unix    2      [ ]          DGRAM              32057
/run/user/1000/systemd/notify
unix    3      [ ]          DGRAM              13869        /run/systemd/notify
unix    2      [ ]          DGRAM              13881        /run/systemd/journal/syslog
unix    9      [ ]          DGRAM              13890        /run/systemd/journal/socket
unix    8      [ ]          DGRAM              14422        /run/systemd/journal/dev-
log
unix    2      [ ]          DGRAM              17750
unix    3      [ ]          DGRAM              16245
unix    3      [ ]          STREAM           CONNECTED      17510        /run/systemd/journal/stdout
unix    3      [ ]          STREAM           CONNECTED      19129        /run/systemd/journal/stdout
unix    3      [ ]          STREAM           CONNECTED      18599        /run/systemd/journal/stdout
unix    3      [ ]          STREAM           CONNECTED      21405
unix    3      [ ]          DGRAM              16107
unix    3      [ ]          DGRAM              16244
unix    3      [ ]          STREAM           CONNECTED      19027
unix    3      [ ]          STREAM           CONNECTED      14885
unix    3      [ ]          STREAM           CONNECTED      19289
unix    3      [ ]          STREAM           CONNECTED      15320        /run/systemd/journal/stdout
unix    3      [ ]          STREAM           CONNECTED      21406
/var/run/dbus/system_bus_socket
unix    3      [ ]          STREAM           CONNECTED      19026
unix    3      [ ]          STREAM           CONNECTED      17509
unix    3      [ ]          STREAM           CONNECTED      17642
unix    3      [ ]          STREAM           CONNECTED      16187
unix    3      [ ]          STREAM           CONNECTED      19712
/var/run/dbus/system_bus_socket
unix    3      [ ]          STREAM           CONNECTED      16188        /run/systemd/journal/stdout
unix    3      [ ]          DGRAM              13870
unix    2      [ ]          DGRAM              16240
unix    2      [ ]          DGRAM              15007
unix    3      [ ]          DGRAM              13871
unix    3      [ ]          DGRAM              16246
unix    3      [ ]          STREAM           CONNECTED      18953        /run/systemd/journal/stdout
unix    3      [ ]          STREAM           CONNECTED      18787        /run/systemd/journal/stdout
unix    3      [ ]          STREAM           CONNECTED      19053
/var/run/dbus/system_bus_socket
unix    3      [ ]          STREAM           CONNECTED      17645        /run/systemd/journal/stdout
unix    3      [ ]          STREAM           CONNECTED      18786
unix    3      [ ]          STREAM           CONNECTED      19128
unix    3      [ ]          DGRAM              16108
unix    2      [ ]          DGRAM              14887
unix    3      [ ]          STREAM           CONNECTED      19290        /run/systemd/journal/stdout
unix    3      [ ]          STREAM           CONNECTED      21048
/var/run/dbus/system_bus_socket

```

unix	3	[]	STREAM	CONNECTED	18951	
unix	2	[]	DGRAM		17522	
unix	3	[]	STREAM	CONNECTED	18598	
unix	2	[]	DGRAM		20311	
unix	3	[]	DGRAM		16243	
unix	3	[]	STREAM	CONNECTED	19028	/run/systemd/journal/stdout
unix	2	[]	DGRAM		14806	
unix	3	[]	STREAM	CONNECTED	15316	/run/systemd/journal/stdout
unix	3	[]	STREAM	CONNECTED	19210	
unix	3	[]	STREAM	CONNECTED	14646	
unix	3	[]	STREAM	CONNECTED	19211	/run/systemd/journal/stdout
unix	3	[]	STREAM	CONNECTED	20939	
unix	3	[]	STREAM	CONNECTED	22598	
unix	2	[]	DGRAM		33542	
unix	3	[]	DGRAM		14986	
unix	3	[]	STREAM	CONNECTED	21411	
/var/run/dbus/system_bus_socket						
unix	3	[]	STREAM	CONNECTED	18328	
unix	3	[]	STREAM	CONNECTED	21046	
/var/run/dbus/system_bus_socket						
unix	3	[]	STREAM	CONNECTED	22601	
unix	2	[]	DGRAM		31863	
unix	3	[]	STREAM	CONNECTED	21178	
unix	3	[]	DGRAM		17535	
unix	3	[]	STREAM	CONNECTED	18329	
unix	3	[]	STREAM	CONNECTED	22594	
unix	2	[]	DGRAM		31981	
unix	3	[]	STREAM	CONNECTED	19052	
/var/run/dbus/system_bus_socket						
unix	3	[]	DGRAM		32059	
unix	3	[]	STREAM	CONNECTED	20942	/run/systemd/journal/stdout
unix	3	[]	DGRAM		17533	
unix	3	[]	STREAM	CONNECTED	21410	
unix	3	[]	STREAM	CONNECTED	19051	
/var/run/dbus/system_bus_socket						
unix	3	[]	STREAM	CONNECTED	21371	
unix	3	[]	STREAM	CONNECTED	21180	/run/systemd/journal/stdout
unix	3	[]	STREAM	CONNECTED	33735	
unix	3	[]	STREAM	CONNECTED	31967	
unix	3	[]	DGRAM		14987	
unix	3	[]	STREAM	CONNECTED	21370	
unix	2	[]	DGRAM		32013	
unix	3	[]	STREAM	CONNECTED	19968	
unix	3	[]	STREAM	CONNECTED	19711	
unix	3	[]	STREAM	CONNECTED	32708	
unix	3	[]	STREAM	CONNECTED	21045	
unix	3	[]	STREAM	CONNECTED	20129	/run/systemd/journal/stdout
unix	3	[]	STREAM	CONNECTED	22600	
unix	3	[]	STREAM	CONNECTED	22593	
unix	3	[]	STREAM	CONNECTED	32707	
unix	2	[]	DGRAM		20818	
unix	3	[]	STREAM	CONNECTED	22599	
unix	3	[]	STREAM	CONNECTED	19049	
unix	3	[]	DGRAM		32058	
unix	2	[]	DGRAM		19789	
unix	2	[]	DGRAM		19042	
unix	3	[]	DGRAM		17532	
unix	3	[]	STREAM	CONNECTED	31977	/run/systemd/journal/stdout
unix	3	[]	STREAM	CONNECTED	19050	
unix	3	[]	STREAM	CONNECTED	33736	
unix	3	[]	STREAM	CONNECTED	21047	
unix	3	[]	STREAM	CONNECTED	19970	/run/systemd/journal/stdout
unix	3	[]	DGRAM		17534	
unix	3	[]	STREAM	CONNECTED	20127	

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>
```

```
ubuntu@ip-172-31-40-210:~$ traceroute spit.ac.in
traceroute to spit.ac.in (43.252.193.19), 30 hops max, 60 byte packets
 1  ec2-52-66-0-38.ap-south-1.compute.amazonaws.com (52.66.0.38)  8.446 ms  ec2-52-66-0-26.ap-south-1.compute.amazonaws.com (52.66.0.26)  2.668 ms  2.660 ms
 2  100.66.8.56 (100.66.8.56)  6.022 ms  100.66.8.126 (100.66.8.126)  3.232 ms  100.66.8.0 (100.66.8.0)  6.714 ms
 3  100.66.11.228 (100.66.11.228)  4.851 ms  100.66.10.4 (100.66.10.4)  1.166 ms  100.66.10.198 (100.66.10.198)  4.823 ms
 4  100.66.7.1 (100.66.7.1)  4.546 ms  100.66.7.133 (100.66.7.133)  0.772 ms  100.66.7.7 (100.66.7.7)  4.512 ms
 5  100.66.4.37 (100.66.4.37)  4.244 ms  * 100.66.4.187 (100.66.4.187)  1.646 ms
 6  100.65.11.65 (100.65.11.65)  0.431 ms  100.65.9.97 (100.65.9.97)  1.148 ms  100.65.9.1 (100.65.9.1)  0.286 ms
 7  52.95.65.134 (52.95.65.134)  1.144 ms  52.95.65.130 (52.95.65.130)  1.108 ms  52.95.67.179 (52.95.67.179)  1.644 ms
 8  52.95.67.16 (52.95.67.16)  2.032 ms  1.511 ms  52.95.67.38 (52.95.67.38)  1.084 ms
 9  52.95.67.7 (52.95.67.7)  1.335 ms  52.95.67.161 (52.95.67.161)  1.147 ms  52.95.67.7 (52.95.67.7)  1.122 ms
10  72.21.221.89 (72.21.221.89)  0.965 ms  0.949 ms  1.020 ms
11  27.109.1.150 (27.109.1.150)  1.295 ms  1.380 ms  1.387 ms
12  103.205.124.82 (103.205.124.82)  1.326 ms  1.398 ms  1.426 ms
13  43.252.192.230 (43.252.192.230)  1.279 ms  1.278 ms  1.385 ms
14  * * *
15  * * *
16  * * *
17  * * *
18  * * *
19  * * *
20  * * *
21  * * *
22  * * *
23  * * *
24  * * *
25  * * *
26  * * *
27  * * *
28  * * *
29  * * *
30  * * *
ubuntu@ip-172-31-40-210:~$ |
```


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. www.cs.grinnell.edu

```
ubuntu@ip-172-31-40-210:~$ traceroute www.cs.grinnell.edu
traceroute to www.cs.grinnell.edu (132.161.132.159), 30 hops max, 60 byte packets
 1 * * ec2-52-66-0-34.ap-south-1.compute.amazonaws.com (52.66.0.34) 3.181 ms
 2 100.66.8.202 (100.66.8.202) 5.486 ms 100.66.8.102 (100.66.8.102) 0.707 ms 100.66.8.104 (100.66.8.104) 1.260 ms
 3 100.66.11.38 (100.66.11.38) 1.030 ms 100.66.11.36 (100.66.11.36) 8.123 ms 100.66.10.228 (100.66.10.228) 2.505 ms
 4 * 100.66.7.5 (100.66.7.5) 4.500 ms 100.66.6.65 (100.66.6.65) 4.037 ms
 5 100.66.4.127 (100.66.4.127) 5.525 ms 100.66.4.7 (100.66.4.7) 4.619 ms 100.66.4.113 (100.66.4.113) 5.501 ms
 6 100.65.8.1 (100.65.8.1) 0.876 ms 100.65.9.33 (100.65.9.33) 0.288 ms 100.65.8.33 (100.65.8.33) 0.331 ms
 7 52.95.65.130 (52.95.65.130) 1.342 ms 52.95.65.128 (52.95.65.128) 1.947 ms 52.95.67.183 (52.95.67.183) 1.117 ms
 8 52.95.66.214 (52.95.66.214) 2.113 ms 52.95.66.148 (52.95.66.148) 2.189 ms 52.95.66.126 (52.95.66.126) 2.125 ms
 9 52.95.65.232 (52.95.65.232) 1.112 ms 52.95.65.236 (52.95.65.236) 1.840 ms 52.95.65.230 (52.95.65.230) 1.620 ms
10 115.114.89.121.static-mumbai.vsnl.net.in (115.114.89.121) 1.387 ms 1.689 ms 115.114.89.57.static-mumbai.vsnl.net.in (115.114.89.57) 0.885 ms
11 * * *
12 ix-ae-2-2.tcore2.cxr-chennai.as6453.net (180.87.37.1) 28.753 ms * 25.723 ms
13 ix-ae-2-2.tcore2.cxr-chennai.as6453.net (180.87.37.1) 28.576 ms if-ae-9-2.tcore2.mlv-mumbai.as6453.net (180.87.37.10) 228.467 ms 229.824 ms
14 if-ae-2-2.tcore1.mlv-mumbai.as6453.net (180.87.38.1) 229.141 ms if-ae-9-2.tcore2.mlv-mumbai.as6453.net (180.87.37.10) 225.719 ms if-ae-2-2.tcore1.mlv-mumbai.as6453.net (180.87.38.1) 229.595 ms
15 if-ae-2-2.tcore1.mlv-mumbai.as6453.net (180.87.38.1) 227.493 ms 221.565 ms if-ae-5-6.tcore1.wyn-marseille.as6453.net (180.87.38.120) 233.234 ms
16 if-ae-29-8.tcore1.wyn-marseille.as6453.net (80.231.217.110) 221.962 ms if-ae-5-2.tcore1.wyn-marseille.as6453.net (80.231.217.29) 227.415 ms 223.993 ms
17 if-ae-2-2.tcore2.wyn-marseille.as6453.net (80.231.217.2) 229.501 ms * *
18 * * *
19 if-ae-26-2.tcore1.ct8-chicago.as6453.net (216.6.81.29) 231.673 ms 232.421 ms if-ae-15-2.tcore2.ldn-london.as6453.net (80.231.131.118) 228.252 ms
20 * if-ae-32-2.tcore2.nto-newyork.as6453.net (63.243.216.22) 244.805 ms *
21 if-ae-26-2.tcore1.ct8-chicago.as6453.net (216.6.81.29) 229.208 ms * *
22 * et3-1-a-0.agr03.des01-ia.us.windstream.net (40.128.250.43) 234.267 ms *
23 et3-1-0-0.agr03.des01-ia.us.windstream.net (40.128.250.43) 231.266 ms 227.860 ms *
24 et4-1-0-0.agr04.des01-ia.us.windstream.net (40.136.117.253) 243.170 ms ae4-0-pe04.grn101-ia.us.windstream.net (40.128.248.35) 238.930 ms 237.276 ms
25 ae4-0-pe04.grn101-ia.us.windstream.net (40.128.248.35) 233.117 ms h29.127.138.40.static-ip.windstream.net (40.138.127.29) 233.318 ms ae4-0-pe04.grn101-ia.us.windstream.net (40.128.248.35) 233.983 ms
26 ae4-0-pe04.grn101-ia.us.windstream.net (40.128.251.179) 244.343 ms * *
27 * grn1-static-grinnellcollege0-0001.Flex.iowatelecom.net (69.66.111.181) 244.865 ms *
28 * * *
29 * * *
30 * * *
```

2. `cs.stanford.edu`

```
ubuntu@ip-172-31-40-210:~$ traceroute cs.stanford.edu
traceroute to cs.stanford.edu (171.64.64.64), 30 hops max, 60 byte packets
 1 * * ec2-52-66-0-30.ap-south-1.compute.amazonaws.com (52.66.0.30) 0.846 ms ec2-52-66-0-36.ap-south-1.compute.amazonaws.com (52.66.0.36) 2.593 ms
 2 * 100.66.8.36 (100.66.8.36) 4.400 ms 100.66.8.44 (100.66.8.44) 0.605 ms
 3 100.66.11.102 (100.66.11.102) 2.222 ms 100.66.10.132 (100.66.10.132) 2.510 ms 100.66.10.34 (100.66.10.34) 5.600 ms
 4 100.66.6.225 (100.66.6.225) 5.161 ms * *
 5 100.66.4.123 (100.66.4.123) 7.725 ms 7.712 ms 100.66.4.83 (100.66.4.83) 9.662 ms
 6 100.65.9.97 (100.65.9.97) 1.023 ms 100.65.10.1 (100.65.10.1) 0.385 ms 100.65.11.65 (100.65.11.65) 0.321 ms
 7 52.95.67.179 (52.95.67.179) 0.885 ms 52.95.65.132 (52.95.65.132) 1.975 ms 52.95.65.134 (52.95.65.134) 0.722 ms
 8 52.95.67.60 (52.95.67.60) 6.548 ms 52.95.67.82 (52.95.67.82) 1.262 ms 52.95.67.170 (52.95.67.170) 1.822 ms
 9 52.95.65.232 (52.95.65.232) 4.983 ms 52.95.66.179 (52.95.66.179) 1.660 ms 52.95.66.47 (52.95.66.47) 1.594 ms
10 115.114.89.57.static-mumbai.vsnl.net.in (115.114.89.57) 0.916 ms 0.877 ms 0.873 ms
11 * * *
12 ix-ae-4-2.tcore2.cxr-chennai.as6453.net (180.87.37.1) 21.764 ms 30.197 ms 34.306 ms
13 ix-ae-2-2.tcore2.cxr-chennai.as6453.net (180.87.37.1) 24.260 ms 24.247 ms *
14 if-ae-7-2.tcore2.lvw-losangeles.as6453.net (180.87.15.26) 248.458 ms if-ae-10-4.tcore2.svw-singapore.as6453.net (180.87.67.16) 251.125 ms if-ae-7-2.tcore2.lvw-losangeles.as6453.net (180.87.15.26) 246.906 ms
15 if-ae-7-2.tcore2.lvw-losangeles.as6453.net (180.87.15.26) 243.002 ms if-ae-2-2.tcore1.lvw-losangeles.as6453.net (66.110.59.1) 266.957 ms 244.819 ms
16 las-b24-link.telina.net (80.239.128.214) 243.489 ms 241.477 ms if-ae-2-2.tcore1.lvw-losangeles.as6453.net (66.110.59.1) 248.150 ms
17 * palo-b24-link.telina.net (62.115.119.90) 291.503 ms las-b24-link.telina.net (80.239.128.214) 249.096 ms
18 palo-b1-link.telina.net (62.115.122.169) 261.807 ms palo-b24-link.telina.net (62.115.119.90) 268.555 ms palo-b1-link.telina.net (62.115.122.169) 262.128 ms
19 hurricane-ic-308019-palo-b1-c.telina.net (80.239.167.174) 261.004 ms 250.993 ms 250.734 ms
20 hurricane-ic-308019-palo-b1-c.telina.net (80.239.167.174) 256.674 ms 256.582 ms stanford-university.100gigabithernet5-1.core1.paol.he.net (184.105.177.238) 247.328 ms
21 cs-est-west-rttr-v13.SUNet (171.66.255.140) 235.179 ms 239.529 ms stanford-university.100gigabithernet5-1.core1.paol.he.net (184.105.177.238) 251.759 ms
22 cs.stanford.edu (171.64.64.64) 230.605 ms cs-est-west-rttr-v13.SUNet (171.66.255.140) 232.964 ms 232.827 ms
ubuntu@ip-172-31-40-210:~$
```

3. `cs.manchester.ac.uk`

```
Last login: Wed Aug 26 17:02:32 2020 from 49.32.58.139
ubuntu@ip-172-31-40-210:~$ traceroute cs.manchester.ac.uk
traceroute to cs.manchester.ac.uk (130.88.101.49), 30 hops max, 60 byte packets
 1 ec2-52-66-0-34.ap-south-1.compute.amazonaws.com (52.66.0.34) 1.017 ms * *
 2 * 100.66.8.236 (100.66.8.236) 8.553 ms 100.66.8.150 (100.66.8.150) 4.316 ms
 3 100.66.10.102 (100.66.10.102) 6.613 ms 100.66.10.2 (100.66.10.2) 3.255 ms 100.66.10.0 (100.66.10.0) 3.283 ms
 4 100.66.6.231 (100.66.6.231) 3.768 ms 100.66.6.129 (100.66.6.129) 1.491 ms *
 5 100.66.4.75 (100.66.4.75) 1.601 ms 100.66.4.59 (100.66.4.59) 7.093 ms 100.66.4.103 (100.66.4.103) 4.885 ms
 6 100.65.11.193 (100.65.11.193) 17.208 ms 100.65.10.161 (100.65.10.161) 2.889 ms 100.65.10.65 (100.65.10.65) 14.174 ms
 7 52.95.67.179 (52.95.67.179) 1.676 ms 52.95.65.130 (52.95.65.130) 1.670 ms 52.95.65.132 (52.95.65.132) 2.031 ms
 8 52.95.66.170 (52.95.66.170) 8.713 ms 52.95.67.38 (52.95.67.38) 4.179 ms 52.95.67.170 (52.95.67.170) 1.388 ms
 9 52.95.65.232 (52.95.65.232) 0.772 ms 52.95.66.113 (52.95.66.113) 1.559 ms 52.95.66.69 (52.95.66.69) 2.015 ms
10 115.114.89.57.static-mumbai.vsnl.net.in (115.114.89.57) 1.015 ms 115.114.89.121.static-mumbai.vsnl.net.in (115.114.89.12)
11 * * *
12 ix-ae-0-100.tcore1.mlv-mumbai.as6453.net (180.87.38.5) 1.505 ms ix-ae-0-100.tcore2.mlv-mumbai.as6453.net (180.87.39.25)
13 if-ae-2-2.tcore1.mlv-mumbai.as6453.net (180.87.38.1) 118.824 ms if-ae-5-6.tcore1.wyn-marseille.as6453.net (180.87.38.126)
14 if-ae-29-8.tcore1.wyn-marseille.as6453.net (80.231.217.110) 119.310 ms if-ae-5-6.tcore1.wyn-marseille.as6453.net (180.87
15 if-ae-11-2.tcore1.pvu-paris.as6453.net (80.231.153.49) 118.721 ms 118.309 ms if-ae-21-2.tcore1.pye-paris.as6453.net (80
16 80.231.153.66 (80.231.153.66) 118.969 ms 118.967 ms if-ae-11-2.tcore1.pvu-paris.as6453.net (80.231.153.49) 118.404 ms
17 80.231.153.66 (80.231.153.66) 118.964 ms * *
18 JANET.bear1.Manchester1.Level3.net (212.187.174.238) 129.879 ms 129.477 ms 129.890 ms
19 JANET.bear1.Manchester1.Level3.net (212.187.174.238) 130.013 ms ae22.mancrh-sbr2.ja.net (146.97.35.189) 129.903 ms 129
20 ae22.mancrh-sbr2.ja.net (146.97.35.189) 130.037 ms 129.830 ms ae23.mancrh-rbr1.ja.net (146.97.38.42) 130.005 ms
21 * ae23.mancrh-rbr1.ja.net (146.97.38.42) 129.581 ms 130.041 ms
22 * * *
23 130.88.249.194 (130.88.249.194) 130.704 ms * *
24 * gw-jh.its.manchester.ac.uk (130.88.250.32) 169.314 ms 169.318 ms
25 eps.its.man.ac.uk (130.88.101.49) 130.728 ms 130.715 ms 130.790 ms
ubuntu@ip-172-31-40-210:~$
```

4) cs.stanford.edu

```
ubuntu@ip-172-31-40-210:~$ traceroute cs.stanford.edu
traceroute to cs.stanford.edu (171.64.64.64), 30 hops max, 60 byte packets
 1 ec2-52-66-0-36.ap-south-1.compute.amazonaws.com (52.66.0.36)  8.654 ms ec2-52-66-0-32.ap-south-1.compute.amazonaws.com (52.66.0.32)  4.166 ms
 2 * 100.66.8.248 (100.66.8.248)  3.643 ms 100.66.8.56 (100.66.8.56)  3.574 ms
 3 100.66.11.160 (100.66.11.160)  1.039 ms 100.66.10.226 (100.66.10.226)  11.292 ms 100.66.10.160 (100.66.10.160)  6.798 ms
 4 100.66.6.231 (100.66.6.231)  1.310 ms 100.66.6.67 (100.66.6.67)  2.712 ms 100.66.6.39 (100.66.6.39)  2.136 ms
 5 100.66.4.205 (100.66.4.205)  2.540 ms 100.66.4.207 (100.66.4.207)  2.605 ms 100.66.4.99 (100.66.4.99)  2.659 ms
 6 100.65.8.65 (100.65.8.65)  1.165 ms 100.65.10.161 (100.65.10.161)  0.393 ms 100.65.9.1 (100.65.9.1)  0.330 ms
 7 52.95.65.134 (52.95.65.134)  1.429 ms 52.95.67.181 (52.95.67.181)  2.103 ms 52.95.65.134 (52.95.65.134)  1.162 ms
 8 52.95.66.192 (52.95.66.192)  2.703 ms 52.95.66.170 (52.95.66.170)  3.423 ms 52.95.67.60 (52.95.67.60)  1.341 ms
 9 52.95.66.91 (52.95.66.91)  1.634 ms 52.95.65.234 (52.95.65.234)  1.766 ms 52.95.66.135 (52.95.66.135)  1.603 ms
10 115.114.89.57.static-Mumbai.vsnl.net.in (115.114.89.57)  0.944 ms 0.809 ms 1.361 ms
11 * * *
12 * * *
13 * ix-ae-4-2.tcore2.cxr-chennai.as6453.net (180.87.37.1)  23.261 ms 18.564 ms
14 if-ae-10-4.tcore2.svw-singapore.as6453.net (180.87.67.16)  245.419 ms if-ae-7-2.tcore2.lvw-losangeles.as6453.net (180.87.15.26)  249.473 ms 243.383 ms
15 if-ae-7-2.tcore2.lvw-losangeles.as6453.net (180.87.15.26)  250.121 ms 253.403 ms 245.067 ms
16 las-b24-link.teliana.net (80.239.128.214)  255.558 ms 247.441 ms if-ae-2-2.tcore1.lvw-losangeles.as6453.net (66.110.59.1)  256.808 ms
17 * palo-b24-link.teliana.net (62.115.119.90)  264.747 ms *
18 palo-b1-link.teliana.net (62.115.122.169)  272.189 ms palo-b24-link.teliana.net (62.115.119.90)  258.990 ms palo-b1-link.teliana.net (62.115.122.169)  260.775 ms
19 palo-b1-link.teliana.net (62.115.122.169)  259.603 ms hurricane-ic-308019-palo-b1.c.teliana.net (80.239.167.174)  254.891 ms 254.811 ms
20 stanford-university.100gigabitethernet5-1.core1.pao1.he.net (184.105.177.238)  249.299 ms 261.208 ms hurricane-ic-308019-palo-b1.c.teliana.net (80.239.167.174)  247.834 ms
21 stanford-university.100gigabitethernet5-1.core1.pao1.he.net (184.105.177.238)  249.606 ms csee-west-rtr-v13.SUNet (171.66.255.140)  239.063 ms 241.848 ms
22 * CS.stanford.edu (171.64.64.64)  236.606 ms csee-west-rtr-v13.SUNet (171.66.255.140)  243.417 ms
ubuntu@ip-172-31-40-210:~$
```

5) csail.mit.edu

```
ubuntu@ip-172-31-40-210:~$ traceroute csail.mit.edu
traceroute to csail.mit.edu (128.30.2.109), 30 hops max, 60 byte packets
 1 ec2-52-66-0-34.ap-south-1.compute.amazonaws.com (52.66.0.34)  1.750 ms ec2-52-66-0-28.ap-south-1.compute.amazonaws.com (52.66.0.28)  3.044 ms
 2 100.66.8.250 (100.66.8.250)  5.049 ms 100.66.8.210 (100.66.8.210)  5.824 ms 100.66.8.162 (100.66.8.162)  4.112 ms
 3 100.66.11.6 (100.66.11.6)  5.695 ms 100.66.10.194 (100.66.10.194)  2.141 ms 100.66.11.128 (100.66.11.128)  7.850 ms
 4 100.66.7.227 (100.66.7.227)  2.698 ms * 100.66.6.35 (100.66.6.35)  7.118 ms
 5 * 100.66.4.65 (100.66.4.65)  5.208 ms 100.66.4.207 (100.66.4.207)  1.568 ms
 6 100.65.9.161 (100.65.9.161)  0.360 ms 100.65.11.65 (100.65.11.65)  0.265 ms 100.65.11.1 (100.65.11.1)  0.365 ms
 7 52.95.65.132 (52.95.65.132)  2.043 ms 52.95.67.181 (52.95.67.181)  1.222 ms 52.95.67.183 (52.95.67.183)  1.432 ms
 8 52.95.66.60 (52.95.66.60)  1.912 ms 52.95.66.104 (52.95.66.104)  1.998 ms 52.95.66.214 (52.95.66.214)  2.471 ms
 9 52.95.66.135 (52.95.66.135)  3.158 ms 52.95.65.226 (52.95.65.226)  1.272 ms 52.95.66.91 (52.95.66.91)  3.219 ms
10 115.114.89.57.static-Mumbai.vsnl.net.in (115.114.89.57)  0.884 ms 0.875 ms 0.937 ms
11 * * *
12 ix-ae-0-100.tcore1.mlv-mumbai.as6453.net (180.87.38.5)  1.729 ms ix-ae-0-100.tcore2.mlv-mumbai.as6453.net (180.87.39.25)  1.493 ms
13 if-ae-2-2.tcore1.mlv-mumbai.as6453.net (180.87.38.1)  192.792 ms 192.544 ms *
14 * * *
15 * * *
16 * * *
17 if-ae-8-49.tcore2.nto-newyork.as6453.net (216.6.81.34)  188.160 ms if-ae-4-2.tcore2.n0v-newyork.as6453.net (80.231.131.15)  198.381 ms
18 if-ae-12-2.tcore1.n75-newyork.as6453.net (66.110.96.5)  193.881 ms
19 193.873 ms 193.599 ms
20 66.110.96.142 (66.110.96.142)  194.790 ms be-10390-cr02.newyork.ny.ibone.comcast.net (68.86.83.89)  193.787 ms 66.110.96.138 (66.110.96.138)  188.218 ms
21 66.110.96.134 (66.110.96.134)  192.577 ms be-10390-cr02.newyork.ny.ibone.comcast.net (68.86.83.89)  193.899 ms 66.110.96.150 (66.110.96.150)  190.412 ms
22 66.110.96.134 (66.110.96.134)  192.659 ms be-10390-cr02.newyork.ny.ibone.comcast.net (68.86.83.89)  194.892 ms 66.110.96.130 (66.110.96.130)  192.969 ms
23 96.110.42.6 (96.110.42.6)  193.013 ms ae0-0-eg-bstpmall74w.boston.ma.boston.comcast.net (68.86.238.34)  193.324 ms 193.253 ms
24 ae0-0-eg-bstpmall74w.boston.ma.boston.comcast.net (68.86.238.34)  238.939 ms 223.959 ms 218.143 ms
25 50-201-57-174-static.hfc.comcastbusiness.net (50.201.57.174)  195.003 ms 193.030 ms 193.104 ms
26 dmz-rtr-1-external-rtr-3.mit.edu (18.0.161.13)  193.231 ms 193.140 ms ae0-0-eg-bstpmall74w.boston.ma.boston.comcast.net (68.86.238.34)  197.832 ms
27 dmz-rtr-1-external-rtr-3.mit.edu (18.0.161.13)  197.497 ms 196.919 ms mitnet.core-1-ext.csail.mit.edu (18.4.7.65)  193.240 ms
28 dmz-rtr-1-external-rtr-3.mit.edu (18.0.161.13)  197.437 ms mitnet.core-1-ext.csail.mit.edu (18.4.7.65)  195.156 ms 195.698 ms
29 mitnet.core-1-ext.csail.mit.edu (18.4.7.65)  197.665 ms 195.824 ms bdr.core-1.csail.mit.edu (128.30.0.246)  194.658 ms
30 * bdr.core-1.csail.mit.edu (128.30.0.246)  195.155 ms *
31 * bdr.core-1.csail.mit.edu (128.30.0.246)  197.965 ms *
ubuntu@ip-172-31-40-210:~$
```

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`).

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.

maths.hws.edu

```
ubuntu@ip-172-31-40-210:~$ traceroute math.hws.edu
traceroute to math.hws.edu (64.89.144.237), 30 hops max, 60 byte packets
 1 ec2-52-66-0-28.ap-south-1.compute.amazonaws.com (52.66.0.28) 4.121 ms ec2-52-66-0-36.ap-south-1.c
ompute.amazonaws.com (52.66.0.36) 7.484 ms 7.475 ms
 2 100.66.8.26 (100.66.8.26) 0.717 ms 100.66.8.22 (100.66.8.22) 1.703 ms 100.66.8.42 (100.66.8.42)
6.522 ms
 3 100.66.10.162 (100.66.10.162) 7.414 ms 7.396 ms 100.66.10.198 (100.66.10.198) 6.549 ms
 4 100.66.7.135 (100.66.7.135) 8.430 ms 100.66.7.195 (100.66.7.195) 4.880 ms 100.66.7.99 (100.66.7.
99) 3.572 ms
 5 * 100.66.4.103 (100.66.4.103) 3.240 ms 100.66.4.207 (100.66.4.207) 4.688 ms
 6 100.65.11.225 (100.65.11.225) 0.510 ms 100.65.9.33 (100.65.9.33) 0.342 ms 100.65.11.129 (100.65.
11.129) 0.327 ms
 7 52.95.65.132 (52.95.65.132) 35.787 ms 52.95.65.128 (52.95.65.128) 35.769 ms 52.95.67.177 (52.95.
67.177) 35.239 ms
 8 52.95.67.170 (52.95.67.170) 1.847 ms 52.95.67.148 (52.95.67.148) 1.559 ms 52.95.66.170 (52.95.66
.170) 2.024 ms
 9 52.95.65.224 (52.95.65.224) 1.513 ms 52.95.65.234 (52.95.65.234) 1.357 ms 52.95.66.69 (52.95.66.
69) 1.557 ms
10 115.114.89.57.static-Mumbai.vsnl.net.in (115.114.89.57) 0.934 ms 115.114.89.121.static-Mumbai.vsn
l.net.in (115.114.89.121) 1.522 ms 1.449 ms
11 * * *
12 ix-ae-0-100.tcore1.mlv-mumbai.as6453.net (180.87.38.5) 1.519 ms 1.415 ms 1.520 ms
13 if-ae-2-2.tcore1.mlv-mumbai.as6453.net (180.87.38.1) 118.648 ms 118.723 ms 118.684 ms
14 if-ae-8-1600.tcore1.pye-paris.as6453.net (80.231.217.6) 118.501 ms if-ae-5-2.tcore1.wyn-marseille
.as6453.net (80.231.217.29) 118.710 ms 137.561 ms
15 if-ae-11-2.tcore1.pvu-paris.as6453.net (80.231.153.49) 118.888 ms 119.651 ms if-ae-8-1600.tcore1
.pye-paris.as6453.net (80.231.217.6) 118.560 ms
16 if-ae-11-2.tcore1.pvu-paris.as6453.net (80.231.153.49) 119.786 ms * 119.645 ms
17 ae-1-3104.edge3.Paris1.Level3.net (4.69.161.110) 118.919 ms 118.958 ms 118.891 ms
18 ae-2-3204.edge3.Paris1.Level3.net (4.69.161.114) 118.981 ms ae-1-3104.edge3.Paris1.Level3.net (4.
69.161.110) 118.999 ms 119.900 ms
19 global-crossing-xe-level3.paris1.level3.net (4.68.63.230) 119.021 ms roc1-ar5-xe-11-0-0-us.twtelecom.net (35.248.1.162) 196.040 ms global-crossing-xe-level3.paris1.level3.net (4.68.63.230) 118.942 ms
20 66-195-65-170.static.ctl.one (66.195.65.170) 202.049 ms roc1-ar5-xe-11-0-0-us.twtelecom.net (35.248.1.162) 196.003 ms 66-195-65-170.static.ctl.one (66.195.65.170) 202.035 ms
21 66-195-65-170.static.ctl.one (66.195.65.170) 201.956 ms nat.hws.edu (64.89.144.100) 203.744 ms 203.876 ms
22 nat.hws.edu (64.89.144.100) 203.954 ms * 203.948 ms
23 * * *
24 * * *
25 * * *
26 * * *
27 * * *
28 * * *
29 * * *
30 * * *
ubuntu@ip-172-31-40-210:~$ |
```

www.hws.edu

```

ubuntu@ip-172-31-40-210:~$ traceroute www.hws.edu
traceroute to www.hws.edu (64.89.145.159), 30 hops max, 60 byte packets
 1 ec2-52-66-0-36.ap-south-1.compute.amazonaws.com (52.66.0.36) 3.767 ms ec2-52-66-0-26.ap-south-1.c
ompute.amazonaws.com (52.66.0.26) 5.341 ms ec2-52-66-0-32.ap-south-1.compute.amazonaws.com (52.66.0.3
2) 3.874 ms
 2 100.66.8.56 (100.66.8.56) 4.872 ms 100.66.8.76 (100.66.8.76) 7.696 ms *
 3 100.66.10.100 (100.66.10.100) 5.855 ms 100.66.10.166 (100.66.10.166) 3.200 ms 100.66.11.96 (100.
66.11.96) 5.631 ms
 4 100.66.6.167 (100.66.6.167) 3.769 ms * 100.66.7.69 (100.66.7.69) 3.932 ms
 5 100.66.4.17 (100.66.4.17) 2.289 ms 100.66.4.125 (100.66.4.125) 6.733 ms 100.66.4.255 (100.66.4.2
55) 8.669 ms
 6 100.65.9.129 (100.65.9.129) 0.442 ms 100.65.10.65 (100.65.10.65) 5.236 ms 100.65.11.65 (100.65.1
1.65) 3.464 ms
 7 52.95.65.132 (52.95.65.132) 3.601 ms 52.95.67.181 (52.95.67.181) 2.786 ms 52.95.65.132 (52.95.65
.132) 2.748 ms
 8 52.95.67.16 (52.95.67.16) 0.997 ms 52.95.66.104 (52.95.66.104) 2.024 ms 52.95.66.170 (52.95.66.1
70) 2.030 ms
 9 52.95.66.135 (52.95.66.135) 1.477 ms 52.95.65.224 (52.95.65.224) 1.743 ms 52.95.66.179 (52.95.66
.179) 1.388 ms
10 115.114.89.57.static-Mumbai.vsnl.net.in (115.114.89.57) 0.935 ms 115.114.89.121.static-Mumbai.vsn
l.net.in (115.114.89.121) 1.335 ms 1.329 ms
11 * * *
12 ix-ae-0-100.tcore2.mlv-mumbai.as6453.net (180.87.39.25) 1.848 ms 1.820 ms ix-ae-0-100.tcore1.mlv
-mumbai.as6453.net (180.87.38.5) 1.468 ms
13 if-ae-2-2.tcore1.mlv-mumbai.as6453.net (180.87.38.1) 118.684 ms 118.654 ms if-ae-5-6.tcore1.wyn-
marseille.as6453.net (180.87.38.126) 118.682 ms
14 if-ae-29-8.tcore1.wyn-marseille.as6453.net (80.231.217.110) 118.629 ms if-ae-5-2.tcore1.wyn-marse
ille.as6453.net (80.231.217.29) 118.421 ms if-ae-21-2.tcore1.pye-paris.as6453.net (80.231.154.208) 1
18.491 ms
15 if-ae-8-1600.tcore1.pye-paris.as6453.net (80.231.217.6) 118.504 ms if-ae-11-2.tcore1.pvu-paris.as
6453.net (80.231.153.49) 118.781 ms if-ae-8-1600.tcore1.pye-paris.as6453.net (80.231.217.6) 118.557
ms
16 80.231.153.66 (80.231.153.66) 118.982 ms 118.816 ms 118.884 ms
17 ae-1-3104.edge3.Paris1.Level3.net (4.69.161.110) 118.850 ms ae-2-3204.edge3.Paris1.Level3.net (4.
69.161.114) 118.791 ms 80.231.153.66 (80.231.153.66) 119.182 ms
18 global-crossing-xe-level3.paris1.level3.net (4.68.63.230) 118.734 ms ae-2-3204.edge3.Paris1.Level
3.net (4.69.161.114) 118.947 ms global-crossing-xe-level3.paris1.level3.net (4.68.63.230) 118.688 ms
19 roc1-ar5-xe-11-0-0-0.us.twtelecom.net (35.248.1.162) 195.791 ms 195.794 ms 195.877 ms
20 66-195-65-170.static.ctl.one (66.195.65.170) 202.130 ms roc1-ar5-xe-11-0-0-0.us.twtelecom.net (35
.248.1.162) 196.089 ms 66-195-65-170.static.ctl.one (66.195.65.170) 202.376 ms
21 nat.hws.edu (64.89.144.100) 203.853 ms 203.929 ms 203.800 ms
22 * * nat.hws.edu (64.89.144.100) 203.788 ms
23 * * *
24 * * *
25 * * *
26 * * *
27 * * *
28 * * *
29 * * *
30 * * *
ubuntu@ip-172-31-40-210:~$ |

```

The first row shows that the process of route tracing has started as the last column shows the Default Gateway of the user. The next three rows in both the cases are similar as the route is being

traced starting from the ISP (Internet service provider) of the user. The next few rows, after which the tracing reaches the common IP address of 66.195.65.170 and then math.hws.edu [64.89.144.100], clearly show that the route is completely different after crossing the ISP for both the cases. A domain name might have multiple IP addresses associated. If this is the case, multiple traces may access two or more IP addresses. This will yield trace paths that differ from one another, even if the origin and destinations are the same. Domains may also use multiple servers for its subdomains. Tracing the path to the base domain might result in a completely different path when tracing to the subdomain. A URL with the **www** prefix is technically a subdomain, so it's possible that traces to **example.com** and **www.example.com** follow two very different paths.

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.

```
ubuntu@ip-172-31-40-210:~$ traceroute cs.stanford.edu
traceroute to cs.stanford.edu (171.64.64.64), 30 hops max, 60 byte packets
 1 ec2-52-66-0-32.ap-south-1.compute.amazonaws.com (52.66.0.32)  4.516 ms ec2-52-66-0-36.ap-south-1.compute.amazonaws.com (52.66.0.36)  1.732 ms  1.716 ms
 2 100.66.8.170 (100.66.8.170)  2.359 ms * 100.66.8.226 (100.66.8.226)  4.721 ms
 3 100.66.10.2 (100.66.10.2)  0.993 ms 100.66.11.2 (100.66.11.2)  2.314 ms 100.66.10.4 (100.66.10.4)  5.251 ms
 4 100.66.6.1 (100.66.6.1)  6.055 ms 100.66.6.135 (100.66.6.135)  8.399 ms 8.413 ms
 5 100.66.4.33 (100.66.4.33)  7.924 ms * 100.66.4.35 (100.66.4.35)  8.073 ms
 6 100.65.10.225 (100.65.10.225)  1.244 ms 100.65.9.33 (100.65.9.33)  0.451 ms 100.65.8.193 (100.65.8.193)  0.701 ms
 7 52.95.65.132 (52.95.65.132)  1.515 ms 52.95.65.128 (52.95.65.128)  1.343 ms 52.95.67.179 (52.95.67.179)  1.499 ms
 8 52.95.67.60 (52.95.67.60)  5.455 ms 52.95.66.60 (52.95.66.60)  2.810 ms 52.95.67.82 (52.95.67.82)  18.470 ms
 9 52.95.66.135 (52.95.66.135)  1.632 ms 52.95.65.228 (52.95.65.228)  1.191 ms 52.95.66.47 (52.95.66.47)  1.610 ms
10 115.110.234.233.static.Mumbai.vsnl.net.in (115.110.234.233)  1.730 ms 1.614 ms 115.114.89.121.static-Mumbai.vsnl.net.in (115.114.89.121)  1.431 ms
11 * * *
12 ix-ae-4-2.tcore2.cxr-chennai.as6453.net (180.87.37.1)  22.737 ms * 23.750 ms
13 * * ix-ae-4-2.tcore2.cxr-chennai.as6453.net (180.87.37.1)  22.674 ms
14 if-ae-10-4.tcore2.svw-singapore.as6453.net (180.87.67.16)  253.837 ms 243.488 ms if-ae-7-2.tcore2.lvw-losangeles.as6453.net (180.87.15.26)  245.387 ms
15 if-ae-7-2.tcore2.lvw-losangeles.as6453.net (180.87.15.26)  245.758 ms if-ae-2-2.tcore1.lvw-losangeles.as6453.net (66.110.59.1)  251.929 ms if-ae-7-2.tcore2.lvw-losangeles.as6453.net (180.87.15.26)  250.133 ms
16 las-b24-link.teliana.net (80.239.128.214)  252.311 ms 252.324 ms if-ae-2-2.tcore1.lvw-losangeles.as6453.net (66.110.59.1)  247.458 ms
17 las-b24-link.teliana.net (80.239.128.214)  252.239 ms 255.553 ms palo-b24-link.teliana.net (62.115.119.90)  258.758 ms
18 palo-b1-link.teliana.net (62.115.122.169)  266.523 ms palo-b24-link.teliana.net (62.115.119.90)  260.425 ms *
19 palo-b1-link.teliana.net (62.115.122.169)  263.898 ms hurricane-ic-308019-palo-b1.c.teliana.net (80.239.167.174)  247.968 ms
20 hurricane-ic-308019-palo-b1.c.teliana.net (80.239.167.174)  258.248 ms stanford-university.100gigabitethernet5-1.core1.pao1.he.net (184.105.177.238)  251.692 ms 247.747 ms
21 stanford-university.100gigabitethernet5-1.core1.pao1.he.net (184.105.177.238)  257.793 ms 249.916 ms 247.896 ms
22 CS.stanford.edu (171.64.64.64)  238.758 ms csee-west-rtr-v13.SUNet (171.66.255.140)  240.578 ms CS.stanford.edu (171.64.64.64)  240.463 ms
ubuntu@ip-172-31-40-210:~$
```

```

ubuntu@ip-172-31-40-210:~$ traceroute csail.mit.edu
traceroute to csail.mit.edu (128.30.2.109), 30 hops max, 60 byte packets
 1  ec2-52-66-0-26.ap-south-1.compute.amazonaws.com (52.66.0.26)  2.630 ms  ec2-52-66-0-24.ap-south-1.compute.amazonaws.com (52.66.0.24)  8.243 ms  ec2-52-66-0-38.ap-south-1.compute.amazonaws.com (52.66.0.38)  3.831 ms
 2  * * 100.66.8.52 (100.66.8.52)  4.376 ms
 3  100.66.11.194 (100.66.11.194)  7.082 ms  100.66.11.70 (100.66.11.70)  5.042 ms  100.66.11.196 (100.66.11.196)  8.971 ms
 4  100.66.6.197 (100.66.6.197)  3.300 ms  100.66.6.37 (100.66.6.37)  7.982 ms  100.66.6.69 (100.66.6.69)  6.777 ms
 5  100.66.4.119 (100.66.4.119)  5.384 ms  100.66.4.91 (100.66.4.91)  8.147 ms  100.66.4.175 (100.66.4.175)  2.713 ms
 6  100.65.8.1 (100.65.8.1)  5.847 ms  100.65.11.129 (100.65.11.129)  0.304 ms  100.65.8.65 (100.65.8.65)  0.474 ms
 7  * 52.95.65.130 (52.95.65.130)  1.701 ms *
 8  52.95.67.126 (52.95.67.126)  1.125 ms * 52.95.66.192 (52.95.66.192)  9.715 ms
 9  52.95.65.234 (52.95.65.234)  0.906 ms 52.95.66.179 (52.95.66.179)  1.511 ms 52.95.66.113 (52.95.66.113)  1.529 ms
10  115.114.89.57.static-Mumbai.vsnl.net.in (115.114.89.57)  0.875 ms 115.114.89.121.static-Mumbai.vsnl.net.in (115.114.89.121)  1.728 ms 115.114.89.57.static-Mumbai.vsnl.net.in (115.114.89.57)  0.988 ms
11  * * *
12  ix-ae-0-100.tcore2.mlv-mumbai.as6453.net (180.87.39.25)  1.643 ms ix-ae-0-100.tcore1.mlv-mumbai.as6453.net (180.87.38.5)  1.622 ms 1.682 ms
13  if-ae-2-2.tcore1.mlv-mumbai.as6453.net (180.87.38.1)  192.672 ms 194.074 ms if-ae-5-6.tcore1.wyn-marseille.as6453.net (180.87.38.126)  196.821 ms
14  if-ae-29-8.tcore1.wyn-marseille.as6453.net (80.231.217.110)  199.818 ms if-ae-5-2.tcore1.wyn-marseille.as6453.net (80.231.217.29)  190.075 ms if-ae-5-6.tcore1.wyn-marseille.as6453.net (180.87.38.126)  197.097 ms
15  if-ae-2-2.tcore2.wyn-marseille.as6453.net (80.231.217.2)  196.376 ms if-ae-9-2.tcore2.l78-london.as6453.net (80.231.200.14)  194.827 ms 195.358 ms
16  if-ae-9-2.tcore2.l78-london.as6453.net (80.231.200.14)  194.829 ms 194.773 ms if-ae-8-49.tcore2.nto-newyork.as6453.net (216.6.81.34)  193.696 ms
17  if-ae-8-49.tcore2.nto-newyork.as6453.net (216.6.81.34)  194.971 ms if-ae-4-2.tcore2.n0v-newyork.as6453.net (80.231.131.158)  199.602 ms if-ae-32-2.tcore2.nto-newyork.as6453.net (63.243.216.22)  190.089 ms
18  if-ae-2-2.tcore1.n0v-newyork.as6453.net (216.6.90.21)  192.371 ms 192.953 ms if-ae-12-2.tcore1.n75-newyork.as6453.net (66.110.96.5)  190.093 ms
19  be-10390-cr02.newyork.ny.ibone.comcast.net (68.86.83.89)  193.968 ms 195.123 ms if-ae-12-2.tcore1.n75-newyork.as6453.net (66.110.96.5)  191.037 ms
20  be-10390-cr02.newyork.ny.ibone.comcast.net (68.86.83.89)  195.476 ms 195.851 ms if-ae-9-2.tcore1.n75-newyork.as6453.net (63.243.128.122)  193.218 ms
21  be-10390-cr02.newyork.ny.ibone.comcast.net (68.86.83.89)  197.786 ms 196.744 ms 199.715 ms
22  96.110.42.14 (96.110.42.14)  193.901 ms 194.901 ms be-1402-cs04.newyork.ny.ibone.comcast.net (96.110.38.45)  196.367 ms
23  ae0-0-eg-bstpmall74w.boston.ma.boston.comcast.net (68.86.238.34)  195.329 ms 195.322 ms 195.268 ms
24  ae0-0-eg-bstpmall74w.boston.ma.boston.comcast.net (68.86.238.34)  197.575 ms dmz-rtr-1-external-rtr-3.mit.edu (18.0.161.13)  192.890 ms 192.861 ms
25  dmz-rtr-1-external-rtr-3.mit.edu (18.0.161.13)  192.999 ms dmz-rtr-2-dmz-rtr-1-2.mit.edu (18.0.162.6)  193.065 ms dmz-rtr-1-external-rtr-3.mit.edu (18.0.161.13)  194.924 ms
26  dmz-rtr-2-dmz-rtr-1-2.mit.edu (18.0.162.6)  192.964 ms mitnet.core-1-ext.csail.mit.edu (18.4.7.65)  193.281 ms dmz-rtr-2-dmz-rtr-1-2.mit.edu (18.0.162.6)  195.125 ms
27  mitnet.core-1-ext.csail.mit.edu (18.4.7.65)  193.772 ms 193.231 ms dmz-rtr-2-dmz-rtr-1-2.mit.edu (18.0.162.6)  197.326 ms
28  dmz-rtr-2-dmz-rtr-1-2.mit.edu (18.0.162.6)  197.559 ms bdr.core-1.csail.mit.edu (128.30.0.246)  195.268 ms mitnet.core-1-ext.csail.mit.edu (18.4.7.65)  195.772 ms
29  bdr.core-1.csail.mit.edu (128.30.0.246)  197.059 ms * *
30  bdr.core-1.csail.mit.edu (128.30.0.246)  204.772 ms 204.759 ms 204.745 ms
ubuntu@ip-172-31-40-210:~$

```

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 tracerouting follows a particular path from the user's IP address through the IP addresses of the ISP and then the path really 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?

Yes, because if the distance between the location of the user and that of the destination url is more, then more hops will be required in order to reach the destination as more number of access points will be used for routing and the greater the number of access points involved, the greater are the chances of access points failing to respond and similarly for searching the alternative optimal path towards the destination.

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?

If the latency of the host causes the traceroute request to get timed out even after the conventional three tries, then it keeps on sending the data packets until the host responds or upto a certain maximum hops. It may not hold for each host as it really depends on the time which the host takes to respond. If the host responds in the first request itself, the tracerouting stops with a success message.

WHOIS

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.


```
ubuntu@ip-172-31-40-210:~$ whois google.com
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: 2019-09-09T15:39:04Z
Creation Date: 1997-09-15T04:00:00Z
Registry Expiry Date: 2028-09-14T04:00:00Z
Registrar: MarkMonitor Inc.
Registrar IANA ID: 292
Registrar Abuse Contact Email: abusecomplaints@markmonitor.com
Registrar Abuse Contact Phone: +1.2083895740
Domain Status: clientDeleteProhibited https://icann.org/epp#clientDeleteProhibited
Domain Status: clientTransferProhibited https://icann.org/epp#clientTransferProhibited
Domain Status: clientUpdateProhibited https://icann.org/epp#clientUpdateProhibited
Domain Status: serverDeleteProhibited https://icann.org/epp#serverDeleteProhibited
Domain Status: serverTransferProhibited https://icann.org/epp#serverTransferProhibited
Domain Status: serverUpdateProhibited https://icann.org/epp#serverUpdateProhibited
Name Server: NS1.GOOGLE.COM
Name Server: NS2.GOOGLE.COM
Name Server: NS3.GOOGLE.COM
Name Server: NS4.GOOGLE.COM
DNSSEC: unsigned
URL of the ICANN Whois Inaccuracy Complaint Form: https://www.icann.org/wicf/
>>> Last update of whois database: 2020-08-28T09:49:28Z <<<
```

For more information on Whois status codes, please visit <https://icann.org/epp>

NOTICE: The expiration date displayed in this record is the date the registrar's sponsorship of the domain name registration in the registry is currently set to expire. This date does not necessarily reflect the expiration date of the domain name registrant's agreement with the sponsoring registrar. Users may consult the sponsoring registrar's Whois database to view the registrar's reported date of expiration for this registration.

TERMS OF USE: You are not authorized to access or query our Whois database through the use of electronic processes that are high-volume and automated except as reasonably necessary to register domain names or modify existing registrations; the Data in VeriSign Global Registry Services' ("VeriSign") Whois database is provided by VeriSign for information purposes only, and to assist persons in obtaining information about or related to a domain name registration record. VeriSign does not guarantee its accuracy. By submitting a Whois query, you agree to abide by the following terms of use: You agree that you may use this Data only for lawful purposes and that under no circumstances will you use this Data to: (1) allow, enable, or otherwise support the transmission of mass unsolicited, commercial advertising or solicitations via e-mail, telephone, or facsimile; or (2) enable high volume, automated, electronic processes that apply to VeriSign (or its computer systems). The compilation, repackaging, dissemination or other use of this Data is expressly prohibited without the prior written consent of VeriSign. You agree not to use electronic processes that are automated and high-volume to access or query the Whois database except as reasonably necessary to register domain names or modify existing registrations. VeriSign reserves the right

domain names or modify existing registrations. VeriSign reserves the right to restrict your access to the Whois database in its sole discretion to ensure operational stability. VeriSign may restrict or terminate your access to the Whois database for failure to abide by these terms of use. VeriSign reserves the right to modify these terms at any time.

The Registry database contains ONLY .COM, .NET, .EDU domains and Registrars.

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: ns1.google.com

Name Server: ns3.google.com

Name Server: ns2.google.com

Name Server: ns4.google.com

DNSSEC: unsigned

URL of the ICANN WHOIS Data Problem Reporting System: <http://wdprs.internic.net/>

>>> Last update of WHOIS database: 2020-08-28T02:41:24-0700 <<<

For more information on WHOIS status codes, please visit:

<https://www.icann.org/resources/pages/epp-status-codes>

If you wish to contact this domain's Registrant, Administrative, or Technical contact, and such email address is not visible above, you may do so via our web form, pursuant to ICANN's Temporary Specification. To verify that you are not a robot, please enter your email address to receive a link to a page that facilitates email communication with the relevant contact(s).

Web-based WHOIS:

<https://domains.markmonitor.com/whois>

```
Web-based WHOIS:
https://domains.markmonitor.com/whois

If you have a legitimate interest in viewing the non-public WHOIS details, send
your request and the reasons for your request to whoisrequest@markmonitor.com
and specify the domain name in the subject line. We will review that request and
may ask for supporting documentation and explanation.

The data in MarkMonitor's WHOIS database is provided for information purposes,
and to assist persons in obtaining information about or related to a domain
name's registration record. While MarkMonitor believes the data to be accurate,
the data is provided "as is" with no guarantee or warranties regarding its
accuracy.

By submitting a WHOIS query, you agree that you will use this data only for
lawful purposes and that, under no circumstances will you use this data to:
(1) allow, enable, or otherwise support the transmission by email, telephone,
or facsimile of mass, unsolicited, commercial advertising, or spam; or
(2) enable high volume, automated, or electronic processes that send queries,
data, or email to MarkMonitor (or its systems) or the domain name contacts (or
its systems).

MarkMonitor reserves the right to modify these terms at any time.

By submitting this query, you agree to abide by this policy.

MarkMonitor Domain Management(TM)
Protecting companies and consumers in a digital world.

Visit MarkMonitor at https://www.markmonitor.com
Contact us at +1.8007459229
In Europe, at +44.02032062220
--
ubuntu@ip-172-31-40-210:~$ |
```

The whois command gives information about the domain name, the Registry Domain ID and some other details such as the details of the Registrar and the Registrant. For example, in case of google.com (domain name), the Registrant Organization is Google LLC, the Registrant State/Province is California and the Registrant Country is the United States. It also provides the domain expiry date.

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.

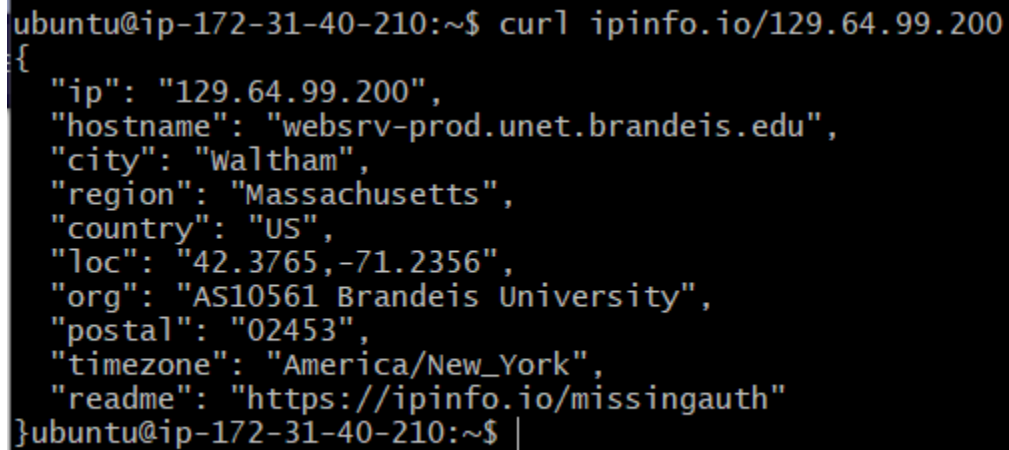
Geolocation — A geolocation service tries to tell, approximately, where a given IP address is located physically. They can't be completely accurate—but they probably get at least the country right most of the time.

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.)

Screenshot:

A screenshot of a terminal window with a black background and white text. The prompt is 'ubuntu@ip-172-31-40-210:~\$'. The command 'curl ipinfo.io/129.64.99.200' has been executed. The output is a JSON object containing various details about the IP address 129.64.99.200, including its hostname, city, region, country, location coordinates, organization, postal code, and timezone. The terminal shows the command being typed and the resulting JSON output.

```
ubuntu@ip-172-31-40-210:~$ curl ipinfo.io/129.64.99.200
{"ip": "129.64.99.200",
  "hostname": "websrv-prod.unet.brandeis.edu",
  "city": "Waltham",
  "region": "Massachusetts",
  "country": "US",
  "loc": "42.3765,-71.2356",
  "org": "AS10561 Brandeis University",
  "postal": "02453",
  "timezone": "America/New_York",
  "readme": "https://ipinfo.io/missingauth"}
ubuntu@ip-172-31-40-210:~$ |
```

Conclusion:

1. Learnt about some basic command line network utilities.
2. Learnt about Network Latency, RTT and the factors impacting RTT.