50.005 Computer System Engineering

NS Lab 1: Internet Routes and Measurement of Round Trip Times

Name: Phang Teng Fone
ID: 1003296

Overview

In this lab exercise, you will learn how to use `ping` and `traceroute` to measure round trip times and find network routes.

Learning objectives

At the end of this lab exercise, you should be able to:

- Understand how the `ping` and `traceroute` utilities work.
- Use the `ping` utility to measure network round trip times.
- Use the `traceroute` utility to find network routes.
- Observe and understand the effects of varying packet sizes on delays experienced.

Preparation

You will need `ping` and `traceroute` to be installed on your Ubuntu virtual machine. Most Ubuntu installations should already include `ping` by default. You can install `traceroute` by running "`sudo apt-get install traceroute`" from the command line.

Part 1: Measurement of round trip times using ping

The `ping` utility is one of the most widely-used network utilities. It enables you to measure the time that it takes for a packet to travel through the Internet to a remote host and back.

The `ping` utility works by sending a short message, known as an echo-request, to a remote host using the Internet Control Message Protocol (ICMP). When a host that supports ICMP receives an echo-request message, it replies by sending an echo-response message back to the originating host.

In the first part of this lab exercise, you will use the `ping` utility to send echo requests to a number of different hosts. In many of the exercises, you will be referring to hosts using their DNS names rather than their IP addresses. For more information about `ping`, you can look up its manual page by running "`man ping`" from the command line.

Round trip times

Use `ping` to send 10 packets to each of the following hosts. Each packet should have a size of 56 bytes, and there should be an interval of 5 seconds between each packet sent.

```
www.csail.mit.edu
www.berkeley.edu www.usyd.edu.au
www.kyoto-u.ac.jp
```

Note: The size of each packet is 56 bytes by default, but you may observe that the actual size of the packet is larger than 56 bytes. You can look up the manual for `ping` to understand why such a discrepancy exists.

Question 1 (10pt): For each host, record the percentage of packets sent that resulted in a successful response. Record also the minimum, average, and maximum round trip times for the packets that resulted in a response.

Website	Successful Percentage %	Min RTT	Average RTT	Max RTT
www.csail.mit.edu	100	4.229	4.548	4.960
www.berkeley.edu	100	195.410	195.992	196.837
www.usyd.edu.au	100	97.336	97.685	97.912
www.kyoto-u.ac.jp	100	76.983	77.159	77.612

Question 2 (10pt): Describe and explain the differences in the minimum round trip time to each of these hosts.

Base on geographical location, Australia server and Japan server are closer to Singapore as compared to Berkeley, United States, therefore the propagation delay will be higher thus resulting in a longer RTT. However, for MIT, United States, the RTT is the lowest among the four although the geolocation is the furthest, this is because geolocation and propagation delay is not the only factor for RTT, there can be IXP such that they can directly connect their network together and allow traffic to pass directly instead of through an upstream intermediaries or the nodes connecting the other endpoint experience more congestion.

Question 3 (10pt): Repeat the exercise using packet sizes of 56, 512 and 1024 bytes. Record the minimum, average, and maximum round trip times for each of the packet sizes. Why are the minimum round-trip times to the same hosts different when using 56, 512, and 1024–byte packets?

Website	Data byte packets	Successful Percentage %	Min RTT	Average RTT	Max RTT
www.csail.mit.edu	**56**	100	4.426	4.620	5.132
	512	100	4.499	4.752	5.101
	1024	100	4.461	4.766	4.980
www.berkeley.edu	**56**	100	210.123	210.419	211.907
	512	100	210.252	210.375	210.558
	1024	100	195.950	196.184	196.829

www.usyd.edu.au	**56**	100	97.572	97.845	98.960
	512	100	97.770	98.024	98.882
	1024	100	97.859	98.049	98.280
www.kyoto-u.ac.jp	**56**	100	77.130	77.403	78.384
	512	100	77.207	77.461	77.707
	1024	100	77.283	77.417	77.627

The minimum RTT time to the same host is different when using different packet sizes as there are transmission delay. The formula for transmission delay is given by the packet length (bits) divided by the link bandwidth (bits/s). As the size of each packet is different, a larger bit packet gives a longer time as compared to a smaller bit packet.

Unanswered pings

Use ping to send 100 packets to the following host. Each packet should have a size of 56 bytes, and there should be an interval of 5 seconds between each packet sent.

`www.wits.ac.za`

Question 4 (10pt): Record the percentage of the packets sent that resulted in a successful response. What are some possible reasons why you may not have received a response? (Be sure to check the host in a web browser.)

Percentage of packets successful response: 0%

```
tengfone@DesktopL:~$ ping -c 100 -s 56 -i 5 www.wits.ac.za
PING ccms.wits.ac.za (146.141.13.50) 56(84) bytes of data.

--- ccms.wits.ac.za ping statistics ---
100 packets transmitted, 0 received, 100% packet loss, time 495070ms
```

- wits.ac.za blocks ICMP protocol thus disallowing ping.
- The ping packet does not go with the same route as the TCP (browser) packet, during the routing of the ping packet, one of the server’s might disallow ICMP protocol, thus there is no return of the packet causing it to have a 100% packet loss.

Part 2: Understanding Internet routes using traceroute

The `traceroute` utility is another useful network utility. It enables you to trace the route taken by a packet from your machine to a remote host.

Here is an example of the output produced when `traceroute` is used to trace the route taken by a packet to `www.mit.edu`.

```
traceroute to www.mit.edu (118.215.81.86), 30 hops max, 60 byte packets
1   192.168.9.2 (192.168.9.2)  0.221 ms  0.193 ms  0.107 ms
2   10.12.0.1 (10.12.0.1)  3.363 ms  2.555 ms  3.253 ms
3   172.16.1.106 (172.16.1.106)  3.072 ms  3.416 ms  3.418 ms
4   172.16.1.210 (172.16.1.210)  4.977 ms  4.712 ms  4.921 ms
5   192.168.22.27 (192.168.22.27)  4.806 ms  6.521 ms  6.451 ms
6   103.24.77.1 (103.24.77.1)  7.172 ms  3.590 ms  3.187 ms
7   201.210-193-8.qala.com.sg (210.193.8.201)  4.312 ms  9.056 ms  7.870
    ms
8   137.203-211-158.unknown.qala.com.sg (203.211.158.137) 8.904 ms
    6.690 ms  6.555 ms
9   213.203-211-158.unknown.qala.com.sg (203.211.158.213) 7.710 ms
5.423 ms  5.193 ms
10  203.116.10.125 (203.116.10.125)  6.783 ms  6.705 ms  6.440 ms
```

Each line in the output begins with a host on the route from your computer to `www.mit.edu`, followed by the round-trip times for 3 packets sent to that host. For more information about `traceroute`, you can look up its manual page by running "`man traceroute`" from the command line.

Basics

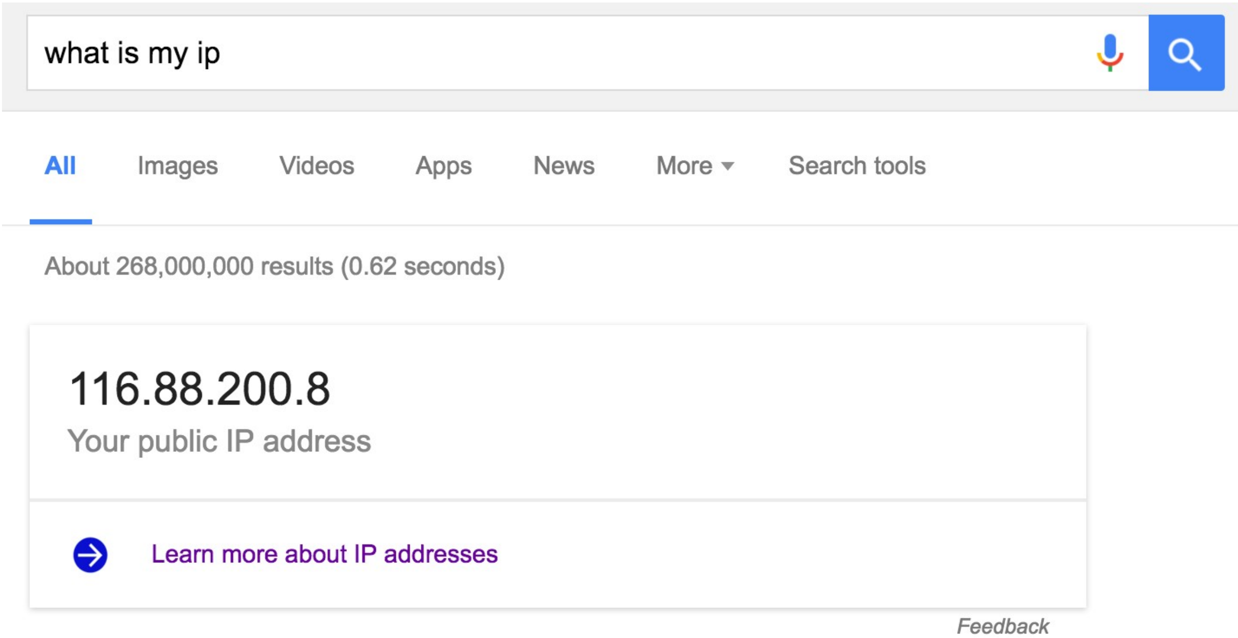
Question 5 (10pt): Explain how `traceroute` discovers a path to a remote host. (Hint: The `traceroute` manual will be helpful for answering this question.)

Traceroute tracks the route packets taken from an IP network on their way to a given host. It utilizes the IP protocol's time to live (TTL) field and attempts to elicit and ICMP_TIME_EXCEEDED response from each gateway along the path to the host.
It will trace the route an IP packet would follow to some internet host by launching probe packets with a small TTL then listening for an ICMP "time exceeded" reply from the gateway. It will start with a TTL of one then slowly increase till there is a ICMP "port unreachable" which means the "host" is reached or hit a maximum of 30 hops. Three probes by default are being sent at each TTL settings and a line is printed showing the TTL, address of the gateway and round-trip time of each probe. The address of each responding system will be printed if the probe answers come from different gateways, else if there is not response within a timeout, an asterisk is being printed for that probe.

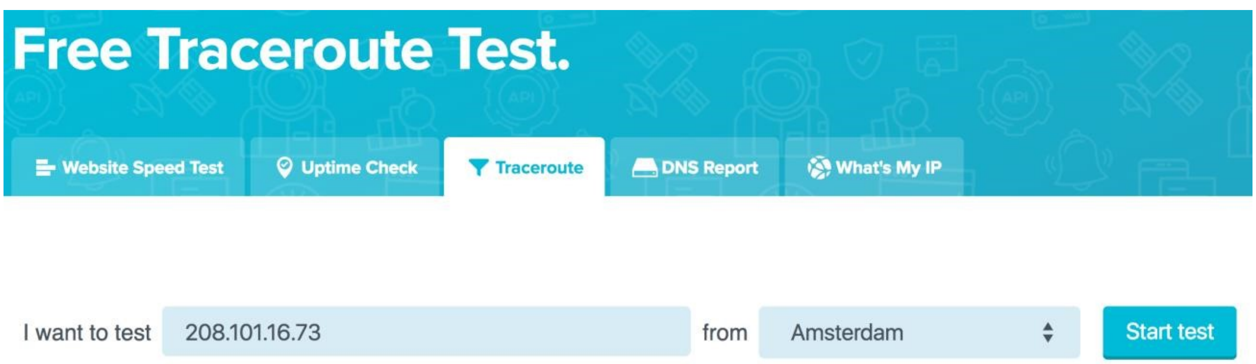
Route asymmetries

In this exercise, you will run `traceroute` in two opposite directions. First, you will run `traceroute` on a remote host to see the route taken to your network. You will also run `traceroute` from your computer to see the route taken to that host.

Step 1: Find out your computer's public IP address. (Hint: You can use a website like http://www.whatismypublicip.com/, or search for "what is my ip" using Google's search engine.)



Step 2: Visit https://www.uptrends.com/tools/traceroute in your web browser. Enter your computer's public IP address, select the "from Location" and click "Start Test" to start a `traceroute` to your computer. Follow the steps shown below for at least three locations namely: New York, Amsterdam, Tokyo.



Step 3: After `traceroute` finishes running, you should be able to view the route taken from `specified location` to your network. Record the IP address of the first hop, which will be used in the next step.

I want to test 200.23.1.54 from New York Start test

Step	Time	Time	Time	Host name	IP address
1	1	<1	<1	72-9-99-137-cust-gw.reverse.ezzi.net	72.9.99.137
2	2	1	2	ads-psc-cr01.ezzi.net	96.45.77.1
3	1	<1	<1	ads-psc-ir01-v261.ezzi.net	72.9.111.109
4	2	1	1	ads-85t-ir01.ezzi.net	72.9.111.213
5	2	1	1	nyk-b5-link.telia.net	213.248.104.110
6	2	2	1	nyk-bb4-link.telia.net	213.155.130.244
7	89	89	89	las-b22-link.telia.net	62.115.114.84
8	251	252	251	starhub-ic-320091-las-b3.c.telia.net	62.115.151.187
9	237	237	237		203.118.15.233
10	246	246	246	r41.starhub.net.sg	203.118.12.18
11	238	238	237		203.116.245.178
12	-	-	-		
13	261	260	260		202.94.70.51

Step 4: On your computer, run `traceroute` using the IP address recorded in the previous step as the remote destination.

```
$ traceroute <ip address from step 3>
```

Question 6 (10pt): Record the output of `traceroute` when run in both directions above.

Step	Time	Time	Time	Host name	IP address
1	1	<1	<1	72-9-99-137-cust-gw.reverse.ezzi.net	72.9.99.137
2	5	2	2	ads-psc-cr01.ezzi.net	96.45.77.1
3	2	<1	<1	ads-psc-ir01-v261.ezzi.net	72.9.111.109
4	1	1	1	ads-psc-ir02-vl32-te2-2.ezzi.net	72.9.111.186
5	2	1	1		38.32.124.49
6	2	2	1	te0-3-1-12.rcr51.ewr06.atlas.cogentco.com	154.24.13.241
7	3	2	2	be3791.rcr21.ewr02.atlas.cogentco.com	154.24.61.177
8	3	3	3	be2236.ccr41.jfk02.atlas.cogentco.com	154.54.45.5
9	3	3	3	be3495.ccr31.jfk10.atlas.cogentco.com	66.28.4.182
10	3	3	3	ae-13.r01.nycmny17.us.bb.gin.ntt.net	129.250.8.145
11	-	-	-		
12	-	-	-		
13	64	63	63	ae-0.r23.sttlwa01.us.bb.gin.ntt.net	129.250.6.30
14	165	165	166	ae-16.r24.osakjp02.jp.bb.gin.ntt.net	129.250.3.61
15	167	175	168	ae-0.r25.osakjp02.jp.bb.gin.ntt.net	129.250.2.151
16	-	-	-		
17	231	226	226	ae-1.r01.sngpsi07.sg.bb.gin.ntt.net	129.250.3.100
18	226	225	230		116.51.18.138
19	234	225	226		203.118.7.74
20	228	226	226		183.90.44.174
21	226	226	226		183.90.44.130

```
[tengfone@TengFones-MBP ~ % traceroute 96.45.77.1
traceroute to 96.45.77.1 (96.45.77.1), 64 hops max, 52 byte packets
 1  router.asus.com (192.168.2.1)  46.862 ms  1.863 ms  31.135 ms
 2  router.asus.com (192.168.1.1)  2.422 ms  1.569 ms  2.576 ms
 3  182.55.229.3 (182.55.229.3)  6.613 ms  5.307 ms  9.024 ms
 4  183.90.44.129 (183.90.44.129)  12.282 ms  19.825 ms
    183.90.44.133 (183.90.44.133)  12.502 ms
 5  183.90.44.177 (183.90.44.177)  56.319 ms  32.342 ms  69.401 ms
 6  203.118.7.73 (203.118.7.73)  9.279 ms
    203.118.7.77 (203.118.7.77)  8.728 ms
    203.118.7.73 (203.118.7.73)  7.944 ms
 7  203.118.7.86 (203.118.7.86)  7.482 ms  8.582 ms  28.234 ms
 8  snge-b2-link.telia.net (62.115.167.48)  12.511 ms  10.403 ms  6.828 ms
 9  snge-b1-link.telia.net (62.115.135.204)  40.617 ms  7.669 ms  9.012 ms
10  sjo-b21-link.telia.net (62.115.114.40)  181.112 ms  171.463 ms  170.140 ms
11  * nyk-bb2-link.telia.net (62.115.119.228)  338.167 ms  308.162 ms
12  nyk-b5-link.telia.net (62.115.115.1)  409.473 ms
    nyk-b5-link.telia.net (80.91.254.14)  313.070 ms
    nyk-b5-link.telia.net (62.115.115.1)  308.317 ms
13  coretech-ic-322321-nyk-b5.c.telia.net (213.248.104.111)  460.338 ms  350.694 ms  306.513 ms
14  ads-psc-ir01-ge4-40.ezzi.net (72.9.111.214)  304.705 ms  236.260 ms  279.483 ms
15  ads-psc-cr01.ezzi.net (72.9.111.110)  406.634 ms  233.642 ms *
tengfone@TengFones-MBP ~ %
```

Question 7 (10pt): Describe anything unusual you might observe about the output. Are the same routers traversed in both directions? If no, why might this be the case?

The network ID is the same, but the Host ID is different. Different routers traversed in both directions. This is because the internet is a shared resource, packet switching is a way to share resources between end hosts, thus each router will change each time when it is non congested.