Internet Routes and Measure of Round Trip Times

Lab 4

50.005 Computer System Engineering

Due: 01 Apr 08:30 AM (Week 10)

Natalie Agus
INFORMATION SYSTEMS TECHNOLOGY AND DESIGN

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 OS. Most **Ubuntu** / **MacOS** installations should already include `ping` by default. You can install `traceroute` by running "`sudo apt-get install traceroute`" from the command line.

Submission

- **The total points for this lab is 35**
- Export this handout and fill in your answers in the blanks denoted in **blue**
- Export as pdf and **ZIP** it (not rar, or any other compression algorithm)
- **Upload** to `@csesubmitbot` telegram bot using the command `/submitlab4`
- **CHECK** your submission by using the command `/checksubmission`

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 [4pt] : 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.

Your answer:

Website	Successful Percentage %	Min RTT	Average RTT	Max RTT
www.csail.mit.edu	100	3.782	5.602	6.707
www.berkeley.edu	100	202.246	325.784	507.912
www.usyd.edu.au	100	95.444	97.985	101.954
www.kyoto-u.ac.jp	100	71.309	74.654	88.235

Question 2 [4pt]: Describe and explain the differences in the minimum round trip time to each of these hosts.

Your answer:

Due to servers in different geographical locations resulting in longer link length resulting in higher propagation delay and thus a longer min RTT.

For example, Berkeley is further away from Singapore as compared to Japan. Henceforth, the link length d for Berkeley is higher so min RTT Is higher. (Although MIT has the lowest min RTT and is far from Singapore, it might have a CDN near Singapore.)

Question 3 [4pt]: 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?

Your answer:

Min RTT increases with packet size because larger packets are being sent back and forth.

Website	Packet Size	Successful Percentage %	Min RTT	Average RTT	Max RTT
www.csail.mit.edu	56	100	4.109	5.785	7.905
	512	100	5.855	7.746	14.401
	1024	100	4.856	10.920	45.159
www.berkeley.edu	56	100	189.053	327.772	550.776
	512	100	188.223	273.077	473.995
	1024	100	190.163	269.474	425.789
www.usyd.edu.au	56	100	95.506	96.959	98.160
	512	100	95.681	101.444	136.702
	1024	100	96.069	97.195	102.202
www.kyoto-u.ac.jp	56	100	71.589	72.749	73.983
	512	100	72.411	76.107	99.180
	1024	100	73.012	73.968	75.612

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 [8pt]: Record the **percentage** of the packets sent that resulted in a **successful response** for each host. What are some possible **reasons** why you may not have received a response? (Be sure to check the host in a web browser).

Your answer:

0% of the packets sent resulted in a successful response.

The end host might have blocked all the ICMP packets due to security reasons.

Or perhaps the network traffic is congested.

```
pprmountain@pprmountain-Lenovo-ideapad-520S-14IKB:~$ ping -c 100 -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 507003ms
```

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 pack-
ets

 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 com- mand line.

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

Your answer:

From my pc (the sender) to the destination, there are routers in between before the packet I sent reaches the end host. The routers are called hops.

Traceroute sends 3 packets to router i (router reached after i hops) on the path towards the end host. Router i will send back a response. The Round Trip TIme from when the packet is sent to the router to the time when the router sends back a response is recorded. Then "i" is incremented.

Route asymmetries

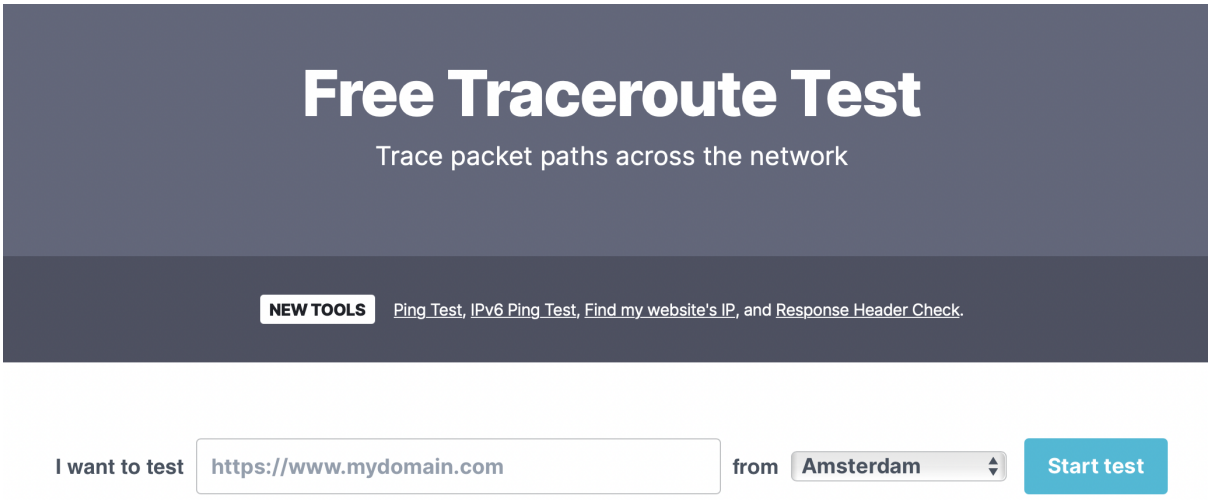
Notes:

- Check whether when you send packets back and forth, path same?
- You don't necessarily take the same way, depending on the traffic

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.)
IP: 138.75.111.89

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.

Hop	Time	Time	Time	Host name	IP address
1	<1	<1	<1	gateway.as64425.com	5.182.210.1
2	-	-	-		
3	1	1	1		212.119.24.97
4	2	1	1	ae-10.r25.amstnl02.nl.bb.gin.ntt.net	129.250.2.90
5	12	12	12	ae-6.r20.parsfr04.fr.bb.gin.ntt.net	129.250.4.138
6	14	15	17	ae-2.r21.parsfr04.fr.bb.gin.ntt.net	129.250.3.46
7	90	87	86	ae-13.r24.asbnva02.us.bb.gin.ntt.net	129.250.6.6
8	149	149	149	ae-2.r24.snjsca04.us.bb.gin.ntt.net	129.250.6.237
9	-	-	-		
10	149	149	149	ae-2.r00.mlpsca01.us.bb.gin.ntt.net	129.250.4.101
11	148	148	148		129.250.24.196
12	155	155	155		129.250.130.254
13	148	148	148		198.107.143.162
14	-	-	-		

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 [5pt]: Record the output of `traceroute` when run in both directions above. **Paste it as screenshots at the end of this document.**

Question 7 [5pt]: 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?

Your answer:

Different routers(hops) are traversed in both directions.

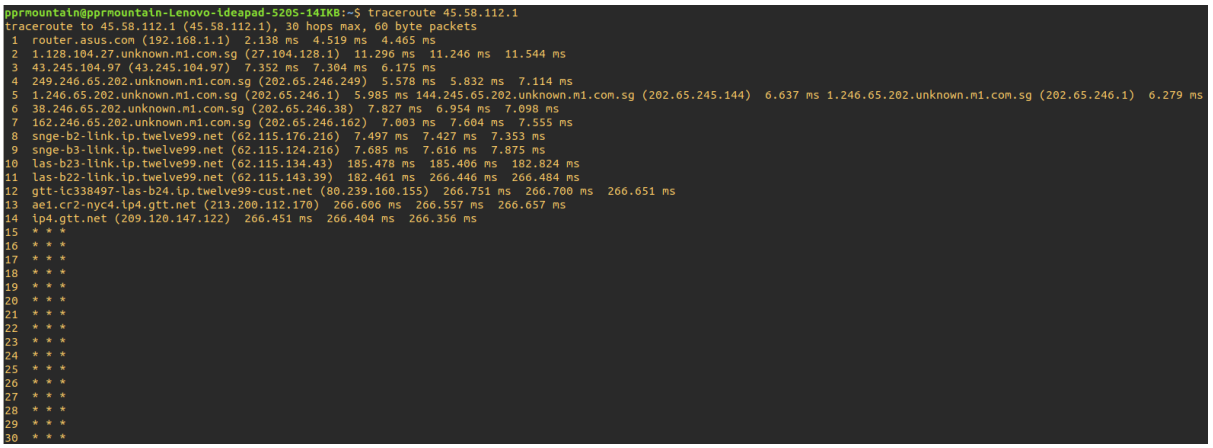
I am unable to reach all 3 routers after 30 hops for all 3.

The internet is vast so there are too many routers, hence the hops taken from local host to end host, and from end host back to local are different (different paths).

Question 6 [5pt]: Record the output of `traceroute` when run in both directions above. **Paste it as screenshots at the end of this document.**

New York

Hop	Time	Time	Time	Host name	IP address
1	2	<1	<1		45.58.112.1
2	<1	<1	<1		38.122.245.121
3	2	1	1		154.24.54.153
4	2	1	2		154.24.56.153
5	2	2	2		154.54.83.165
6	8	8	8		154.54.40.110
7	19	19	19		154.54.24.222
8	33	33	33		154.54.28.130
9	48	49	49		154.54.30.162
10	57	57	57		154.54.42.77
11	69	68	68		154.54.45.162
12	68	68	68		154.54.25.150
13	68	68	69		38.122.147.146
14	243	243	250		202.65.246.14
15	244	244	244		202.65.246.222
16	243	243	245		202.65.246.186
17	245	244	244		27.104.128.1



Amsterdam

Hop	Time	Time	Time	Host name	IP address
1	<1	<1	<1		5.182.210.1
2	*	*	*	Request timed out	
3	*	*	*	Request timed out	
4	16	15	15		202.84.178.53
5	202	200	200		202.84.140.141
6	203	202	203		202.84.140.141
7	222	200	201		202.84.224.197
8	174	174	173		61.14.145.194
9	173	172	172		202.65.246.222
10	175	174	174		202.65.246.186
11	175	174	174		27.104.128.1

```
pprmountain@pprmountain-Lenovo-ideapad-520S-14IKB:~$ traceroute 5.182.210.1
traceroute to 5.182.210.1 (5.182.210.1), 30 hops max, 60 byte packets
 1  router.asus.com (192.168.1.1)  3.710 ms  3.588 ms  3.534 ms
 2  1.128.104.27.unknown.m1.com.sg (27.104.128.1)  5.623 ms  5.843 ms  6.272 ms
 3  43.245.104.97 (43.245.104.97)  6.583 ms  7.744 ms  7.695 ms
 4  181.246.65.202.unknown.m1.com.sg (202.65.246.181)  9.511 ms  8.551 ms  8.503 ms
 5  38.246.65.202.unknown.m1.com.sg (202.65.246.38)  8.455 ms  11.128 ms  8.357 ms
 6  162.246.65.202.unknown.m1.com.sg (202.65.246.162)  8.307 ms  4.050 ms  4.264 ms
 7  * * *
 8  100ge11-1.core1.mrs1.he.net (184.105.65.14)  141.301 ms  141.245 ms  142.228 ms
 9  100ge5-2.core1.par2.he.net (184.105.81.29)  224.236 ms  224.194 ms  222.053 ms
10  100ge10-1.core1.ams1.he.net (184.105.81.110)  229.488 ms  229.447 ms  226.822 ms
11  * * *
12  * * *
13  * * *
14  * * *
15  * * *
16  * * *
17  * * *
18  * * *
19  * * *
20  * * *
21  * * *
22  * * *
23  * * *
24  * * *
25  * * *
26  * * *
27  * * *
28  * * *
29  * * *
30  * * *
```

Tokyo

Hop	Time	Time	Time	Host name	IP address
1	<1	1	1		31.204.145.130
2	<1	<1	<1		109.200.218.1
3	81	111	81		109.200.218.223
4	81	111	79		103.231.152.128
5	81	111	80		202.65.246.222
6	81	111	80		202.65.246.186
7	81	111	80		27.104.128.1

```
pprmountain@pprmountain-Lenovo-ideapad-520S-14IKB:~$ traceroute 31.204.145.130
traceroute to 31.204.145.130 (31.204.145.130), 30 hops max, 60 byte packets
 1  router.asus.com (192.168.1.1)  1.514 ms  1.396 ms  3.027 ms
 2  1.128.104.27.unknown.m1.com.sg (27.104.128.1)  7.472 ms  8.347 ms  8.271 ms
 3  43.245.104.97 (43.245.104.97)  11.570 ms  11.797 ms  11.949 ms
 4  249.246.65.202.unknown.m1.com.sg (202.65.246.249)  4.518 ms  5.084 ms  5.015 ms
 5  1.246.65.202.unknown.m1.com.sg (202.65.246.1)  4.965 ms 144.245.65.202.unknown.m1.com.sg (202.65.245.144)  5.095 ms  5.024 ms
 6  38.246.65.202.unknown.m1.com.sg (202.65.246.38)  8.225 ms  5.488 ms  5.349 ms
 7  162.246.65.202.unknown.m1.com.sg (202.65.246.162)  4.381 ms  5.069 ms  5.257 ms
 8  ix-xe-2-1-2-602.tcore1.svw-singapore.as6453.net (180.87.12.145)  4.087 ms  4.291 ms  4.220 ms
 9  if-ae-2-2.tcore2.svw-singapore.as6453.net (180.87.12.2)  87.425 ms  87.347 ms if-ae-36-2.tcore1.tv2-tokyo.as6453.net (120.29.217.12)  78.047 ms
10  if-ae-44-2.tcore2.tv2-tokyo.as6453.net (180.87.181.191)  87.034 ms if-ae-2-2.tcore2.tv2-tokyo.as6453.net (180.87.180.2)  78.117 ms  80.831 ms
11  180.87.181.147 (180.87.181.147)  71.826 ms  79.365 ms  79.612 ms
12  * * *
13  * * *
14  * * *
15  * * *
16  * * *
17  * * *
18  * * *
19  * * *
20  * * *
21  * * *
22  * * *
23  * * *
24  * * *
25  * * *
26  * * *
27  * * *
28  * * *
29  * * *
30  * * *
```