50.005 Computer System Engineering

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

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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				
www.berkeley.edu				
www.usyd.edu.au				
www.kyoto-u.ac.jp				

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

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**				
	512				
	1024				
www.berkeley.edu	**56**				
	512				
	1024				
www.usyd.edu.au	**56**				
	512				
	1024				
www.kyoto-u.ac.jp	**56**				
	512				
	1024				

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.)

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 command line.

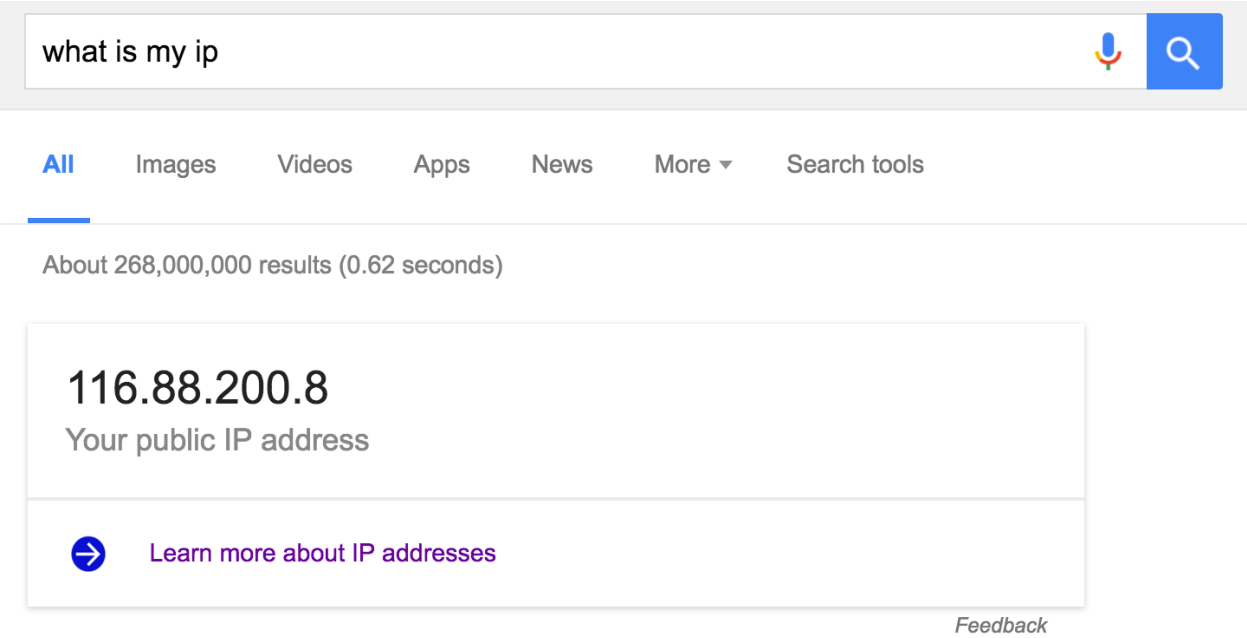
Basics

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

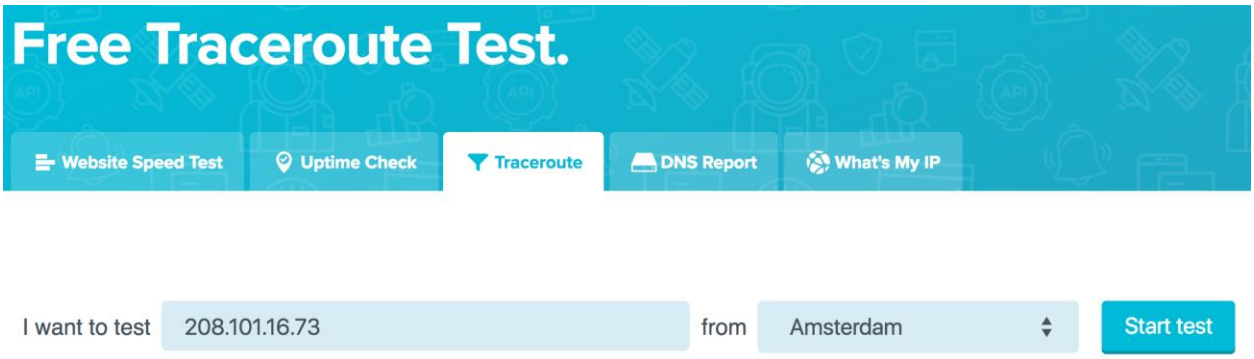
Route asymmetries

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.

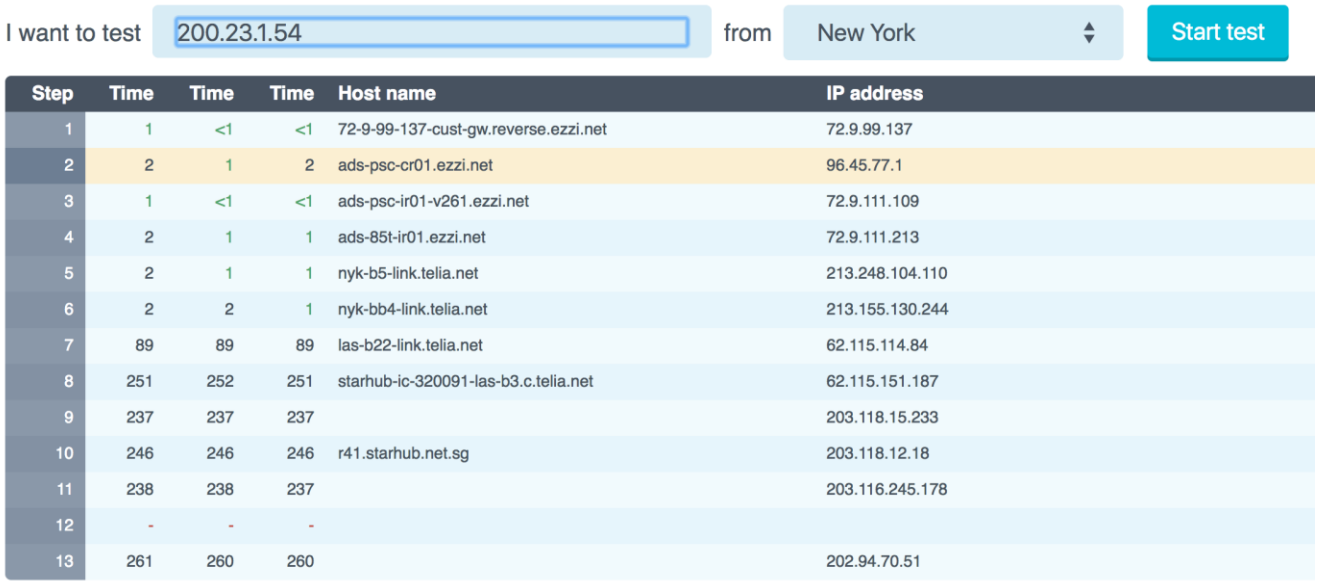
Step 1: Find out your computer's public IP address. (*Hint:* You can use a website like http://www.whatismypublicip.com/, or search for "*what is my ip*" using Google's search engine.)



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.



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.

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?