



SINGAPORE UNIVERSITY OF  
TECHNOLOGY AND DESIGN

Established in collaboration with MIT

50.005 Computer System Engineering

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

**Name:**

**ID:**

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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.

## **Deliverables**

Complete the activities and answer the questions in the handout. Submit a report containing your name, student ID and answers to eDimension before **Tuesday 29 March 2016, 11:59pm** latest. Late submissions will be dealt with according to the course policy.

## 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 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.

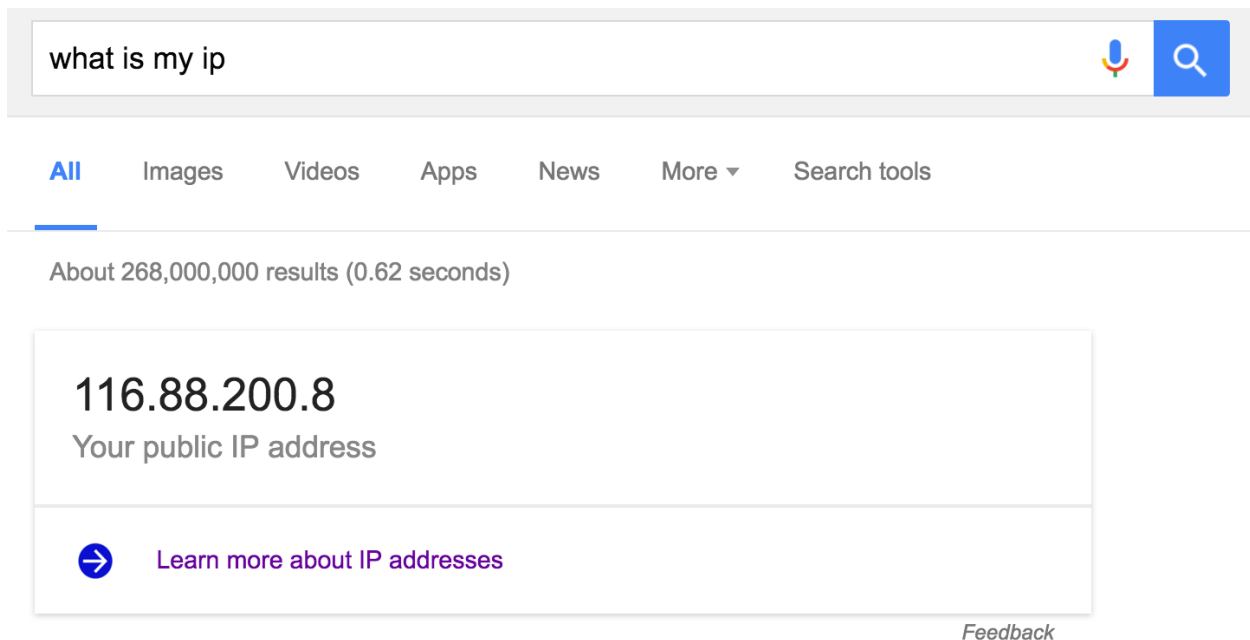
## Basics

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

## Route asymmetries

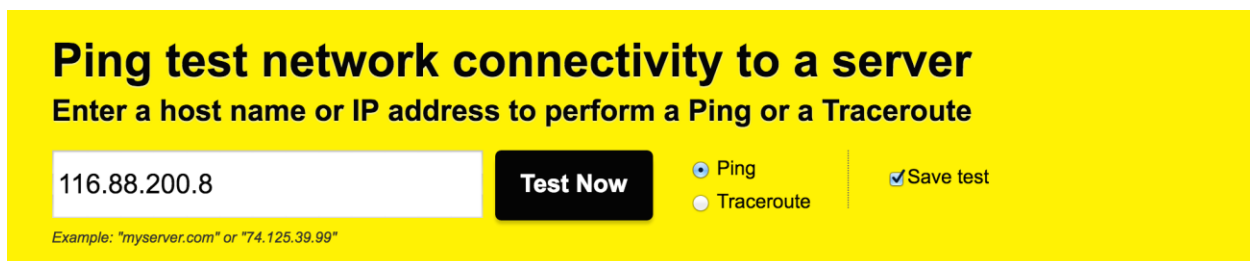
In this exercise, you will run `tracert` in two opposite directions. First, you will run `tracert` on a remote host to see the route taken to your network. You will also run `tracert` from your computer to see the route taken to that host.

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



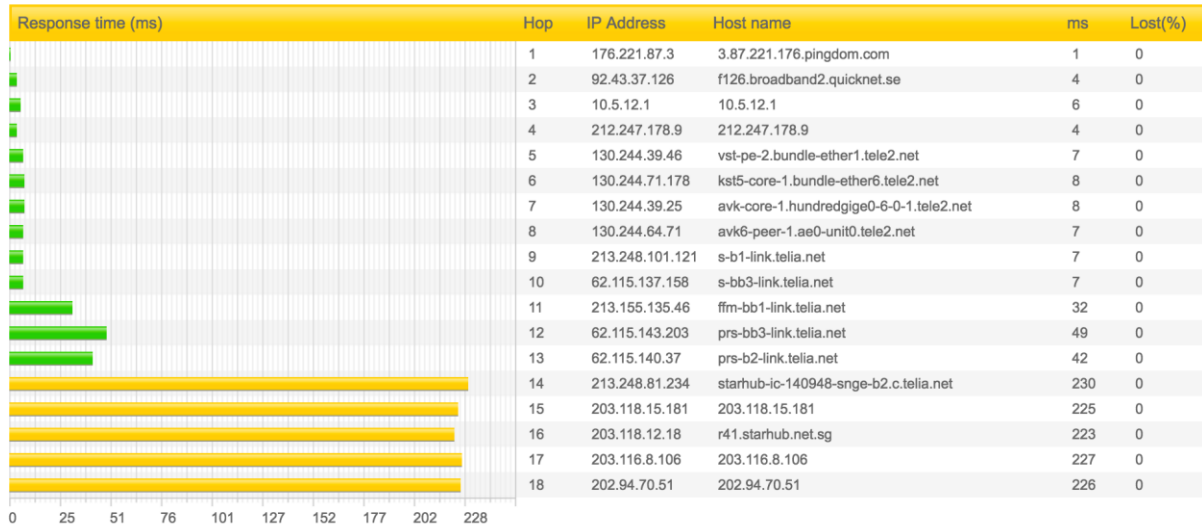
A screenshot of a Google search interface. The search bar contains the text "what is my ip". Below the search bar, there are tabs for "All", "Images", "Videos", "Apps", "News", "More", and "Search tools". The "All" tab is selected. Below the tabs, it says "About 268,000,000 results (0.62 seconds)". The main result shows the IP address "116.88.200.8" in large text, followed by "Your public IP address" in smaller text. Below this, there is a link with a right arrow icon and the text "Learn more about IP addresses". At the bottom right of the result box, there is a "Feedback" link.

**Step 2:** Visit <http://tools.pingdom.com/ping/> in your web browser. Enter your computer's public IP address, select the “Traceroute” option and click “Test Now” to start a `tracert` to your computer.



A screenshot of the Pingdom website. The main heading is "Ping test network connectivity to a server". Below it, the text says "Enter a host name or IP address to perform a Ping or a Traceroute". There is a text input field containing "116.88.200.8". To the right of the input field is a black button labeled "Test Now". Further right, there are two radio buttons: "Ping" (selected) and "Traceroute". To the right of these is a checkbox labeled "Save test" which is checked. At the bottom left, there is a small text example: "Example: 'myserver.com' or '74.125.39.99'".

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



**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?

## Blackholes

Run `traceroute` with `18.31.0.200` set as the remote host.

```
$ traceroute 18.31.0.200
```

**Question 8 (10pt):** Record the output of the above command. Describe what is strange about the observed output, and why `traceroute` gives you such an output. (*Hint: The `traceroute` manual will be helpful for answering this question.*)