

Lab Exercise 1: Tools of the Trade

[Specification](#)[Make Submission](#)[Check Submission](#)[Collect Submission](#)

There are 6 labs during this course. For each student, the 5 best performing labs will contribute to your final lab mark.

Objectives:

- Get familiar with the basic networking tools: ping, traceroute, ifconfig, netstat, nslookup
- Gain insights into evaluating network performance and understanding network topology

Prerequisites:

- Week 1 Lectures
- Relevant Parts of Chapter 1 of the textbook
- Introduction to Tools of the Trade (<https://webcms3.cse.unsw.edu.au/COMP3331/20T3/resources/51942>)
- runping.sh (<https://webcms3.cse.unsw.edu.au/COMP3331/20T3/resources/52062>)
- plot.sh (<https://webcms3.cse.unsw.edu.au/COMP3331/20T3/resources/52086>)
- Basic understanding of Linux. A good resource is (<http://www.ee.surrey.ac.uk/Teaching/Unix/>) here (<http://www.ee.surrey.ac.uk/Teaching/Unix/>) but there are several other resources available online

Marks: 10 marks

- This lab comprises of a number of exercises. Please note that not all the exercises for this lab are marked. However, you have to submit a report containing answers for all of the lab exercises.
- Please attend only in your allocated lab slot.
- We expect the students to go through as much of the lab exercises as they can at home and come to the lab for clarifying any doubts in procedure/specifications.

Deadline:

11:00 am Tuesday 29/09/2020. You can submit as many times as you wish before the deadline. A later submission will override the earlier submission, so make sure you submit the correct file. Do not leave until the last moment to submit, as there may be technical or communications error and you will not have time to rectify it.

Note: For all your lab exercises you are asked to put a screenshot of your outputs (e.g., graphs, traceroute, dig comments) in your report.

Late Penalty:

The late penalty will be applied as follows:

- 1 day after deadline: 20% reduction
- 2 days after deadline: 40% reduction
- 3 or more days late: NOT accepted

Note that the above penalty is applied to your final mark. For example, if you submit your lab work 2 days late and your score on the lab is 8, then your final mark will be $8 - 3.2$ (40% penalty) = 4.8.

Submission Instructions:

Prepare a PDF document **Lab1.pdf** with answers to all questions for all exercises. To include other supporting documents, create a tar archive of all the files called **Lab1.tar**. Submit the archive using give or WebCMS3 interface. You can submit from a lab machine or ssh into the CSE login server. Instructions to ssh into CSE login servers are here (https://taggi.cse.unsw.edu.au/FAQ/Logging_In_With_SSH/) .

1. Put all your files (e.g., Lab1.pdf, output.txt) in a directory lab1.
 2. Type "tar -cvf Lab1.tar lab1"
 3. When you are ready to submit, at the bash prompt type 3331
 4. Next, type: give cs3331 Lab1 Lab1.tar
- Please make sure that the tar archive is not corrupted. You can untar (use tar -xvf Lab1.tar) the created archive to check that all the files are intact.
 - Max file size for submission is **3MB** .
 - COMP9331 students should also use 'give cs3331'

Original Work Only:

You are strongly encouraged to discuss the questions with other students in your lab. However, each student must submit his or her own work. You may need to refer to the material indicated above (particularly Tools of the Trade document) and also conduct your own research to answer the questions.

OS Compatibility:

Please note that the instructions provided herein assume that you are running the exercises on a Linux machine (similar to the CSE lab machines). These commands (and the scripts provided) may not work as prescribed on other OSes (Windows, OS X, etc.). We strongly recommend that you run these experiments on CSE machines. If you are running from off-campus, you can use VNC to connect to VLAD. (<https://taggi.cse.unsw.edu.au/Vlab/>) We will be unable to help you diagnose any issues that may arise with OSes other than Linux.

Exercise 1: nslookup

Use the nslookup command from the "Tools of the Trade" and answer the following questions:

1. Which is the IP address of the website www.koala.com.au? In your opinion, what is the reason of having several IP addresses as an output?
2. Find out the name of the IP address 127.0.0.1. What is special about this IP address?

Exercise 2: Use ping to test host reachability

Are the following hosts reachable from your machine by using ping:

- www.unsw.edu.au (<http://www.unsw.edu.au>)
- (<http://www.cse.unsw.edu.au>) www.getfittest.com.au (<http://www.getfittest.com.au>)
- www.mit.edu (<http://www.mit.edu>)

- www.intel.com.au (<http://www.intel.com.au>)
- (<http://www.intel.com.au>) www.tpg.com.au (<http://www.tpg.com.au>)
- (<http://www.telstra.com.au>) www.hola.hp (<http://www.hola.hp>)
- (<http://www.hola.hp>) www.amazon.com (<http://www.amazon.com>)
- (<http://www.wikileaks.org>) www.tsinghua.edu.cn (<http://www.tsinghua.edu.cn>)
- (<http://www.tsinghua.edu.cn>) www.kremlin.ru (<http://www.kremlin.ru>)
- 8.8.8.8

If you observe that some hosts are not reachable, then can you explain why? Check if the addresses unreachable by the ping command are reachable from the Web browser.

Exercise 3: Use traceroute to understand network topology

Note: Include all traceroute outputs in your report.

1. Run traceroute on your machine to www.columbia.edu (<http://www.columbia.edu>) . How many routers are there between your workstation and www.columbia.edu (<http://www.columbia.edu>) ? How many routers along the path are part of the UNSW network? Between which two routers do packets cross the Pacific Ocean? Hint: compare the round trip times from your machine to the routers using ping.
2. Run traceroute from your machine to the following destinations: (i) www.ucla.edu (<http://www.ucla.edu>) (ii) www.u-tokyo.ac.jp (<http://www.u-tokyo.ac.jp>) and (iii) www.lancaster.ac.uk (<http://www.lancaster.ac.uk>) . At which router do the paths from your machine to these three destinations diverge? Find out further details about this router. (HINT: You can find out more about a router by running the Whois command: Whois router-IP-address). Is the number of hops on each path proportional the physical distance? HINT: You can find out the geographical location of a server using the following tool - <http://www.yougetsignal.com/tools/network-location/> (<http://www.yougetsignal.com/tools/network-location/>)
3. Several servers distributed around the world provide a web interface from which you can perform a traceroute to any other host in the Internet. Here are two examples: (i) <http://www.speedtest.com.sg/tr.php> (<http://www.speedtest.com.sg/tr.php>) and (ii) <https://www.telstra.net/cgi-bin/trace> (<https://www.telstra.net/cgi-bin/trace>) . Run traceroute from both these servers towards your machine and in the reverse direction (i.e. From your machine to these servers). You may also try other traceroute servers from the list at www.traceroute.org (<http://www.traceroute.org>) . What are the IP addresses of the two servers that you have chosen. Does the reverse path go through the same routers as the forward path? If you observe common routers between the forward and the reverse path, do you also observe the same IP addresses? Why or why not?

Exercise 4: Use ping to gain insights into network performance

Note: Include all graphs in your report. You need to run the scripts (runping.sh and plot.sh) when you are physically using a lab machine or connected to a CSE server/lab machine using VLAB / VNC client. You need to ensure gnuplot and ps2pdf are available on your system if you are planning to do this exercise on your own machine.

We now use the ping utility to investigate network delay and its implications on network performance. In particular, we will analyze the dependency of packet size and delay.

There is a shell script, runping.sh (<https://webcms3.cse.unsw.edu.au/COMP3331/20T3/resources/52062>) , provided that you can use instead of running many pings with different packet sizes by hand. After downloading this script on your machine make sure you can execute it. If not, you will have to execute the following command in the command line: `chmod u+x runping.sh` . To run the ping traces you may use the runping.sh script as follows: `./runping.sh www.abc.net` (<http://www.abc.net>) (or whatever other destination you want to ping). It will automatically run ping for different packet sizes and with 50 ping packets per size. Note, since a ping is sent once per second, this script will take a few minutes to finish. Basically, this script only executes the commands:

```
$ ping -s 22 -c 50 -i 1 www.abc.net > www.abc.net-p50
...
$ ping -s 1472 -c 50 -i 1 www.abc.net > www.abc.net-p1500
```

and writes the output of the pings to the corresponding files.

Use this script for the following destinations:

(i) www.uq.edu.au (<http://www.uq.edu.au/>) (ii) www.upm.edu.my (<http://www.upm.edu.my>) (replacing www.dlsu.edu.ph ([http://www.dlsu.edu.ph/](http://www.dlsu.edu.ph)) as the hosting appears to have changed) and (iii) www.tu-berlin.de (<http://www.tu-berlin.de/>)

In other words, execute the following commands

```
$ ./runping.sh www.uq.edu.au
$ ./runping.sh www.upm.edu.my
$ ./runping.sh www.tu-berlin.de
```

In case you notice one of the hosts above is not responsive, select the following alternate destinations: (i) within Australia (www.flinders.edu.au ([http://www.flinders.edu.au/](http://www.flinders.edu.au)) , www.unsw.edu.au ([http://www.unsw.edu.au/](http://www.unsw.edu.au))) (ii) Asia (www.smu.edu.sg (<http://www.smu.edu.sg>) , upd.edu.ph ([http://upd.edu.ph/](http://upd.edu.ph))) (iii) Europe (www.aau.dk ([http://www.aau.dk/](http://www.aau.dk)) , www.uio.no ([http://www.uio.no/](http://www.uio.no)))

Note that all delay values reported are in milliseconds (ms) and reflect the round trip time (RTT) between your host and the destinations.

When the runping.sh script is finished for all destinations, you can plot the results using another provided script, plot.sh (<https://webcms3.cse.unsw.edu.au/COMP3331/20T3/resources/52086>) , as follows:

```
$ ./plot.sh www.uq.edu.au-p*
$ ./plot.sh www.upm.edu.my-p*
$ ./plot.sh www.tu-berlin.de-p*
```

If you cannot execute plot.sh, then fix the permissions by executing the following command in the command line:

```
$ chmod u+x plot.sh
```

The script plot.sh will produce the following files: destination_delay.pdf, destination_scatter.pdf, and destination_avg.txt for each of the destinations (e.g., for www.uq.edu.au ([http://www.uq.edu.au/](http://www.uq.edu.au)) we have [www.uq.edu.au_delay.pdf](http://www.cse.unsw.edu.au/~cs3331/www.uq.edu.au_delay.pdf) (http://www.cse.unsw.edu.au/~cs3331/www.uq.edu.au_delay.pdf) , [www.uq.edu.au_scatter.pdf](http://www.cse.unsw.edu.au/~cs3331/www.uq.edu.au_scatter.pdf) (http://www.cse.unsw.edu.au/~cs3331/www.uq.edu.au_scatter.pdf) and [www.uq.edu.au_avg.txt](http://www.cse.unsw.edu.au/~cs3331/www.uq.edu.au_avg.txt) (http://www.cse.unsw.edu.au/~cs3331/www.uq.edu.au_avg.txt)).

The graph *destination_delay.pdf* shows how delay varies over time (different colours correspond to different packet sizes), and *destination_scatter.pdf* shows delay vs. packet size as a scatter plot. *destination_avg.txt* contains the average (2nd column) and minimum (3rd column) delay values corresponding to each packet size (1st column).

1. For each of these locations find the (approximate) physical distance from UNSW using Google Maps and compute the shortest possible time T for a packet to reach that location from UNSW. You should assume that the packet moves (i.e. propagates) at the speed of light, 3×10^8 m/s. Note that the shortest possible time will simply be the distance divided by the propagation speed. Plot a graph where the x-axis represents the distance to each city (i.e. Brisbane, Serdang and Berlin), and the y-axis represents the ratio between the minimum delay (i.e. RTT) as measured by the ping program (select the values for 50 byte packets) and the shortest possible time T to reach that city from UNSW. (Note that the

y-values are no smaller than 2 since it takes at least $2*T$ time for any packet to reach the destination from UNSW and get back). Can you think of at least two reasons why the y-axis values that you plot are greater than 2?

2. Is the delay to the destinations constant or does it vary over time? Explain why.
3. Explore where the website for www.epfl.ch (<http://www.epfl.ch/>) is hosted. Is it in Switzerland?
4. The measured delay (i.e., the delay you can see in the graphs) is composed of propagation delay, transmission delay, processing delay and queuing delay. Which of these delays depend on the packet size and which do not?

Resource created [18 days ago](#) (Friday, 04 September 2020, 10:33:15 AM), last modified [2 days ago](#) (Sunday, 20 September 2020, 01:25:12 PM).

Comments

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Aran Pando (/users/z5160688) [about 16 hours ago](#) (Mon Sep 21 2020 16:35:17 GMT+0800 (中国标准时间))

I've been using traceroute on the cse machines via tigervnc and I've been getting lots of blank routers ***** when routing to www.ucla.edu (<http://www.ucla.edu>) (ii) www.u-tokyo.ac.jp (<http://www.u-tokyo.ac.jp>) and (iii) www.lancaster.ac.uk (<http://www.lancaster.ac.uk>) in Exercise 3, question 2.

Is that expected? I've set max hops to 200 and its all blanks till 200. Do these blanks mean that it is still going or is traceroute just guessing there is more? I don't understand if this is supposed to happen. Thank you

Reply



Salil Kanhere (/users/z3116703) [about 13 hours ago](#) (Mon Sep 21 2020 19:43:46 GMT+0800 (中国标准时间))

I briefly mentioned this in the lecture. Some network admins configure routers in their networks to not respond to traceroute messages originating externally. Q: Why ? A: To keep their internal network organisation hidden (security).

You will notice that the last correctly received response will be from a router that is very close to the server hosting the destination domain. For example, when I traceroute to www.lancaster.ac.uk (<http://www.lancaster.ac.uk>), the last meaningful response is from lancaster-uni.ja.net, which is most likely a router located in the lancaster uni network. So you may approximate that response to be the final one.

Reply



Anson Lee (/users/z5258712) [about 20 hours ago](#) (Mon Sep 21 2020 12:33:21 GMT+0800 (中国标准时间))

Is there something wrong with plot.sh? I'm getting the same error as Tom whenever I run any of the plot commands in Exercise 4.

```
Error: /undefinedfilename in (www.uq.edu.au_delay.ps)
Operand stack:
Execution stack:
%interp_exit .runexec2 --nostringval-- --nostringval-- --nostringval-- 2 %stop
Dictionary stack:
--dict:960/1684(ro)(G)-- --dict:0/20(G)-- --dict:77/200(L)--
Current allocation mode is local
Last OS error: No such file or directory
GPL Ghostscript 9.26: Unrecoverable error, exit code 1
ps2pdf www.uq.edu.au_scatter.ps
Error: /undefinedfilename in (www.uq.edu.au_scatter.ps)
Operand stack:
Execution stack:
%interp_exit .runexec2 --nostringval-- --nostringval-- --nostringval-- 2 %stop
Dictionary stack:
--dict:960/1684(ro)(G)-- --dict:0/20(G)-- --dict:77/200(L)--
Current allocation mode is local
Last OS error: No such file or directory
GPL Ghostscript 9.26: Unrecoverable error, exit code 1
```

[Reply](#)

Ruiqi Li (/users/z5183936) about 9 hours ago (Mon Sep 21 2020 23:36:22 GMT+0800 (中国标准时间)), last modified about 9 hours ago (Tue Sep 22 2020 00:01:52 GMT+0800 (中国标准时间))

~~You might have a type when running the runping.sh. I encountered the same problem and got the identical error msg with you.~~

Still have the same issue after re-run the script through ssh, but this issue was eventually solved by running the command in TigerVNC. That's weird. Hope Dr.Salil can explain this later in the lecture

[Reply](#)

Salil Kanhere (/users/z3116703) about 20 hours ago (Mon Sep 21 2020 13:09:47 GMT+0800 (中国标准时间))

Works like a charm when connected through VLAB. Make sure you are not introducing errors on the command line when using the scripts.

[Reply](#)

Harry Zhu (/users/z5282494) a day ago (Sun Sep 20 2020 19:02:06 GMT+0800 (中国标准时间))

Hi Salil, I am confused with the result of trackroute. In my opinion, the round trip time of a route should be longer than the routes before it, because the packets have to pass these previous routes to reach it. However, the round trip time of unswbr1-te-2-13.gw.unsw.edu.au, which is about 6.1ms, is obviously longer than the time of its next route et-1-3-0.pe1.sxt.bkvl.nsw.aarnet.net.au, which is about 1.9ms. Could you explain it for me?

[Reply](#)

Salil Kanhere (/users/z3116703) a day ago (Sun Sep 20 2020 19:32:56 GMT+0800 (中国标准时间))

That's due to the difference in the queuing experienced by those probe messages, which can be attributed to network traffic dynamics. I discussed this in more detail in Friday's lecture - go to approx. 1:52:00 in the Youtube lecture. Let me know if you have further questions.

Reply



Harry Zhu (/users/z5282494) a day ago (Sun Sep 20 2020 21:05:55 GMT+0800 (中国标准时间))

Yes, I got it in 1:58:00. This issue is because of the different queuing when our packets reach the route. Thanks, Salil.

Reply



Tom Wright (/users/z5207952) 2 days ago (Sun Sep 20 2020 11:20:01 GMT+0800 (中国标准时间))

Hi Salil, I'm getting an error when trying to run plot.sh, and I'm not exactly sure why. What am I missing? Thanks for your help!

```
Error: /undefinedfilename in (www.uq.edu.au_delay.ps (http://www.uq.edu.au_delay.ps))
Operand stack:
Execution stack:
%interp_exit .runexec2 --nostringval-- --nostringval-- --nostringval-- 2 %stop
Dictionary stack:
--dict:960/1684(ro)(G)-- --dict:0/20(G)-- --dict:77/200(L)--
Current allocation mode is local
Last OS error: No such file or directory
GPL Ghostscript 9.26: Unrecoverable error, exit code 1
ps2pdf www.uq.edu.au_scatter.ps (http://www.uq.edu.au_scatter.ps)
Error: /undefinedfilename in (www.uq.edu.au_scatter.ps (http://www.uq.edu.au_scatter.ps))
Operand stack:
Execution stack:
%interp_exit .runexec2 --nostringval-- --nostringval-- --nostringval-- 2 %stop
Dictionary stack:
--dict:960/1684(ro)(G)-- --dict:0/20(G)-- --dict:77/200(L)--
Current allocation mode is local
Last OS error: No such file or directory
GPL Ghostscript 9.26: Unrecoverable error, exit code 1
```

Reply



Salil Kanhere (/users/z3116703) 2 days ago (Sun Sep 20 2020 14:05:52 GMT+0800 (中国标准时间))

Where are you executing this ? VLAB through VNC ?

Reply



Tom Wright (/users/z5207952) a day ago (Sun Sep 20 2020 18:39:22 GMT+0800 (中国标准时间))

Seems to work now, I was using VLAB. Must have been a typo!! Thanks anyway
Salil!

[Reply](#)



Kook Jin Noh (/users/z3018780) 2 days ago (Sun Sep 20 2020 02:43:29 GMT+0800 (中国标准时间)), last modified 2 days ago (Sun Sep 20 2020 02:53:18 GMT+0800 (中国标准时间))

For exercise 4.1, the ratio for Manila (San Francisco instead of Manila: Tracerouting www.dlsu.edu.ph (<http://www.dlsu.edu.ph>) shows it is located in San Francisco) is less than 2. How should I answer the question? The question appears to assume the ratio is greater than 2.

[Reply](#)



Salil Kanhere (/users/z3116703) 2 days ago (Sun Sep 20 2020 13:18:09 GMT+0800 (中国标准时间))

Well spotted. It appears that the hosting for www.dlsu.edu.ph (<http://www.dlsu.edu.ph>) has changed. It appears to be hosted by a CDN (possibly cloudflare). I am not sure where you got San Francisco. Perhaps you are accessing from an overseas location ? In that exercise our goal is to get you to compare network latencies to sites hosted in 3 different parts of the world (Australia, Europe, and Asia). Please use www.upm.edu.my (<http://www.upm.edu.my>) (in place of www.dlsu.edu.ph (<http://www.dlsu.edu.ph>)) which is hosted in Malaysia. I will update the spec.

[Reply](#)



Feddrick Aquino (/users/z5238236) 2 days ago (Sun Sep 20 2020 14:28:23 GMT+0800 (中国标准时间)), last modified 2 days ago (Sun Sep 20 2020 14:29:21 GMT+0800 (中国标准时间))

I did whois on one of www.dlsu.edu.ph (<http://www.dlsu.edu.ph>) 's IP address and this is part of output that i got. What is cloudflare? And on the picture it says the location of San Francisco, which i assume what Kook is referring to.

```
NetType: Direct Assignment
OriginAS: AS13335
Organization: Cloudflare, Inc. (CLOUD14)
RegDate: 2015-02-25
Updated: 2017-02-17
Comment: All Cloudflare abuse reporting can be done via https://www.cloudflare.com/abuse
Ref: https://rdap.arin.net/registry/ip/172.64.0.0

OrgName: Cloudflare, Inc.
OrgId: CLOUD14
Address: 101 Townsend Street
City: San Francisco
StateProv: CA
PostalCode: 94107
Country: US
RegDate: 2010-07-09
Updated: 2019-09-25
Ref: https://rdap.arin.net/registry/entity/CLOUD14
```

[Reply](#)



Salil Kanhere (/users/z3116703) a day ago (Sun Sep 20 2020 15:23:21 GMT+0800 (中国标准时间))

Good work Feddrick. Cloudflare provides content distribution network services for web content. We will discuss CDNs in Weeks 2 and 3. The address shown here is the registered business address for Cloudflare. CDN's deploy servers all around the world. Client requests are directed to the "closest" CDN server. The one I contacted when requesting for dlsu.edu.ph was only a few hops away - most certainly located in Sydney.

[Reply](#)



Carlo Pane (/users/z5162115) 3 days ago (Sat Sep 19 2020 18:58:22 GMT+0800 (中国标准时间))

For exercise 2: Does 100% packet loss mean it is still reachable?

[Reply](#)



Salil Kanhere (/users/z3116703) 3 days ago (Sat Sep 19 2020 20:37:55 GMT+0800 (中国标准时间))

No, not reachable

[Reply](#)