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Exercise 1: nslookup

1.1

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?
The IPv4 addresses of www.koala.com.au are 104.18.60.21 and 104.18.61.21, the IPv6 addresses are 2606:4700:30::6812:3c15 and 2606:4700:30::6812:3d15
The reason of having several IP addresses as an output is to increase website performance by receiving it from IP that is the closest based on location.

1.2

Find out the name of the IP address 127.0.0.1. What is special about this IP address?
The name is localhost. It can run network services on host/local machine without physical network interface by using a local loopback mechanism.

Exercise 2: Use ping to test host reachability

Host	Reachable		Reason
	ping	website	
www.unsw.edu.au	T	T	-
www.getfittest.com.au	F	F	NXDOMAIN, Non-Existent Domain
www.mit.edu	T	T	-
www.intel.com.au	T	T	-
www.tpg.com.au	T	T	-
www.hola.hp	F	F	NXDOMAIN, Non-Existent Domain
www.amazon.com	T	T	-
www.tsinghua.edu.cn	T	T	-
www.kremlin.ru	F	T	Firewall blocking ICMP traffic
8.8.8.8	T	F	Domain name server

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.

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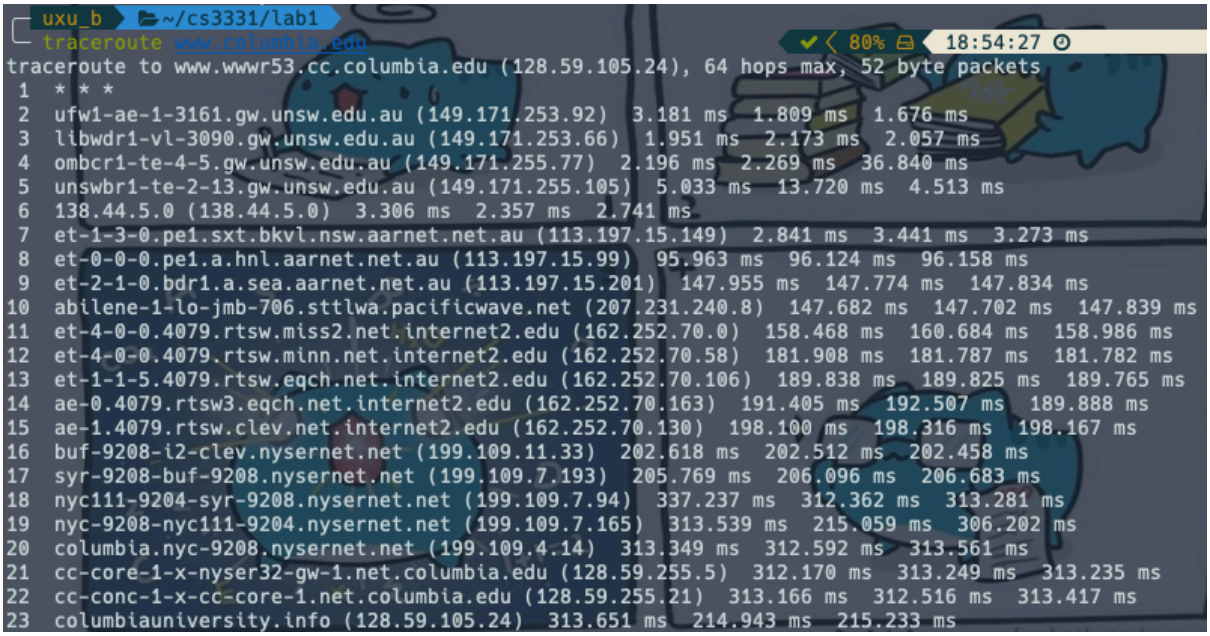
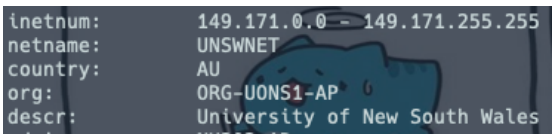
Exercise 3: Use traceroute to understand network topology
**Include all traceroute outputs in your report.*

3.1

Run traceroute on your machine to www.columbia.edu. How many routers are there between your workstation and 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.*
There are 23 routers, there are 4 routers part of UNSW, between the 9th and 10th router the packets cross the pacific ocean.





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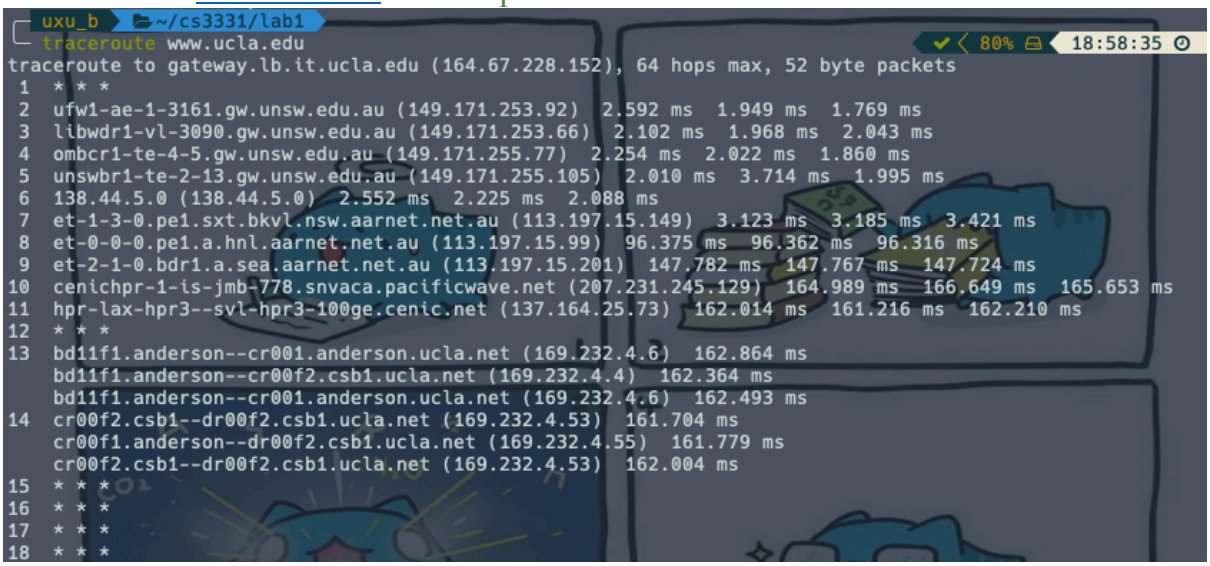
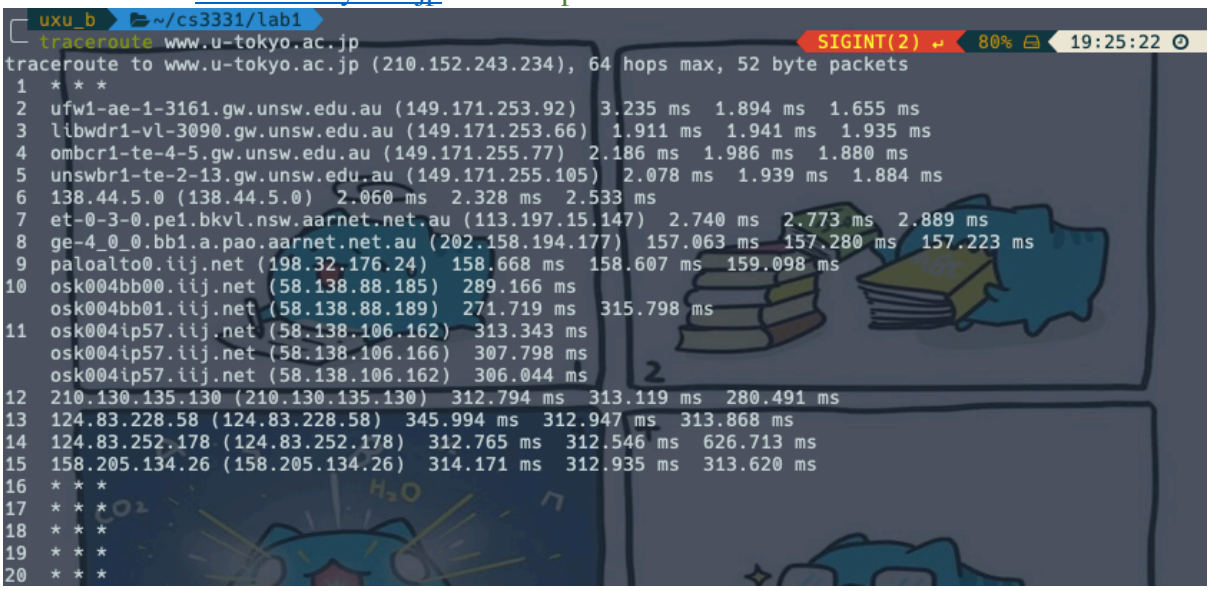
3.2

Run traceroute from your machine to the following destinations:

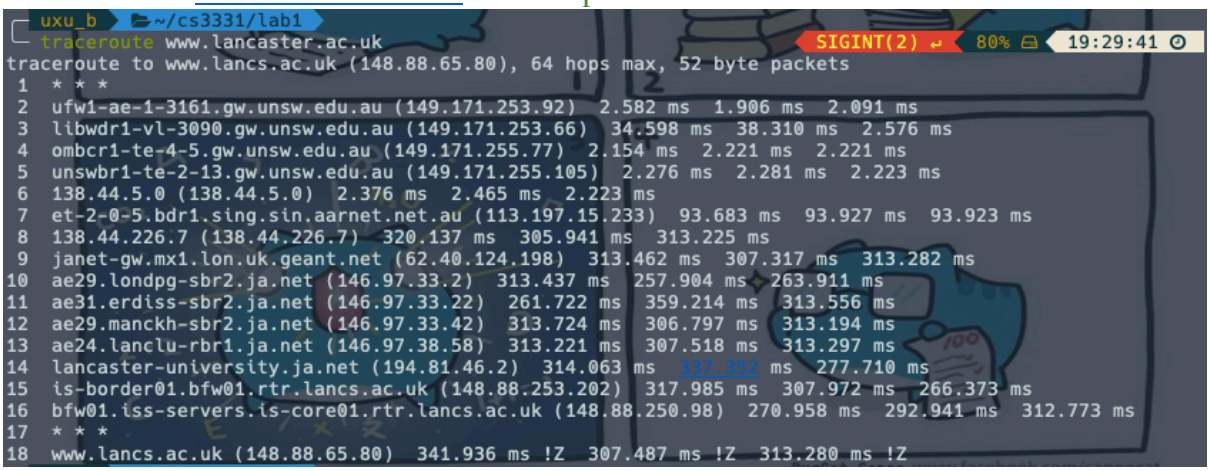
- www.ucla.edu → 14 hops



- www.u-tokyo.ac.jp → 15 hops



- www.lancaster.ac.uk → 18 hops



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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 geographical location of a server using the following tool* *http://www.yougetsignal.com/tools/network-location/*
At the 7th router, the path to these 3 destinations diverge. Japan has a shorter geographical compared to US but US(14 hops) took one less hop compared to Japan(15 hops) thus the number of hops on each path is not proportional to the physical distance.

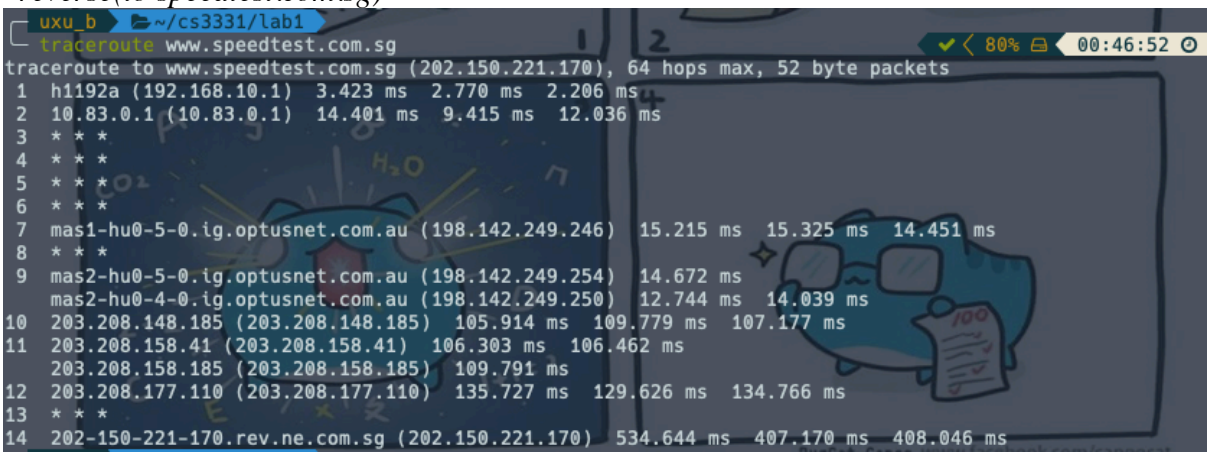
3.3

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:

- http://www.speedtest.com.sg/tr.php

```
traceroute to 110.23.193.34 (110.23.193.34), 30 hops max, 60 byte packets
 1  ge2-8.r01.sin01.ne.com.sg (202.150.221.169)  0.155 ms  0.186 ms  0.203 ms
 2  10.15.62.222 (10.15.62.222)  32.886 ms  32.895 ms  32.898 ms
 3  xe-0-0-24-2.a01.newthk03.hk.bb.gin.ntt.net (203.131.240.133)  33.045 ms  33.053 ms  33.061 ms
 4  ae-12.r03.tkokhk01.hk.bb.gin.ntt.net (129.250.5.254)  171.040 ms  171.077 ms  171.049 ms
 5  ae-6.r25.tkokhk01.hk.bb.gin.ntt.net (129.250.6.101)  34.727 ms  34.532 ms  34.763 ms
 6  ae-7.r24.osakjp02.jp.bb.gin.ntt.net (129.250.2.42)  77.299 ms  77.701 ms  77.769 ms
 7  ae-4.r23.sttlwa01.us.bb.gin.ntt.net (129.250.3.60)  166.650 ms  166.454 ms  171.356 ms
 8  ae-11.r04.sttlwa01.us.bb.gin.ntt.net (129.250.2.6)  177.090 ms  171.740 ms  177.078 ms
 9  sea-b2-link.telia.net (213.248.70.12)  193.951 ms  185.730 ms  193.935 ms
10  port-b1-link.telia.net (62.115.115.23)  179.366 ms sjo-b21-link.telia.net (62.115.118.169)  178.526 ms port-b1-link.te
11  palo-b22-link.telia.net (62.115.115.216)  194.260 ms palo-b22-link.telia.net (62.115.125.0)  200.311 ms palo-b22-link.
12  las-b24-link.telia.net (62.115.119.91)  194.734 ms las-b24-link.telia.net (62.115.136.47)  191.754 ms sjo-b21-link.tel
13  singaporetelecom-ic-335365-las-b24.c.telia.net (62.115.8.203)  179.454 ms  180.207 ms  181.564 ms
14  203.208.171.117 (203.208.171.117)  180.016 ms  181.728 ms  184.735 ms
15  singaporetelecom-ic-335365-las-b24.c.telia.net (62.115.8.203)  180.913 ms 203.208.191.186 (203.208.191.186)  233.140 m
16  * * *
17  203.208.169.130 (203.208.169.130)  227.460 ms * *
18  * * *
19  * * *
20  210.49.119.90 (210.49.119.90)  229.358 ms * *
21  * * *
22  * * *
23  * * *
24  * * *
```

**reverse(to speedtest.com.sg)*



- https://www.telstra.net/cgi-bin/trace

```
1  gigabitethernet3-3.exi2.melbourne.telstra.net (203.50.77.53)  0.332 ms  0.205 ms  0.240 ms
2  bundle-ether3-100.win-core10.melbourne.telstra.net (203.50.80.129)  2.615 ms  1.472 ms  2.114 ms
3  bundle-ether12.ken-core10.sydney.telstra.net (203.50.11.122)  13.360 ms  12.346 ms  12.986 ms
4  bundle-ether1.ken-edge903.sydney.telstra.net (203.50.11.173)  11.608 ms  11.848 ms  11.485 ms
5  opt2822815.lnk.telstra.net (110.145.210.198)  12.985 ms  12.973 ms  12.984 ms
```

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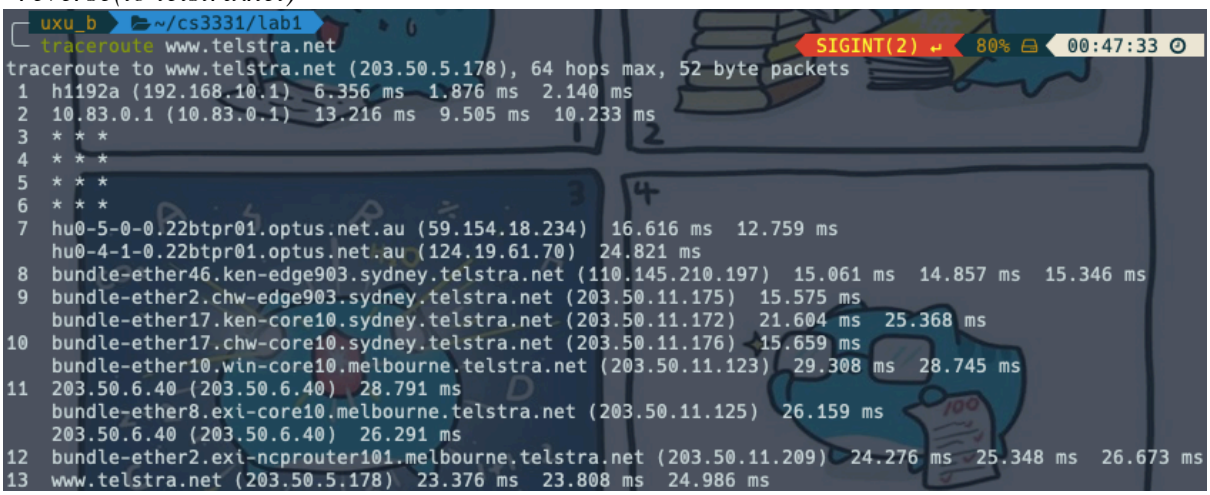
**reverse(to telstra.net)*



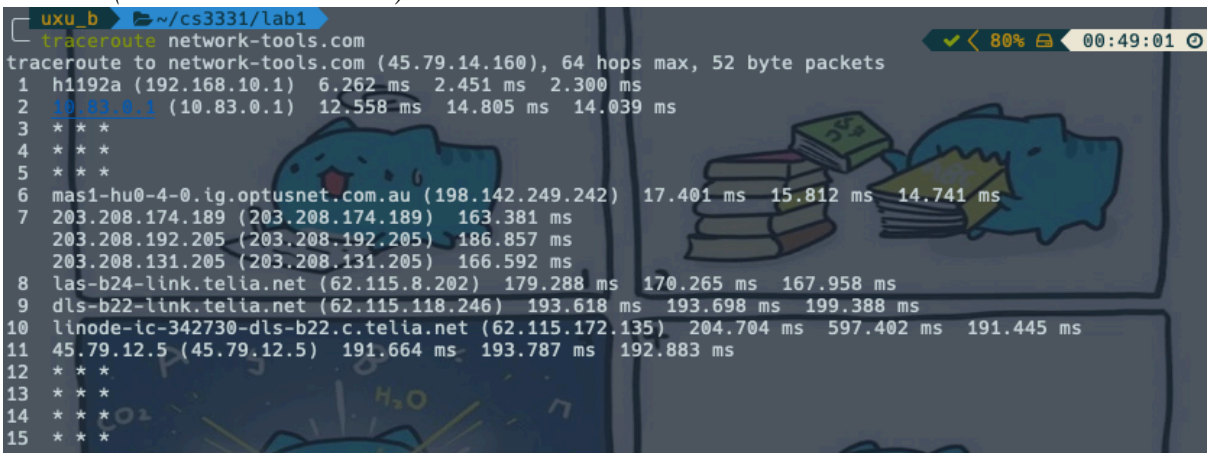
Run traceroute from both these servers towards your machine and in the reverse direction (i.e. from your machine to these servers). You may also try other traceroute servers from the list at www.traceroute.org . What are the IP addresses of the two servers that you have chosen. Does the reverse path 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?

- https://network-tools.com

Traceroute Check for: **'110.23.193.34'**

traceroute to 110.23.193.34 (110.23.193.34), 10 hops max, 60 byte packets
1 45.79.12.202 (45.79.12.202) 1.144 ms 45.79.12.201 (45.79.12.201) 0.710 ms 45.79.12.202 (45.79.12.202) 1.127 ms
2 45.79.12.6 (45.79.12.6) 1.013 ms 1.009 ms 45.79.12.0 (45.79.12.0) 0.593 ms
3 dls-b22-link.telia.net (62.115.172.134) 0.985 ms 0.966 ms 45.79.12.9 (45.79.12.9) 0.948 ms
4 phx-b1-link.telia.net (62.115.136.85) 23.586 ms dls-b22-link.telia.net (62.115.172.134) 0.927 ms phx-b1-link.telia.net (62.115.136.85) 23.722 ms
5 singaporetelecom-ic-335365-las-b24.c.telia.net (62.115.8.203) 40.388 ms 40.383 ms las-b24-link.telia.net (62.115.119.174) 31.196 ms
6 singaporetelecom-ic-335365-las-b24.c.telia.net (62.115.8.203) 40.357 ms 203.208.171.117 (203.208.171.117) 31.055 ms 31.139 ms
7 203.208.191.186 (203.208.191.186) 194.024 ms 193.653 ms 203.208.171.117 (203.208.171.117) 31.063 ms
8 203.208.191.186 (203.208.191.186) 193.878 ms 203.208.169.130 (203.208.169.130) 185.768 ms *
9 * * *
10 * * *

**reverse(to network-tools.com)*



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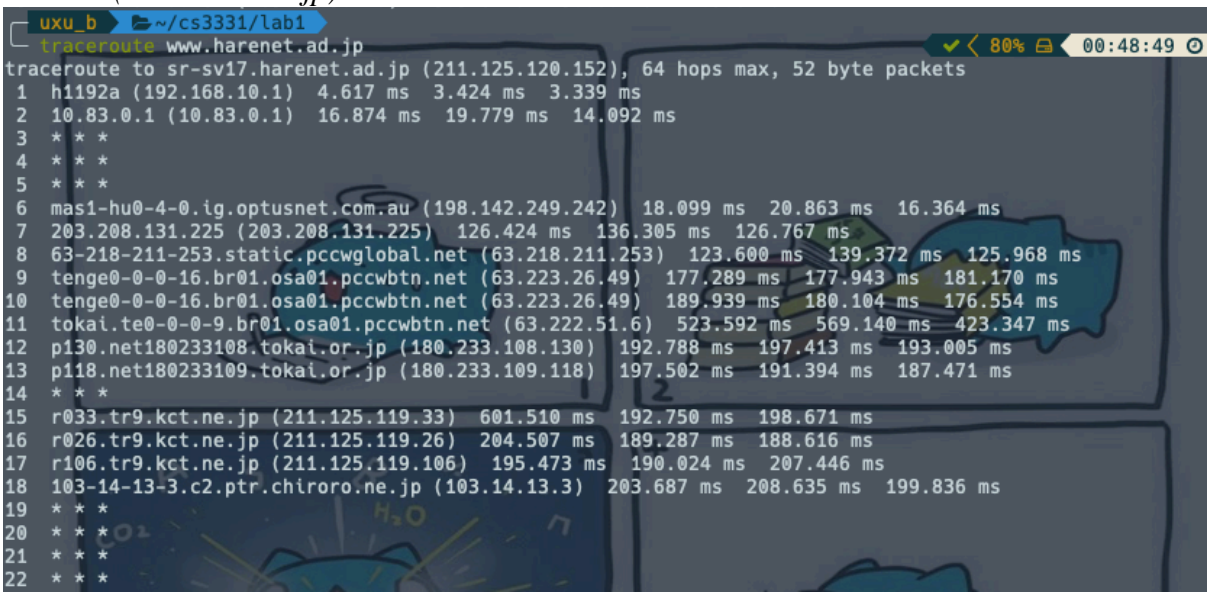
- www.harenet.ad.jp

Traceroute from www.harenet.ad.jp to 110.23.193.34

```
traceroute to 110.23.193.34 (110.23.193.34), 30 hops max, 60 byte packets
 1  no50-0.lcgbsvr (192.168.0.50)  0.024 ms  0.006 ms  0.005 ms
 2  * * *
 3  * * *
 4  * * *
 5  * * *
 6  * * *
 7  * * *
 8  * * *
 9  * * *
10  * * *
11  * * *
12  * * *
13  * * *
14  * * *
15  * * *
16  * * *
17  * * *
18  * * *
19  * * *
20  * * *
21  * * *
22  * * *
23  * * *
24  * * *
25  * * *
26  * * *
27  * * *
28  * * *
29  * * *
30  * * *
```

**reverse(to harenet.ad.jp)*



The IP address of the chosen 2 are network-tools.com(45.79.14.160) and harenet.ad.jp(211.125.120.152). Both didn't go to and from on the same path/ routers but there are common routers with different IP as routing selects the optimal path.

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Exercise 4: use ping to gain insights into network performance
**Include all graphs in your report*

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 , 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 (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:

```
$ ./runping.sh www.uq.edu.au
$ ./runping.sh www.dlsu.edu.ph
$ ./runping.sh www.tu-berlin.de
```

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 , as follows:

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).

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

Use this script for the following destinations:

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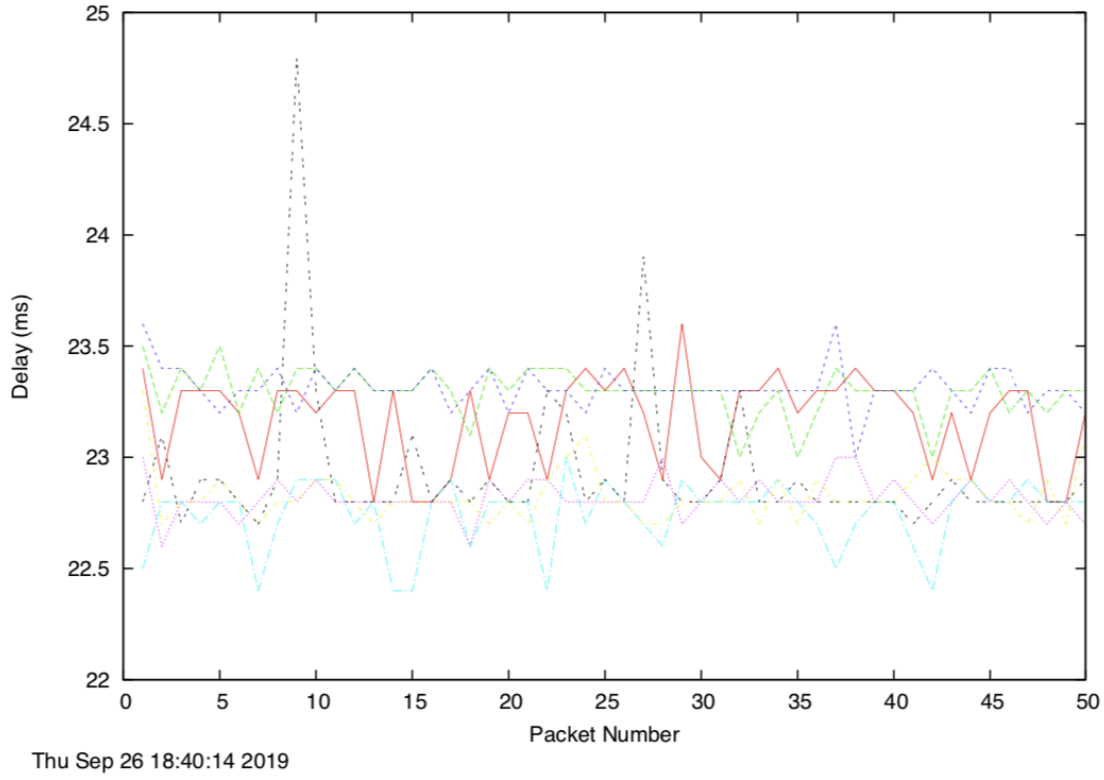
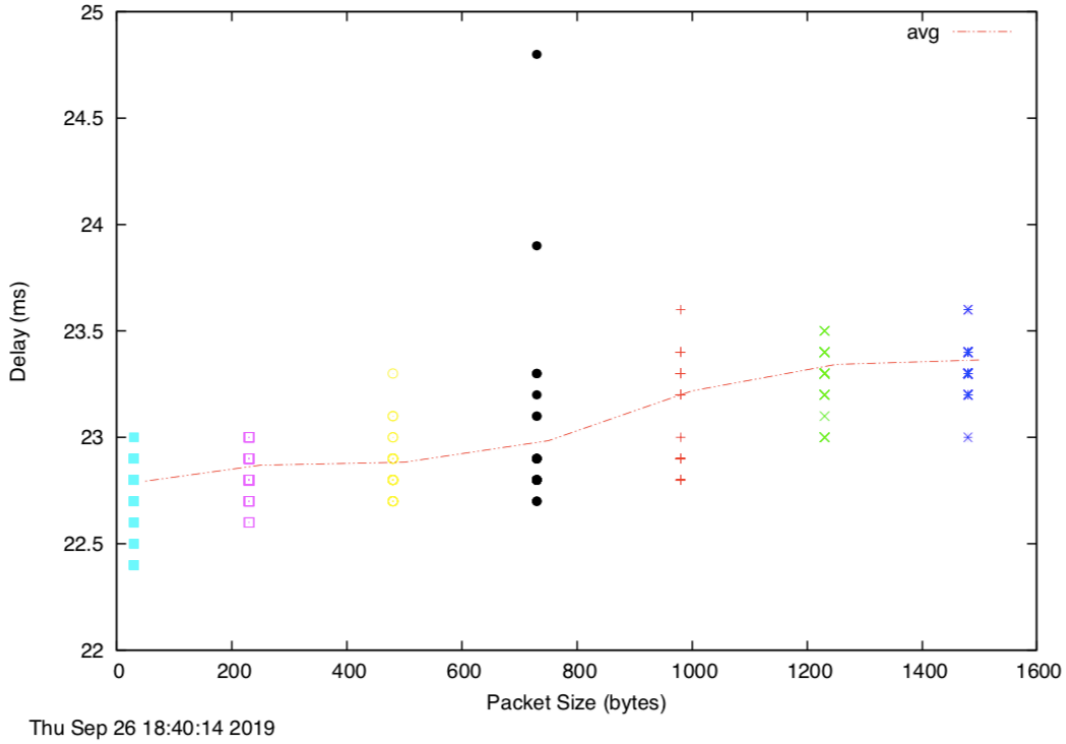
- www.unsw.edu.au/



*delay



*scatter

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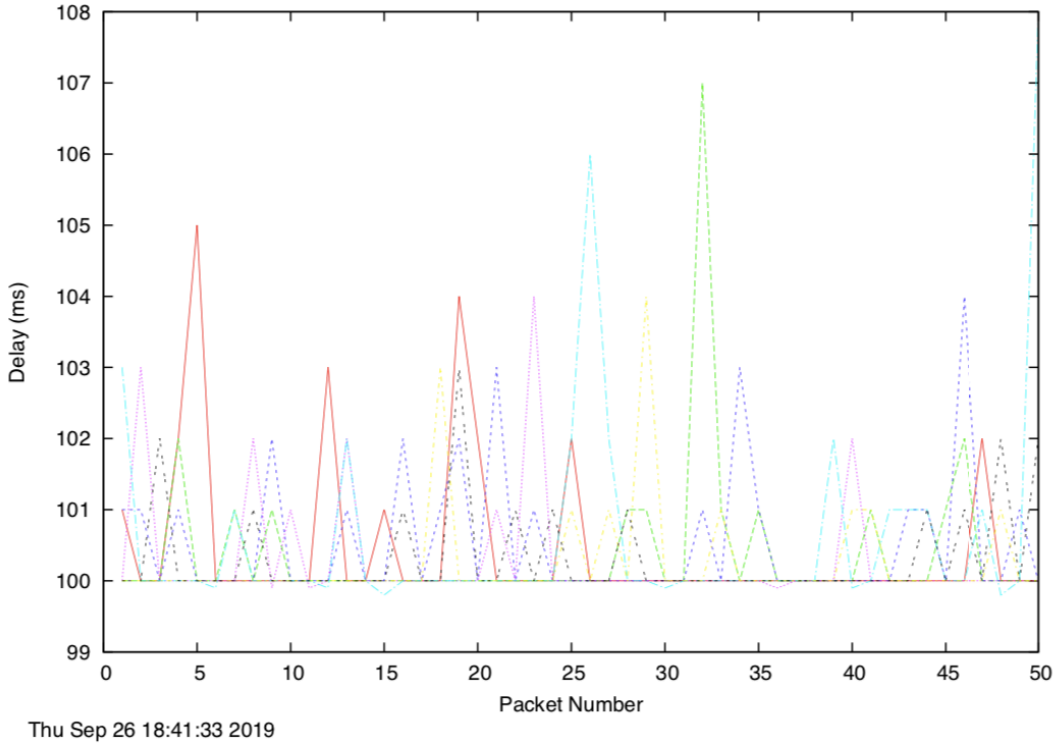
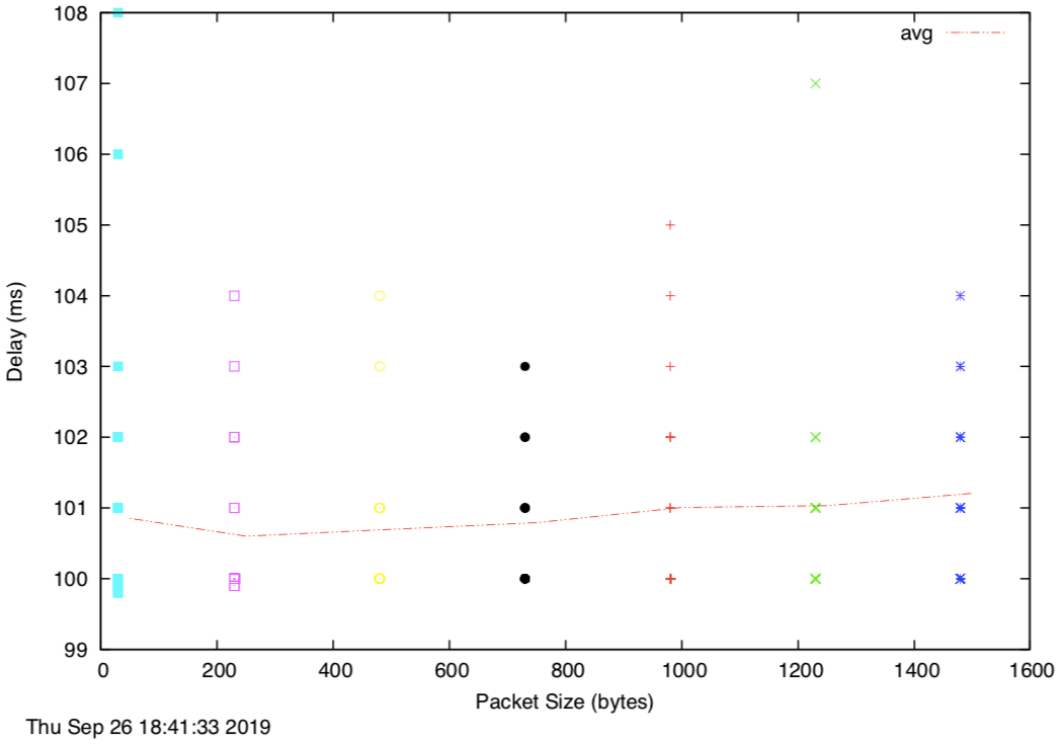
- www.upm.edu.my/



*delay



*scatter

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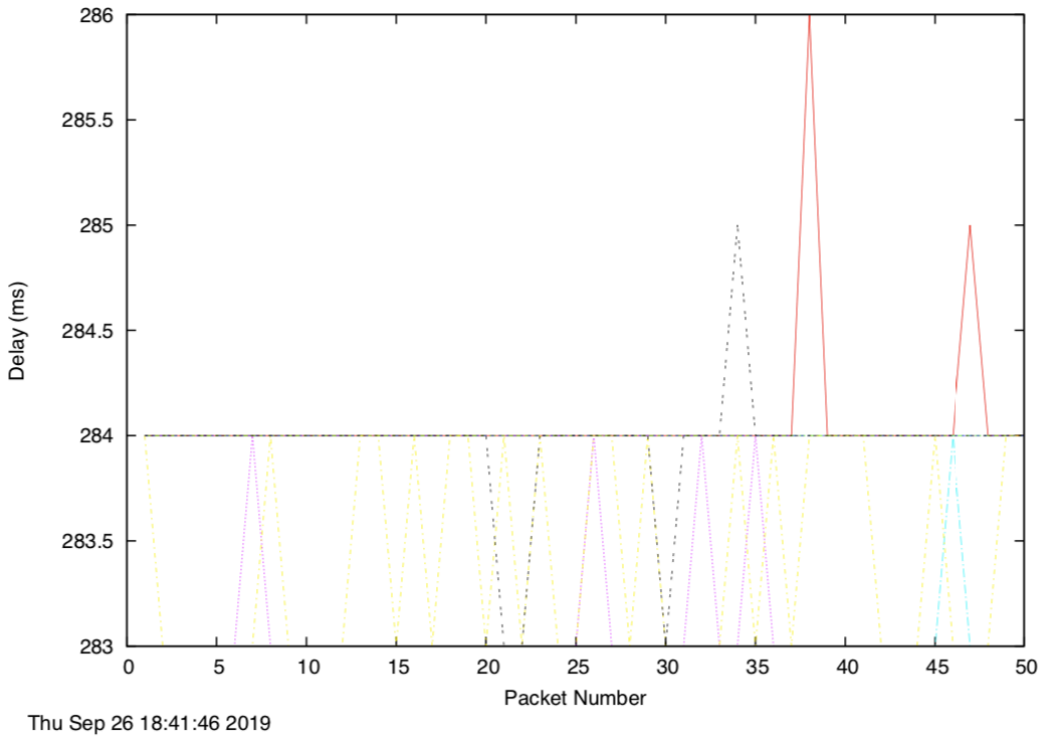
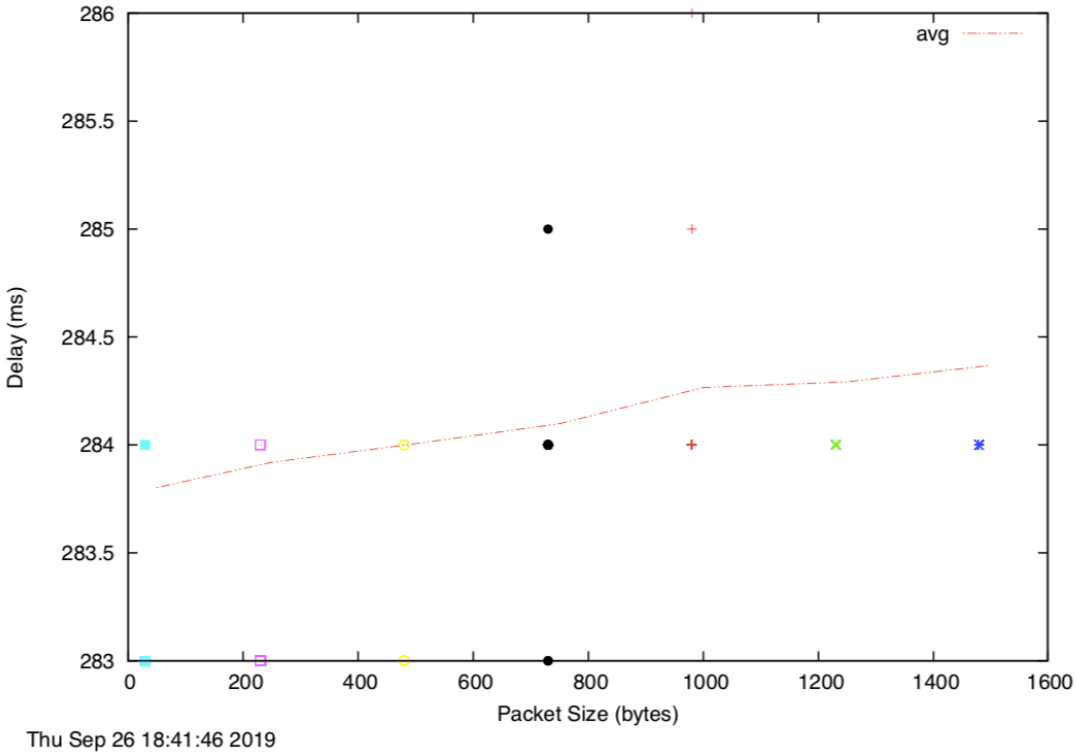
- www.tu-berlin.de



*delay



*scatter

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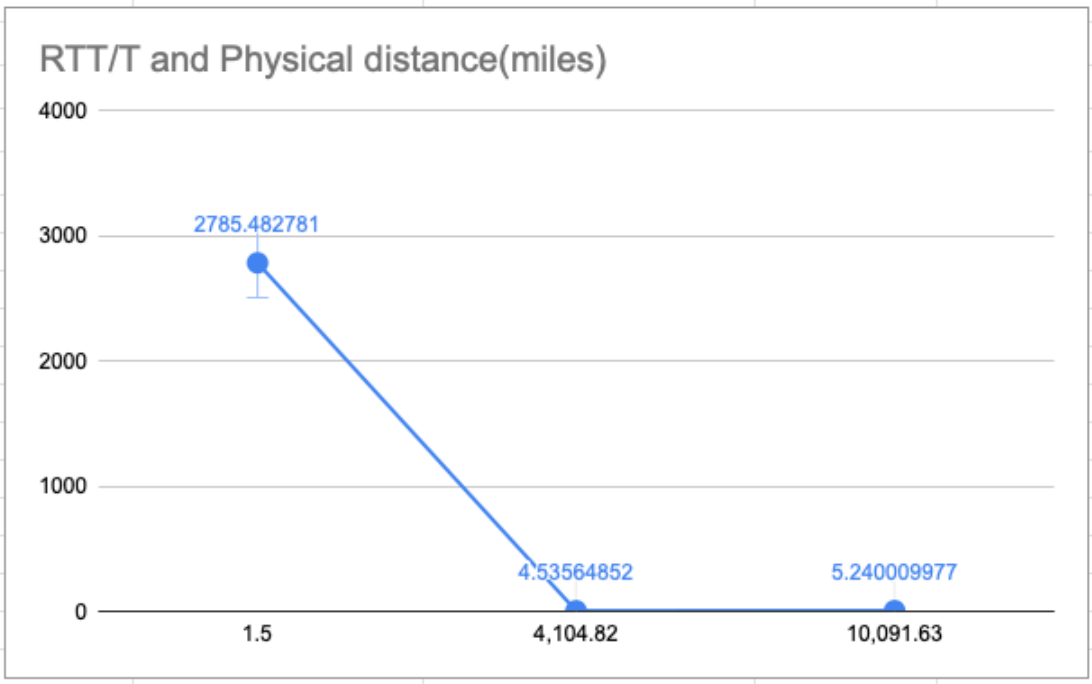
4.1

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 x 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, Manila 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?

	Physical distance(miles)	Shortest possible time, T(s)	RTT (ms)	RTT/T
UNSW -> UNSV	1.5	8.05E-06	22.414	2.79E+03
UNSW -> UPM	4,104.82	2.20E-02	99.876	4.54E+00
UNSW -> TU	10,091.63	5.41E-02	283.675	5.24E+00
1 mile =	1609.344			
Speed of light	300000000			
1ms =	0.001			



The round trip time, RTT is the time taken to travel to and from source to destination. The shortest possible time, T taken thus, RTT will be more or at least 2*T, also it can't be faster than the speed of light.

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4.2

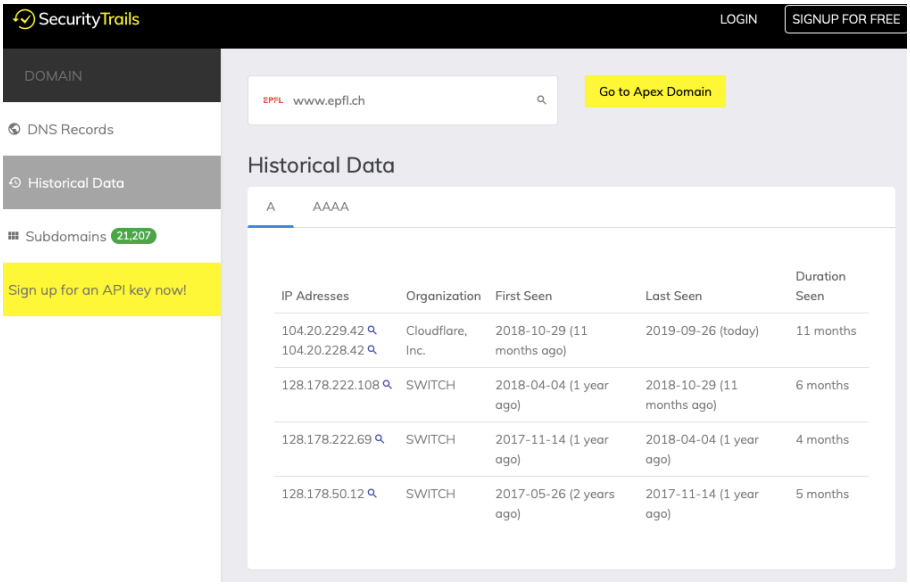
Is the delay to the destinations constant or does it vary over time? Explain why.

It seems pretty constant expect for UNSW -> UNSW. I am assuming that since UNSW -> UNSW have shortest length of physical link, the propagation delay might have effect and queueing delay might have also have effected it as it depends on congestion level of the routers and the time waiting(output link) for transmission

4.3

Explore where the website for www.epfl.ch is hosted. Is it in Switzerland?

Yes it is in Switzerland.



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4.4

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?

	Dependant on packet size.	
	Yes	No
Propagation delay		√
Transmission delay	√	
Processing delay		√
Queueing delay		√