Exercise 1: nslookup

1. The IP address of the website www.koala.com.au is 104.21.45.210 and 172.67.219.46. In my opinion, the reason of having several IP addresses as an output is that a website can be hosted on multiple address and locations for security and redundancy. In this case, even if one of the hosts goes down, you can still access the site by the other hosts. Another reason for having multiple IP addresses is user can use the closest one to access the site.

```
z5261536@vx5:/tmp_amd/reed/export/reed/3/z5261536/Desktop/cs3331$ nslookup www.koala.com.au
Server:         129.94.242.45
Address:        129.94.242.45#53

Non-authoritative answer:
Name:   www.koala.com.au
Address: 104.21.45.210
Name:   www.koala.com.au
Address: 172.67.219.46
```

2. The name of the IP address 127.0.0.1: localhost

```
z5261536@vx5:/tmp_amd/reed/export/reed/3/z5261536/Desktop/cs3331$ nslookup 127.0.0.1
Server:         129.94.242.45
Address:        129.94.242.45#53

1.0.0.127.in-addr.arpa  name = localhost.
```

127.0. 0.1 is the loopback Internet protocol (IP) address also referred to as the localhost.(Wikipedia) The address is used to establish an IP connection to the same machine or computer being used by the users, but it does not let machines connect with other devices as a real IP address does.

Exercise 2: Use ping to test host reachability

- www.unsw.edu.au   Yes.
- www.getfittest.com.au   No, website does not exist.
- www.mit.edu   Yes.
- www.intel.com.au   Yes.
- www.tpg.com.au   Yes.
- www.hola.hp   No, website does not exist.
- www.amazon.com   Yes.
- www.tsinghua.edu.cn   Yes.
- www.kremlin.ru   No, reachable from the Web browser, but host has no response to the ping request.
- 8.8.8.8   Yes.

Hosts of www.getfittest.com.au and www.hola.hp are not reachable because websites do not exist, and kreminlin.ru is not reachable since the host has no response to the ping request.

Exercise 3: Use traceroute to understand network topology.

1. There are 22 routers between my workstation and www.columbia.edu (included). 5 routers along the path are part of the UNSW network. Packets cross the Pacific Ocean Between router 7(Canberra, AU) and router 10(Seattle, US) due to huge increases in the delay, and you can also tell from the name of router 9 sea.aarnet.net.au that the packets was crossing the Pacific Ocean.

```
z5261536@vx5:/tmp_amd/reed/export/reed/3/z5261536/Desktop/cs3331$ traceroute www.columbia.edu
traceroute to www.columbia.edu (128.59.105.24), 30 hops max, 60 byte packets
 1  cserouter1-server.cse.unsw.EDU.AU (129.94.242.251)  0.086 ms  0.073 ms  0.068 ms
 2  129.94.39.17 (129.94.39.17)  0.853 ms  0.806 ms  0.879 ms
 3  libudnex1-vl-3154.gw.unsw.edu.au (149.171.253.34)  1.562 ms  1.567 ms ombudnex1-vl-3154.gw.unsw.edu.a
u (149.171.253.35)  1.292 ms
 4  ombcr1-po-6.gw.unsw.edu.au (149.171.255.169)  9.936 ms libcr1-po-6.gw.unsw.edu.au (149.171.255.201)
1.144 ms libcr1-po-5.gw.unsw.edu.au (149.171.255.165)  1.156 ms
 5  unswbr1-te-1-9.gw.unsw.edu.au (149.171.255.101)  1.162 ms  1.171 ms unswbr1-te-2-13.gw.unsw.edu.au (1
49.171.255.105)  1.228 ms
 6  138.44.5.0 (138.44.5.0)  1.328 ms  1.916 ms  1.910 ms
 7  et-1-3-0.pe1.sxt.bkvl.nsw.aarnet.net.au (113.197.15.149)  1.990 ms  2.164 ms  2.202 ms
 8  et-0-0-0.pe1.a.hnl.aarnet.net.au (113.197.15.99)  95.337 ms  95.315 ms  95.211 ms
 9  et-2-1-0.bdr1.a.sea.aarnet.net.au (113.197.15.201)  146.750 ms  146.701 ms  146.726 ms
10  abilene-1-lo-jmb-706.sttlwa.pacificwave.net (207.231.240.8)  177.425 ms  177.435 ms  177.426 ms
11  ae-1.4079.rtsw.minn.net.internet2.edu (162.252.70.173)  202.853 ms  202.889 ms  202.909 ms
12  ae-1.4079.rtsw.eqch.net.internet2.edu (162.252.70.106)  209.281 ms  208.407 ms  208.383 ms
13  ae-0.4079.rtsw3.eqch.net.internet2.edu (162.252.70.163)  207.127 ms  207.001 ms  206.991 ms
14  ae-1.4079.rtsw.clev.net.internet2.edu (162.252.70.130)  212.989 ms  212.877 ms  212.863 ms
15  buf-9208-I2-CLEV.nysernet.net (199.109.11.33)  216.269 ms  216.477 ms  216.412 ms
16  syr-55a1-buf-9208.nysernet.net (199.109.7.213)  219.823 ms  219.760 ms  220.038 ms
17  nyc32-55a1-syr-55a1.nysernet.net (199.109.7.206)  225.505 ms  225.350 ms  224.958 ms
18  nyc32-9208-nyc32-55a1.nysernet.net (199.109.7.201)  225.104 ms  224.976 ms  225.156 ms
19  columbia.nyc-9208.nysernet.net (199.109.4.14)  224.783 ms  224.782 ms  224.800 ms
20  cc-core-1-x-nyser32-gw-1.net.columbia.edu (128.59.255.5)  224.978 ms  225.100 ms  225.060 ms
21  cc-conc-1-x-cc-core-1.net.columbia.edu (128.59.255.21)  225.176 ms  225.116 ms  225.145 ms
22  www.neurotheory.columbia.edu (128.59.105.24)  225.020 ms  225.127 ms  225.266 ms
```

2. At the router 6 the paths from my machine to these three destinations diverge. Router 6 is 138.44.5.0 which owned by AARNET, AUS Academic and Research Network.

```
% Information related to '138.44.5.0/24AS7575'

route:          138.44.5.0/24
origin:         AS7575
descr:          Australian Academic and Research Network
                Building 9
                Banks Street
mnt-by:         MAINT-AARNET-AP
last-modified:  2019-04-03T03:55:51Z
source:         APNIC

% This query was served by the APNIC Whois Service version 1.88.15-SNAPSHOT (WHOIS-AU1)
```

Distance to each sever by using network location tool: Japan 4913.8miles < UK 9120miles < US 9399.8 miles, but the number of hops on each path: Jap 15, UK 14, US 14. Therefore, since there are more hops to the Japanese site than to the UK and US site despite Japan has the closest physical distance, the number of hops on each path is not proportional to the physical distance.

3.

CSE Machine: 129.94.242.119

www.speedtest.com.sg :202.150.221.170

www.telstra.net : 203.50.5.178

(i) CSE machine to www.speedtest.com.sg

```
z5261536@vx6:/tmp_amd/reed/export/reed/3/z5261536/Desktop$ traceroute www.speedtest.com.sg
traceroute to www.speedtest.com.sg (202.150.221.170), 30 hops max, 60 byte packets
 1  cserouter1-server.cse.unsw.EDU.AU (129.94.242.251)  0.084 ms  0.064 ms  0.071 ms
 2  129.94.39.17 (129.94.39.17)  0.814 ms  0.848 ms  0.855 ms
 3  ombudnex1-vl-3154.gw.unsw.edu.au (149.171.253.35)  1.507 ms libudnex1-vl-3154.gw.unsw.edu.au (149.17
1.253.34)  1.332 ms ombudnex1-vl-3154.gw.unsw.edu.au (149.171.253.35)  1.497 ms
 4  ombcr1-po-6.gw.unsw.edu.au (149.171.255.169)  1.085 ms  1.125 ms libcr1-po-5.gw.unsw.edu.au (149.171
.255.165)  1.132 ms
 5  unswbr1-te-1-9.gw.unsw.edu.au (149.171.255.101)  1.265 ms unswbr1-te-2-13.gw.unsw.edu.au (149.171.25
5.105)  1.142 ms  1.168 ms
 6  138.44.5.0 (138.44.5.0)  1.322 ms  1.311 ms  1.258 ms
 7  et-0-3-0.pe1.alxd.nsw.aarnet.net.au (113.197.15.153)  1.717 ms  2.761 ms  2.702 ms
 8  xe-0-2-7.bdr1.a.lax.aarnet.net.au (202.158.194.173)  147.707 ms  147.640 ms  147.643 ms
 9  singtel.as7473.any2ix.coresite.com (206.72.210.63)  147.972 ms  147.981 ms  147.956 ms
10  203.208.171.117 (203.208.171.117)  189.452 ms 203.208.178.185 (203.208.178.185)  319.893 ms 203.208.
173.21 (203.208.173.21)  320.987 ms
11  203.208.177.110 (203.208.177.110)  330.182 ms 203.208.172.145 (203.208.172.145)  246.113 ms 203.208.
151.233 (203.208.151.233)  236.599 ms
12  203.208.158.17 (203.208.158.17)  327.109 ms 203.208.182.253 (203.208.182.253)  315.538 ms 203.208.15
8.17 (203.208.158.17)  327.324 ms
13  203.208.158.185 (203.208.158.185)  326.844 ms 202-150-221-170.rev.ne.com.sg (202.150.221.170)  212.3
68 ms 203.208.177.110 (203.208.177.110)  331.367 ms
```

(ii) CSE machine to www.telstra.net

```
traceroute to www.telstra.net (203.50.5.178), 30 hops max, 60 byte packets
 1  cserouter1-server.cse.unsw.EDU.AU (129.94.242.251)  0.140 ms  0.073 ms  0.065 ms
 2  129.94.39.17 (129.94.39.17)  0.795 ms  0.826 ms  0.862 ms
 3  libudnex1-vl-3154.gw.unsw.edu.au (149.171.253.34)  4.396 ms ombudnex1-vl-3154.gw.unsw.edu.au (149.17
1.253.35)  3.028 ms libudnex1-vl-3154.gw.unsw.edu.au (149.171.253.34)  4.413 ms
 4  libcr1-po-6.gw.unsw.edu.au (149.171.255.201)  1.069 ms ombcr1-po-5.gw.unsw.edu.au (149.171.255.197)
 1.125 ms ombcr1-po-6.gw.unsw.edu.au (149.171.255.169)  1.189 ms
 5  unswbr1-te-1-9.gw.unsw.edu.au (149.171.255.101)  1.247 ms  1.246 ms  1.244 ms
 6  138.44.5.0 (138.44.5.0)  1.348 ms  1.333 ms  1.331 ms
 7  et-1-1-0.pe1.rsby.nsw.aarnet.net.au (113.197.15.12)  1.770 ms  1.666 ms  1.884 ms
 8  xe-0-0-3.bdr1.rsby.nsw.aarnet.net.au (113.197.15.31)  1.789 ms  1.698 ms  1.707 ms
 9  HundredGigE0-1-0-4.ken-edge903.sydney.telstra.net (139.130.0.77)  2.184 ms  2.319 ms  2.201 ms
10  bundle-ether2.chw-edge903.sydney.telstra.net (203.50.11.175)  2.544 ms bundle-ether17.ken-core10.syd
ney.telstra.net (203.50.11.172)  2.595 ms bundle-ether2.chw-edge903.sydney.telstra.net (203.50.11.175)
2.538 ms
11  bundle-ether17.chw-core10.sydney.telstra.net (203.50.11.176)  2.190 ms bundle-ether10.win-core10.mel
bourne.telstra.net (203.50.11.123)  13.454 ms bundle-ether17.chw-core10.sydney.telstra.net (203.50.11.17
6)  3.767 ms
12  bundle-ether1-2.exi-core10.melbourne.telstra.net (203.50.6.40)  16.038 ms  15.874 ms bundle-ether8.e
xi-core10.melbourne.telstra.net (203.50.11.125)  16.298 ms
13  203.50.11.209 (203.50.11.209)  15.063 ms  15.076 ms  14.332 ms
14  www.telstra.net (203.50.5.178)  14.697 ms  14.646 ms  13.582 ms
```

(iii) www.speedtest.com.sg to CSE machine

```
Traceroute Result:

traceroute to 129.94.242.119 (129.94.242.119), 30 hops max, 60 byte packets
 1  ge2-8.r01.sin01.ne.com.sg (202.150.221.169)  0.132 ms  0.147 ms  0.167 ms
 2  10.11.34.146 (10.11.34.146)  0.389 ms  0.478 ms  0.557 ms
 3  aarnet.sgix.sg (103.16.102.67)  218.351 ms  218.361 ms  218.405 ms
 4  et-7-3-0.pe1.nsw.brwy.aarnet.net.au (113.197.15.232)  212.470 ms  212.498 ms  212.478 ms
 5  138.44.5.1 (138.44.5.1)  208.382 ms  208.448 ms  208.511 ms
 6  libcr1-te-1-5.gw.unsw.edu.au (149.171.255.102)  208.460 ms  208.497 ms  208.365 ms
 7  libudnex1-po-1.gw.unsw.edu.au (149.171.255.166)  209.893 ms  209.566 ms ombudnex1-po-1.gw.unsw.edu.au (149.171.255.202)  216.093 ms
 8  ufw1-ae-1-3154.gw.unsw.edu.au (149.171.253.36)  215.698 ms  215.580 ms  215.614 ms
 9  129.94.39.23 (129.94.39.23)  210.041 ms  210.047 ms  210.043 ms
10  * * *
11  * * *
12  * * *
13  * * *
14  * * *
15  * * *
16  * * *
17  * * *
18  * * *
19  * * *
20  * * *
21  * * *
22  * * *
23  * * *
24  * * *
25  * * *
26  * * *
27  * * *
28  * * *
29  * * *
30  * * *

Traceroute Completed.
```

(iv) www.telstra.net to CSE machine

This traceroute commences from **www.telstra.net**, within **AS 1221**.

Enter the desired destination host.domain or IPv4 or IPv6 address: `129.94.242.119`

```
 1  gigabitethernet3-3.exi2.melbourne.telstra.net (203.50.77.53)  0.254 ms  0.347 ms  0.245 ms
 2  bundle-ether3-100.win-core10.melbourne.telstra.net (203.50.80.129)  1.243 ms  1.862 ms  2.119 ms
 3  bundle-ether12.ken-core10.sydney.telstra.net (203.50.11.122)  12.634 ms  12.734 ms  13.462 ms
 4  bundle-ether1.ken-edge903.sydney.telstra.net (203.50.11.173)  12.362 ms  11.850 ms  11.862 ms
 5  aar3533567.lnk.telstra.net (139.130.0.78)  12.238 ms  21.852 ms  11.612 ms
 6  et-7-1-0.pe1.brwy.nsw.aarnet.net.au (113.197.15.13)  11.864 ms  11.855 ms  11.864 ms
 7  138.44.5.1 (138.44.5.1)  11.988 ms  11.983 ms  11.988 ms
 8  ombcr1-te-1-5.gw.unsw.edu.au (149.171.255.106)  12.113 ms  12.107 ms  11.988 ms
 9  ombudnex1-po-2.gw.unsw.edu.au (149.171.255.170)  12.364 ms  12.232 ms  12.363 ms
10  ufw1-ae-1-3154.gw.unsw.edu.au (149.171.253.36)  12.736 ms  12.731 ms  12.736 ms
11  129.94.39.23 (129.94.39.23)  12.863 ms  12.858 ms  12.863 ms
```

The reverse path does not go through the exact same routers as the forward path, but it does go through some similar ones with similar IP addresses. And even there exists common routers, the IP addresses can be different since each host can have multiple IP addresses and each network can have multiple hosts.

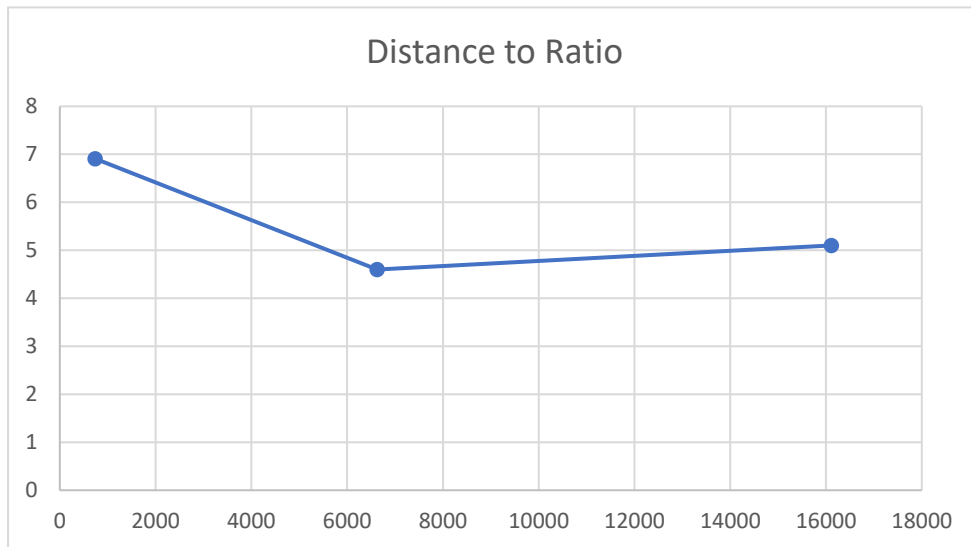## Exercise 4: Use ping to gain insights into network performance

1.

Location	Distance(km)	Time(T)	Min RTT(ms)	Ratio
UQ(Queensland)	735.63km	2.4521ms	16.945ms	6.91
UPM(Malaysia)	6625.87km	22.086ms	101.661ms	4.60
Tech Uni Berlin	16111.09km	53.703ms	273.918ms	5.1

Distance to Ratio

The first reason is that the time it takes to a destination and back will take at least twice as long, packet need to reach and get back. Besides, delays like queueing, transmission and processing delay will make the packet take a longer time to travel. Therefore, the minimum delay (RTT) will be at least twice as the shortest possible time T, hence the y-axis values are greater than 2.

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

It varies over time. Different factors can affect the transmission of packets as well as the delay to the destination. For example, the speed of device and the congestion of network will affect the processing delay to the destinations. Besides, propagation speed over the physical medium may also get affected by some environmental factors and cause some propagation delay.

www.uq.edu.au   www.upm.edu.my   www.tu-berlin.de
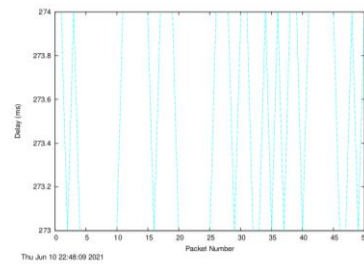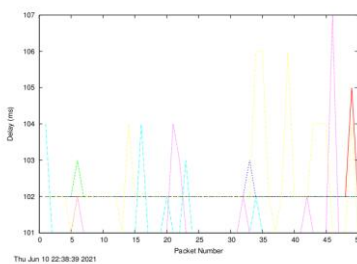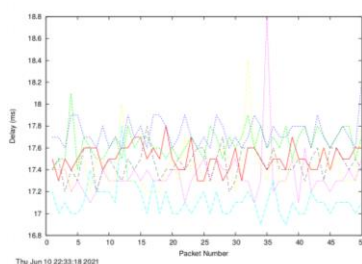
3. Explore where the website for www.epfl.ch is hosted. Is it in Switzerland?

It is hosted by the CloudFlareNet in the San Francisco, US not in Switzerland.

```
z5261536@vx3:/tmp_amd/reed/export/reed/3/z5261536/Desktop/cs3331/lab01$ nslookup www.epfl.ch
Server:          129.94.242.45
Address:         129.94.242.45#53

Non-authoritative answer:
www.epfl.ch      canonical name = www.epfl.ch.cdn.cloudflare.net.
Name:   www.epfl.ch.cdn.cloudflare.net
Address: 104.20.228.42
Name:   www.epfl.ch.cdn.cloudflare.net
Address: 104.20.229.42
Name:   www.epfl.ch.cdn.cloudflare.net
Address: 172.67.2.106
```

```
z5261536@vx3:/tmp_amd/reed/export/reed/3/z5261536/Desktop/cs3331/lab01$ whois 104.20.228.42
#
# ARIN WHOIS data and services are subject to the Terms of Use
# available at: https://www.arin.net/resources/registry/whois/tou/
#
# If you see inaccuracies in the results, please report at
# https://www.arin.net/resources/registry/whois/inaccuracy_reporting/
#
# Copyright 1997-2021, American Registry for Internet Numbers, Ltd.
#


NetRange:       104.16.0.0 - 104.31.255.255
CIDR:           104.16.0.0/12
NetName:        CLOUDFLARENET
NetHandle:      NET-104-16-0-0-1
Parent:         NET104 (NET-104-0-0-0-0)
NetType:        Direct Allocation
OriginAS:       AS13335
Organization:   Cloudflare, Inc. (CLOUD14)
RegDate:        2014-03-28
Updated:        2021-05-26
Comment:        All Cloudflare abuse reporting can be done via https://www.cloudflare.com/abuse
Ref:            https://rdap.arin.net/registry/ip/104.16.0.0


OrgName:        Cloudflare, Inc.
OrgId:          CLOUD14
Address:        101 Townsend Street
City:           San Francisco
StateProv:      CA
PostalCode:     94107
Country:        US
RegDate:        2010-07-09
Updated:        2021-01-11
Ref:            https://rdap.arin.net/registry/entity/CLOUD14
```

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?

Propagation delay is the amount of time it takes for the head of the signal to travel from the sender to the receiver, dependent on the length of physical link on the propagation speed in medium. (No)

Transmission delay is the amount of time required to push all the packet's bit into the wire, so it depends on the packet size and link bandwidth. (Yes)

Processing delay is the time it takes to process a packet in a network node which is dependent on the speed of the device and congestion in the network. (No)

Queuing delay depends on congestion level of router. (No)

Thus, only transmission delay depends on the packet size and the rest are not.