Exercise 1: nslookup

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 IP address of the website www.koala.com.au is 104.18.61.21 and 104.18.61.21 .

```
z5259842@vx5:/tmp_amd/reed/export/reed/2/z5259842/Desktop$ 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: 104.18.60.21
Name:   www.koala.com.au
Address: 104.18.61.21
```

The reason for having several IP addresses as an output could be potentially to optimise routing to prevent traffic and reduce the load. Additionally, if one IP address is down, the other IP address could be used to compensate.

2. **Find out the name of the IP address 127.0.0.1. What is special about this IP address?**

```
z5259842@vx3:/tmp_amd/reed/export/reed/2/z5259842/Desktop$ 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.
```

The name of the IP address 127.0.0.1 is localhost which is also known as the loopback address. The IP address is special because it refers to the local machine only and can not refer to another machine.

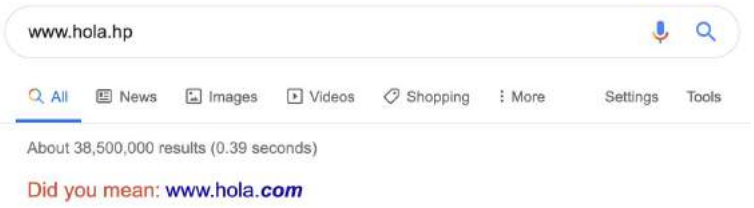
Exercise 2: Use ping to test host reachability

Host	Reachability by Ping	Reachability by web browser
www.unsw.edu.au	Reachable	Reachable
www.getfittest.com.au	Unreachable	Unreachable
www.mit.edu	Reachable	Reachable
www.intel.com.au	Reachable	Reachable
www.tpg.com.au	Reachable	Reachable
www.hola.hp	Unreachable	Unreachable
www.amazon.com	Reachable	Reachable
www.tsinghua.edu.cn	Reachable	Reachable
www.kremlin.ru	Unreachable	Reachable
8.8.8.8	Reachable	Unreachable

```
Ashleys-MacBook-Pro:~ ashleyhuang$ ping www.getfittest.com.au
ping: cannot resolve www.getfittest.com.au: Unknown host
```

www.getfittest.com.au cannot be reached by ping or by web browser because the domain does not exist.

```
Ashleys-MacBook-Pro:~ ashleyhuang$ ping www.hola.hp
ping: cannot resolve www.hola.hp: Unknown host
```



www.hola.hp can not be reached by ping or by web browser because "hp" is not a domain extension. However, www.hola.com is reachable through both ping and web browser.

```
Ashleys-MacBook-Pro:~ ashleyhuang$ ping www.kremlin.ru
PING www.kremlin.ru (95.173.136.71): 56 data bytes
Request timeout for icmp_seq 0
Request timeout for icmp_seq 1
Request timeout for icmp_seq 2
Request timeout for icmp_seq 3
Request timeout for icmp_seq 4
Request timeout for icmp_seq 5
Request timeout for icmp_seq 6
Request timeout for icmp_seq 7
Request timeout for icmp_seq 8
Request timeout for icmp_seq 9
Request timeout for icmp_seq 10
Request timeout for icmp_seq 11
Request timeout for icmp_seq 12
^Z
[3]+  Stopped                 ping www.kremlin.ru
```

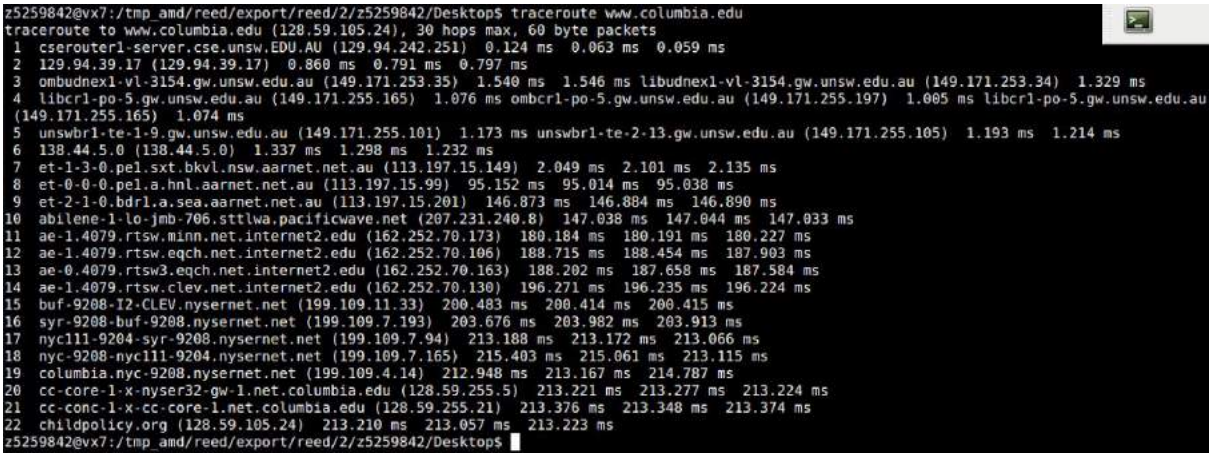
www.kremlin.ru is unreachable by ping, however, it is reachable through the web browser. This is because although the request packets were being successfully sent to the host, the host did not respond to the request and thus no return packets were sent back, thus resulting in request timeout and unreachability through ping. A possible reason could be potentially related to security reasons.

```
Ashleys-MacBook-Pro:~ ashleyhuang$ ping 8.8.8.8
PING 8.8.8.8 (8.8.8.8): 56 data bytes
64 bytes from 8.8.8.8: icmp_seq=0 ttl=56 time=38.831 ms
64 bytes from 8.8.8.8: icmp_seq=1 ttl=56 time=16.935 ms
64 bytes from 8.8.8.8: icmp_seq=2 ttl=56 time=16.684 ms
64 bytes from 8.8.8.8: icmp_seq=3 ttl=56 time=30.049 ms
64 bytes from 8.8.8.8: icmp_seq=4 ttl=56 time=14.413 ms
64 bytes from 8.8.8.8: icmp_seq=5 ttl=56 time=14.870 ms
64 bytes from 8.8.8.8: icmp_seq=6 ttl=56 time=19.609 ms
```

8.8.8.8 is reachable by ping. However, it is not reachable through the web browser. This is because 8.8.8.8 is the IP address for Google's DNS server and there is no web server to allow it to run in the web browser.

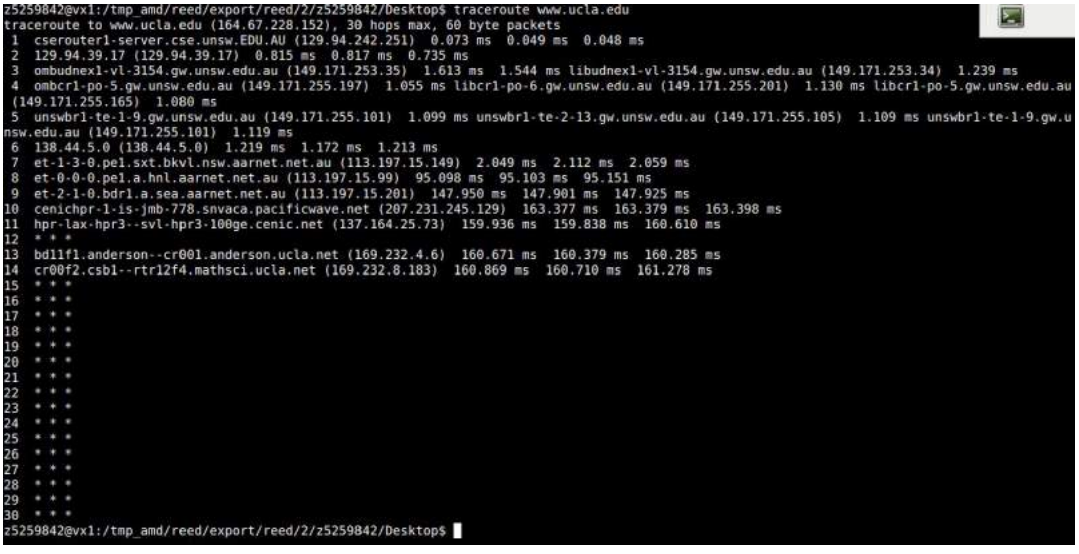
Exercise 3: Use traceroute to understand network topology

1. **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 21 routers. 4 routers are along the path that is part of the UNSW network. The packets cross the Pacific Ocean between routers 113.197.15.149 to 113.197.15.201.

2. **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 to the physical distance?**



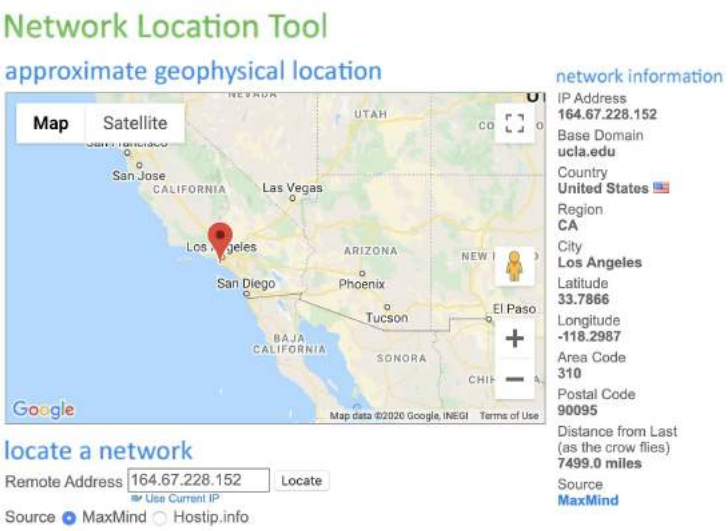
```
z5259842@vx3:/tmp_amd/reed/export/reed/2/z5259842/Desktop$ traceroute www.lancaster.ac.uk
traceroute to www.lancaster.ac.uk (148.88.65.80), 30 hops max, 60 byte packets
 1  cserouter1-server.cse.unsw.EDU.AU (129.94.242.251)  0.093 ms  0.072 ms  0.053 ms
 2  129.94.39.17 (129.94.39.17)  0.883 ms  0.835 ms  0.823 ms
 3  ombudnex1-vl-3154.gw.unsw.edu.au (149.171.253.35)  1.751 ms libudnex1-vl-3154.gw.unsw.edu.au (149.171.253.34)  1.217 ms ombudnex1-vl-315
4.gw.unsw.edu.au (149.171.253.35)  1.710 ms
 4  ombcr1-po-5.gw.unsw.edu.au (149.171.255.197)  1.140 ms  1.100 ms libcr1-po-6.gw.unsw.edu.au (149.171.255.201)  1.110 ms
 5  unswbr1-te-2-13.gw.unsw.edu.au (149.171.255.105)  1.110 ms unswbr1-te-1-9.gw.unsw.edu.au (149.171.255.101)  1.133 ms unswbr1-te-2-13.gw.
unsw.edu.au (149.171.255.105)  1.117 ms
 6  138.44.5.0 (138.44.5.0)  38.414 ms  37.750 ms  37.736 ms
 7  et-2-0-5.bdr1.sing.sin.aarnet.net.au (113.197.15.233)  92.520 ms  92.835 ms  92.816 ms
 8  138.44.226.7 (138.44.226.7)  259.958 ms  259.873 ms  259.821 ms
 9  janet-gw.mx1.lon.uk.geant.net (62.40.124.198)  260.107 ms  260.073 ms  260.031 ms
10  ae29.londpg-sbr2.ja.net (146.97.33.2)  260.783 ms  260.776 ms  260.757 ms
11  ae31.erdiss-sbr2.ja.net (146.97.33.22)  270.732 ms  264.276 ms  264.268 ms
12  ae29.manckh-sbr2.ja.net (146.97.33.42)  266.104 ms  266.107 ms  266.188 ms
13  ae24.lanclu-rbr1.ja.net (146.97.38.58)  268.437 ms  269.162 ms  269.186 ms
14  lancaster-university.ja.net (194.81.46.2)  288.026 ms  288.021 ms  288.004 ms
15  is-border01.bfw01.rtr.lancs.ac.uk (148.88.253.202)  268.923 ms  269.010 ms  268.852 ms
16  bfw01.iss-servers.is-core01.rtr.lancs.ac.uk (148.88.250.98)  275.458 ms  270.918 ms  270.890 ms
17  * * *
18  www.lancs.ac.uk (148.88.65.80)  269.036 ms !X  268.953 ms !X  269.026 ms !X
z5259842@vx3:/tmp_amd/reed/export/reed/2/z5259842/Desktop$
```

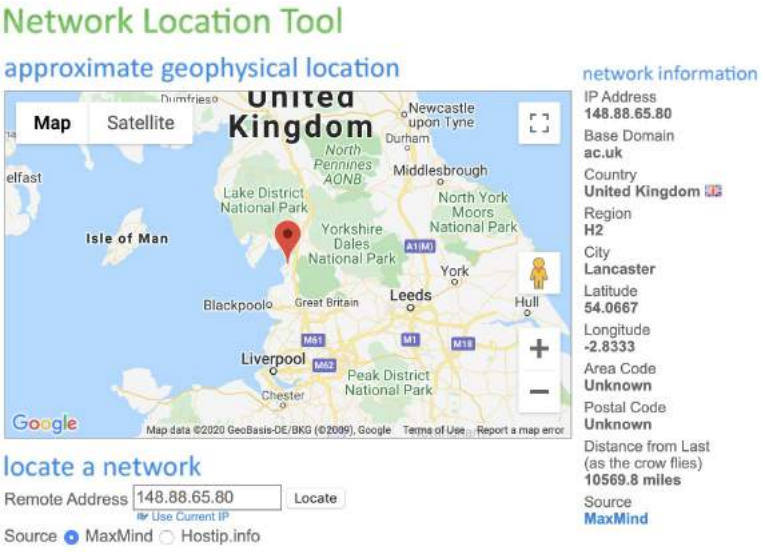
```
z5259842@vx3:/tmp_amd/reed/export/reed/2/z5259842/Desktop$ traceroute  www.u-tokyo.ac.jp
traceroute to www.u-tokyo.ac.jp (210.152.243.234), 30 hops max, 60 byte packets
 1  cserouter1-server.cse.unsw.EDU.AU (129.94.242.251)  0.078 ms  0.054 ms  0.053 ms
 2  129.94.39.17 (129.94.39.17)  0.879 ms  0.868 ms  0.847 ms
 3  libudnex1-vl-3154.gw.unsw.edu.au (149.171.253.34)  1.561 ms  1.552 ms ombudnex1-vl-3154.gw.unsw.edu.au (149.171.253.35)  1.349 ms
 4  ombcr1-po-5.gw.unsw.edu.au (149.171.255.197)  34.056 ms  34.051 ms  34.031 ms
 5  unswbr1-te-2-13.gw.unsw.edu.au (149.171.255.105)  1.119 ms unswbr1-te-1-9.gw.unsw.edu.au (149.171.255.101)  1.134 ms unswbr1-te-2-13.gw.
unsw.edu.au (149.171.255.105)  1.114 ms
 6  138.44.5.0 (138.44.5.0)  1.259 ms  1.282 ms  1.264 ms
 7  et-0-3-0.pe1.bkvl.nsw.aarnet.net.au (113.197.15.147)  1.834 ms  1.760 ms  1.838 ms
 8  ge-4_0_0.bb1.a.pao.aarnet.net.au (202.158.194.177)  154.959 ms  154.907 ms  154.967 ms
 9  paloalto0.iij.net (198.32.176.24)  156.464 ms  156.462 ms  156.476 ms
10  osk004bb01.IIJ.Net (58.138.88.189)  269.287 ms osk004bb00.IIJ.Net (58.138.88.185)  287.119 ms osk004bb01.IIJ.Net (58.138.88.189)  269.22
9 ms
11  osk004ip57.IIJ.Net (58.138.106.162)  277.953 ms osk004ip57.IIJ.Net (58.138.106.166)  269.397 ms  269.337 ms
12  210.130.135.130 (210.130.135.130)  286.920 ms  278.126 ms  278.106 ms
13  124.83.228.58 (124.83.228.58)  276.349 ms  269.448 ms  269.383 ms
14  124.83.252.178 (124.83.252.178)  284.117 ms  292.929 ms  284.318 ms
15  158.205.134.26 (158.205.134.26)  275.208 ms  284.216 ms  275.369 ms
16  * * *
17  * * *
18  * * *
19  * * *
20  * * *
21  * * *
22  * * *
23  * * *
24  * * *
25  * * *
26  * * *
27  * * *
28  * * *
29  * * *
30  * * *
z5259842@vx3:/tmp_amd/reed/export/reed/2/z5259842/Desktop$
```

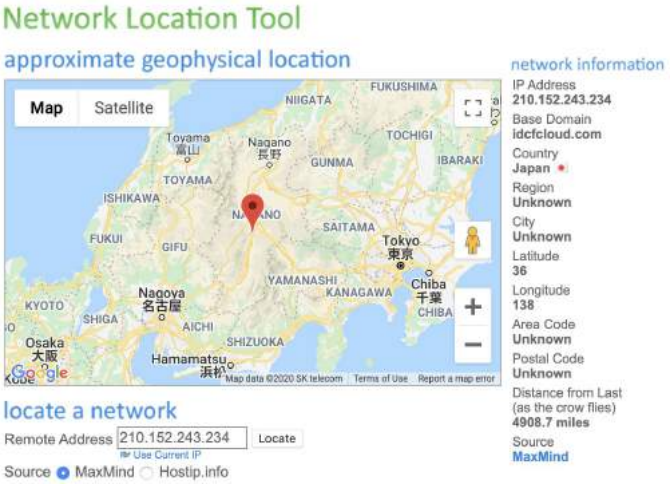
At router 138.44.5.0, the paths from my machine to these three destinations diverge after.

```
inetnum:        113.197.15.0 - 113.197.15.255
netname:        IIPC
descr:          Customer Connection Network
country:        AU
admin-c:        ANOC-AP
tech-c:         ANOC-AP
status:         ASSIGNED NON-PORTABLE
remarks:        AARNet customer network
mnt-by:         MAINT-AARNET-AP
mnt-lower:      MAINT-AARNET-AP
mnt-routes:     MAINT-AARNET-AP
mnt-irt:        IRT-AARNET-AU
last-modified:  2011-10-20T08:36:39Z
source:         APNIC

irt:            IRT-AARNET-AU
address:        AARNet Pty Ltd
address:        26 Dick Perry Avenue
address:        Kensington, Western Australia
address:        Australia
e-mail:         abuse@aarnet.edu.au
abuse-mailbox:  abuse@aarnet.edu.au
admin-c:        SM6-AP
tech-c:         ANOC-AP
auth:           # Filtered
remarks:        abuse@aarnet.edu.au was validated on 2019-12-03
mnt-by:         MAINT-AARNET-AP
last-modified:  2019-12-03T21:30:31Z
source:         APNIC

role:           AARNet Network Operations Centre
remarks:
address:        AARNet Pty Ltd
address:        GPO Box 1559
address:        Canberra
address:        ACT  2601
country:        AU
```

By running the whois command, the address is in 26 Dick Perry Avenue, Kensington, Western Australia. It is also involved in the AARNet Network Operations Centre.







By examining “Distance from Last (as the crow flies)” and the traceroutes, it can be gathered that:

- www.ucla.edu - 7499 miles - at least 14 hops
- www.u-tokyo.ac.jp - 4908.7 miles - at least 15 hops
- www.lancaster.ac.uk - 10569.8 miles - 17 hops

Thus, by observation, the number of hops on each path is not proportional to physical distance because although the location of www.lancaster.ac.uk is further than both www.ucla.edu and www.u-tokyo.ac.jp, the number of hops from www.lancaster.ac.uk will be either similar or possibly less than the other two domains. Therefore, it is not proportional.

3. **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?**

Traceroute from home to Singapore Speedtest:

```
z5259842@vx3:/tmp_amd/reed/export/reed/2/z5259842/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)  0.090 ms  0.066 ms  0.044 ms
 2  129.94.39.17 (129.94.39.17)  0.890 ms  0.824 ms  0.821 ms
 3  ombudnex1-vl-3154.gw.unsw.edu.au (149.171.253.35)  1.455 ms  1.448 ms libudnex1-vl-3154.gw.unsw.edu.au (149.171.253.34)  1.714 ms
 4  ombcr1-po-6.gw.unsw.edu.au (149.171.255.169)  1.095 ms ombcr1-po-5.gw.unsw.edu.au (149.171.255.197)  1.125 ms libcr1-po-6.gw.unsw.edu.au
(149.171.255.201)  1.041 ms
 5  unswbr1-te-2-13.gw.unsw.edu.au (149.171.255.105)  1.132 ms  1.142 ms unswbr1-te-1-9.gw.unsw.edu.au (149.171.255.101)  1.151 ms
 6  138.44.5.0 (138.44.5.0)  1.316 ms  1.277 ms  1.270 ms
 7  et-0-3-0.pe1.alxd.nsw.aarnet.net.au (113.197.15.153)  2.517 ms  2.083 ms  2.137 ms
 8  xe-0-2-7.bdr1.a.lax.aarnet.net.au (202.158.194.173)  147.602 ms  147.597 ms  147.548 ms
 9  singtel.as7473.any2ix.coresite.com (206.72.210.63)  148.000 ms  147.992 ms  147.975 ms
10  203.208.172.153 (203.208.172.153)  324.883 ms 203.208.171.117 (203.208.171.117)  149.549 ms  149.566 ms
11  203.208.177.110 (203.208.177.110)  330.352 ms 203.208.151.233 (203.208.151.233)  237.636 ms  237.606 ms
12  203.208.182.253 (203.208.182.253)  321.553 ms * 203.208.158.17 (203.208.158.17)  317.625 ms
13  203.208.177.110 (203.208.177.110)  335.386 ms 203.208.158.185 (203.208.158.185)  330.774 ms 202-150-221-170.rev.ne.com.sg (202.150.221.1
70)  212.396 ms
z5259842@vx3:/tmp_amd/reed/export/reed/2/z5259842/Desktop$
```

Traceroute from Singapore Speed Test to home:

Traceroute From Singapore To (Hostname/IP Address):

Submit

Traceroute Result:

```
traceroute to 202.172.108.174 (202.172.108.174), 30 hops max, 60 byte packets
 1  ge2-8.r01.sin01.ne.com.sg (202.150.221.169)  0.134 ms  0.169 ms  0.188 ms
 2  10.15.62.222 (10.15.62.222)  33.168 ms  33.183 ms  33.195 ms
 3  vlan844.r01.hkg01.ne.com.sg (203.174.80.105)  33.687 ms  33.893 ms  33.999 ms
 4  HundredGE0-3-0-0.br02.hkg08.pccwbtn.net (63.223.29.194)  34.006 ms  34.103 ms  34.211 ms
 5  63-218-205-10.static.pccwglobal.net (63.218.205.10)  34.865 ms  34.874 ms  34.692 ms
 6  203.208.151.93 (203.208.151.93)  34.975 ms  34.935 ms  34.948 ms
 7  203.208.177.190 (203.208.177.190)  151.403 ms  153.044 ms  153.343 ms
 8  59.154.142.46 (59.154.142.46)  154.131 ms  154.180 ms 59.154.18.148 (59.154.18.148)  154.415 ms
 9  202.139.16.66 (202.139.16.66)  153.603 ms  153.813 ms  153.690 ms
10  203.23.236.5 (203.23.236.5)  154.581 ms  154.452 ms  154.788 ms
11  be40.bng01.syd01.spintel.net.au (203.23.236.11)  155.655 ms  155.719 ms  155.306 ms
12  * * *
13  * * *
14  * * *
15  * * *
16  * * *
17  * * *
18  * * *
19  * * *
20  * * *
21  * * *
22  * * *
23  * * *
24  * * *
25  * * *
26  * * *
27  * * *
28  * * *
29  * * *
30  * * *
```

Traceroute Completed.

Traceroute from home to Telstra:

```
z5259842@vx3:/tmp_amd/reed/export/reed/2/z5259842/Desktop$ traceroute 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)  0.070 ms  0.064 ms  0.052 ms
 2  129.94.39.17 (129.94.39.17)  0.826 ms  0.836 ms  0.838 ms
 3  ombudnex1-vl-3154.gw.unsw.edu.au (149.171.253.35)  1.254 ms  1.341 ms  1.487 ms
 4  libcr1-po-5.gw.unsw.edu.au (149.171.255.165)  1.169 ms  1.174 ms ombcr1-po-5.gw.unsw.edu.au (149.171.255.197)  1.118 ms
 5  unswbr1-te-2-13.gw.unsw.edu.au (149.171.255.105)  1.295 ms unswbr1-te-1-9.gw.unsw.edu.au (149.171.255.101)  1.186 ms unswbr1-te-2-13.gw.
unsw.edu.au (149.171.255.105)  1.287 ms
 6  138.44.5.0 (138.44.5.0)  1.376 ms  1.274 ms  1.269 ms
 7  xe-0-0-0.bdr1.rsby.nsw.aarnet.net.au (113.197.15.33)  11.453 ms  11.361 ms  11.326 ms
 8  gigabitethernet3-11.ken37.sydney.telstra.net (139.130.0.77)  2.106 ms  3.260 ms  3.204 ms
 9  bundle-ether13.ken-core10.sydney.telstra.net (203.50.11.94)  3.959 ms bundle-ether2.chw-edge901.sydney.telstra.net (203.50.11.103)  2.37
7 ms  2.220 ms
10  bundle-ether10.win-core10.melbourne.telstra.net (203.50.11.123)  14.064 ms bundle-ether13.chw-core10.sydney.telstra.net (203.50.11.98)
3.584 ms bundle-ether10.win-core10.melbourne.telstra.net (203.50.11.123)  13.948 ms
11  203.50.6.40 (203.50.6.40)  13.830 ms bundle-ether8.exi-core10.melbourne.telstra.net (203.50.11.125)  14.289 ms 203.50.6.40 (203.50.6.40)
  13.571 ms
12  bundle-ether2.exi-ncprouter101.melbourne.telstra.net (203.50.11.209)  13.453 ms  13.083 ms  13.244 ms
13  www.telstra.net (203.50.5.178)  12.652 ms  12.653 ms  12.401 ms
z5259842@vx3:/tmp_amd/reed/export/reed/2/z5259842/Desktop$
```

Traceroute from Telstra to home:

```
 1  gigabitethernet3-3.exi1.melbourne.telstra.net (203.50.77.49)  0.258 ms  0.270 ms  0.242 ms
 2  bundle-ether3-100.exi-core10.melbourne.telstra.net (203.50.80.1)  1.740 ms  1.417 ms  2.242 ms
 3  bundle-ether12.chw-core10.sydney.telstra.net (203.50.11.124)  13.110 ms  13.036 ms  11.608 ms
 4  bundle-ether1.chw-edge903.sydney.telstra.net (203.50.11.177)  11.733 ms  11.912 ms  11.485 ms
 5  opt2823000.lnk.telstra.net (110.145.206.62)  12.360 ms  12.536 ms  12.485 ms
```

The IP addresses of the two servers I have chosen are 202.150.221.170 (http://www.speedtest.com.sg/tr.php) and 203.50.5.178 (https://www.telstra.net/cgi-bin/trace) by using nslookup. Through observation, the reverse path does not go through the same routers as the forward path. Common routers between the forward and reverse path were not observed. Common IP addresses were also not observed.

Exercise 4: Use ping to gain insights into network performance

```
z5259842@vx3:/tmp_amd/reed/export/reed/2/z5259842/Downloads$ ./runping.sh www.uq.edu.au

ping -s 22 -c 50 -i 1 www.uq.edu.au > www.uq.edu.au-p50
ping -s 222 -c 50 -i 1 www.uq.edu.au > www.uq.edu.au-p250
ping -s 472 -c 50 -i 1 www.uq.edu.au > www.uq.edu.au-p500
ping -s 722 -c 50 -i 1 www.uq.edu.au > www.uq.edu.au-p750
ping -s 972 -c 50 -i 1 www.uq.edu.au > www.uq.edu.au-p1000
ping -s 1222 -c 50 -i 1 www.uq.edu.au > www.uq.edu.au-p1250
ping -s 1472 -c 50 -i 1 www.uq.edu.au > www.uq.edu.au-p1500


z5259842@vx3:/tmp_amd/reed/export/reed/2/z5259842/Downloads$ ./runping.sh www.dlsu.edu.ph

ping -s 22 -c 50 -i 1 www.dlsu.edu.ph > www.dlsu.edu.ph-p50
ping -s 222 -c 50 -i 1 www.dlsu.edu.ph > www.dlsu.edu.ph-p250
ping -s 472 -c 50 -i 1 www.dlsu.edu.ph > www.dlsu.edu.ph-p500
ping -s 722 -c 50 -i 1 www.dlsu.edu.ph > www.dlsu.edu.ph-p750
ping -s 972 -c 50 -i 1 www.dlsu.edu.ph > www.dlsu.edu.ph-p1000
ping -s 1222 -c 50 -i 1 www.dlsu.edu.ph > www.dlsu.edu.ph-p1250
ping -s 1472 -c 50 -i 1 www.dlsu.edu.ph > www.dlsu.edu.ph-p1500
```

```
z5259842@vx3:/tmp_amd/reed/export/reed/2/z5259842/Downloads$ ./runping.sh www.tu-berlin.de

ping -s 22 -c 50 -i 1 www.tu-berlin.de > www.tu-berlin.de-p50
ping -s 222 -c 50 -i 1 www.tu-berlin.de > www.tu-berlin.de-p250
ping -s 472 -c 50 -i 1 www.tu-berlin.de > www.tu-berlin.de-p500
ping -s 722 -c 50 -i 1 www.tu-berlin.de > www.tu-berlin.de-p750
ping -s 972 -c 50 -i 1 www.tu-berlin.de > www.tu-berlin.de-p1000
ping -s 1222 -c 50 -i 1 www.tu-berlin.de > www.tu-berlin.de-p1250
ping -s 1472 -c 50 -i 1 www.tu-berlin.de > www.tu-berlin.de-p1500


z5259842@vx3:/tmp_amd/reed/export/reed/2/z5259842/Downloads$
```

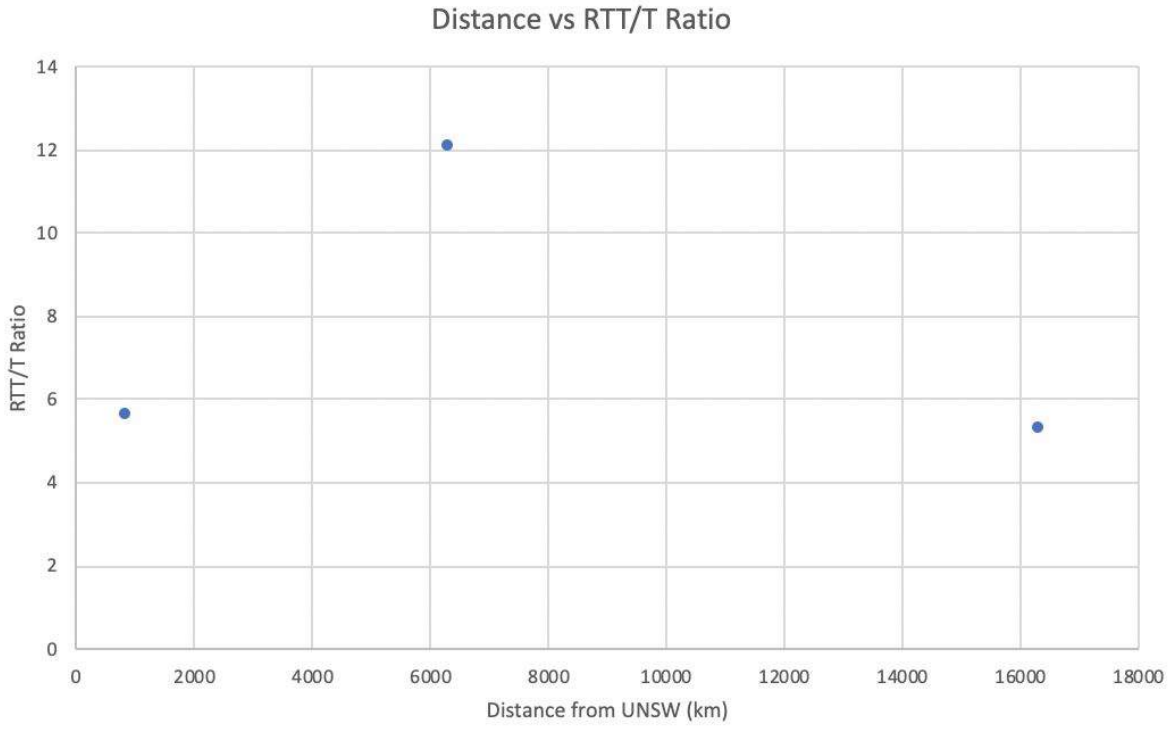
1. **For each of these locations find the (approximate) physical distance from UNSW using Google Maps and compute the shortest possible time T for a packet to reach that location from UNSW. You should assume that the packet moves (i.e. propagates) at the speed of light, 3 x 10 8 m/s. Note that the shortest 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?**

Host	Distance from UNSW (km)	Time (seconds)	RTT/T Ratio (4 d.p.)
www.uq.edu.au	891	0.00297	$\frac{16.518}{0.00297\times1000}$ = 5.5616
www.dlsu.edu.ph	6340	0.02113	$\frac{254.457}{0.02113\times1000}$ = 12.0425
www.tu-berlin.de	16338	0.05446	$\frac{287.557}{0.05446\times1000}$ = 5.2802

```
--- www.uq.edu.au ping statistics ---
50 packets transmitted, 50 received, 0% packet loss, time 49085ms
rtt min/avg/max/mdev = 16.518/16.846/18.074/0.390 ms
```

```
--- www.dlsu.edu.ph ping statistics ---
50 packets transmitted, 50 received, 0% packet loss, time 1071523ms
rtt min/avg/max/mdev = 254.457/255.318/264.480/1.424 ms
```

```
--- www.tu-berlin.de ping statistics ---
50 packets transmitted, 50 received, 0% packet loss, time 49072ms
rtt min/avg/max/mdev = 287.557/288.220/311.173/3.343 ms
```



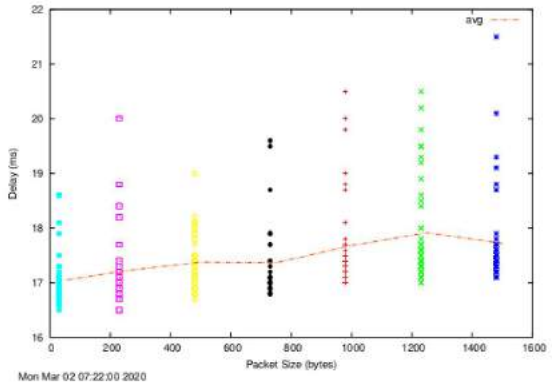
Two reasons why the y-axis values are greater than 2:

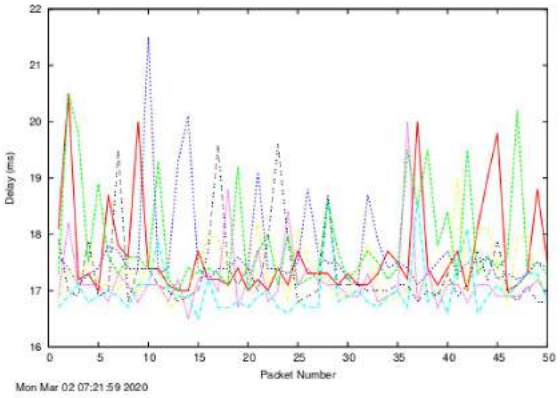
One of the reasons that the y-axis values are greater than 2 is that the transfer medium is assumed to travel at the speed of light which is only possible in the perfect conditions of a vacuum which is highly unlikely due to delays and traffic. The minimum time for a round-trip to occur would be 2T. Thus, another reason that contributes to a y-axis value greater than 2 involves delays in processing, queueing, transmission and propagation of packets, thus the RTT/T ratio ultimately increases and is greater than 2. External sources of interference could also impact on the increase of y-axis values.

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

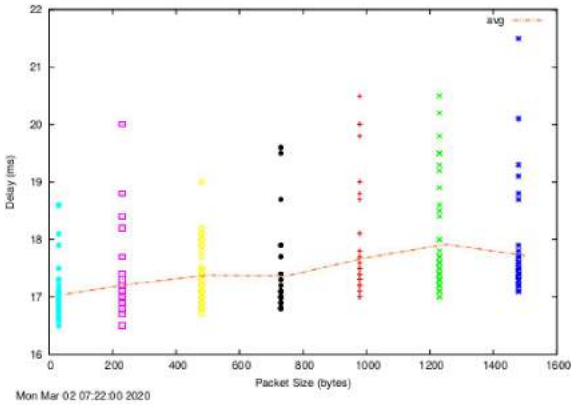
By examining the graphs, the delay to the destinations vary over time. This is because each individual router has its own delays and traffic that fluctuate over time, thus varying the delay.

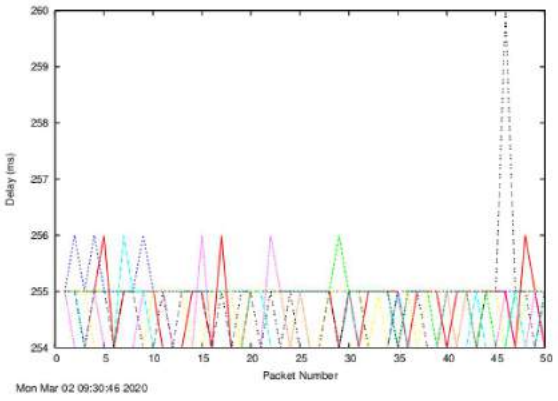
www.uq.edu.au



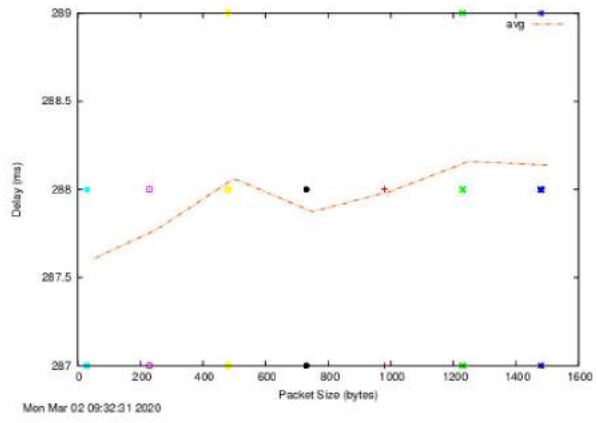


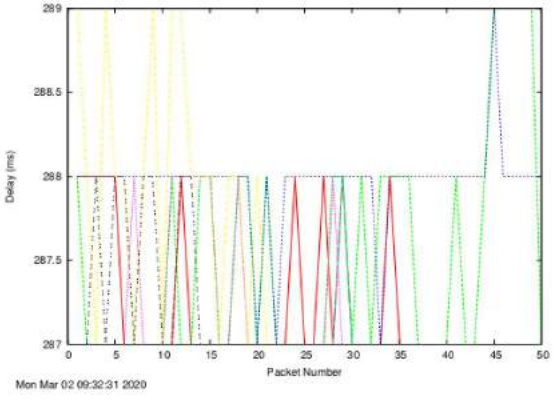
www.dlsu.edu.ph





www.tu-berlin.de





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

Whois Record for EPFL.ch

— Domain Profile

Registrar Status	taken
Name Servers	STISUN1.EPFL.CH (has 54 domains) STISUN2.EPFL.CH (has 54 domains)
Tech Contact	—
IP Address	104.20.228.42 is hosted on a dedicated server
IP Location	- California - San Francisco - Cloudflare Inc.
ASN	AS13335 CLOUDFLARENET, US (registered Jul 14, 2010)

— Website

Website Title	500 SSL negotiation failed:
Response Code	500

Whois Record (last updated on 2020-03-01)

```
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
```

The website is not hosted in Switzerland, the IP address and IP location show that it is hosted in California, San Francisco.

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?**

Types of Delays	**Dependence on Packet Size**
Propagation delay	Independent, it depends on the speed of light and the distance it is required to travel
Transmission delay	Dependent, the larger the packet size, the more bits that are required to be transmitted
Process delay	Dependent, the amount of time it takes to decode the packet will vary depending on packet size and complexity
Queueing delay	Independent, it depends on how many packets are in the queue already (traffic) rather than the packet size itself