

COMP3331 Lab01 Report

Exercise 1

1. The IP address of www.koala.com.au is 104.21.45.210 and 172.67.219.46. In my opinion, a website such as koala.com will have an intermediate level of traffic and possibly high traffic during sales. Thus, during peak traffic, it may be impossible to answer all requests through one IP address. To mitigate this problem, several servers and IP addresses are used to even the load.

```
z5255891@vx5:/tmp_amd/ravel/export/ravel/4/z5255891/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 is localhost. This IP address is special as it refers to the loopback address from the local computer. It is often used to test network services **inside** your own network. For example, if you have a locally coded website you can run it in a web browser if you run it through <http://localhost>. However, if you were to send any packets **outside** of your network, you cannot use localhost.

```
z5255891@vx5:/tmp_amd/ravel/export/ravel/4/z5255891/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.
```

Exercise 2

The results from testing if the following hosts are reachable from my machine are below:

Host	Reachable by Ping	Reachable by browser
www.unsw.edu.au	Yes	Yes
www.getfittest.com.au	No	No
www.mit.edu	Yes	Yes
www.intel.com.au	Yes	Yes
www.tpg.com.au	Yes	Yes
www.hola.hp	No	No
www.amazon.com	Yes	Yes
www.tsinghua.edu.cn	Yes	Yes
www.kremlin.ru	No	Yes
8.8.8.8	Yes	No

Most of the websites given I was able to reach by ping and through browser. For the cases of **www.getfittest.com** and **www.hola.hp**, they were unreachable by both ping and browser. The message “unknown host” for the ping test means that the website does not exist at all. For the case of **www.kremlinn.ru**, the website was able to be reached however it was unreachable by ping as no packets were received. This means that for whatever reason, the website has blocked the Internet Control Message Protocol (ICMP). In this case, it seems to be a government website and they chose to block the ICMP for security reasons. In the case of **8.8.8.8**, I was able to reach it by ping but not by browser. This because it is a public DNS server provided by Google, not a website.

Below are screenshots of each ping test.

www.unsw.edu.au

```
z5255891@vx4:/tmp_amd/ravel/export/ravel/4/z5255891$ ping www.unsw.edu.au
PING cdn.prod65.unsw.adobecqms.net (13.226.106.23) 56(84) bytes of data.
64 bytes from server-13-226-106-23.syd4.r.cloudfront.net (13.226.106.23): icmp_seq=1 ttl=244 time=1.14 ms
64 bytes from server-13-226-106-23.syd4.r.cloudfront.net (13.226.106.23): icmp_seq=2 ttl=244 time=1.17 ms
64 bytes from server-13-226-106-23.syd4.r.cloudfront.net (13.226.106.23): icmp_seq=3 ttl=244 time=1.13 ms
^C
--- cdn.prod65.unsw.adobecqms.net ping statistics ---
3 packets transmitted, 3 received, 0% packet loss, time 2003ms
rtt min/avg/max/mdev = 1.138/1.152/1.176/0.042 ms
```

www.getfittest.com.au

```
z5255891@vx4:/tmp_amd/ravel/export/ravel/4/z5255891$ ping www.getfittest.com.au
ping: unknown host www.getfittest.com.au
```

www.mit.edu

```
z5255891@vx4:/tmp_amd/ravel/export/ravel/4/z5255891$ ping www.mit.edu
PING e9566.dscb.akamaiedge.net (23.77.146.209) 56(84) bytes of data.
64 bytes from a23-77-146-209.deploy.static.akamaitechnologies.com (23.77.146.209): icmp_seq=1 ttl=56 time=1.28 ms
64 bytes from a23-77-146-209.deploy.static.akamaitechnologies.com (23.77.146.209): icmp_seq=2 ttl=56 time=1.24 ms
64 bytes from a23-77-146-209.deploy.static.akamaitechnologies.com (23.77.146.209): icmp_seq=3 ttl=56 time=1.40 ms
^C
--- e9566.dscb.akamaiedge.net ping statistics ---
3 packets transmitted, 3 received, 0% packet loss, time 2003ms
rtt min/avg/max/mdev = 1.243/1.310/1.405/0.074 ms
```

www.intel.com.au

```
z5255891@vx4:/tmp_amd/ravel/export/ravel/4/z5255891$ ping www.intel.com.au
PING e19235.dsca.akamaiedge.net (23.8.95.246) 56(84) bytes of data.
64 bytes from a23-8-95-246.deploy.static.akamaitechnologies.com (23.8.95.246): icmp_seq=1 ttl=56 time=2.12 ms
64 bytes from a23-8-95-246.deploy.static.akamaitechnologies.com (23.8.95.246): icmp_seq=2 ttl=56 time=1.27 ms
64 bytes from a23-8-95-246.deploy.static.akamaitechnologies.com (23.8.95.246): icmp_seq=3 ttl=56 time=1.21 ms
^C
--- e19235.dsca.akamaiedge.net ping statistics ---
3 packets transmitted, 3 received, 0% packet loss, time 2002ms
rtt min/avg/max/mdev = 1.214/1.536/2.126/0.419 ms
```

www.tpg.com.au

```
z5255891@vx4:/tmp_amd/ravel/export/ravel/4/z5255891$ ping www.tpg.com.au
PING www.tpg.com.au (203.26.27.38) 56(84) bytes of data.
64 bytes from www.tpg.com.au (203.26.27.38): icmp_seq=1 ttl=119 time=1.67 ms
64 bytes from www.tpg.com.au (203.26.27.38): icmp_seq=2 ttl=119 time=1.68 ms
64 bytes from www.tpg.com.au (203.26.27.38): icmp_seq=3 ttl=119 time=1.61 ms
^C
--- www.tpg.com.au ping statistics ---
3 packets transmitted, 3 received, 0% packet loss, time 2002ms
rtt min/avg/max/mdev = 1.619/1.661/1.689/0.056 ms
```

www.hola.hp

```
z5255891@vx4:/tmp_amd/ravel/export/ravel/4/z5255891$ ping www.hola.hp
ping: unknown host www.hola.hp
```

www.amazon.com

```
z5255891@vx4:/tmp_amd/ravel/export/ravel/4/z5255891$ ping www.amazon.com
PING d3ag4hukkh62yn.cloudfront.net (13.226.110.30) 56(84) bytes of data.
64 bytes from server-13-226-110-30.syd4.r.cloudfront.net (13.226.110.30): icmp_seq=1 ttl=244 time=1.27 ms
64 bytes from server-13-226-110-30.syd4.r.cloudfront.net (13.226.110.30): icmp_seq=2 ttl=244 time=1.24 ms
64 bytes from server-13-226-110-30.syd4.r.cloudfront.net (13.226.110.30): icmp_seq=3 ttl=244 time=1.20 ms
^C
--- d3ag4hukkh62yn.cloudfront.net ping statistics ---
3 packets transmitted, 3 received, 0% packet loss, time 2003ms
rtt min/avg/max/mdev = 1.202/1.239/1.276/0.041 ms
```

www.tsinghua.edu.cn

```
z5255891@vx4:/tmp_amd/ravel/export/ravel/4/z5255891$ ping www.tsinghua.edu.cn
PING www.tsinghua.edu.cn (166.111.4.100) 56(84) bytes of data.
64 bytes from www.tsinghua.edu.cn (166.111.4.100): icmp_seq=1 ttl=44 time=174 ms
64 bytes from www.tsinghua.edu.cn (166.111.4.100): icmp_seq=2 ttl=44 time=174 ms
64 bytes from www.tsinghua.edu.cn (166.111.4.100): icmp_seq=3 ttl=44 time=174 ms
^C
--- www.tsinghua.edu.cn ping statistics ---
3 packets transmitted, 3 received, 0% packet loss, time 2002ms
rtt min/avg/max/mdev = 174.064/174.111/174.168/0.043 ms
```

www.kremlin.ru

```
z5255891@vx4:/tmp_amd/ravel/export/ravel/4/z5255891$ ping www.kremlin.ru
PING www.kremlin.ru (95.173.136.71) 56(84) bytes of data.
^C
--- www.kremlin.ru ping statistics ---
11 packets transmitted, 0 received, 100% packet loss, time 10239ms
```

8.8.8.8

```
z5255891@vx4:/tmp_amd/ravel/export/ravel/4/z5255891$ ping 8.8.8.8
PING 8.8.8.8 (8.8.8.8) 56(84) bytes of data.
64 bytes from 8.8.8.8: icmp_seq=1 ttl=115 time=1.28 ms
64 bytes from 8.8.8.8: icmp_seq=2 ttl=115 time=1.26 ms
64 bytes from 8.8.8.8: icmp_seq=3 ttl=115 time=1.23 ms
^C
--- 8.8.8.8 ping statistics ---
3 packets transmitted, 3 received, 0% packet loss, time 2002ms
rtt min/avg/max/mdev = 1.234/1.261/1.281/0.035 ms
```

Exercise 3

1. The output for running traceroute to www.columbia.edu is below:

```
z5255891@vx4:/tmp_amd/ravel/export/ravel/4/z5255891$ traceroute www.columbia.edu
traceroute to www.columbia.edu (128.59.105.24), 30 hops max, 60 byte packets
 0 cserouter1-server.cse.unsw.EDU.AU (129.94.242.251) 0.075 ms 0.050 ms 0.070 ms
 1 129.94.39.17 (129.94.39.17) 0.872 ms 0.826 ms 0.885 ms
 2 libudnxt1-vl-3154.gw.unsw.edu.au (149.171.253.34) 1.373 ms ombudnxt1-vl-3154.gw.unsw.edu.au (149.171.253.35) 5.514 ms 5.516 ms
 3 ombcr1-po-5.gw.unsw.edu.au (149.171.255.197) 1.115 ms libcr1-po-5.gw.unsw.edu.au (149.171.255.165) 1.126 ms libcr1-po-6.gw.unsw.edu.au (149.171.255.201) 1.128 ms
 4 unswbr1-te-2-13.gw.unsw.edu.au (149.171.255.105) 1.222 ms 1.217 ms unswbr1-te-1-9.gw.unsw.edu.au (149.171.255.101) 1.236 ms
 5 138.44.5.0 (138.44.5.0) 1.362 ms 1.330 ms 1.294 ms
 6 et-1-3-0.pe1.sxt.bkvl.nsw.aarnet.net.au (113.197.15.149) 2.147 ms 1.836 ms 1.835 ms
 7 et-0-0-0.pe1.a.hnl.aarnet.net.au (113.197.15.99) 95.229 ms 95.267 ms 95.366 ms
 8 et-2-1-0.bdr1.a.sea.aarnet.net.au (113.197.15.201) 146.660 ms 146.724 ms 146.681 ms
 9 abilene-1-lo-jmb-706.sttlwa.pacificwave.net (207.231.240.8) 177.523 ms 177.531 ms 177.506 ms
10 ae-1.4079.rtsw.minn.net.internet2.edu (162.252.70.173) 202.104 ms 202.109 ms 202.068 ms
11 ae-1.4079.rtsw.eqch.net.internet2.edu (162.252.70.106) 207.149 ms 207.317 ms 206.950 ms
12 ae-0.4079.rtsw3.eqch.net.internet2.edu (162.252.70.163) 254.563 ms 234.826 ms 234.723 ms
13 ae-1.4079.rtsw.clev.net.internet2.edu (162.252.70.130) 212.841 ms 212.757 ms 212.851 ms
14 buf-9208-12-CLEV.nysernet.net (199.109.11.33) 216.339 ms 216.460 ms 216.437 ms
15 syr-55a1-buf-9208.nysernet.net (199.109.7.213) 219.874 ms 219.879 ms 219.851 ms
16 nyc32-55a1-syr-55a1.nysernet.net (199.109.7.206) 225.303 ms 225.396 ms 225.267 ms
17 nyc32-9208-nyc32-55a1.nysernet.net (199.109.7.201) 225.097 ms 225.018 ms 225.148 ms
18 columbia.nyc-9208.nysernet.net (199.109.4.14) 224.840 ms 224.736 ms 224.669 ms
19 cc-core-1-x-cc-core-1.net.columbia.edu (128.59.255.5) 225.096 ms 226.118 ms 225.123 ms
20 cc-conc-1-x-cc-core-1.net.columbia.edu (128.59.255.21) 225.114 ms 225.178 ms 225.021 ms
21 www-ltm.cc.columbia.edu (128.59.105.24) 224.940 ms 224.960 ms 225.052 ms
```


From the output above, we can determine that there are 22 routers between my workstation and www.columbia.edu. There are also 4 routers which are part of the UNSW network, namely 1,3,4,5 and we can determine this from the name of the routers. To determine when my packet had crossed the Pacific Ocean, I used ping to test the round times for each router. I found that hop 7 [113.197.15.149] had an average ms of 1.939 and hop 8 [113.197.15.99] had an average ms of 96.220. Thus, this sudden jump is explained by the crossing of the Pacific Ocean.

Below are the two ping tests for hop 7 and hop 8 respectively.

```
z5255891@vx4:/tmp_amd/ravel/export/ravel/4/z5255891$ ping 113.197.15.149
PING 113.197.15.149 (113.197.15.149) 56(84) bytes of data.
64 bytes from 113.197.15.149: icmp_seq=1 ttl=58 time=1.80 ms
64 bytes from 113.197.15.149: icmp_seq=2 ttl=58 time=2.08 ms
64 bytes from 113.197.15.149: icmp_seq=3 ttl=58 time=1.90 ms
64 bytes from 113.197.15.149: icmp_seq=4 ttl=58 time=1.96 ms
^C
--- 113.197.15.149 ping statistics ---
4 packets transmitted, 4 received, 0% packet loss, time 3004ms
rtt min/avg/max/mdev = 1.804/1.939/2.082/0.109 ms
```

```
z5255891@vx4:/tmp_amd/ravel/export/ravel/4/z5255891$ ping 113.197.15.99
PING 113.197.15.99 (113.197.15.99) 56(84) bytes of data.
64 bytes from 113.197.15.99: icmp_seq=1 ttl=57 time=95.1 ms
64 bytes from 113.197.15.99: icmp_seq=2 ttl=57 time=95.4 ms
64 bytes from 113.197.15.99: icmp_seq=3 ttl=57 time=99.3 ms
64 bytes from 113.197.15.99: icmp_seq=4 ttl=57 time=95.0 ms
^C
--- 113.197.15.99 ping statistics ---
4 packets transmitted, 4 received, 0% packet loss, time 3002ms
rtt min/avg/max/mdev = 95.008/96.220/99.322/1.797 ms
```

2. I) Below is the output for running traceroute to www.ucla.edu

```
z5255891@vx4:/tmp_amd/ravel/export/ravel/4/z5255891$ traceroute www.ucla.edu
traceroute to www.ucla.edu (164.67.228.152), 30 hops max, 60 byte packets
 1 cserouter1-server.cse.unsw.EDU.AU (129.94.242.251) 0.115 ms 0.082 ms 0.058 ms
 2 129.94.39.17 (129.94.39.17) 0.861 ms 0.849 ms 0.827 ms
 3 ombudnex1-vl-3154.gw.unsw.edu.au (149.171.253.35) 1.479 ms libudnex1-vl-3154.gw.unsw.edu.au (14
 9.171.253.34) 1.365 ms ombudnex1-vl-3154.gw.unsw.edu.au (149.171.253.35) 1.435 ms
 4 libcr1-po-6.gw.unsw.edu.au (149.171.255.201) 1.120 ms ombcr1-po-5.gw.unsw.edu.au (149.171.255.1
 97) 1.127 ms 1.125 ms
 5 unswbr1-te-1-9.gw.unsw.edu.au (149.171.255.101) 4.561 ms unswbr1-te-2-13.gw.unsw.edu.au (149.17
 1.255.105) 4.504 ms unswbr1-te-1-9.gw.unsw.edu.au (149.171.255.101) 4.568 ms
 6 138.44.5.0 (138.44.5.0) 1.280 ms 1.673 ms 1.658 ms
 7 et-1-3-0.pel.sxt.bkvl.nsw.aarnet.net.au (113.197.15.149) 1.903 ms 1.968 ms 1.943 ms
 8 et-0-0-0.pel.a.hnl.aarnet.net.au (113.197.15.99) 95.361 ms 95.217 ms 95.246 ms
 9 et-2-1-0.bdr1.a.sea.aarnet.net.au (113.197.15.201) 146.670 ms 146.659 ms 146.650 ms
10 cenichpr-1-is-jmb-778.snvaca.pacificwave.net (207.231.245.129) 163.837 ms 163.835 ms 163.174
 ms
11 svl-aggl0-hpr--svl-hpr3--100g.cenic.net (137.164.25.106) 164.168 ms 163.983 ms 164.276 ms
12 hpr-lax-aggl0--svl-aggl0-100ge.cenic.net (137.164.25.73) 160.768 ms 160.837 ms 159.967 ms
13 * * *
14 bd11f1.anderson--cr00f2.csbl.ucla.net (169.232.4.4) 161.004 ms 160.380 ms 161.185 ms
15 cr00f2.csbl--rtr11f4.mathsci.ucla.net (169.232.8.181) 160.349 ms cr00f1.anderson--rtr11f4.maths
 ci.ucla.net (169.232.8.185) 161.381 ms 160.548 ms
16 * * *
17 * * *
18 * * *
19 * * *
```

II) Below is the output for running traceroute to www.u-tokyo.ac.jp

```
z5255891@vx4:/tmp_amd/ravel/export/ravel/4/z5255891$ 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) 0.132 ms 0.098 ms 0.074 ms
 2 129.94.39.17 (129.94.39.17) 0.899 ms 0.887 ms 0.865 ms
 3 libudnex1-vl-3154.gw.unsw.edu.au (149.171.253.34) 1.776 ms 1.720 ms ombudnex1-vl-3154.gw.unsw.edu.au (149.171.253.35) 1.401 ms
 4 ombcr1-po-6.gw.unsw.edu.au (149.171.255.169) 1.229 ms libcr1-po-5.gw.unsw.edu.au (149.171.255.165) 17.149 ms libcr1-po-6.gw.unsw.edu.au (149.171.255.201) 17.141 ms
 5 unswbr1-te-1-9.gw.unsw.edu.au (149.171.255.101) 1.274 ms 1.263 ms unswbr1-te-2-13.gw.unsw.edu.au (149.171.255.105) 1.336 ms
 6 138.44.5.0 (138.44.5.0) 1.311 ms 1.514 ms 1.457 ms
 7 et-0-3-0.pe1.bkvl.nsw.aarnet.net.au (113.197.15.147) 2.021 ms 1.758 ms 1.864 ms
 8 ge-4 0 0.bb1.a.pao.aarnet.net.au (202.158.194.177) 155.419 ms 155.319 ms 155.247 ms
 9 paloalto0.iij.net (198.32.176.24) 156.416 ms 156.497 ms 156.525 ms
10 osk004bb01.IIJ.Net (58.138.88.189) 266.848 ms 266.853 ms 266.827 ms
11 osk004ip57.IIJ.Net (58.138.106.166) 276.857 ms 276.831 ms 276.778 ms
12 210.130.135.130 (210.130.135.130) 276.932 ms 287.210 ms 277.094 ms
13 124.83.228.58 (124.83.228.58) 287.409 ms 277.258 ms 287.195 ms
14 124.83.252.178 (124.83.252.178) 272.735 ms 272.692 ms 272.640 ms
15 158.205.134.26 (158.205.134.26) 283.641 ms 272.703 ms 272.646 ms
16 * * *
17 * * *
18 * * *
19 * * *
20 * * *
```

III) Below is the output for running traceroute to www.lancaster.ac.uk

```
z5255891@vx4:/tmp_amd/ravel/export/ravel/4/z5255891$ 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) 0.074 ms 0.046 ms 0.045 ms
 2 129.94.39.17 (129.94.39.17) 0.828 ms 0.862 ms 0.796 ms
 3 ombudnex1-vl-3154.gw.unsw.edu.au (149.171.253.35) 1.557 ms libudnex1-vl-3154.gw.unsw.edu.au (149.171.253.34) 4.471 ms ombudnex1-vl-3154.gw.unsw.edu.au (149.171.253.35) 1.531 ms
 4 ombcr1-po-6.gw.unsw.edu.au (149.171.255.169) 1.067 ms ombcr1-po-5.gw.unsw.edu.au (149.171.255.197) 1.144 ms libcr1-po-5.gw.unsw.edu.au (149.171.255.165) 1.060 ms
 5 unswbr1-te-2-13.gw.unsw.edu.au (149.171.255.105) 1.182 ms unswbr1-te-1-9.gw.unsw.edu.au (149.171.255.101) 1.105 ms 1.311 ms
 6 138.44.5.0 (138.44.5.0) 1.392 ms 1.253 ms 1.386 ms
 7 et-2-0-5.bdr1.sing.sin.aarnet.net.au (113.197.15.233) 92.720 ms 92.737 ms 92.663 ms
 8 138.44.226.7 (138.44.226.7) 255.850 ms 255.987 ms 255.920 ms
 9 janet-gw.mx1.lon.uk.geant.net (62.40.124.198) 256.109 ms 256.095 ms 256.090 ms
10 ae29.londpg-sbr2.ja.net (146.97.33.2) 256.391 ms 256.350 ms 256.335 ms
11 ae31.erdiss-sbr2.ja.net (146.97.33.22) 260.302 ms 260.296 ms 260.279 ms
12 ae29.manckh-sbr2.ja.net (146.97.33.42) 267.545 ms 262.131 ms 262.169 ms
13 ae25.manckh-ban1.ja.net (146.97.35.50) 262.132 ms 262.117 ms 261.961 ms
14 lancaster-uni.ja.net (146.97.40.178) 307.552 ms 307.549 ms 307.517 ms
15 * * *
16 * * *
17 * * *
18 * * *
19 * * *
20 * * *
```

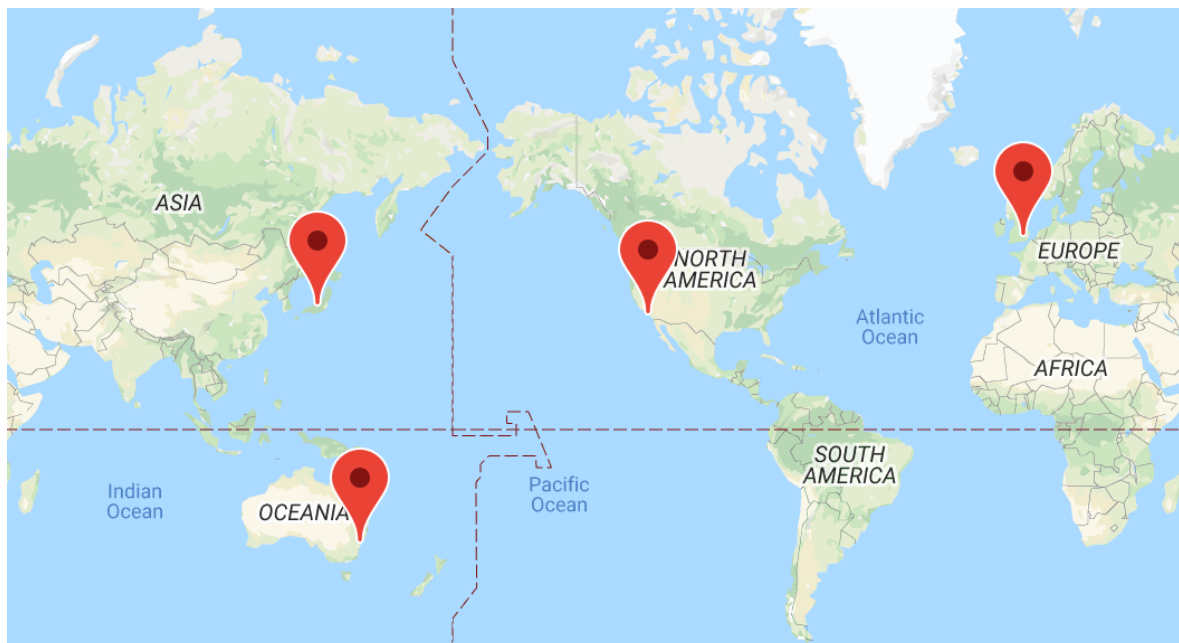
The three paths diverge at hop number 6 [**138.44.5.0**]. Using the whois command in the terminal, I found that this router was not registered in the Asia Pacific Network Information Centre (APNIC), which means I was not able to find more information about it. However, using ping to test the round times of hop 7 and 8 (the next two routers) for each of these hosts, I found a large increase in ms. This leads me to believe that this router that these paths diverge at is a router in Australia that connects to ones overseas.

Below is a screenshot from my output from using the whois command on [138.44.5.0].

```
z5255891@vx4:/tmp_amd/ravel/export/ravel/4/z5255891$ whois 138.44.5.0
#
# 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:      138.44.0.0 - 138.44.255.255
CIDR:          138.44.0.0/16
NetName:       APNIC-ERX-138-44-0-0
NetHandle:     NET-138-44-0-0-1
Parent:        NET138 (NET-138-0-0-0-0)
NetType:       Early Registrations, Transferred to APNIC
OriginAS:
Organization:  Asia Pacific Network Information Centre (APNIC)
RegDate:       2003-12-11
Updated:       2009-10-08
Comment:       This IP address range is not registered in the ARIN database.
Comment:       This range was transferred to the APNIC Whois Database as
Comment:       part of the ERX (Early Registration Transfer) project.
Comment:       For details, refer to the APNIC Whois Database via
Comment:       WHOIS.APNIC.NET or http://wq.apnic.net/apnic-bin/whois.pl
```

Using <https://www.yougetsignal.com/tools/network-location/>, I was able to mark the three destinations on a map and calculate the distances to each router.



The approximate straight-line distance from my device to those routers are as follows:

UCLA: 12068.47 Kilometres

Tokyo: 7899.79 Kilometres

Lancaster: 17014.31 Kilometres

From this information, we would expect Lancaster to have the most hops, followed by UCLA and then Tokyo as that is the order from longest distance to shortest. However, we find that Lancaster had the least number of hops with 14, while UCLA and Tokyo were both tied with 15. These results mean that it is likely that the number of hops on each path is not proportional to the physical distance, however we should keep in mind that this small sample size may not lead to conclusive data.

3. Below is the traceroute output from <http://www.speedtest.com.sg/tr.php> to my IP address.

```
traceroute to 129.94.8.50 (129.94.8.50), 30 hops max, 60 byte packets
 1  ge2-8-r01.sin01.ne.com.sg (202.150.221.169)  0.131 ms  0.145 ms  0.169 ms
 2  10.11.34.146 (10.11.34.146)  0.481 ms  0.558 ms  0.632 ms
 3  aarnet.sgix.sg (103.16.102.67)  200.124 ms  200.138 ms  200.147 ms
 4  et-7-3-0.pe1.nsw.brwy.aarnet.net.au (113.197.15.232)  209.049 ms  209.065 ms  209.126 ms
 5  138.44.5.1 (138.44.5.1)  211.709 ms  211.663 ms  211.583 ms
 6  libcr1-te-1-5.gw.unsw.edu.au (149.171.255.102)  211.615 ms  211.575 ms  211.514 ms
 7  ombwdr1-te-1-1.gw.unsw.edu.au (149.171.255.94)  208.509 ms  libwdr1-te-1-1.gw.unsw.edu.au (149.171.255.90)  209.338 ms
 8  cfw1-ae-1-3090.gw.unsw.edu.au (149.171.253.68)  209.964 ms  209.806 ms  209.881 ms
 9  * * *
10  * * *
11  * * *
12  * * *
13  * * *
```

Below is the traceroute output when reversed.

```
z5255891@vx4:/tmp_amd/ravel/export/ravel/4/z5255891$ 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)  0.111 ms  0.087 ms  0.069 ms
 2  129.94.39.17 (129.94.39.17)  0.887 ms  0.921 ms  0.923 ms
 3  ombudnex1-vl-3154.gw.unsw.edu.au (149.171.253.35)  2.095 ms  2.096 ms  2.100 ms
 4  libcr1-po-5.gw.unsw.edu.au (149.171.255.165)  1.128 ms  libcr1-po-6.gw.unsw.edu.au (149.171.255.201)
 1.166 ms  1.159 ms
 5  unswbr1-te-1-9.gw.unsw.edu.au (149.171.255.101)  1.175 ms  unswbr1-te-2-13.gw.unsw.edu.au (149.171.25
 5.105)  1.169 ms  unswbr1-te-1-9.gw.unsw.edu.au (149.171.255.101)  1.163 ms
 6  138.44.5.0 (138.44.5.0)  1.694 ms  1.260 ms  1.317 ms
 7  et-0-3-0.pe1.alxd.nsw.aarnet.net.au (113.197.15.153)  1.739 ms  1.827 ms  1.748 ms
 8  xe-0-2-7.bdr1.a.lax.aarnet.net.au (202.158.194.173)  148.908 ms  148.909 ms  148.938 ms
 9  singtel.as7473.any2ix.coresite.com (206.72.210.63)  148.948 ms  148.880 ms  148.933 ms
10  203.208.171.117 (203.208.171.117)  149.248 ms  203.208.154.45 (203.208.154.45)  330.752 ms  203.208.17
 1.117 (203.208.171.117)  149.370 ms
11  203.208.173.73 (203.208.173.73)  251.684 ms  203.208.177.110 (203.208.177.110)  334.748 ms  334.739 m
 s
12  203.208.158.17 (203.208.158.17)  319.671 ms  319.609 ms  319.587 ms
13  203.208.158.185 (203.208.158.185)  328.434 ms  327.280 ms  327.260 ms
14  202-150-221-170.rev.ne.com.sg (202.150.221.170)  214.520 ms  203.208.177.110 (203.208.177.110)  330.1
 62 ms  330.120 ms
```

Below is the traceroute output from <https://www.telstra.net/cgi-bin/trace> to my IP address.

```
1  gigabitethernet3-3.exi2.melbourne.telstra.net (203.50.77.53)  0.423 ms  0.223 ms  0.244 ms
2  bundle-ether3-100.win-core10.melbourne.telstra.net (203.50.80.129)  1.244 ms  1.611 ms  2.244 ms
3  bundle-ether12.ken-core10.sydney.telstra.net (203.50.11.122)  13.987 ms  12.482 ms  12.861 ms
4  bundle-ether1.ken-edge903.sydney.telstra.net (203.50.11.173)  27.979 ms  11.982 ms  11.988 ms
5  aar3533567.lnk.telstra.net (139.130.0.78)  11.613 ms  11.733 ms  11.611 ms
6  et-7-1-0.pe1.brwy.nsw.aarnet.net.au (113.197.15.13)  11.738 ms  11.731 ms  17.735 ms
7  138.44.5.1 (138.44.5.1)  11.988 ms  11.983 ms  11.987 ms
8  libcr1-te-1-5.gw.unsw.edu.au (149.171.255.102)  12.488 ms  11.982 ms  11.988 ms
9  libwdr1-te-1-1.gw.unsw.edu.au (149.171.255.90)  12.112 ms  12.106 ms  12.114 ms
10  cfw1-ae-1-3090.gw.unsw.edu.au (149.171.253.68)  12.611 ms  12.730 ms  12.736 ms
```

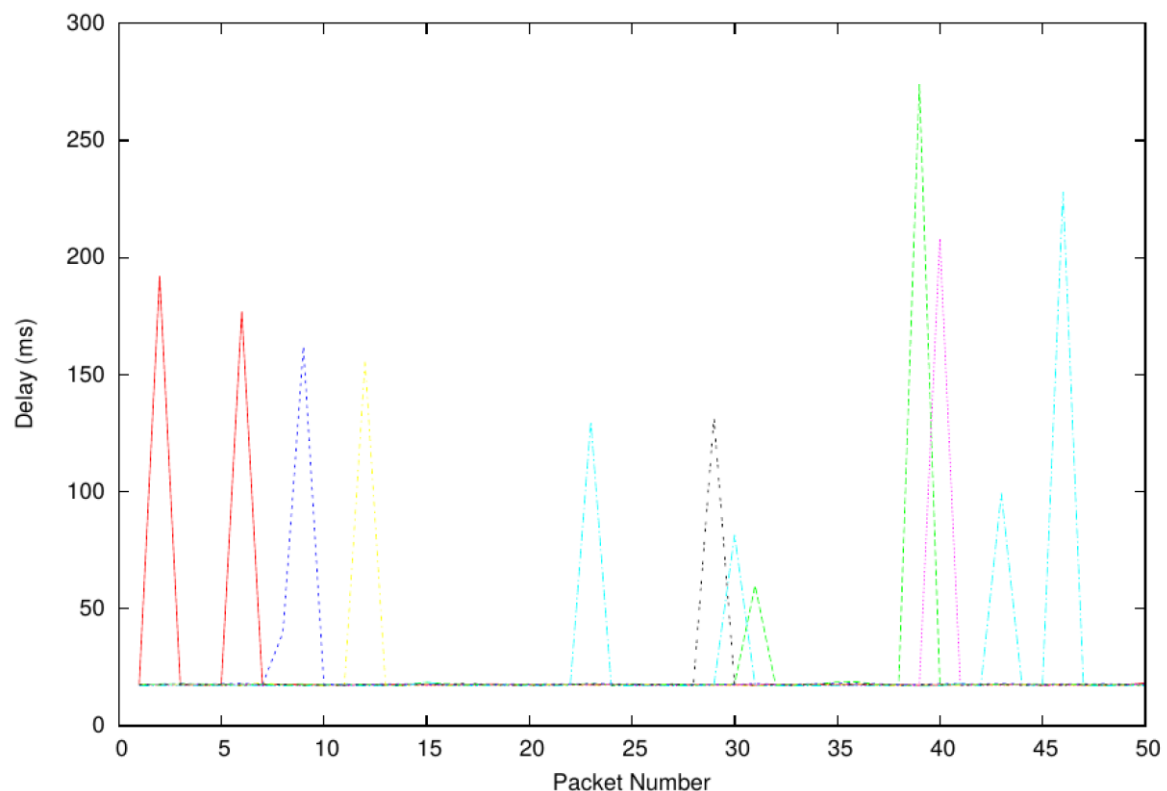

Below is the traceroute output when reversed.

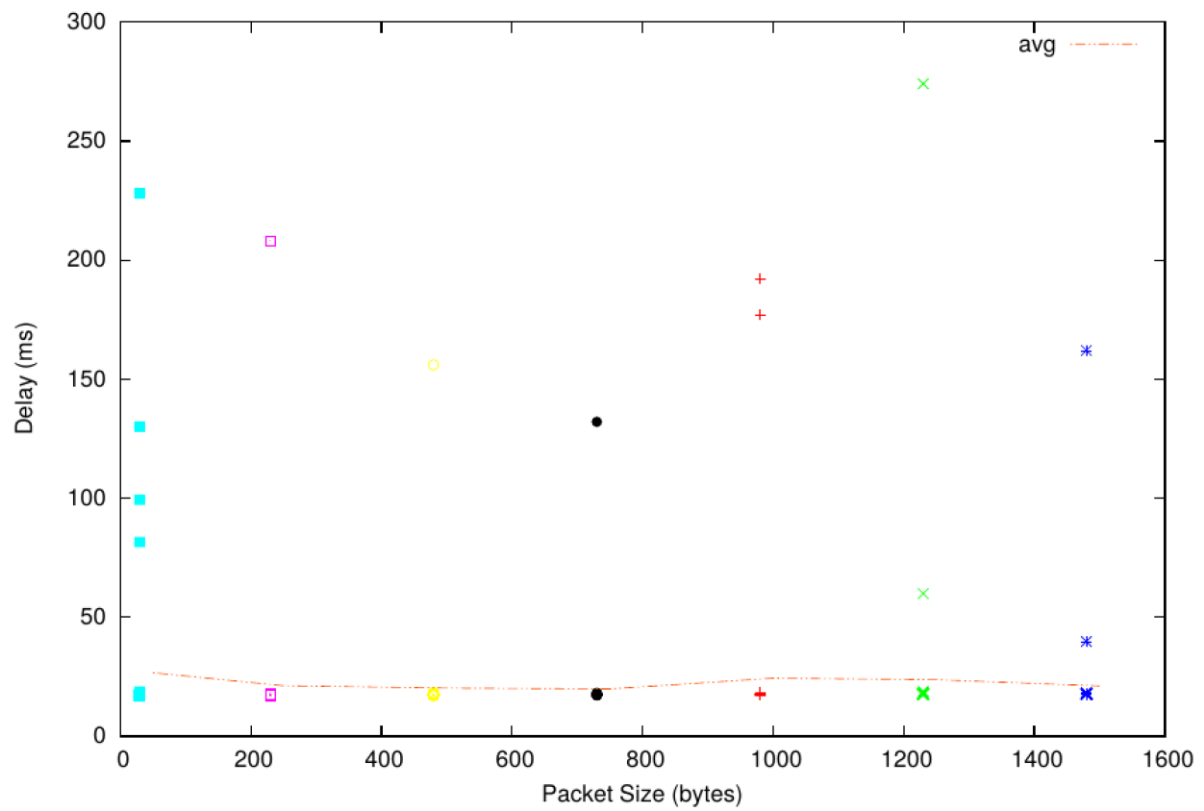
```
z5255891@vx4:/tmp_amd/ravel/export/ravel/4/z5255891$ traceroute www.telstra.net
traceroute to www.telstra.net (203.50.5.178), 30 hops max, 60 byte packets
 1 cserouter1-server.cse.unsw.EDU.AU (129.94.242.251) 0.110 ms 0.054 ms 0.047 ms
 2 129.94.39.17 (129.94.39.17) 0.903 ms 0.864 ms 0.858 ms
 3 ombudnex1-vl-3154.gw.unsw.edu.au (149.171.253.35) 1.519 ms libudnex1-vl-3154.gw.unsw.edu.au (149.17
1.253.34) 5.969 ms 1.380 ms
 4 libcr1-po-6.gw.unsw.edu.au (149.171.255.201) 1.093 ms libcr1-po-5.gw.unsw.edu.au (149.171.255.165)
1.123 ms ombcr1-po-6.gw.unsw.edu.au (149.171.255.169) 1.073 ms
 5 unswbr1-te-1-9.gw.unsw.edu.au (149.171.255.101) 1.165 ms 1.156 ms unswbr1-te-2-13.gw.unsw.edu.au (
149.171.255.105) 1.161 ms
 6 138.44.5.0 (138.44.5.0) 8.015 ms 7.317 ms 7.251 ms
 7 et-1-1-0.pe1.rsby.nsw.aarnet.net.au (113.197.15.12) 1.799 ms 1.755 ms 1.759 ms
 8 xe-0-0-3.bdr1.rsby.nsw.aarnet.net.au (113.197.15.31) 1.510 ms 1.600 ms 1.546 ms
 9 HundredGigE0-1-0-4.ken-edge903.sydney.telstra.net (139.130.0.77) 2.235 ms 2.313 ms 2.207 ms
10 bundle-ether17.ken-core10.sydney.telstra.net (203.50.11.172) 3.299 ms 2.876 ms 2.835 ms
11 bundle-ether17.chw-core10.sydney.telstra.net (203.50.11.176) 3.523 ms 3.698 ms bundle-ether10.win-
core10.melbourne.telstra.net (203.50.11.123) 14.818 ms
12 bundle-ether1-2.exi-core10.melbourne.telstra.net (203.50.6.40) 14.887 ms 14.842 ms 14.798 ms
13 203.50.11.209 (203.50.11.209) 14.811 ms 14.432 ms 14.373 ms
14 www.telstra.net (203.50.5.178) 14.323 ms 14.245 ms 14.452 ms
```

The IP addresses of the two servers I have chosen are speedtest: [202.150.221.170] and Telstra: [203.50.5.178]. For both these servers, the forward and reverse paths took different paths. However, there were some common routers found in the forward and reverse paths. The reason for the difference in hops for the forward and reverse paths is because the packet always seeks the optimal route to travel, and this will not always be the same as the amount of traffic in different routers changes constantly.

Exercise 4

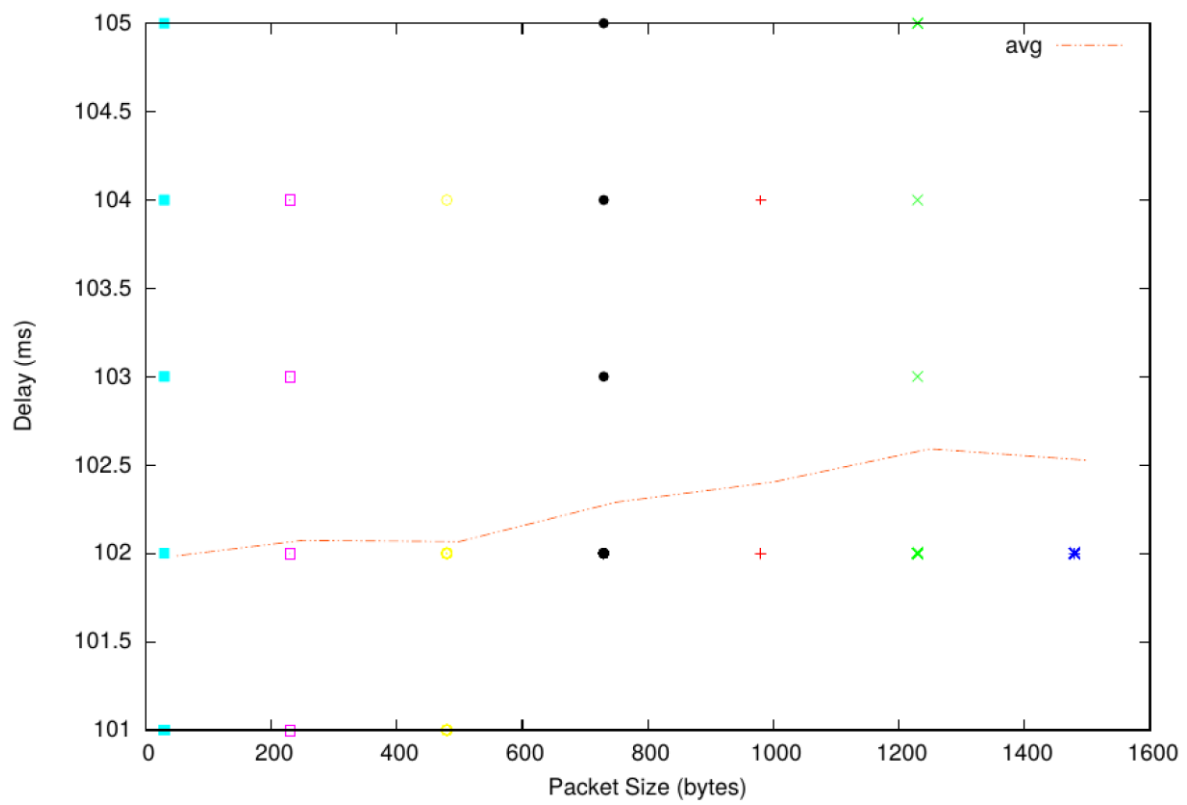
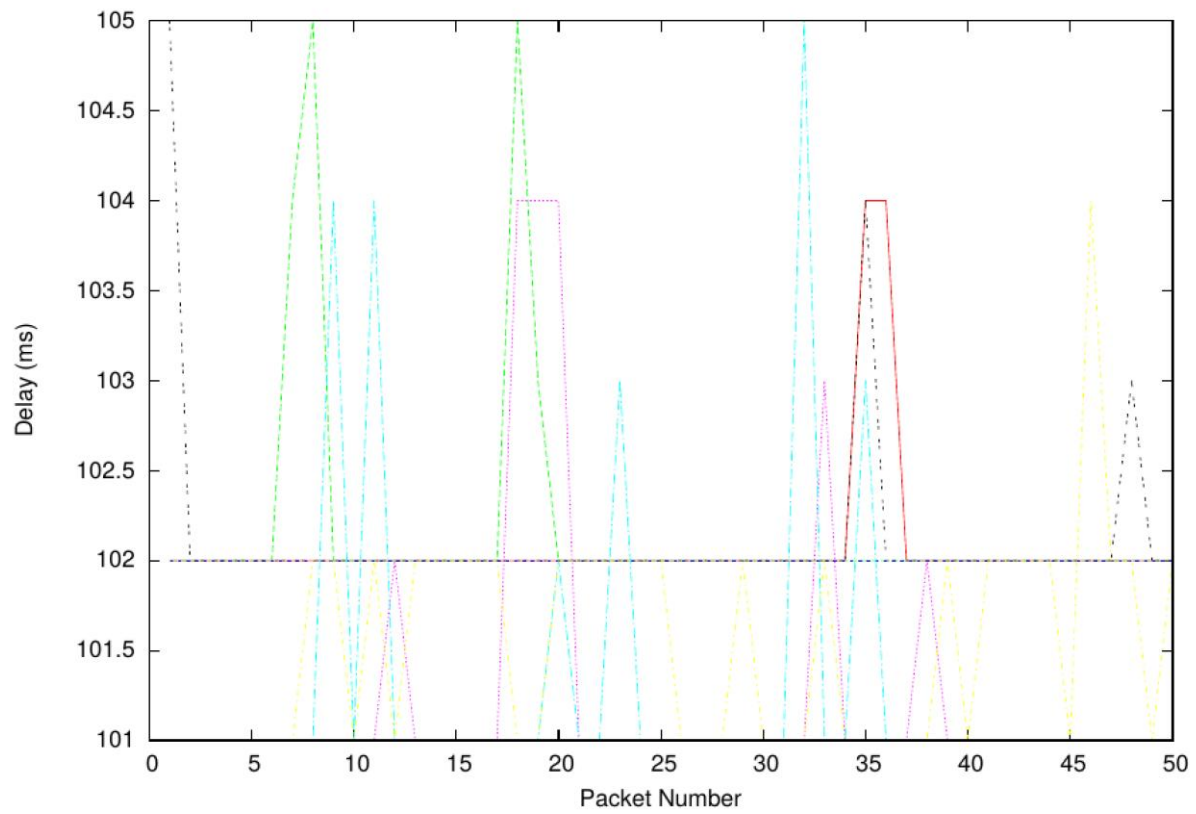
Below is the delay plot, scatter plot and text file for www.uq.edu.au respectively.





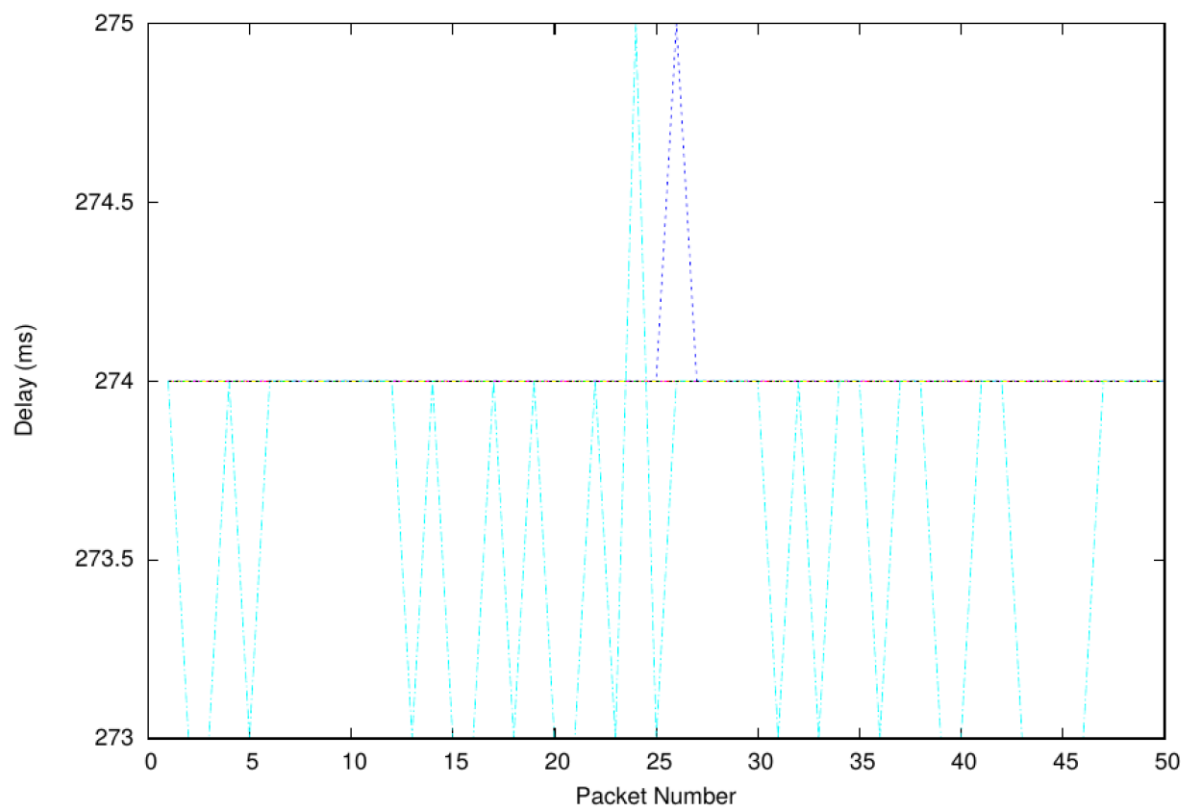
```
www.uq.edu.au_avg.txt (~) - GVIM
File Edit Tools Syntax Buffers Window Help
[Icons]
50 26.678 16.958
250 21.200 17.149
500 20.228 17.193
750 19.868 17.352
1000 24.342 17.432
1250 23.756 17.517
1500 21.160 17.565
```

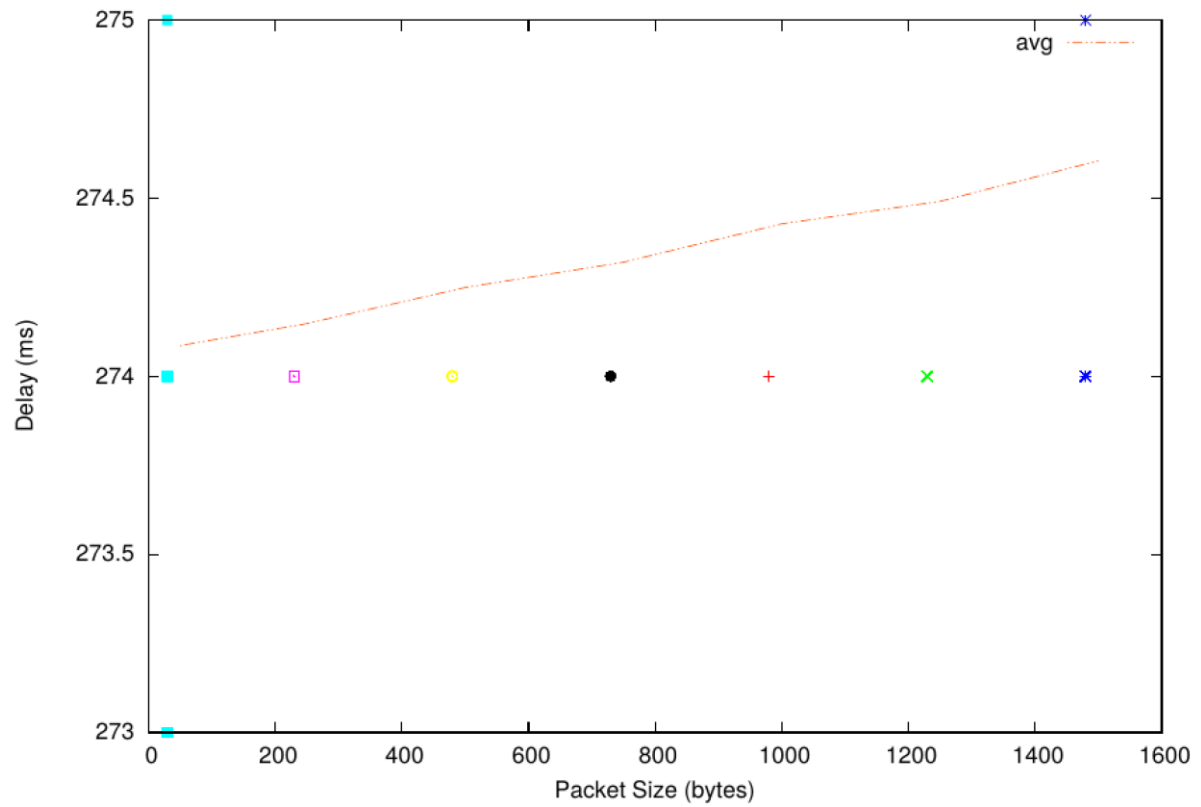
Below is the delay plot, scatter plot and text file for www.upm.edu.my respectively.



```
www.upm.edu.my_avg.txt (~) - GVIM
File Edit Tools Syntax Buffers Window Help
[Icons]
50 101.986 101.623
250 102.073 101.752
500 102.067 101.885
750 102.290 102.069
1000 102.404 102.184
1250 102.591 102.263
1500 102.527 102.448
~
```

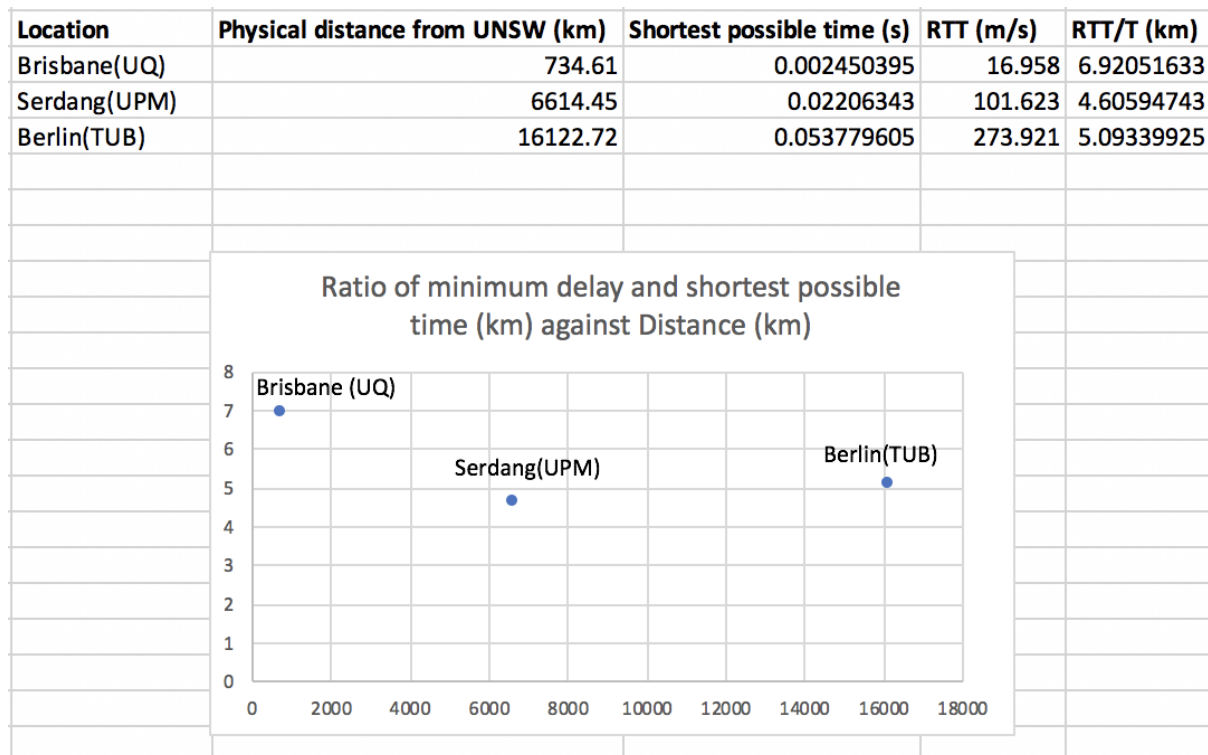
Below is the delay plot, scatter plot and text file for www.tu-berlin.de for respectively





```
www.tu-berlin.de_avg.txt (~) - GVIM
File Edit Tools Syntax Buffers Window Help
50 274.086 273.921
250 274.148 274.042
500 274.249 274.139
750 274.320 274.230
1000 274.428 274.301
1250 274.491 274.409
1500 274.605 274.502
~
```


- Below are the numbers and graph produced from plotting RTT/T against distance for the three locations provided. For RTT I used the minimum value (third column) of the 50-byte packet data in the text files generated.



As stated in the question, the minimum Y-value will be 2. This value of 2 can only occur theoretically in a perfect scenario where the packet is able to travel at the speed of light in a straight-line to the destination. However, in the real world this is unachievable due to several factors. One factor could be traffic build ups in the routers along the way to the destination and thus the packet will lose time from waiting for other packets first, which is called queuing delay. Another source of delay could be from the network itself. If it is an unstable network sending the package, this could cause transmission delays with the packet, increasing its time to reach the destination.

- The delay to Brisbane was not constant however surprisingly the delay to Malaysia and Berlin were relatively constant. However, with this small sample size it is more likely that they are generally not constant. This is due to the random traffic that changes at different routers constantly. This leads to queuing delay which would be generally inconsistent.
- Below is a screenshot of the whois command being blocked by www.epfl.ch.

```
z5255891@vx4:/tmp_amd/ravel/export/ravel/4/z5255891$ whois www.epfl.ch
Requests of this client are not permitted. Please use https://www.nic.ch/whois/
for queries.
```

I used nslookup to find the IP address associated with the website.

```
z5255891@vx4:/tmp_amd/ravel/export/ravel/4/z5255891$ nslookup www.epfl.ch
Server:      129.94.242.2
Address:     129.94.242.2#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
```

I then used the IP address to run the whois command.

```
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.cloud
flare.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
```

From the whois command we can determine that it is hosted in San Francisco, USA.

4. Measured delay is composed of propagation delay, transmission delay, processing delay and queuing delay. Out of those four types of delays, only transmission delay is dependent on package size, whereas the other three are not.