Exercise 1

1. The IP address of the website www.koala.com.au is 104.21.45.210 and 172.67.219.46. Multiple IP's may be used for DNS load balancing. This distributes incoming network traffic across multiple servers. In case another server goes down, there will also be other ones that are still up.
2. The name of the IP address 127.0.0.1. is 'localhost'. This IP address allows the machine to connect to and communicate with itself.

Exercise 2

- www.google.com.au yes
- www.stanford.edu yes
- www.wikipedia.org yes
- ec.ho no, not reachable through web browser. Does not exist.
- pin.gs no, not reachable through web browser. Does not exist.
- nasa.gov no, reachable through web browser. Since it is a government website they want to stop people accessing their IPs. For example, they might get DDOS attacked.
- yes.no yes
- one.one.one.one yes
- theguardian.com yes
- xn--i-7iq.ws yes

Exercise 3

1.

```
traceroute to www.tu-berlin.de (130.149.7.201), 30 hops max, 60 byte packets
 1  cserouter1-server.orchestra.cse.unsw.EDU.AU (129.94.242.251)  0.054 ms  0.063 ms  0.077 ms
 2  129.94.39.17 (129.94.39.17)  0.910 ms  0.877 ms  0.917 ms
 3  172.17.31.154 (172.17.31.154)  2.069 ms  1.528 ms  2.027 ms
 4  po-3-1901.libcr1.gw.unsw.edu.au (129.94.24.12)  1.181 ms po-3-1902.ombcr1.gw.unsw.edu.au (129.94.24.20)  1.225 ms po-3-19
01.libcr1.gw.unsw.edu.au (129.94.24.12)  1.296 ms
 5  unswbr1-te-1-9.gw.unsw.edu.au (149.171.255.101)  1.267 ms  1.344 ms  1.310 ms
 6  138.44.5.0 (138.44.5.0)  1.425 ms  1.438 ms  1.449 ms
 7  et-2-0-5.bdr1.sing.sin.aarnet.net.au (113.197.15.233)  92.677 ms  92.872 ms  92.757 ms
 8  138.44.226.7 (138.44.226.7)  263.699 ms  263.664 ms  263.631 ms
 9  ae9.mx1.ams.nl.geant.net (62.40.98.128)  268.887 ms  268.856 ms  268.898 ms
10  ae1.mx1.ham.de.geant.net (62.40.98.61)  280.528 ms  280.575 ms  280.535 ms
11  cr-tub1.x-win.dfn.de (62.40.125.171)  279.680 ms  279.675 ms  279.817 ms
12  kr-tub248.x-win.dfn.de (188.1.235.118)  279.272 ms  279.231 ms  279.205 ms
13  enc-fp.gate.tu-berlin.de (130.149.126.189)  279.486 ms  279.692 ms  279.693 ms
14  en-dist2-en-core.gate.tu-berlin.de (130.149.126.150)  280.083 ms  279.640 ms  279.592 ms
15  e-ns-e-n.gate.tu-berlin.de (130.149.126.78)  279.532 ms  279.838 ms  279.506 ms
16  www.tu-berlin.de (130.149.7.201)  279.466 ms  279.425 ms  279.375 ms
```

- How many routers are there between your workstation and www.tu-berlin.de?
  15
- How many routers along the path are part of the UNSW network?
  5
- Which router is the first router outside of Australia?
  et-2-0-5.bdr1.sing.sin.aarnet.net.au. Router number 7 It is in Singapore.
- Which router is the first router in Europe?
  ae9.mx1.ams.nl.geant.net

2.

```
 1  cserouter1-server.orchestra.cse.unsw.EDU.AU (129.94.242.251)  0.067 ms  0.063 ms  0.044 ms
 2  129.94.39.17 (129.94.39.17)  0.887 ms  0.846 ms  0.896 ms
 3  172.17.31.154 (172.17.31.154)  1.609 ms  1.556 ms  1.980 ms
 4  po-3-1902.ombcr1.gw.unsw.edu.au (129.94.24.20)  1.196 ms  1.255 ms  1.182 ms
 5  unswbr1-te-2-13.gw.unsw.edu.au (149.171.255.105)  1.290 ms  1.186 ms  1.235 ms
 6  138.44.5.0 (138.44.5.0)  1.387 ms  1.275 ms  1.292 ms
 7  et-0-1-0.bdr1.msct.nsw.aarnet.net.au (113.197.15.109)  1.442 ms  3.498 ms  3.510 ms
 8  210.7.39.22 (210.7.39.22)  15.454 ms  14.724 ms  14.717 ms
 9  210.7.37.209 (210.7.37.209)  48.220 ms  48.252 ms  48.212 ms
10  210.7.37.210 (210.7.37.210)  69.936 ms  69.958 ms  69.943 ms
11  202.36.179.65 (202.36.179.65)  48.188 ms  48.279 ms  48.228 ms
12  132.181.3.236 (132.181.3.236)  49.575 ms  49.651 ms  49.637 ms
13  132.181.106.9 (132.181.106.9)  48.223 ms  48.312 ms  48.249 ms
z5417590@vx04:~$ traceroute  stanford.edu
traceroute to stanford.edu (171.67.215.200), 30 hops max, 60 byte packets
 1  cserouter1-server.orchestra.cse.unsw.EDU.AU (129.94.242.251)  0.055 ms  0.050 ms  0.055 ms
 2  129.94.39.17 (129.94.39.17)  0.866 ms  0.869 ms  0.896 ms
 3  172.17.31.154 (172.17.31.154)  1.531 ms  2.116 ms  2.237 ms
 4  po-3-1902.ombcr1.gw.unsw.edu.au (129.94.24.20)  1.217 ms po-3-1901.libcr1.gw.unsw.edu.au (129.94.24.12)  1.137 ms  1.143 ms
 5  * * *
 6  138.44.5.0 (138.44.5.0)  1.514 ms  2.048 ms  2.049 ms
 7  et-1-3-0.pe1.sxt.bkvl.nsw.aarnet.net.au (113.197.15.149)  2.349 ms  2.111 ms  2.118 ms
 8  et-0-0-0.pe1.a.hnl.aarnet.net.au (113.197.15.99)  94.560 ms  94.380 ms  94.493 ms
 9  et-2-1-0.bdr1.a.sea.aarnet.net.au (113.197.15.201)  143.584 ms  143.744 ms  143.654 ms
10  cenichpr-1-is-jmb-778.snvaca.pacificwave.net (207.231.245.129)  161.810 ms  162.352 ms  162.287 ms
11  hpr-oak-agg8--svl-hpr3-100g.cenic.net (137.164.25.95)  163.888 ms  164.029 ms  163.893 ms
12  137.164.26.241 (137.164.26.241)  164.193 ms  168.424 ms  168.378 ms
13  woa-west-rtr-vl3.SUNet (171.66.255.132)  164.361 ms  163.657 ms  163.748 mst
14  * * *
15  web.stanford.edu (171.67.215.200)  165.487 ms  164.243 ms  164.764 ms
z5417590@vx04:~$ traceroute reading.ac.uk
traceroute to reading.ac.uk (134.225.0.151), 30 hops max, 60 byte packets
 1  cserouter1-server.orchestra.cse.unsw.EDU.AU (129.94.242.251)  0.086 ms  0.079 ms  0.074 ms
 2  129.94.39.17 (129.94.39.17)  0.881 ms  0.828 ms  0.848 ms
 3  172.17.31.154 (172.17.31.154)  7.501 ms  7.453 ms  7.470 ms
 4  po-3-1902.ombcr1.gw.unsw.edu.au (129.94.24.20)  1.082 ms po-3-1901.libcr1.gw.unsw.edu.au (129.94.24.12)  3.839 ms  3.847 ms
 5  unswbr1-te-2-13.gw.unsw.edu.au (149.171.255.105)  1.161 ms unswbr1-te-1-9.gw.unsw.edu.au (149.171.255.101)  1.169 ms unswbr1-te-
2-13.gw.unsw.edu.au (149.171.255.105)  1.163 ms
 6  138.44.5.0 (138.44.5.0)  1.318 ms  1.333 ms  1.321 ms
 7  et-2-0-5.bdr1.sing.sin.aarnet.net.au (113.197.15.233)  92.805 ms  92.970 ms  92.963 ms
 8  138.44.226.7 (138.44.226.7)  263.624 ms  263.564 ms  263.563 ms
 9  janet-gw.mx1.lon.uk.geant.net (62.40.124.198)  263.610 ms  263.541 ms  263.533 ms
10  ae29.londpg-sbr2.ja.net (146.97.33.2)  263.979 ms  263.964 ms  263.886 ms
11  ae19.readdy-rbr1.ja.net (146.97.37.194)  264.765 ms  264.832 ms  264.754 ms
12  reading-university-1.ja.net (193.63.109.26)  282.531 ms  286.697 ms  286.432 ms
13  xe-0-0-7.fw-ext.net.rdg.ac.uk (134.225.255.38)  265.166 ms  265.310 ms  265.200 ms
14  alumni.reading.ac.uk (134.225.0.151)  266.281 ms  266.251 ms  266.265 ms
```

The last common router is 138.44.5.0 (138.44.5.0).
Router - Australian Academic and Research Network

The number of hops in a traceroute is not necessarily proportional to physical distance. It is primarily influenced by the network routing decisions made by various routers along the path.

reading.ac.uk 14 hops – 17071km
web.stanford.edu 15 – 11960km
canterbury.ac.nz 13 – 2156 km

As we can see the number of hops is not proportional to physical distance

3. Traceroute from home to www.speedtest.com.sg 11 hops

```
z5417590@vx04:~$ traceroute  www.speedtest.com.sg
traceroute to www.speedtest.com.sg (202.150.221.170), 30 hops max, 60 byte packets
 1  cserouter1-server.orchestra.cse.unsw.EDU.AU (129.94.242.251)  0.076 ms  0.074 ms  0.079 ms
 2  129.94.39.17 (129.94.39.17)  0.912 ms  0.914 ms  0.922 ms
 3  172.17.31.154 (172.17.31.154)  2.309 ms  2.249 ms  2.255 ms
 4  po-3-1901.libcr1.gw.unsw.edu.au (129.94.24.12)  2.613 ms po-3-1902.ombcr1.gw.unsw.edu.au (129.94.24.20)  1.188 ms  1.197 ms
 5  unswbr1-te-2-13.gw.unsw.edu.au (149.171.255.105)  1.244 ms  1.276 ms unswbr1-te-1-9.gw.unsw.edu.au (149.171.255.101)  1.167 ms
 6  138.44.5.0 (138.44.5.0)  1.404 ms  1.295 ms  1.312 ms
 7  et-2-0-5.bdr1.sing.sin.aarnet.net.au (113.197.15.233)  97.484 ms  96.846 ms  96.826 ms
 8  ae1.bdr2.sing.sin.aarnet.net.au (113.197.15.235)  92.866 ms  92.871 ms  92.876 ms
 9  newmedia-express.sgix.sg (103.16.102.22)  93.243 ms  93.499 ms  93.324 ms
10  * * *
11  202.150.221.170 (202.150.221.170)  92.994 ms  92.927 ms  93.054 ms
```

Traceroute from www.speedtest.com.sg to home 6 hops

```
traceroute to 129.94.242.251 (129.94.242.251), 30 hops max, 60 byte packets
 1  202.150.221.169 (202.150.221.169)  0.186 ms  0.179 ms  0.173 ms
 2  10.11.34.146 (10.11.34.146)  0.465 ms  0.526 ms  0.601 ms
 3  aarnet.sgix.sg (103.16.102.67)  0.960 ms  0.893 ms  0.891 ms
 4  et-7-3-0.pe1.nsw.brwy.aarnet.net.au (113.197.15.232)  93.306 ms  93.177 ms  93.300 ms
 5  138.44.5.1 (138.44.5.1)  106.497 ms  106.405 ms  106.453 ms
 6  libdr1-eth-1-33.gw.unsw.edu.au (149.171.255.43)  106.591 ms  106.486 ms  106.255 ms
 7  * * *
 8  * * *
 9  * * *
10  * * *
11  * * *
12  * * *
13  * * *
14  * * *
15  * * *
16  * * *
17  * * *
18  * * *
19  * * *
20  * * *
21  * * *
22  * * *
23  * * *
24  * * *
25  * * *
26  * * *
27  * * *
28  * * *
29  * * *
30  * * *
```

Traceroute from home to www.as13030.net 24 hops.

```
z5417590@vx04:~$ traceroute  www.as13030.net
traceroute to www.as13030.net (213.144.137.198), 30 hops max, 60 byte packets
 1  cserouter1-server.orchestra.cse.unsw.EDU.AU (129.94.242.251)  0.348 ms  0.339 ms  0.331 ms
 2  129.94.39.17 (129.94.39.17)  0.992 ms  0.989 ms  0.982 ms
 3  172.17.31.154 (172.17.31.154)  1.717 ms  1.664 ms  1.997 ms
 4  po-3-1902.ombcr1.gw.unsw.edu.au (129.94.24.20)  1.139 ms po-3-1901.libcr1.gw.unsw.edu.au (129.94.24.12)  1.090 ms po-3-1902.ombc
r1.gw.unsw.edu.au (129.94.24.20)  1.110 ms
 5  unswbr1-te-1-9.gw.unsw.edu.au (149.171.255.101)  1.092 ms unswbr1-te-2-13.gw.unsw.edu.au (149.171.255.105)  1.123 ms unswbr1-te-
1-9.gw.unsw.edu.au (149.171.255.101)  1.132 ms
 6  138.44.5.0 (138.44.5.0)  1.332 ms  1.378 ms  1.368 ms
 7  ae1.170.bdr1.b.sea.aarnet.net.au (113.197.15.63)  140.798 ms  140.771 ms  140.784 ms
 8  xe-4-1-1.mpr1.sea1.us.above.net (64.125.193.129)  140.893 ms  140.839 ms  140.783 ms
 9  ae27.cs1.sea1.us.eth.zayo.com (64.125.29.0)  277.801 ms  277.664 ms  277.662 ms
10  * * *
11  * * *
12  * * *
13  ae4.mpr1.lhr15.uk.zip.zayo.com (64.125.28.195)  263.083 ms  263.752 ms  263.676 ms
14  linx-1.init7.net (195.66.224.175)  263.734 ms  270.647 ms  270.871 ms
15  r2lon2.core.init7.net (5.180.135.248)  263.988 ms  263.934 ms  263.951 ms
16  r2fra3.core.init7.net (5.180.135.129)  275.398 ms  274.979 ms  274.863 ms
17  r1fra3.core.init7.net (80.81.192.67)  276.422 ms  276.481 ms  274.930 ms
18  r2zrh2.core.init7.net (5.180.135.172)  280.412 ms  280.688 ms  280.633 ms
19  r2zrh5.core.init7.net (5.180.135.233)  280.433 ms  280.440 ms  280.386 ms
20  r1glb3.core.init7.net (5.180.135.68)  280.670 ms  280.619 ms  280.527 ms
21  r1zrh10.core.init7.net (5.180.135.58)  280.937 ms  280.983 ms  280.921 ms
22  r1win9.core.init7.net (5.180.135.57)  280.829 ms  281.061 ms  280.864 ms
23  r2win9.core.init7.net (5.180.135.0)  280.878 ms  280.859 ms  281.109 ms
24  r2win7.core.init7.net (5.180.135.30)  280.952 ms  281.474 ms  281.023 ms
25  * * *
26  * * *
27  * * *
28  * * *
29  * * *
30  * * *
```

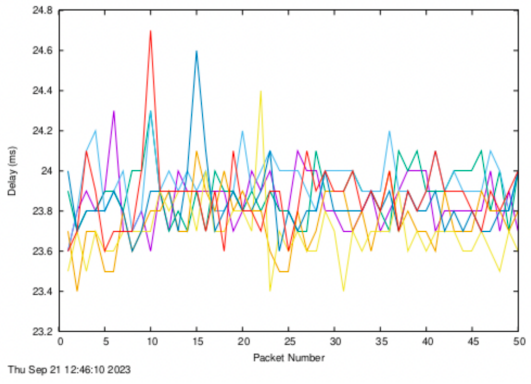
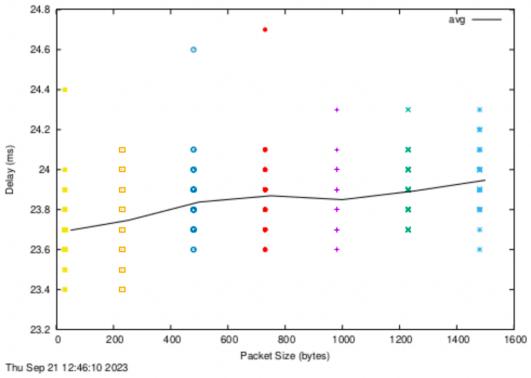
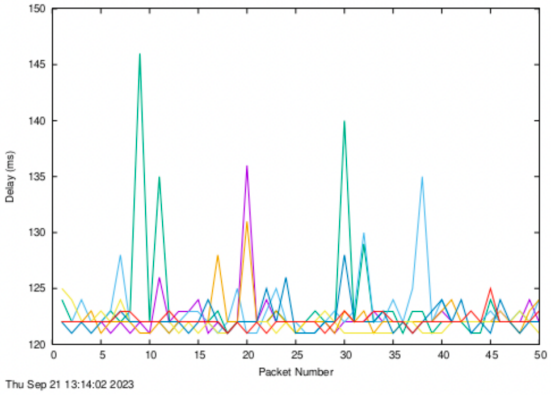
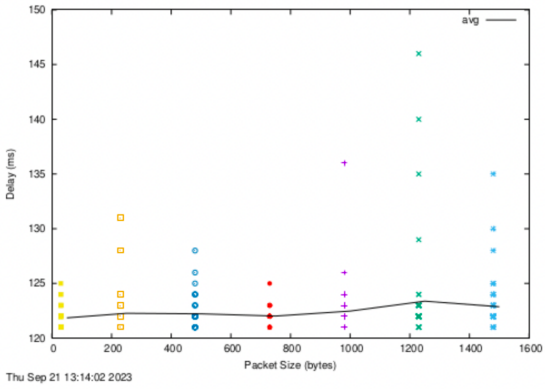
Traceroute from www.as13030.net to home 19 hops

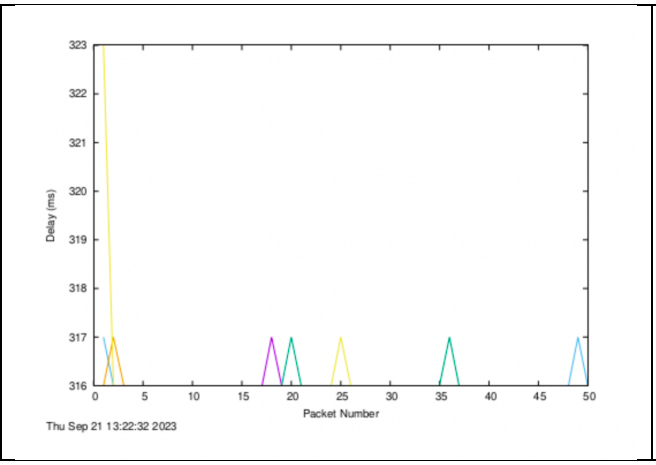
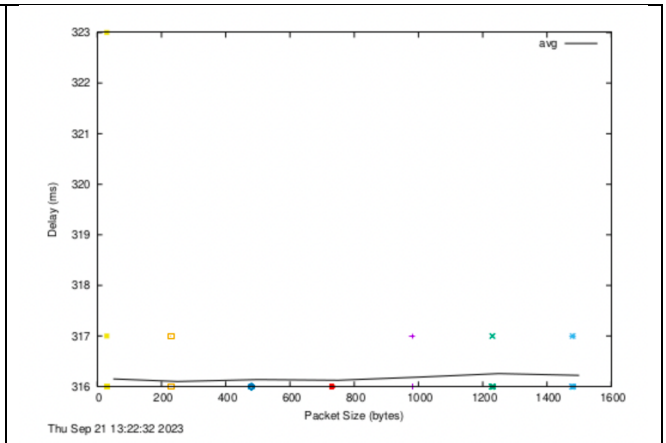
```
traceroute to 129.94.242.251 (129.94.242.251), 30 hops max, 60 byte packets
 1  r2win7.core.init7.net (213.144.137.193) [AS13030]  1.175 ms  1.431 ms  1.732 ms
 2  r2win9.core.init7.net (5.180.135.31) [AS13030]  1.074 ms  1.296 ms  1.576 ms
 3  r1win9.core.init7.net (5.180.135.1) [AS13030]  0.994 ms  1.255 ms  1.579 ms
 4  r1zrh10.core.init7.net (5.180.135.56) [AS13030]  1.097 ms  1.406 ms  1.714 ms
 5  r1glb3.core.init7.net (5.180.135.59) [AS13030]  1.299 ms  1.644 ms  2.005 ms
 6  r2zrh5.core.init7.net (5.180.135.69) [AS13030]  1.245 ms  1.512 ms  1.651 ms
 7  r2zrh2.core.init7.net (5.180.135.232) [AS13030]  1.412 ms  1.596 ms  1.878 ms
 8  r1fra3.core.init7.net (5.180.135.173) [AS13030]  7.028 ms  7.354 ms  7.552 ms
 9  xe-1-2-0.mpr1.fra4.de.above.net (80.81.194.26) [*]  6.448 ms  6.432 ms  6.415 ms
10  * * *
11  * * *
12  * * *
13  * * *
14  * * *
15  * * *
16  * * *
17  ae2.cs1.sea1.us.eth.zayo.com (64.125.29.26) [*]  145.701 ms  145.619 ms  145.573 ms
18  ae27.mpr1.sea1.us.zip.zayo.com (64.125.29.1) [*]  139.697 ms  139.745 ms  139.802 ms
19  64.125.193.130.i223.above.net (64.125.193.130) [*]  144.341 ms  144.310 ms  144.301 ms
```

As shown above, the reverse path does not go through the same paths as the forward path. Every route would have its own rules, so the path forward is not the same as the path home.

Exercise 4

1.

Location	Delay	Scatter
Flinders University		
University of Philippines		

University of Oslo		

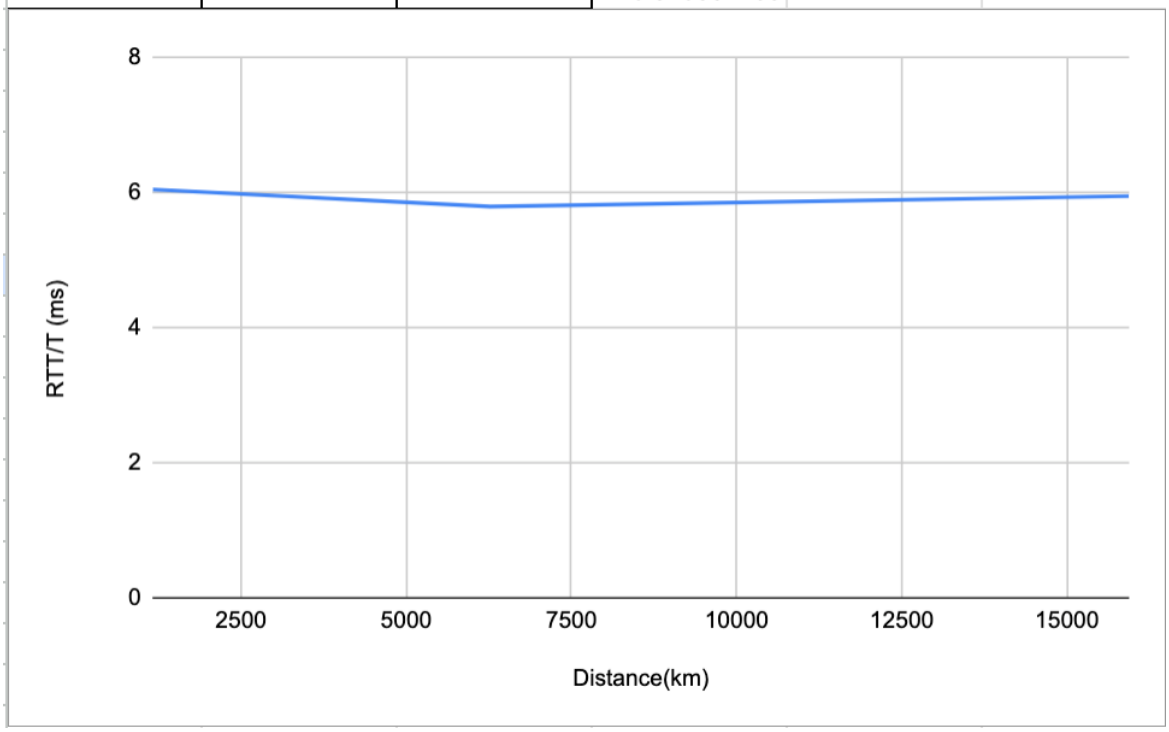
Location	Delay Values
Flinders University	50 23.697 23.393 250 23.746 23.436 500 23.838 23.594 750 23.869 23.573 1000 23.850 23.552 1250 23.893 23.677 1500 23.947 23.616
University of Philippines	50 121.855 121.033 250 122.277 121.294 500 122.225 121.190 750 122.028 121.229 1000 122.474 121.318 1250 123.383 121.318 1500 122.872 121.211
University of Oslo	50 316.151 315.729 250 316.100 315.864 500 316.138 315.884 750 316.125 315.902 1000 316.187 315.931 1250 316.257 315.936 1500 316.222 316.006

The speed of light = 300 000 km/second

Location	Distance(km)	Shortest time(seconds)	RTT(ms)

Flinders University	1163.48	T = 1163.48/300000 = 0.00387	23.393
University of Philippines	6270.06	T = 6270.06/300000 = 0.0209	121.033
University of Oslo	15939.09	T =15939.09/300000 = 0.0531	315.729

Distance	T(ms)	RTT(ms)	RTT/T
1163.48	3.87	23.393	6.044702842
6270.06	20.9	121.033	5.791052632
15939.09	53.1	315.729	5.945932203



Round-trip time(RTT) is the time it takes for a packet to be sent from the source to destination and for a response to be received from the destination back to the source, whereas T is the shortest time to reach the destination. Therefore, RTT will be at least two time T because it has to travel back and forth between source and destination whilst T is only from source to destination. Thus, the Y axis value will be greater than 2. Furthermore, the value is greater than 2.

Another reason is that there are other delays to consider such as queueing, transmission and processing delays which add more time.

2. Delays to the destinations are not constant over time. As you can see in the graphs above the delays with the different packet sizes vary. One example that may be affecting the delays are increased queueing delays from the packet sizes.
3. Transmission delay and processing delay depend on packet size whilst propagation and queuing delay do not. Propagation delay depends on the length of the physical link, whilst queueing delay depends on time waiting at the output link for transmission.