

Exercise 1: nslookup

1. There are three IP addresses for www.koala.com.au. For example, if one IP address stands on one server, we can get the service of this website is running on three servers at the same time from the result given below. This can reduce the workload of different servers. This is because using different servers can separate the users who want to visit this website. Furthermore, reducing the workload can also improve security and make servers more stable. If these three servers are running in different networks, it can speed up the process of doing ISP routing. This can improve the speed for users using different kinds of the network to visit this website.

```
z5241868@vx3:/tmp_amd/kamen/export/kamen/5/z5241868$ 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: 172.67.219.46
Name:   www.koala.com.au
Address: 104.18.60.21
Name:   www.koala.com.au
Address: 104.18.61.21
```

2. From the result, we can find that the name of 127.0.0.1 is the localhost. Localhost means the local computer itself. The address 127.0.0.1, also the localhost, is called the loopback address. This is because for any network using this address to send data package will finally back to the local computer(machine) itself. This address is often used to do some local tests. For example, setting up a local website, we can use the localhost to check whether the website is right or not.

```
z5241868@vx3:/tmp_amd/kamen/export/kamen/5/z5241868$ 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: Using ping to test host reachability

1. Reachable address:

- a. www.unsw.edu.au: 32.6ms
- b. www.mit.edu: 100.7ms
- c. www.intel.com.au: 1.5ms
- d. www.tpg.com.au: 6.3ms
- e. www.amazon.com: 2.3ms
- f. www.tsinghua.edu.au: 209ms
- g. 8.8.8.8: 79ms

2. Unreachable address:

a. www.getfittest.com.au: This website cannot be opened in the chrome. No website is called www.getfittest.com.au. From the terminal in the VLAB, we can get the information that is the unknown host.

b. www.hola.hp: This website cannot be opened in the chrome. No website called www.hola.hp. From the terminal in the VLAB, we can get the information that is the unknown host.

c. www.kremlin.ru: We can use chrome or other web browsers to open this website. From chrome, we can find this website is for the Russian government. But if we use the ping command we can find the packet loss is 100%. This is because the server of this website may block the data packet to make sure the security of this website. This can avoid some attacks from hackers, such as the DDOS attack.

Exercise 3: Using traceroute to understand the network topology

1. By using the traceroute command, we can get the two following pictures below. From the second picture, we can easily find that there are 21 routers between my workstation and www.columbia.edu. Furthermore, from the first picture, we can find that the 5th router is still UNSW. But the 6th router has been changed. Using the 'whois' command we can get the 6th router belongs to AARNET. The 6th router does not belong to UNSW. Therefore, there are 5 routers along the path are part of the UNSW network.

According to Wikipedia – Southern Cross

Cable(https://en.wikipedia.org/wiki/Southern_Cross_Cable), we can get the distance from Eastern Australia to West America through the cable in the ocean is about 13910 km. From these 2

websites(<https://www.m2optics.com/blog/bid/70587/calculating-optical-fiber-latency>) and the

calculator(<https://www.timbercon.com/resources/calculators/time-delay-of-light-in-fiber-calculator/>), we can get the speed of different kinds of fibers.

Therefore, the RTT is nearly 140ms. From the first picture, by doing the calculation the RTT between the 7th router and 9th router is 143.3ms. Therefore, between the 7th and 9th router do packets cross the Pacific Ocean.

```
z5241868@vx3:/tmp_amd/kamen/export/kamen/5/z5241868$ 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) 0.115 ms 0.103 ms 0.08
4 ms
 2 129.94.39.17 (129.94.39.17) 0.852 ms 0.858 ms 0.858 ms
 3 ombudnex1-vl-3154.gw.unsw.edu.au (149.171.253.35) 1.300 ms libudnex1-vl-315
4.gw.unsw.edu.au (149.171.253.34) 1.644 ms 1.590 ms
 4 libcr1-po-5.gw.unsw.edu.au (149.171.255.165) 1.033 ms libcr1-po-6.gw.unsw.e
du.au (149.171.255.201) 1.100 ms 1.106 ms
 5 unswbr1-te-1-9.gw.unsw.edu.au (149.171.255.101) 1.185 ms unswbr1-te-2-13.gw
.unsw.edu.au (149.171.255.105) 1.234 ms 1.169 ms
 6 138.44.5.0 (138.44.5.0) 1.330 ms 1.378 ms 1.237 ms
 7 et-1-3-0.pe1.sxt.bkvl.nsw.aarnet.net.au (113.197.15.149) 3.459 ms 2.921 ms
2.870 ms
 8 et-0-0-0.pe1.a.hnl.aarnet.net.au (113.197.15.99) 95.138 ms 95.037 ms 95.0
68 ms
 9 et-2-1-0.bdr1.a.sea.aarnet.net.au (113.197.15.201) 149.705 ms 149.726 ms
149.687 ms
10 abilene-1-lo-jmb-706.sttlwa.pacificwave.net (207.231.240.8) 146.753 ms 146
.757 ms 146.742 ms
11 ae-1.4079.rts.w.minn.net.internet2.edu (162.252.70.173) 179.409 ms 179.390
ms 179.352 ms
12 ae-1.4079.rts.w.eqch.net.internet2.edu (162.252.70.106) 189.601 ms 190.157
ms 190.200 ms
13 ae-0.4079.rts.w3.eqch.net.internet2.edu (162.252.70.163) 187.134 ms 187.513
ms 191.566 ms
14 ae-1.4079.rts.w.clev.net.internet2.edu (162.252.70.130) 193.100 ms 193.154
ms 193.139 ms
15 buf-9208-I2-CLEV.nysernet.net (199.109.11.33) 196.590 ms 196.530 ms 196.5
18 ms
16 syr-9208-buf-9208.nysernet.net (199.109.7.193) 199.769 ms 199.949 ms 199.
817 ms
17 nyc111-9204-syr-9208.nysernet.net (199.109.7.94) 208.993 ms 208.895 ms 20
8.975 ms
```

```

5  unswbr1-te-1-9.gw.unsw.edu.au (149.171.255.101)  1.185 ms unswbr1-te-2-13.gw
.unsw.edu.au (149.171.255.105)  1.234 ms  1.169 ms
6  138.44.5.0 (138.44.5.0)  1.330 ms  1.378 ms  1.237 ms
7  et-1-3-0.pe1.sxt.bkvl.nsw.aarnet.net.au (113.197.15.149)  3.459 ms  2.921 ms
2.870 ms
8  et-0-0-0.pe1.a.hnl.aarnet.net.au (113.197.15.99)  95.138 ms  95.037 ms  95.0
68 ms
9  et-2-1-0.bdr1.a.sea.aarnet.net.au (113.197.15.201)  149.705 ms  149.726 ms
149.687 ms
10 abilene-1-lo-jmb-706.sttlwa.pacificwave.net (207.231.240.8)  146.753 ms  146
.757 ms  146.742 ms
11 ae-1.4079.rtsw.minn.net.internet2.edu (162.252.70.173)  179.409 ms  179.390
ms  179.352 ms
12 ae-1.4079.rtsw.eqch.net.internet2.edu (162.252.70.106)  189.601 ms  190.157
ms  190.200 ms
13 ae-0.4079.rtsw3.eqch.net.internet2.edu (162.252.70.163)  187.134 ms  187.513
ms  191.566 ms
14 ae-1.4079.rtsw.clev.net.internet2.edu (162.252.70.130)  193.100 ms  193.154
ms  193.139 ms
15 buf-9208-I2-CLEV.nysernet.net (199.109.11.33)  196.590 ms  196.530 ms  196.5
18 ms
16 syr-9208-buf-9208.nysernet.net (199.109.7.193)  199.769 ms  199.949 ms  199.
817 ms
17 nyc111-9204-syr-9208.nysernet.net (199.109.7.94)  208.993 ms  208.895 ms  20
8.975 ms
18 nyc-9208-nyc111-9204.nysernet.net (199.109.7.165)  209.032 ms  208.967 ms  2
09.147 ms
19 columbia.nyc-9208.nysernet.net (199.109.4.14)  208.898 ms  208.997 ms  208.8
20 ms
20 cc-core-1-x-nyser32-gw-1.net.columbia.edu (128.59.255.5)  209.163 ms  209.35
5 ms  209.274 ms
21 cc-conc-1-x-cc-core-1.net.columbia.edu (128.59.255.21)  212.836 ms  212.850
ms  212.848 ms
22 columbia.edu (128.59.105.24)  209.096 ms  209.099 ms  209.203 ms
z5241868@vx3:/tmp_amd/kamen/export/kamen/5/z5241868$

```

```
% Abuse contact for '138.44.0.0 - 138.44.255.255' is 'abuse@aarnet.edu.au'
```

```

inetnum:      138.44.0.0 - 138.44.255.255
netname:      AARNET
descr:        Australian Academic and Research Network
descr:        Building 9
descr:        Banks Street
country:      AU
org:          ORG-AAAR1-AP
admin-c:      SM6-AP
tech-c:       ANOC-AP
abuse-c:      AA1638-AP
status:       ALLOCATED PORTABLE
remarks:      -+-+-+
remarks:      This object can only be updated by APNIC hostmasters.
remarks:      To update this object, please contact APNIC
remarks:      hostmasters and include your organisation's account
remarks:      name in the subject line.
remarks:      -+-+-+
notify:       irrcontact@aarnet.edu.au
mnt-by:       APNIC-HM
mnt-lower:    MAINT-AARNET-AP
mnt-routes:   MAINT-AARNET-AP
mnt-irt:      IRT-AARNET-AU
last-modified: 2020-06-22T05:22:11Z
source:       APNIC

```

2. From the following three pictures, we can find the diverge is 138.44.5.0. According to the previous result(Exercise 3 question 1 third picture), we got by using the 'whois' command, we can find 138.44.5.0 belongs to AARNET. We can get distance information from Google Maps. From my workstation to www.ucla.edu is nearly 7493.45 miles, the number of hops is 15. From my workstation to www.u-tokyo.ac.jp is nearly 4909.7 miles, the number of hops is 15. The distance from my workstation to www.lancaster.ac.uk is 10570.2 miles, the number of hops is 14. From all these data given above, the number of hops is not proportional to the physical distance.

```
z5241868@vx3:/tmp_amd/kamen/export/kamen/5/z5241868$ 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) 0.113 ms 0.087 ms 0.075 ms
 2 129.94.39.17 (129.94.39.17) 0.813 ms 0.861 ms 0.779 ms
 3 ombudnex1-vl-3154.gw.unsw.edu.au (149.171.253.35) 21.891 ms libudnex1-vl-3154.gw.unsw.edu.au (149.171.253.34) 4.151 ms 4.104 ms
 4 ombcr1-po-6.gw.unsw.edu.au (149.171.255.169) 1.074 ms libcr1-po-6.gw.unsw.edu.au (149.171.255.201) 1.091 ms libcr1-po-5.gw.unsw.edu.au (149.171.255.165) 1.052 ms
 5 unswbr1-te-1-9.gw.unsw.edu.au (149.171.255.101) 1.159 ms 1.092 ms unswbr1-te-2-13.gw.unsw.edu.au (149.171.255.105) 1.188 ms
 6 138.44.5.0 (138.44.5.0) 2.431 ms 1.757 ms 1.711 ms
 7 et-1-3-0-pe1.sxt.bkvl.nsw.aarnet.net.au (113.197.15.149) 2.017 ms 1.924 ms 1.924 ms
 8 et-0-0-0-pe1.a.hnl.aarnet.net.au (113.197.15.99) 95.223 ms 95.164 ms 95.181 ms
 9 et-2-1-0-bdr1.a.sea.aarnet.net.au (113.197.15.201) 148.824 ms 148.851 ms 148.794 ms
10 cenichpr-1-is-jmb-778.snvac.pacificwave.net (207.231.245.129) 163.873 ms 163.125 ms 163.116 ms
11 svl-aggr10-hpr-svl-hpr3-100g.cenic.net (137.164.25.106) 163.486 ms 163.257 ms 163.501 ms
12 hpr-lax-aggr10-svl-aggr10-100ge.cenic.net (137.164.25.73) 160.684 ms 160.645 ms 160.628 ms
13 * * *
14 bd11f1.anderson--cr001.anderson.ucla.net (169.232.4.6) 160.182 ms bd11f1.anderson--cr00f2.csbl.ucla.net (169.232.4.4) 161.001 ms bd11f1.anderson--cr001.anderson.ucla.net (169.232.4.6) 189.145 ms
15 cr00f1.anderson--rtr11f4.mathsci.ucla.net (169.232.8.185) 160.331 ms cr00f2.csbl--rtr11f4.mathsci.ucla.net (169.232.8.181) 160.342 ms cr00f1.anderson--rtr11f4.mathsci.ucla.net (169.232.8.185) 160.098 ms
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```
z5241868@vx3:/tmp_amd/kamen/export/kamen/5/z5241868$ 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) 0.087 ms 0.052 ms 0.063 ms
 2 129.94.39.17 (129.94.39.17) 0.824 ms 1.133 ms 1.082 ms
 3 libudnex1-vl-3154.gw.unsw.edu.au (149.171.253.34) 1.786 ms 1.805 ms 1.754 ms
 4 ombcr1-po-5.gw.unsw.edu.au (149.171.255.197) 1.095 ms libcr1-po-5.gw.unsw.edu.au (149.171.255.165) 1.228 ms ombcr1-po-5.gw.unsw.edu.au (149.171.255.197) 1.227 ms
 5 unswbr1-te-1-9.gw.unsw.edu.au (149.171.255.101) 1.312 ms unswbr1-te-2-13.gw.unsw.edu.au (149.171.255.105) 1.233 ms unswbr1-te-1-9.gw.unsw.edu.au (149.171.255.101) 1.275 ms
 6 138.44.5.0 (138.44.5.0) 1.301 ms 1.454 ms 1.417 ms
 7 et-0-3-0-pe1.bkvl.nsw.aarnet.net.au (113.197.15.147) 1.700 ms 1.717 ms 1.780 ms
 8 ge-4-0-bbl.a.pao.aarnet.net.au (202.158.194.177) 155.065 ms 155.070 ms 154.965 ms
 9 paloalto0.iiij.net (198.32.176.24) 156.443 ms 157.803 ms 157.794 ms
10 osk004bb00.IIJ.Net (58.138.88.185) 269.175 ms 269.256 ms 269.255 ms
11 osk004ip57.IIJ.Net (58.138.106.162) 269.156 ms 269.147 ms osk004ip57.IIJ.Net (58.138.106.166) 269.020 ms
12 210.130.135.130 (210.130.135.130) 269.351 ms 269.345 ms 269.286 ms
13 124.83.228.58 (124.83.228.58) 273.119 ms 269.432 ms 269.342 ms
14 124.83.252.178 (124.83.252.178) 276.207 ms 275.284 ms 275.285 ms
15 158.205.134.26 (158.205.134.26) 275.180 ms 275.100 ms 275.234 ms
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30 * * *
z5241868@vx3:/tmp_amd/kamen/export/kamen/5/z5241868$
```

```

z5241868@vx3:/tmp_amd/kamen/export/kamen/5/z5241868$ 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) 0.097 ms 0.063 ms 0.082 ms
 2 129.94.39.17 (129.94.39.17) 0.853 ms 0.842 ms 0.829 ms
 3 ombudnex1-vl-3154.gw.unsw.edu.au (149.171.253.35) 1.738 ms 1.660 ms libudnex1-vl-3154.gw.unsw.edu.au (149.171.253.34) 1.351 ms
 4 libcr1-po-5.gw.unsw.edu.au (149.171.255.165) 1.114 ms libcr1-po-6.gw.unsw.edu.au (149.171.255.201) 1.142 ms ombcr1-po-6.gw.unsw.edu.au (149.171.255.169) 1.172 ms
 5 unswbr1-te-2-13.gw.unsw.edu.au (149.171.255.105) 1.152 ms 1.164 ms unswbr1-te-1-9.gw.unsw.edu.au (149.171.255.101) 1.205 ms
 6 138.44.5.0 (138.44.5.0) 1.302 ms 1.269 ms 1.267 ms
 7 et-2-0-5.bdr1.sing.sin.aarnet.net.au (113.197.15.233) 92.676 ms 92.838 ms 92.817 ms
 8 138.44.226.7 (138.44.226.7) 263.776 ms 263.678 ms 263.657 ms
 9 janet-gw.mx1.lon.uk.geant.net (62.40.124.198) 263.791 ms 263.761 ms 263.723 ms
10 ae29.londpg-sbr2.ja.net (146.97.33.2) 264.391 ms 264.386 ms 264.357 ms
11 ae31.erdiss-sbr2.ja.net (146.97.33.22) 268.991 ms 267.950 ms 267.890 ms
12 ae29.manckh-sbr2.ja.net (146.97.33.42) 270.872 ms 270.026 ms 269.875 ms
13 ae25.manckh-ban1.ja.net (146.97.35.50) 269.873 ms 269.960 ms 269.937 ms
14 lancaster-uni.ja.net (146.97.40.178) 287.100 ms 286.316 ms 286.300 ms
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30 * * *
z5241868@vx3:/tmp_amd/kamen/export/kamen/5/z5241868$

```

3. The 1st and 2nd pictures are the result of the Speedtest website. Also, the 3rd and 4th pictures are the results of the Telstra website. The IP address of the Speedtest is 202.150.221.170, and the IP address of Telstra is 203.50.5.178. The path of moving forward and backward are different. This is because the routing path is determined by the routing table of routers. The routers may go different paths in the forward and backward process. Therefore, the forward and backward paths are not the same.

The IP address in forward and backward paths are different. This is because the router connects different networks. Furthermore, the router provides one interface for different networks. Therefore, to separate each network the router should have a different IP address for each network.

```

z5241868@vx4:/tmp_amd/kamen/export/kamen/5/z5241868$ 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) 0.101 ms 0.062 ms 0.059 ms
 2 129.94.39.17 (129.94.39.17) 0.855 ms 0.842 ms 0.820 ms
 3 ombudnex1-vl-3154.gw.unsw.edu.au (149.171.253.35) 1.990 ms libudnex1-vl-3154.gw.unsw.edu.au (149.171.253.34) 1.231 ms 1.435 ms
 4 libcr1-po-6.gw.unsw.edu.au (149.171.255.201) 1.115 ms ombcr1-po-6.gw.unsw.edu.au (149.171.255.169) 1.080 ms libcr1-po-6.gw.unsw.edu.au (149.171.255.201) 1.079 ms
 5 unswbr1-te-2-13.gw.unsw.edu.au (149.171.255.105) 1.093 ms 1.123 ms 1.134 ms
 6 138.44.5.0 (138.44.5.0) 3.316 ms 2.667 ms 2.645 ms
 7 et-0-3-0.pel.alxd.nsw.aarnet.net.au (113.197.15.153) 1.674 ms 1.733 ms 1.715 ms
 8 xe-0-2-7.bdr1.a.lax.aarnet.net.au (202.158.194.173) 147.727 ms 147.663 ms 147.644 ms
 9 singtel.as7473.any2ix.coresite.com (206.72.210.63) 147.684 ms 147.646 ms 147.623 ms
10 203.208.172.165 (203.208.172.165) 330.198 ms 203.208.171.117 (203.208.171.117) 147.878 ms 203.208.172.133 (203.208.172.133) 320.529 ms
11 203.208.172.145 (203.208.172.145) 244.485 ms 244.464 ms 203.208.177.110 (203.208.177.110) 330.362 ms
12 203.208.158.17 (203.208.158.17) 330.833 ms 330.604 ms 203.208.182.253 (203.208.182.253) 334.514 ms
13 203.208.158.185 (203.208.158.185) 329.865 ms 203.208.177.110 (203.208.177.110) 328.908 ms 328.839 ms
14 * * 202-150-221-170.rev.ne.com.sg (202.150.221.170) 209.074 ms

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```

traceroute to 129.94.242.117 (129.94.242.117), 30 hops max, 60 byte packets
 1  ge2-8.r01.sin01.ne.com.sg (202.150.221.169)  0.134 ms  0.152 ms  0.170 ms
 2  10.11.34.146 (10.11.34.146)  0.362 ms  0.557 ms  0.619 ms
 3  aarnet.sgix.sg (103.16.102.67)  213.015 ms  212.893 ms  212.815 ms
 4  et-7-3-0.pel.nsw.brwy.aarnet.net.au (113.197.15.232)  209.140 ms  209.181 ms  209.198 ms
 5  138.44.5.1 (138.44.5.1)  208.344 ms  208.292 ms  208.391 ms
 6  ombcr1-te-1-5.gw.unsw.edu.au (149.171.255.106)  199.743 ms  199.697 ms  199.738 ms
 7  libudnex1-po-2.gw.unsw.edu.au (149.171.255.198)  209.063 ms  208.759 ms  208.863 ms
 8  ufw1-ae-1-3154.gw.unsw.edu.au (149.171.253.36)  200.367 ms  200.418 ms  200.407 ms
 9  129.94.39.23 (129.94.39.23)  209.110 ms  209.138 ms  209.070 ms
10  * * *
11  * * *

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z5241868@vx4:/tmp_amd/kamen/export/kamen/5/z5241868$ 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)  0.133 ms  0.090 ms  0.066 ms
 2  129.94.39.17 (129.94.39.17)  0.890 ms  0.865 ms  0.858 ms
 3  ombudnex1-vl-3154.gw.unsw.edu.au (149.171.253.35)  46.397 ms libudnex1-vl-3154.gw.unsw.edu.au (149.171.253.34)  13.055 ms  13.053 ms
 4  ombcr1-po-6.gw.unsw.edu.au (149.171.255.169)  1.121 ms  1.074 ms libcr1-po-6.gw.unsw.edu.au (149.171.255.201)  1.109 ms
 5  unswbr1-te-2-13.gw.unsw.edu.au (149.171.255.105)  1.111 ms  1.124 ms  1.148 ms
 6  138.44.5.0 (138.44.5.0)  1.311 ms  1.287 ms  1.263 ms
 7  et-1-1-0.pel.rsby.nsw.aarnet.net.au (113.197.15.12)  1.556 ms  2.059 ms  2.056 ms
 8  xe-0-0-3.bdr1.rsby.nsw.aarnet.net.au (113.197.15.31)  1.635 ms  1.530 ms  1.547 ms
 9  HundredGigE0-1-0-4.ken-edge903.sydney.telstra.net (139.130.0.77)  2.046 ms  2.090 ms  2.139 ms
10  bundle-ether17.ken-core10.sydney.telstra.net (203.50.11.172)  3.564 ms bundle-ether2.chw-edge903.sydney.telstra.net (203.50.11.175)  2.263 ms  2.717 ms
11  bundle-ether10.win-core10.melbourne.telstra.net (203.50.11.123)  13.648 ms bundle-ether17.chw-core10.sydney.telstra.net (203.50.11.176)  4.186 ms bundle-ether10.win-core10.melbourne.telstra.net (203.50.11.123)  14.431 ms
12  203.50.6.40 (203.50.6.40)  15.452 ms bundle-ether8.exi-core10.melbourne.telstra.net (203.50.11.125)  14.467 ms 203.50.6.40 (203.50.6.40)  15.209 ms
13  bundle-ether2.exi-ncprouter101.melbourne.telstra.net (203.50.11.209)  14.841 ms  14.263 ms  14.216 ms
14  www.telstra.net (203.50.5.178)  14.282 ms  13.535 ms  13.795 ms

```

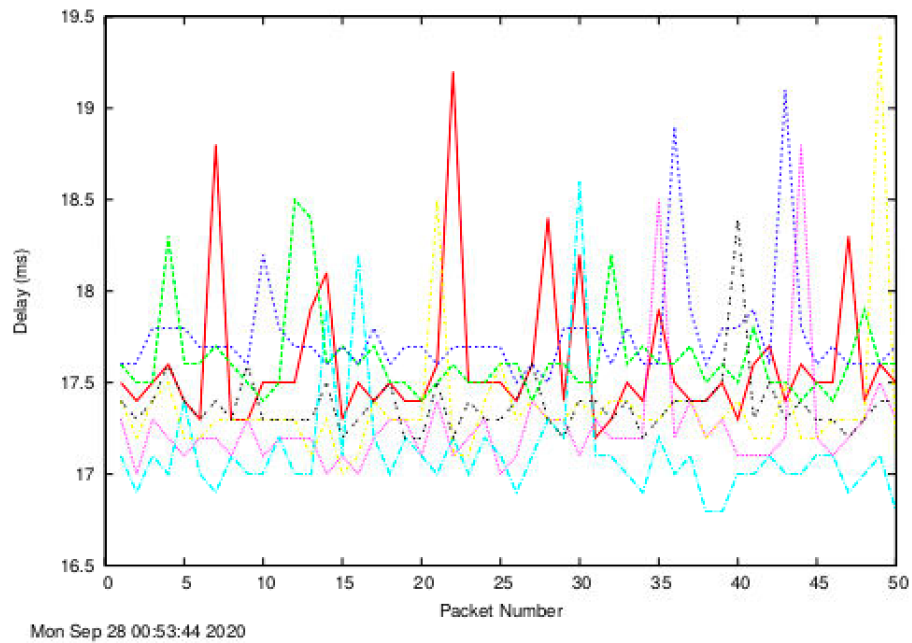
```

 1  gigabitethernet3-3.exi2.melbourne.telstra.net (203.50.77.53)  0.358 ms  0.205 ms  0.241 ms
 2  bundle-ether3-100.win-core10.melbourne.telstra.net (203.50.80.129)  1.239 ms  1.610 ms  2.235 ms
 3  bundle-ether12.ken-core10.sydney.telstra.net (203.50.11.122)  11.986 ms  12.348 ms  12.610 ms
 4  bundle-ether1.ken-edge903.sydney.telstra.net (203.50.11.173)  12.235 ms  12.095 ms  12.362 ms
 5  aar3533567.lnk.telstra.net (139.130.0.78)  11.609 ms  11.600 ms  11.610 ms
 6  et-7-1-0.pel.brwy.nsw.aarnet.net.au (113.197.15.13)  11.985 ms  11.974 ms  11.862 ms
 7  138.44.5.1 (138.44.5.1)  12.109 ms  12.101 ms  11.986 ms
 8  libcr1-te-1-5.gw.unsw.edu.au (149.171.255.102)  12.108 ms  12.098 ms  12.110 ms
 9  ombudnex1-po-1.gw.unsw.edu.au (149.171.255.202)  12.359 ms
10  ufw1-ae-1-3154.gw.unsw.edu.au (149.171.253.36)  12.731 ms  12.725 ms  12.735 ms
11  129.94.39.23 (129.94.39.23)  12.859 ms  12.975 ms  12.861 ms

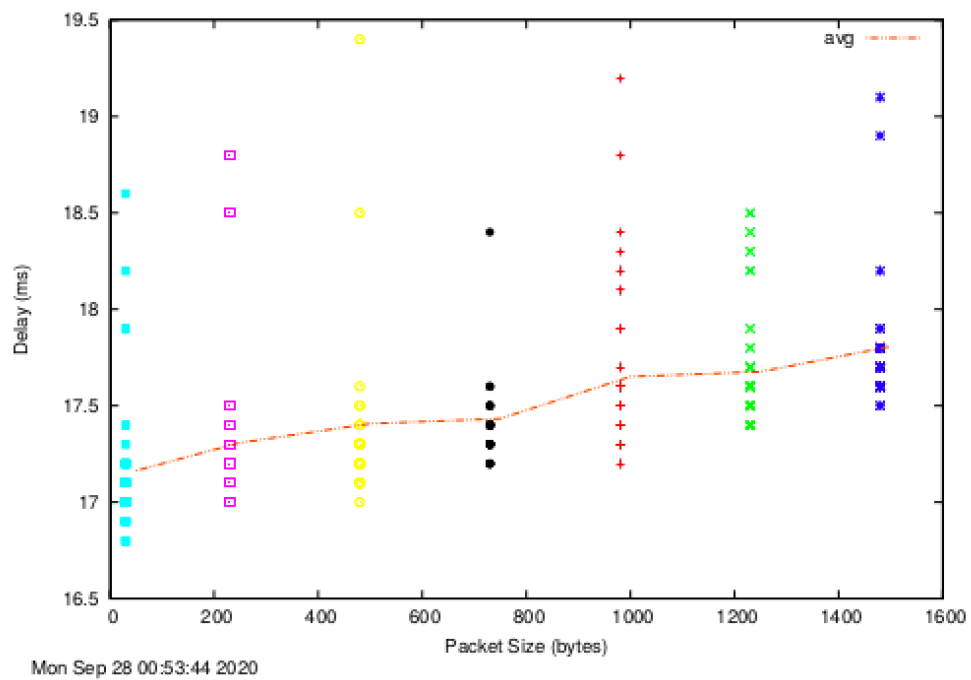
```

Exercise 4: Use ping to gain insights into network performance

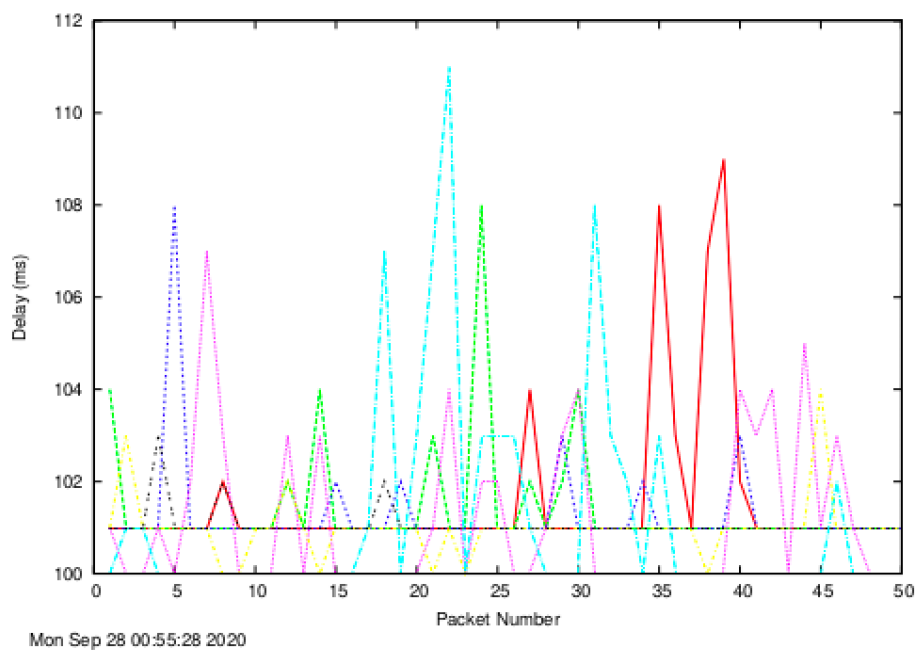
Delay for www.uq.edu.au:



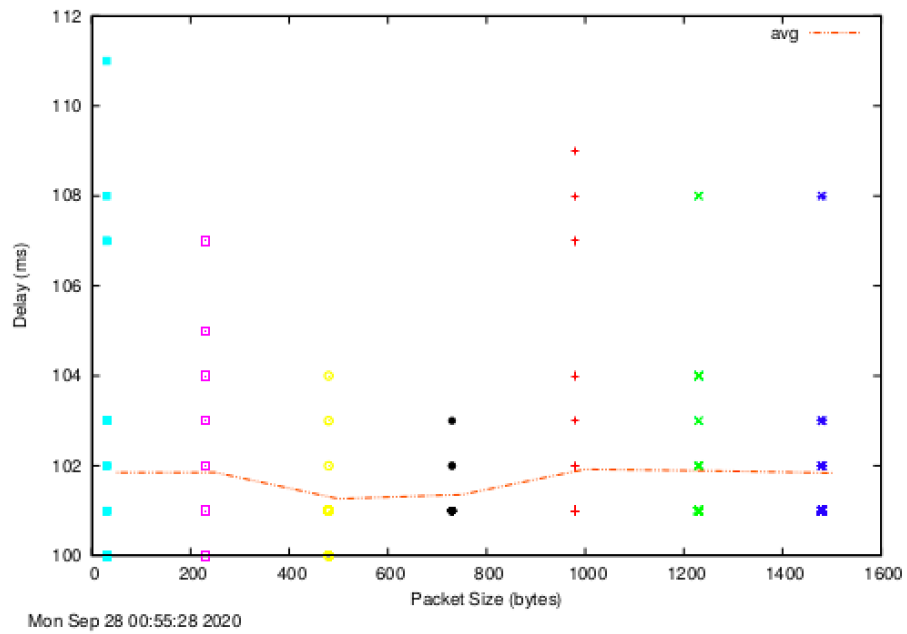
Scatter for www.uq.edu.au:



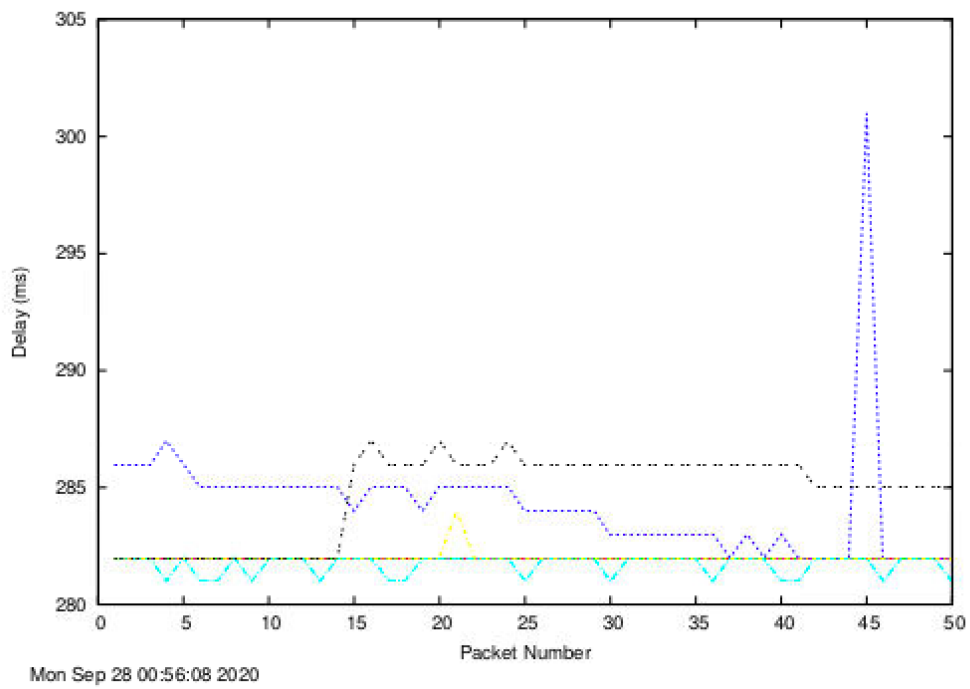
Delay for www.ump.edu.my:



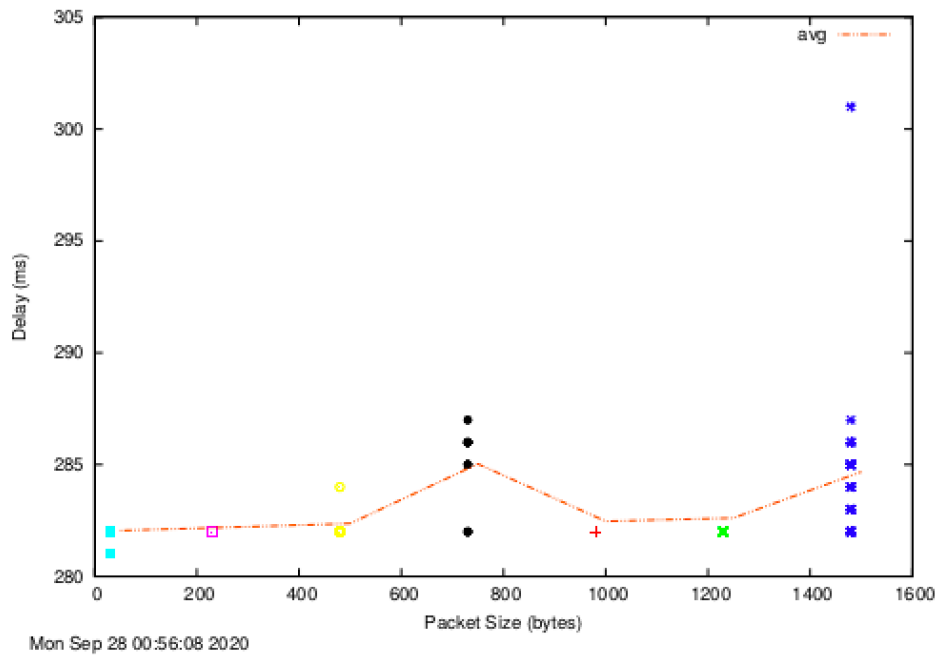
Scatter for www.ump.edu.my:



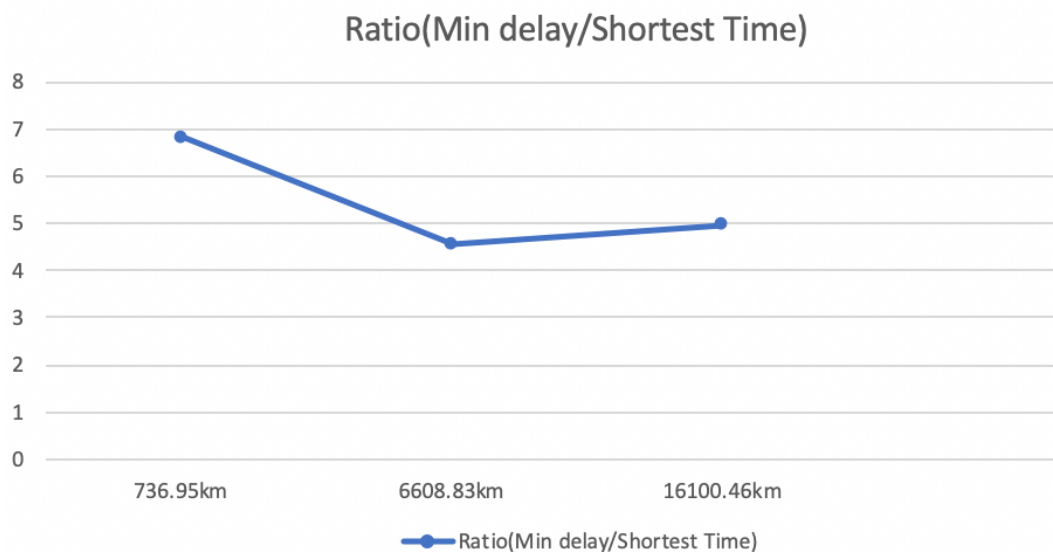
Delay for www.tu-berlin.de:



Scatter for www.tu-berlin.de:



1. From the graph we can easily find that ratios are between 4 and 7. All of these ratios are higher than 2. One reason is the real distance of the routing path may longer than the straight physical distance(a straight line). This is because when we set up the cable under the ocean, we cannot draw a straight line from the start point to the destination. Furthermore, the different routing tables of ISP will also cause that the real distance is more longer. The other reason is that when we talking about delay, there are different kinds of delay. Not only propagation delay, but also nodal processing delay, queueing delay and transmission delay. For example, just like the traffic jam, if some part of the line is busy, the transmission delay will grow. This is due to the fixed bandwidth.



2. From all these delay graphs, we can find that RTT varies a lot in a period. This is due to the condition of the pathway, whether the pathway is busy or not. A

good example, when the router's efficiency will due to the workload in different periods. This can also cause a change in the routing path.

3. The RTT is about 1.5ms from my workstation. The low-level delay can indicate that the routers mostly are in Sydney. Therefore, the delay can stay between 1 ms – 2 ms.

```
z5241868@vx4:/tmp_amd/kamen/export/kamen/5/z5241868$ traceroute www.epfl.ch
traceroute to www.epfl.ch (172.67.2.106), 30 hops max, 60 byte packets
 1 cserouter1-server.cse.unsw.EDU.AU (129.94.242.251) 0.073 ms 0.053 ms 0.05
 2 ms
 2 129.94.39.17 (129.94.39.17) 0.822 ms 0.810 ms 0.844 ms
 3 ombudnex1-vl-3154.gw.unsw.edu.au (149.171.253.35) 1.386 ms libudnex1-vl-315
 4.gw.unsw.edu.au (149.171.253.34) 1.570 ms 1.556 ms
 4 libcr1-po-5.gw.unsw.edu.au (149.171.255.165) 1.083 ms ombcr1-po-5.gw.unsw.e
 du.au (149.171.255.197) 1.082 ms libcr1-po-6.gw.unsw.edu.au (149.171.255.201)
 1.125 ms
 5 unswbr1-te-1-9.gw.unsw.edu.au (149.171.255.101) 1.123 ms 1.149 ms 1.165 m
 s
 6 138.44.5.0 (138.44.5.0) 1.364 ms 1.310 ms 1.281 ms
 7 ae2.bdr1.msc4.nsw.aarnet.net.au (113.197.15.77) 1.800 ms 1.721 ms 1.665 m
 s
 8 as4826.bdr1.msc4.nsw.aarnet.net.au (138.44.10.45) 3.530 ms 3.227 ms 3.230
 ms
 9 be107.cor02.syd04.nsw.vocus.network (114.31.192.82) 2.272 ms 2.312 ms 2.2
 43 ms
 10 be101.bdr02.syd03.nsw.vocus.network (114.31.192.37) 2.575 ms be100.bdr02.sy
 d03.nsw.vocus.network (114.31.192.39) 2.523 ms be101.bdr02.syd03.nsw.vocus.netw
 ork (114.31.192.37) 2.608 ms
 11 as13335.bdr02.syd03.nsw.VOCUS.net.au (175.45.124.197) 3.128 ms 3.314 ms 3
 .277 ms
 12 172.67.2.106 (172.67.2.106) 1.584 ms 1.637 ms 1.560 ms
 z5241868@vx4:/tmp_amd/kamen/export/kamen/5/z5241868$
```

4. Propagation delay: This kind of delay is equal to the ratio of the physical link length d and the speed of propagation s , which is $d_{prop} = d/s$. Therefore, the propagation delay depends on physical link length and the speed of propagation.

Transmission delay: This kind of delay is equal to the ratio of packet length L and link bandwidth R , which is $d_{trans} = L/R$.

Nodal Processing delay: This kind of delay is caused by checking bit errors in the packet. If the size of the packet is large, the time of checking errors is longer. Therefore, this kind of delay is determined by the size of the packet.

Queueing delay: This kind of delay is caused by waiting at the output link for transmission. It depends on the congestion level of the router.