

Lab 1

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?

```
z5195715@bongo17:~$ nslookup www.koala.com.au
Server:      129.94.208.2
Address:     129.94.208.2#53

Non-authoritative answer:
Name:   www.koala.com.au
Address: 104.18.60.21
Name:   www.koala.com.au
Address: 104.18.61.21
```

IP address of www.koala.com.au is 104.18.60.21 and 104.18.61.21

Because multiple IP addresses can balance the loads and make the website performs better especially in peak hours.

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

```
z5195715@bongo17:~$ nslookup 127.0.0.1
Server:      129.94.208.2
Address:     129.94.208.2#53

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

The name of the IP address 127.0.0.1 is localhost. 127.0.0.1 is also called the loopback address. It is not routable. It is the internal interface used by the machine to send a packet to itself.

Exercise 2: Use ping to test host reachability

Are the following hosts reachable from your machine by using ping:

www.unsw.edu.au

www.getfittest.com.au

www.mit.edu

www.intel.com.au

www.tpg.com.au

www.hola.hp

www.amazon.com

www.tsinghua.edu.cn

www.kremlin.ru

8.8.8.8

If you observe that some hosts are not reachable, then can you explain why? Check if the addresses unreachable by the ping command are reachable from the Web browser.

www.getfittest.com.au and www.hola.hp are unreachable by the ping command nor the Web browser, because www.getfittest.com.au and www.hola.hp are unknown host links.

www.kremlin.ru can be visited by the Web browser, but it shows request time out by ping command because of its firework for security reason.

The rest of the hosts are reachable: www.cse.unsw.edu.au , www.mit.edu , www.intel.com.au , www.tpg.com.au , www.tsinghua.edu.cn , www.amazon.com and 8.8.8.8.

Exercise 3: Use traceroute to understand network topology

1. Run traceroute on your machine to www.columbia.edu . 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.)

```
z5195715@bongo17:~$ traceroute www.columbia.edu
traceroute to www.columbia.edu (128.59.105.24), 30 hops max, 60 byte packets
 1 cserouter1-trusted.cse.unsw.EDU.AU (129.94.208.251) 0.170 ms 0.132 ms 0.153 ms
 2 129.94.39.17 (129.94.39.17) 0.842 ms 0.903 ms 0.876 ms
 3 libudnex1-v1-3154.gw.unsw.edu.au (149.171.253.34) 1.662 ms 1.506 ms ombudn
ex1-v1-3154.gw.unsw.edu.au (149.171.253.35) 1.298 ms
 4 ombcr1-po-6.gw.unsw.edu.au (149.171.255.169) 1.258 ms 1.289 ms libcr1-po-5
.gw.unsw.edu.au (149.171.255.165) 1.069 ms
 5 unswbr1-te-2-13.gw.unsw.edu.au (149.171.255.105) 1.348 ms unswbr1-te-1-9.gw
.unsw.edu.au (149.171.255.101) 1.250 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) 1.355 ms 1.300 ms 1.353 ms
 7 et-1-3-0.pe1.sxt.bkvl.nsw.aarnet.net.au (113.197.15.149) 2.417 ms 2.259 ms
2.350 ms
 8 et-0-0-0.pe1.a.hnl.aarnet.net.au (113.197.15.99) 95.457 ms 95.458 ms 95.3
79 ms
 9 et-2-1-0.bdr1.a.sea.aarnet.net.au (113.197.15.201) 146.847 ms 146.778 ms
146.788 ms
10 abilene-1-lo-jmb-706.sttlwa.pacificwave.net (207.231.240.8) 146.744 ms 146
.723 ms 146.685 ms
11 et-4-0-0.4079.rtsw.miss2.net.internet2.edu (162.252.70.0) 158.665 ms 158.6
66 ms 158.124 ms
12 et-4-0-0.4079.rtsw.minn.net.internet2.edu (162.252.70.58) 180.795 ms 180.5
99 ms 180.573 ms
13 et-1-1-5.4079.rtsw.eqch.net.internet2.edu (162.252.70.106) 188.373 ms 190.
068 ms 191.314 ms
14 ae-0.4079.rtsw3.eqch.net.internet2.edu (162.252.70.163) 190.560 ms 188.916
ms 188.808 ms
15 ae-1.4079.rtsw.clev.net.internet2.edu (162.252.70.130) 197.233 ms 197.099
ms 197.065 ms
16 buf-9208-I2-CLEV.nysernet.net (199.109.11.33) 201.711 ms 201.667 ms 201.6
29 ms
17 syr-9208-buf-9208.nysernet.net (199.109.7.193) 204.735 ms 204.766 ms 204.
636 ms
18 nyc111-9204-syr-9208.nysernet.net (199.109.7.94) 227.672 ms 219.767 ms 21
4.224 ms
19 nyc-9208-nyc111-9204.nysernet.net (199.109.7.165) 213.748 ms 214.988 ms 2
14.228 ms
20 columbia.nyc-9208.nysernet.net (199.109.4.14) 214.256 ms 214.125 ms 214.0
74 ms
21 cc-core-1-x-nyser32-gw-1.net.columbia.edu (128.59.255.5) 214.205 ms 214.29
0 ms 214.108 ms
22 cc-conc-1-x-cc-core-1.net.columbia.edu (128.59.255.21) 214.276 ms 214.489
ms 214.454 ms
23 teachtechaward.org (128.59.105.24) 214.026 ms 214.288 ms 214.245 ms
z5195715@bongo17:~$
```

There are 22 routers between my workstation and www.columbia.edu.

The first 5 routers are belong to UNSW network because their hostnames contain 'unsw.edu.au'.

Between 7-8 and 8-9 packets go cross the ocean because the ping greatly increases from 2.417ms to 95.457ms and from 95.457ms to 146.847ms.

2.Run traceroute from your machine to the following destinations: (i) www.ucla.edu (ii) www.u-tokyo.ac.jp and (iii) www.lancaster.ac.uk . 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 the physical distance? (HINT: You can find out geographical location of a server using the following tool - <http://www.yougetsignal.com/tools/network-location/>)

My machine to www.ucla.edu:

```
z51957150@bongo17:~$ traceroute www.ucla.edu
traceroute to www.ucla.edu (164.67.228.152), 30 hops max, 60 byte packets
 1 cserouter1-trusted.cse.unsw.edu.au (129.94.208.251) 0.407 ms 0.362 ms 0.329 ms
 2 129.94.39.17 (129.94.39.17) 0.915 ms 0.896 ms 0.865 ms
 3 libudhex1-vl-3154.gw.unsw.edu.au (149.171.253.34) 1.763 ms 1.669 ms ombudhex1-vl-3154.gw.unsw.edu.au (149.171.253.35) 1.427 ms
 4 libcr1-po-6.gw.unsw.edu.au (149.171.255.201) 1.103 ms libcr1-po-5.gw.unsw.edu.au (149.171.255.165) 1.128 ms ombcr1-po-5.gw.unsw.edu.au (149.171.255.197) 1.103 ms
 5 unsubst1-te-2-13.gw.unsw.edu.au (149.171.255.105) 1.177 ms 1.207 ms 1.306 ms
 6 138.44.5.0 (138.44.5.0) 1.324 ms 1.440 ms 1.404 ms
 7 et-1-3-0.pe1.sxt.bkvl.nsw.aarnet.net.au (113.197.15.149) 2.175 ms 2.409 ms 2.286 ms
 8 et-0-0-0.pe1.a.hnl.aarnet.net.au (113.197.15.99) 95.542 ms 95.471 ms 95.478 ms
 9 et-2-1-0.bdrl.a.sea.aarnet.net.au (113.197.15.201) 146.784 ms 146.676 ms 146.595 ms
10 cenichpr-1-is-jmb-778.srvaca.pacificwave.net (207.231.245.129) 164.034 ms 164.546 ms 164.005 ms
11 hpr-lax-hpr3--svl-hpr3-100ge.cenic.net (137.164.25.73) 160.168 ms 160.173 ms 160.016 ms
12 * * *
13 bd11f1.anderson--cr00f2.csbl.ucla.net (169.232.4.4) 162.006 ms 160.467 ms 160.413 ms
14 cr00f1.anderson--dr00f2.csbl.ucla.net (169.232.4.55) 160.383 ms cr00f2.csbl--dr00f2.csbl.ucla.net (169.232.4.53) 161.265 ms 161.078 ms
15 * * *
16 * * *
17 * * *
18 * * *
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23 * * *
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25 * * *
26 * * *
27 * * *
28 * * *
29 * * *
30 * * *
```

My machine to www.u-tokyo.ac.jp:

```

z5195715@bongo17:~$ 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-trusted.cse.unsw.EDU.AU (129.94.208.251) 0.180 ms 0.140 ms 0.112 ms
 2 129.94.39.17 (129.94.39.17) 0.948 ms 0.933 ms 0.906 ms
 3 libudnex1-v1-3154.gw.unsw.edu.au (149.171.253.34) 1.678 ms ombudnex1-v1-3154.gw.unsw.edu.au (149.171.253.35) 1.521 ms libudnex1-v1-3154.gw.unsw.edu.au (149.171.253.34) 1.754 ms
 4 libcr1-po-6.gw.unsw.edu.au (149.171.255.201) 1.121 ms libcr1-po-5.gw.unsw.edu.au (149.171.255.165) 1.106 ms ombcr1-po-6.gw.unsw.edu.au (149.171.255.169) 1.068 ms
 5 unswbr1-te-2-13.gw.unsw.edu.au (149.171.255.105) 1.142 ms 1.164 ms 1.285 ms
 6 138.44.5.0 (138.44.5.0) 1.369 ms 1.440 ms 1.405 ms
 7 et-0-3-0.pe1.bkvl.nsw.aarnet.net.au (113.197.15.147) 2.247 ms 1.858 ms 1.859 ms
 8 ge-4_0_0.bb1.a.pao.aarnet.net.au (202.158.194.177) 156.385 ms 156.388 ms 156.360 ms
 9 paloalto0.iiij.net (198.32.176.24) 157.479 ms 157.459 ms 157.421 ms
10 osk004bb00.IIJ.Net (58.138.88.185) 288.232 ms osk004bb01.IIJ.Net (58.138.88.189) 270.670 ms 270.669 ms
11 osk004ip57.IIJ.Net (58.138.106.162) 288.090 ms osk004ip57.IIJ.Net (58.138.106.166) 270.607 ms 270.697 ms
12 210.130.135.130 (210.130.135.130) 270.526 ms 270.503 ms 279.661 ms
13 124.83.228.58 (124.83.228.58) 279.558 ms 288.419 ms 288.390 ms
14 124.83.252.178 (124.83.252.178) 294.245 ms 294.052 ms 285.405 ms
15 158.205.134.26 (158.205.134.26) 276.660 ms 276.632 ms 308.338 ms
16 * * *
17 * * *
18 * * *
19 * * *
20 * * *
21 * * *
22 * * *
23 * * *
24 * * *
25 * * *
26 * * *
27 * * *
28 * * *
29 * * *
30 * * *
z5195715@bongo17:~$

```

My machine to www.lancaster.ac.uk

```

z5195715@bongo17:~$ traceroute www.lancaster.ac.uk
traceroute to www.lancaster.ac.uk (148.88.65.80), 30 hops max, 60 byte packets
 1 cserouter1-trusted.cse.unsw.EDU.AU (129.94.208.251) 0.204 ms 0.157 ms 0.126 ms
 2 129.94.39.17 (129.94.39.17) 0.864 ms 0.841 ms 0.928 ms
 3 libudnex1-v1-3154.gw.unsw.edu.au (149.171.253.34) 1.459 ms 1.633 ms ombudnex1-v1-3154.gw.unsw.edu.au (149.171.253.35) 1.454 ms
 4 ombcr1-po-6.gw.unsw.edu.au (149.171.255.169) 1.157 ms libcr1-po-5.gw.unsw.edu.au (149.171.255.165) 1.105 ms ombcr1-po-5.gw.unsw.edu.au (149.171.255.197) 1.842 ms
 5 unswbr1-te-1-9.gw.unsw.edu.au (149.171.255.101) 1.403 ms 1.379 ms 1.393 ms
 6 138.44.5.0 (138.44.5.0) 1.505 ms 1.383 ms 1.343 ms
 7 et-2-0-5.bdr1.sing.sin.aarnet.net.au (113.197.15.233) 92.811 ms 92.574 ms 92.542 ms
 8 138.44.226.7 (138.44.226.7) 256.519 ms 256.449 ms 256.457 ms
 9 janet-gw.mxl.lon.uk.geant.net (62.40.124.198) 256.545 ms 256.474 ms 256.510 ms
10 ae29.londpg-sbr2.ja.net (146.97.33.2) 256.756 ms 256.733 ms 256.705 ms
11 ae31.erdiss-sbr2.ja.net (146.97.33.22) 260.634 ms 260.559 ms 260.488 ms
12 ae29.manckh-sbr2.ja.net (146.97.33.42) 262.513 ms 262.787 ms 262.434 ms
13 ae24.lanclu-rbr1.ja.net (146.97.38.58) 264.805 ms 264.920 ms 264.890 ms
14 lancaster-university.ja.net (194.81.46.2) 275.034 ms 274.785 ms 274.711 ms
15 is-border01.bfw01.rtr.lancs.ac.uk (148.88.253.202) 265.152 ms 265.173 ms 265.118 ms
16 bfw01.iss-servers.is-core01.rtr.lancs.ac.uk (148.88.250.98) 270.491 ms 267.136 ms 267.276 ms
17 * * *
18 www.lancs.ac.uk (148.88.65.80) 265.311 ms !X 265.332 ms !X 265.337 ms !X
z5195715@bongo17:~$

```

After the 6th router(138.44.5.0), paths from my machine to these three destinations diverge.

More information about 138.44.5.0 by using whois command:

```

admin-c:      SM6-AP
tech-c:       ANOC-AP
auth:         # Filtered
mnt-by:       MAINT-AARNET-AP
last-modified: 2010-11-08T08:02:43Z
source:       APNIC

organisation: ORG-AAAR1-AP
org-name:     Australian Academic and Research Network
country:      AU
address:      Building 9
address:      Banks Street
phone:        +61-2-6222-3530
fax-no:       +61-2-6222-3535
e-mail:       irrcontact@aar.net.edu.au
mnt-ref:      APNIC-HM
mnt-by:       APNIC-HM
last-modified: 2017-10-09T12:56:36Z
source:       APNIC

role:         AARNet Network Operations Centre
remarks:
address:      AARNet Pty Ltd
address:      GPO Box 1559
address:      Canberra
address:      ACT 2601
country:      AU
phone:        +61 1300 275 662
phone:        +61 2 6222 3555
remarks:
e-mail:       noc@aar.net.edu.au
remarks:
remarks:      Send abuse reports to abuse@aar.net.edu.au
remarks:      Please include timestamps and offset to UTC in logs
remarks:      Peering requests to peering@aar.net.edu.au

admin-c:      SM6-AP
tech-c:       BM-AP
nic-hdl:      ANOC-AP
mnt-by:       MAINT-AARNET-AP
last-modified: 2010-06-30T13:16:48Z
source:       APNIC

```

approximate geophysical location



network information

IP Address
164.67.228.152
 Base Domain
ucla.edu
 Country
United States 
 Region
CA
 City
Los Angeles
 Latitude
33.7866
 Longitude
-118.2987
 Area Code
310
 Postal Code
90095
 Distance from Last
 (as the crow flies)
7499.0 miles
 Source
MaxMind

locate a network

Remote Address
☐ Use Current IP
 Source ☒ MaxMind ☐ Hostip.info

approximate geophysical location



network information

IP Address
210.152.243.234
Base Domain
idcfcloud.com
Country
Japan
Region
Unknown
City
Unknown
Latitude
36
Longitude
138
Area Code
Unknown
Postal Code
Unknown
Distance from Last
(as the crow flies)
5558.0 miles
Source
MaxMind

locate a network

Remote Address
☒ Use Current IP
Source ☒ MaxMind ☐ Hostip.info

approximate geophysical location



network information

IP Address
148.88.65.80
Base Domain
ac.uk
Country
United Kingdom
Region
H2
City
Lancaster
Latitude
54.0667
Longitude
-2.8333
Area Code
Unknown
Postal Code
Unknown
Distance from Last
(as the crow flies)
5797.1 miles
Source
MaxMind

locate a network

Remote Address
☒ Use Current IP
Source ☒ MaxMind ☐ Hostip.info

From the distances shown above, Sydney to Los Angeles is further than it to Tokyo. However, the number of hops to Los Angeles is 14 and to Tokyo is 15. So, the number of hops is not proportional to the physical distance.

2. Several servers distributed around the world provide a web interface from which you can perform a traceroute to any other host in the Internet. Here are two examples: (i) <http://www.speedtest.com.sg/tr.php> and (ii) <https://www.telstra.net/cgi-bin/trace>. Run traceroute from both these servers towards your machine and in the reverse direction (i.e. from your machine to these servers). You may also try other traceroute servers from the list at www.traceroute.org. 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?

IP address of my machine is 129.94.208.2, IP address of www.telstra.net is 203.50.5.178

Telstra to my machine:

```
1 gigabitethernet3-3.exi2.melbourne.telstra.net (203.50.77.53) 0.475 ms 0.204 ms 0.242 ms
2 bundle-ether3-100.win-core10.melbourne.telstra.net (203.50.80.129) 2.738 ms 1.477 ms 2.116 ms
3 bundle-ether12.ken-core10.sydney.telstra.net (203.50.11.122) 13.861 ms 12.220 ms 13.485 ms
4 bundle-ether1.ken-edge901.sydney.telstra.net (203.50.11.95) 11.984 ms 11.972 ms 11.985 ms
5 aarnet6.lnk.telstra.net (139.130.0.78) 11.861 ms 11.598 ms 11.485 ms
6 xe-5-2-2.pe1.brwy.nsw.aarnet.net.au (113.197.15.32) 11.858 ms 11.848 ms 11.858 ms
7 138.44.5.1 (138.44.5.1) 11.985 ms 11.975 ms 11.985 ms
8 libcr1-te-1-5.gw.unsw.edu.au (149.171.255.102) 28.352 ms 13.844 ms 15.736 ms
9 ombudnex1-po-1.gw.unsw.edu.au (149.171.255.202) 12.481 ms 13.097 ms 13.362 ms
10 ufw1-ae-1-3154.gw.unsw.edu.au (149.171.253.36) 12.608 ms 12.597 ms 12.611 ms
11 129.94.39.23 (129.94.39.23) 13.233 ms 13.225 ms 12.985 ms
```

My machine to Telstra:

```
z5195715@bongol7:~$ traceroute www.telstra.net
traceroute to www.telstra.net (203.50.5.178), 30 hops max, 60 byte packets
1 cserouter1-trusted.cse.unsw.EDU.AU (129.94.208.251) 0.217 ms 0.171 ms 0.136 ms
2 129.94.39.17 (129.94.39.17) 0.863 ms 0.885 ms 0.923 ms
3 libudnex1-v1-3154.gw.unsw.edu.au (149.171.253.34) 1.638 ms ombudnex1-v1-3154.gw.unsw.edu.au (149.171.253.35) 1.435 ms libudnex1-v1-3154.gw.unsw.edu.au (149.171.253.34) 1.581 ms
4 ombcr1-po-6.gw.unsw.edu.au (149.171.255.169) 1.066 ms libcr1-po-5.gw.unsw.edu.au (149.171.255.165) 1.040 ms ombcr1-po-5.gw.unsw.edu.au (149.171.255.197) 1.132 ms
5 unswbr1-te-1-9.gw.unsw.edu.au (149.171.255.101) 1.204 ms 1.176 ms 1.169 ms
6 138.44.5.0 (138.44.5.0) 1.322 ms 1.325 ms 1.289 ms
7 xe-0-0-0.bdr1.nsw.aarnet.net.au (113.197.15.33) 1.541 ms 1.675 ms 1.606 ms
8 gigabitethernet3-11.ken37.sydney.telstra.net (139.130.0.77) 2.405 ms 2.218 ms 2.349 ms
9 bundle-ether13.ken-core10.sydney.telstra.net (203.50.11.94) 2.439 ms 3.415 ms 2.692 ms
10 bundle-ether10.win-core10.melbourne.telstra.net (203.50.11.123) 14.536 ms 14.495 ms bundle-ether13.chw-core10.sydney.telstra.net (203.50.11.98) 3.139 ms
11 203.50.6.40 (203.50.6.40) 15.368 ms bundle-ether8.exi-core10.melbourne.telstra.net (203.50.11.125) 14.351 ms 14.355 ms
12 bundle-ether2.exi-nrcrouter101.melbourne.telstra.net (203.50.11.209) 25.220 ms 24.516 ms 24.399 ms
13 www.telstra.net (203.50.5.178) 24.259 ms 24.200 ms 22.682 ms
z5195715@bongol7:~$
```

IP address of my machine is 129.94.208.2, IP address of www.speedtest.com.sg is 202.150.221.170

www.speedtest.com.sg to my machine:

```
traceroute to 129.94.208.2 (129.94.208.2), 30 hops max, 60 byte packets
1 ge2-8.r01.sin01.ne.com.sg (202.150.221.169) 0.153 ms 0.195 ms 0.216 ms
2 10.15.62.210 (10.15.62.210) 0.234 ms 0.239 ms 0.265 ms
3 aarnet.sgix.sg (103.16.102.67) 199.409 ms 199.478 ms 199.451 ms
4 et-7-3-0.pe1.brwy.nsw.aarnet.net.au (113.197.15.232) 208.156 ms 208.173 ms 208.189 ms
5 138.44.5.1 (138.44.5.1) 213.678 ms 213.704 ms 213.837 ms
6 ombcr1-te-1-5.gw.unsw.edu.au (149.171.255.106) 208.333 ms 208.624 ms 208.509 ms
7 libudnex1-po-2.gw.unsw.edu.au (149.171.255.198) 207.516 ms 207.611 ms 207.522 ms
8 ufw1-ae-1-3154.gw.unsw.edu.au (149.171.253.36) 209.040 ms 208.952 ms 208.913 ms
9 129.94.39.23 (129.94.39.23) 200.552 ms 200.650 ms 200.662 ms
```

My machine to www.speedtest.com.sg:

```
z5195715@bongol7:~$ traceroute www.speedtest.com.sg
traceroute to www.speedtest.com.sg (202.150.221.170), 30 hops max, 60 byte packets
1 cserouter1-trusted.cse.unsw.EDU.AU (129.94.208.251) 0.409 ms 0.362 ms 0.328 ms
2 129.94.39.17 (129.94.39.17) 0.854 ms 0.837 ms 0.874 ms
3 ombudnex1-v1-3154.gw.unsw.edu.au (149.171.253.35) 1.480 ms libudnex1-v1-3154.gw.unsw.edu.au (149.171.253.34) 1.632 ms 1.606 ms
4 libcr1-po-6.gw.unsw.edu.au (149.171.255.201) 1.045 ms 1.085 ms ombcr1-po-5.gw.unsw.edu.au (149.171.255.197) 1.054 ms
5 unswbr1-te-1-9.gw.unsw.edu.au (149.171.255.101) 1.138 ms 1.182 ms unswbr1-te-2-13.gw.unsw.edu.au (149.171.255.105) 1.157 ms
6 138.44.5.0 (138.44.5.0) 1.275 ms 1.294 ms 1.310 ms
7 et-0-3-0.pe1.alxd.nsw.aarnet.net.au (113.197.15.153) 1.738 ms 1.808 ms 1.808 ms
8 xe-0-2-7.bdr1.a.lax.aarnet.net.au (202.158.194.173) 147.880 ms 147.882 ms 147.857 ms
9 singtel.as7473.any2ix.coresite.com (206.72.210.63) 147.830 ms 147.761 ms 147.727 ms
10 203.208.154.45 (203.208.154.45) 333.674 ms 203.208.171.117 (203.208.171.117) 148.050 ms 148.098 ms
11 203.208.177.110 (203.208.177.110) 319.914 ms 203.208.172.145 (203.208.172.145) 243.971 ms 203.208.177.110 (203.208.177.110) 317.289 ms
12 203.208.182.253 (203.208.182.253) 326.637 ms * *
13 203.208.158.185 (203.208.158.185) 331.801 ms 331.893 ms 202-150-221-170.rev.ne.com.sg (202.150.221.170) 209.289 ms
z5195715@bongol7:~$
```

Not all the routers of the reverse path is the same as forward path but they have some routers in

common. For example, 138.44.5.0 and 138.44.5.1. They refer to the same router but with different IPs.

This is because IP addresses are dynamically allocated for trace-routing.

Exercise 4: Use ping to gain insights into network performance

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, 3×10^8 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 $2 \times T$ 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?

UNSW to Brisbane roughly 747km

UNSW to Manila roughly 6280km

UNSW to Berlin roughly 16100km

the shortest possible time that a packet will take to reach these 3 destinations are:

Brisbane: $747 / (3 \times 10^8) = 2.49\text{ms}$

Manila: $6280 / (3 \times 10^8) = 20.933\text{ms}$ (roughly)

Berlin: $16100 / (3 \times 10^8) = 53.667\text{ms}$ (roughly)

The minimum RTT (for 50 byte packets) to these 3 destinations are:

```
--- www.uq.edu.au ping statistics ---
50 packets transmitted, 50 received, 0% packet loss, time 49091ms
rtt min/avg/max/mdev = 17.417/18.115/22.885/1.154 ms
```

So, $\text{Ratio}(\text{uq}) = 18.115 / 2.49 = 7.275$

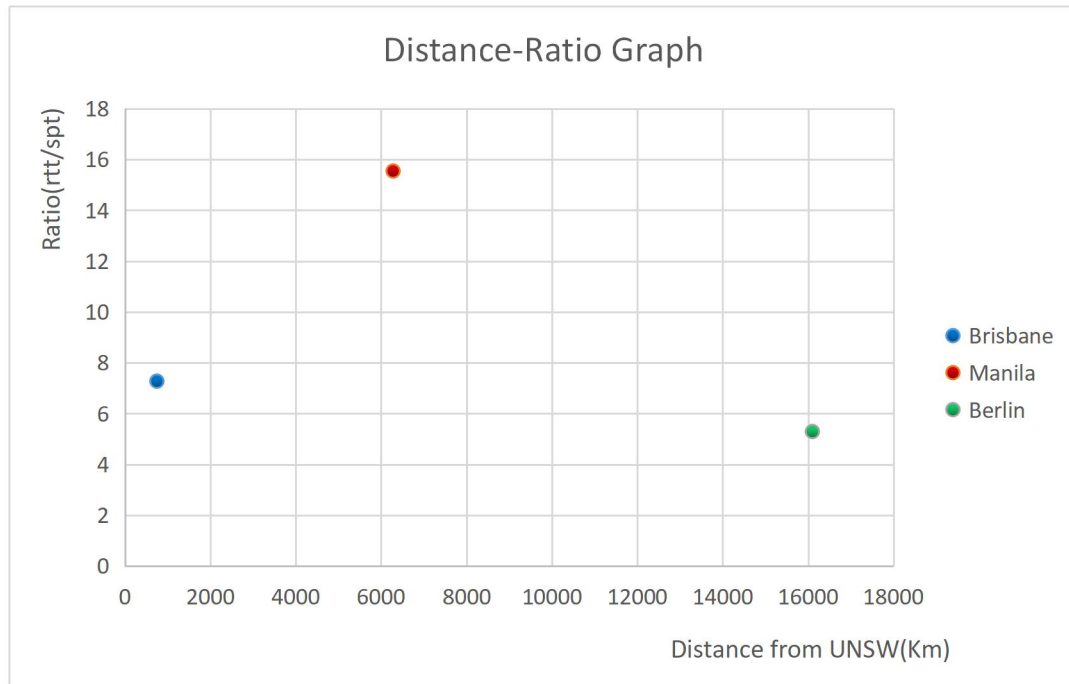
```
--- www.dlsu.edu.ph ping statistics ---
50 packets transmitted, 50 received, 0% packet loss, time 49070ms
rtt min/avg/max/mdev = 319.592/325.412/354.306/8.534 ms
```

So, $\text{Ratio}(\text{dlsu}) = 325.412 / 20.933 = 15.545$

```
--- www.tu-berlin.de ping statistics ---
50 packets transmitted, 50 received, 0% packet loss, time 49057ms
rtt min/avg/max/mdev = 283.829/284.040/284.395/0.437 ms
```

So, $\text{Ratio}(\text{tu-berlin}) = 284.040 / 53.667 = 5.293$

Graph as follows:



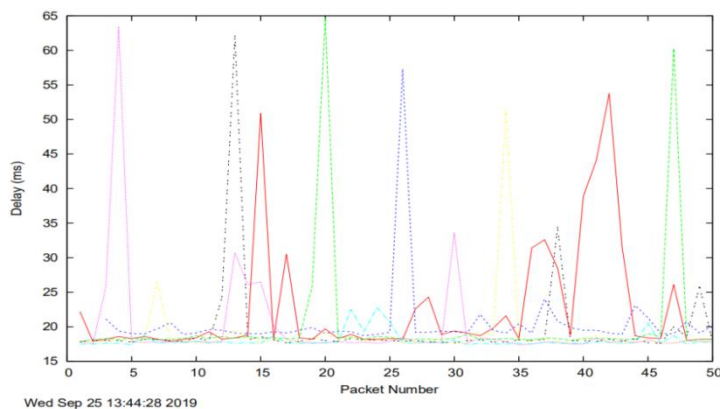
Reasons for ratio > 2:

- (1) speed of light does not consider delays such as transmission delays or queuing delay.
- (2) In real condition(air,water,etc),speed of light is smaller than 3×10^8 m/s.

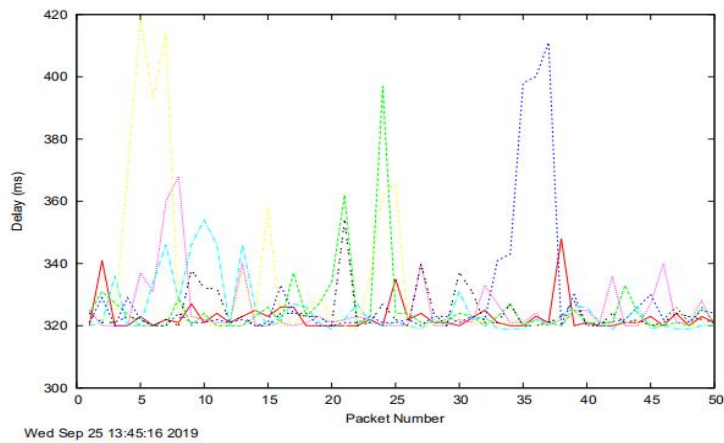
2. *Is the delay to the destinations constant or does it vary over time? Explain why.*

The following graphs shows for a given packet size,different delays as packet numbers increase and there are different sizes ranging from 50 to 1500.

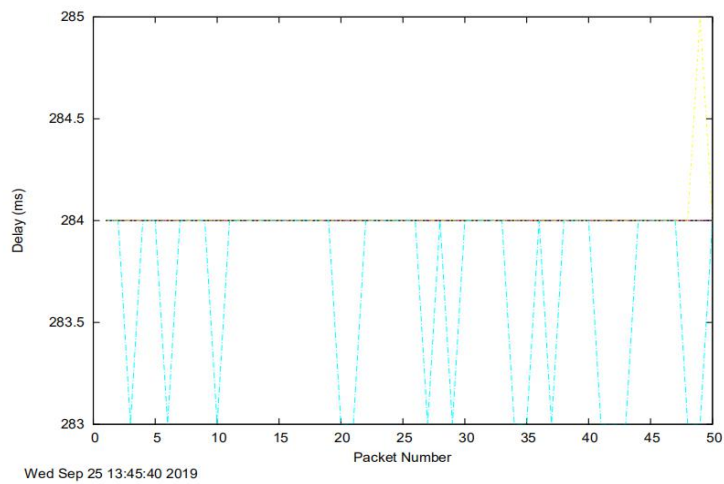
www.uq.edu.au:



www.dlsu.edu.ph:



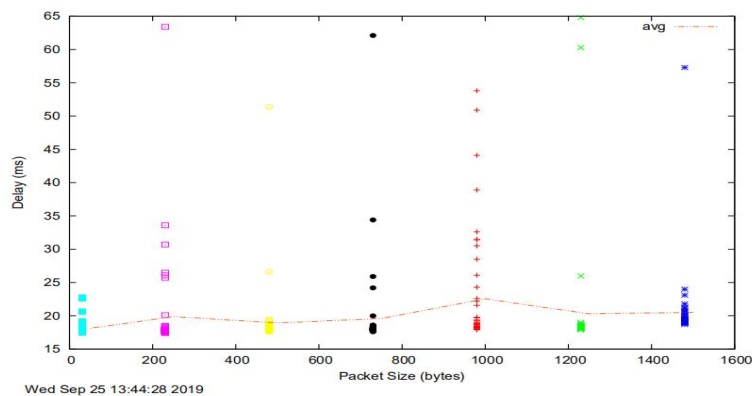
[www.tu-berlin.de:](http://www.tu-berlin.de)



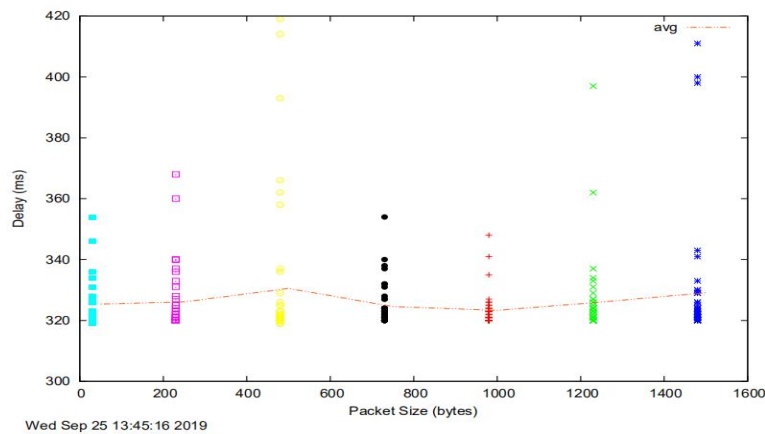
As is shown in the 3 graphs, the delay varies over time because of the different processing and queuing delays. The difference of delays are caused by the quality of the network path of different countries.

Following graphs mainly shows average delay for different size of packets among 3 countries.

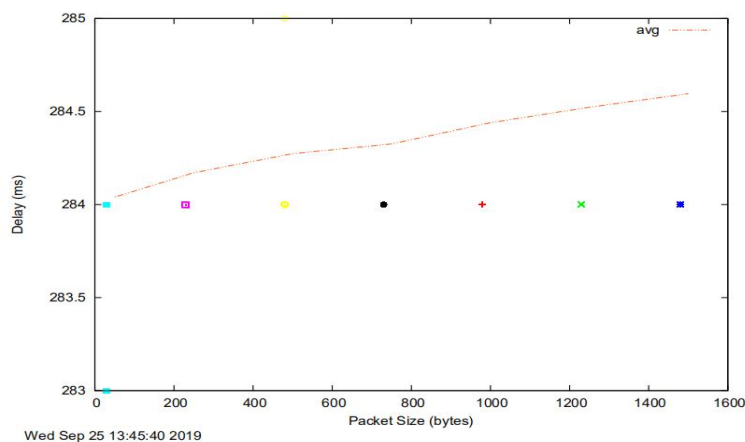
[www.uq.edu.au:](http://www.uq.edu.au)



[www.dlsu.edu.ph:](http://www.dlsu.edu.ph)



www.tu-berlin.de:



From these 3 graphs, we can conclude that the bigger size of packet, the longer delay time is only true for tu-berlin. For uq and dlsu, packet size has a little impact on delays. These 2 graphs are relatively stable.

From above, we can conclude that the delays of 3 destinations vary over time.

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

```
z5195715@piano13:~$ traceroute www.epfl.ch
traceroute to www.epfl.ch (104.20.229.42), 30 hops max, 60 byte packets
 1 cserouter1-trusted.cse.unsw.edu.au (129.94.208.251) 0.217 ms 0.165 ms 0.155 ms
 2 129.94.39.17 (129.94.39.17) 0.897 ms 0.880 ms 0.895 ms
 3 ombudnex1-v1-3154.gw.unsw.edu.au (149.171.253.35) 1.314 ms libudnex1-v1-315
 4.gw.unsw.edu.au (149.171.253.34) 1.799 ms 1.748 ms
 4 libcr1-po-5.gw.unsw.edu.au (149.171.255.165) 1.141 ms 1.116 ms libcr1-po-6
 .gw.unsw.edu.au (149.171.255.201) 1.140 ms
 5 unswbr1-te-1-9.gw.unsw.edu.au (149.171.255.101) 1.182 ms 1.153 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) 1.339 ms 1.323 ms 1.360 ms
 7 113.197.15.101 (113.197.15.101) 1.442 ms 1.449 ms 1.408 ms
 8 as4826.sydneymegaport.com (103.26.68.248) 2.266 ms 3.650 ms 3.628 ms
 9 be-111.cor01.syd11.nsw.vocus.net.au (175.45.72.32) 2.154 ms 2.128 ms 2.02
 0 ms
10 BE-101.bdr02.syd03.nsw.VOCUS.net.au (114.31.192.37) 2.199 ms BE-100.bdr02,s
 yd03.nsw.VOCUS.net.au (114.31.192.39) 1.955 ms BE-101.bdr02.syd03.nsw.VOCUS.net
 .au (114.31.192.37) 2.042 ms
11 as13335.bdr02.syd03.nsw.VOCUS.net.au (175.45.124.197) 2.166 ms 2.559 ms 2
 .556 ms
12 104.20.229.42 (104.20.229.42) 1.709 ms 1.656 ms 6.102 ms
```

```

z5195715@piano13:~$ whois 104.20.229.42
#
# ARIN WHOIS data and services are subject to the Terms of Use
# available at: https://www.arin.net/resources/registry/whois/tou/
#
# If you see inaccuracies in the results, please report at
# https://www.arin.net/resources/registry/whois/inaccuracy\_reporting/
#
# Copyright 1997-2019, American Registry for Internet Numbers, Ltd.
#

NetRange: 104.16.0.0 - 104.31.255.255
CIDR: 104.16.0.0/12
NetName: CLOUDFLARENET
NetHandle: NET-104-16-0-0-1
Parent: NET104 (NET-104-0-0-0-0)
NetType: Direct Assignment
OriginAS: AS13335
Organization: Cloudflare, Inc. (CLOUD14)
RegDate: 2014-03-28
Updated: 2017-02-17
Comment: All Cloudflare abuse reporting can be done via https://www.cloudflare.com/abuse
Ref: https://rdap.arin.net/registry/ip/104.16.0.0

OrgName: Cloudflare, Inc.
OrgId: CLOUD14
Address: 101 Townsend Street
City: San Francisco
StateProv: CA
PostalCode: 94107
Country: US
RegDate: 2010-07-09
Updated: 2018-10-10
Comment: All Cloudflare abuse reporting can be done via https://www.cloudflare.com/abuse
Ref: https://rdap.arin.net/registry/entity/CLOUD14

```

No it isn't. From traceroute command we know its IP (104.20.229.42) and by using whois command, we know the country is USA instead of Switzerland.

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?

Transmission delay depend on packet size and the others don't.

Propagation delay mainly depend on the physical distance.

Processing delay is related to the processing of packet including error check and finding the next the router, etc.

Queuing delay will occur during network congestion.