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Exercise 1: nslookup

Use the nslookup command from the "Tools of the Trade" and answer the following questions:

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?

Answer: The IP address are 104.18.60.21, 172.67.219.46, 104.18.61.21. Having several IP allows the website to prevent traffic from being exchanged via the gateway, speeding things up and reducing the load.

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

Answer: The name is localhost. It is used to access the network services that are running on the host via the loopback network interface. Using the loopback interface bypasses any local network interface hardware.

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.

Answer:

- www.unsw.edu.au reachable by ping and web browser
- www.getfittest.com.au not reachable by ping or web browser, non-exist domain
- www.mit.edu reachable by ping and web browser
- www.intel.com.au reachable by ping and web browser
- www.tpg.com.au reachable by ping and web browser
- www.hola.hp not reachable by ping or web browser, non-exist domain

- www.amazon.com reachable by ping and web browser
- www.tsinghua.edu.cn reachable by ping and web browser
- www.kremlin.ru not reachable by ping but reachable by web browser, firewall blocking ICMP
- 8.8.8.8 reachable by ping not web browser, domain name server

Exercise 3: Use traceroute to understand network topology

Note: Include all traceroute outputs in your report.

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.

Answer:

There are 22 routers between my workstation and www.columbia.edu, 4 routers are part of the unsw network.

10th and 11th routers do packets cross the pacific ocean since the 9th is still in Australia and the trip time takes a big jump from the 10th to the 11th.

```
z5187469@vx5:/tmp_amd/reed/export/reed/1/z5187469$ 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)  0.082 ms  0.067 ms  0.053 ms
 2  129.94.39.17 (129.94.39.17)  0.771 ms  0.778 ms  0.806 ms
 3  libudnex1-vl-3154.gw.unsw.edu.au (149.171.253.34)  1.389 ms ombudnex1-vl-3154.gw.unsw.edu.au
(149.171.253.35)  1.756 ms  1.716 ms
 4  libcr1-po-6.gw.unsw.edu.au (149.171.255.201)  1.038 ms ombcr1-po-5.gw.unsw.edu.au (149.171.255.197)  1.010 ms
libcr1-po-5.gw.unsw.edu.au (149.171.255.165)  1.046 ms
 5  unswbr1-te-2-13.gw.unsw.edu.au (149.171.255.105)  1.070 ms unswbr1-te-1-9.gw.unsw.edu.au (149.171.255.101)
1.114 ms  1.121 ms
 6  138.44.5.0 (138.44.5.0)  1.376 ms  1.242 ms  1.259 ms
 7  et-1-3-0.pe1.sxt.bkvl.nsw.aarnet.net.au (113.197.15.149)  2.207 ms  2.055 ms  1.991 ms
 8  et-0-0-0.pe1.a.hnl.aarnet.net.au (113.197.15.99)  95.029 ms  95.060 ms  95.112 ms
 9  et-2-1-0.bdr1.a.sea.aarnet.net.au (113.197.15.201)  146.956 ms  146.973 ms  146.953 ms
10  abilene-1-lo-jmb-706.sttlwa.pacificwave.net (207.231.240.8)  160.258 ms  160.270 ms  160.264 ms
11  ae-1.4079.rtsw.minn.net.internet2.edu (162.252.70.173)  192.482 ms  192.839 ms  192.768 ms
12  ae-1.4079.rtsw.eqch.net.internet2.edu (162.252.70.106)  201.427 ms  201.518 ms  201.454 ms
13  ae-0.4079.rtsw3.eqch.net.internet2.edu (162.252.70.163)  201.139 ms  200.847 ms  200.252 ms
14  ae-1.4079.rtsw.clev.net.internet2.edu (162.252.70.130)  209.752 ms  210.014 ms  209.998 ms
15  buf-9208-I2-CLEV.nysernet.net (199.109.11.33)  213.324 ms  213.351 ms  213.254 ms
16  syr-9208-buf-9208.nysernet.net (199.109.7.193)  217.437 ms  217.301 ms  217.251 ms
17  nyc111-9204-syr-9208.nysernet.net (199.109.7.94)  226.479 ms  226.566 ms  226.346 ms
18  nyc-9208-nyc111-9204.nysernet.net (199.109.7.165)  236.628 ms  236.587 ms  226.083 ms
19  columbia.nyc-9208.nysernet.net (199.109.4.14)  225.618 ms  225.866 ms  225.696 ms
20  cc-core-1-x-nyser32-gw-1.net.columbia.edu (128.59.255.5)  226.830 ms  226.739 ms  226.827 ms
21  cc-conc-1-x-cc-core-1.net.columbia.edu (128.59.255.21)  227.340 ms  226.183 ms  226.230 ms
22  columbiauniversity.org (128.59.105.24)  225.953 ms  226.356 ms  226.116 ms
```

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 the geographical location of a server using the following tool
   - http://www.yougetsignal.com/tools/network-location/

   Ucla 14 hops

```
z5187469@vx5:/tmp_amd/reed/export/reed/1/z5187469$ 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)  0.101 ms  0.096 ms  0.089 ms
 2  129.94.39.17 (129.94.39.17)  0.757 ms  0.773 ms  0.790 ms
 3  ombudnex1-vl-3154.gw.unsw.edu.au (149.171.253.35)  1.417 ms  1.434 ms libudnex1-vl-3154.gw.unsw.edu.au
(149.171.253.34)  1.224 ms
 4  libcr1-po-5.gw.unsw.edu.au (149.171.255.165)  1.018 ms  0.985 ms ombcr1-po-6.gw.unsw.edu.au
(149.171.255.169)  1.095 ms
 5  unswbr1-te-1-9.gw.unsw.edu.au (149.171.255.101)  1.064 ms  1.014 ms unswbr1-te-2-13.gw.unsw.edu.au
(149.171.255.105)  1.116 ms
 6  138.44.5.0 (138.44.5.0)  1.318 ms  1.201 ms  1.224 ms
 7  et-1-3-0.pe1.sxt.bkvl.nsw.aarnet.net.au (113.197.15.149)  2.080 ms  2.099 ms  2.083 ms
 8  et-0-0-0.pe1.a.hnl.aarnet.net.au (113.197.15.99)  95.135 ms  95.151 ms  95.210 ms
 9  et-2-1-0.bdr1.a.sea.aarnet.net.au (113.197.15.201)  146.861 ms  146.877 ms  146.805 ms
10  cenichpr-1-is-jmb-778.snvaca.pacificwave.net (207.231.245.129)  163.446 ms  163.452 ms  163.359 ms
11  hpr-lax-hpr3--svl-hpr3-100ge.cenic.net (137.164.25.73)  159.857 ms  160.477 ms  159.665 ms
12  * * *
13  bd11f1.anderson--cr00f2.csb1.ucla.net (169.232.4.4)  161.019 ms  161.177 ms  161.161 ms
14  cr00f1.anderson--rtr11f4.mathsci.ucla.net (169.232.8.185)  160.532 ms cr00f2.csb1--rtr11f4.mathsci.ucla.net
(169.232.8.181)  160.493 ms cr00f1.anderson--rtr11f4.mathsci.ucla.net (169.232.8.185)  161.142 ms
15  * * *
16  * * *
17  * * *
18  * * *
19  * * *
20  * * *
21  * * *
22  * * *
23  * * *
24  * * *
25  * * *
26  * * *
27  * * *
28  * * *
29  * * *
30  * * *
```

u-tokyo 16 hops

```
z5187469@vx5:/tmp_amd/reed/export/reed/1/z5187469$ 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)  0.118 ms  0.094 ms  0.078 ms
 2  129.94.39.17 (129.94.39.17)  0.829 ms  0.850 ms  0.768 ms
 3  ombudnex1-vl-3154.gw.unsw.edu.au (149.171.253.35)  1.326 ms libudnex1-vl-3154.gw.unsw.edu.au
(149.171.253.34)  1.504 ms  1.258 ms
 4  ombcr1-po-5.gw.unsw.edu.au (149.171.255.197)  1.053 ms  1.067 ms libcr1-po-6.gw.unsw.edu.au (149.171.255.201)
1.228 ms
 5  unswbr1-te-1-9.gw.unsw.edu.au (149.171.255.101)  1.133 ms unswbr1-te-2-13.gw.unsw.edu.au (149.171.255.105)
1.076 ms unswbr1-te-1-9.gw.unsw.edu.au (149.171.255.101)  1.159 ms
 6  138.44.5.0 (138.44.5.0)  1.205 ms  1.279 ms  1.223 ms
 7  et-0-3-0.pe1.bkvl.nsw.aarnet.net.au (113.197.15.147)  1.589 ms  1.632 ms  1.728 ms
 8  ge-4_0_0.bb1.a.pao.aarnet.net.au (202.158.194.177)  154.889 ms  154.898 ms  154.934 ms
 9  paloalto0.iij.net (198.32.176.24)  156.456 ms  156.362 ms  156.512 ms
10  osk004bb01.IIJ.Net (58.138.88.189)  269.269 ms osk004bb00.IIJ.Net (58.138.88.185)  286.871 ms  286.900 ms
11  osk004ip57.IIJ.Net (58.138.106.166)  284.799 ms osk004ip57.IIJ.Net (58.138.106.162)  278.009 ms  277.989 ms
12  210.130.135.130 (210.130.135.130)  278.159 ms  278.022 ms  277.976 ms
13  124.83.228.58 (124.83.228.58)  286.870 ms  278.194 ms  286.964 ms
14  124.83.252.178 (124.83.252.178)  284.018 ms  284.078 ms  292.947 ms
15  158.205.134.26 (158.205.134.26)  284.015 ms  292.998 ms  292.945 ms
16  158.205.121.46 (158.205.121.46)  292.941 ms  284.084 ms  284.054 ms
17  * * *
18  * * *
19  * * *
20  * * *
21  * * *
22  * * *
23  * * *
24  * * *
25  * * *
26  * * *
27  * * *
28  * * *
29  * * *
30  * * *
```

Lancaster uni 23 hops

```
z5187469@vx5:/tmp_amd/reed/export/reed/1/z5187469$ 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)  0.126 ms  0.108 ms  0.094 ms
 2  129.94.39.17 (129.94.39.17)  0.853 ms  0.884 ms  0.841 ms
 3  ombudnex1-vl-3154.gw.unsw.edu.au (149.171.253.35)  1.334 ms libudnex1-vl-3154.gw.unsw.edu.au
(149.171.253.34)  4.310 ms  4.546 ms
 4  ombcr1-po-6.gw.unsw.edu.au (149.171.255.169)  4.096 ms libcr1-po-6.gw.unsw.edu.au (149.171.255.201)  1.048 ms
libcr1-po-5.gw.unsw.edu.au (149.171.255.165)  1.049 ms
 5  unswbr1-te-2-13.gw.unsw.edu.au (149.171.255.105)  1.113 ms  1.167 ms  1.155 ms
 6  138.44.5.0 (138.44.5.0)  1.331 ms  1.278 ms  1.377 ms
 7  et-1-1-0.pe1.rsby.nsw.aarnet.net.au (113.197.15.12)  1.545 ms  1.562 ms  1.658 ms
 8  xe-1-1-0.pe1.eskp.nsw.aarnet.net.au (113.197.15.199)  3.041 ms  2.884 ms  2.797 ms
 9  et-0-3-0.pe1.prka.sa.aarnet.net.au (113.197.15.42)  20.047 ms  19.986 ms  20.116 ms
10  et-0-3-0.pe1.knsg.wa.aarnet.net.au (113.197.15.45)  45.654 ms  45.944 ms  45.744 ms
11  et-2-1-2.bdr2.sing.sin.aarnet.net.au (113.197.15.247)  92.019 ms  91.839 ms  91.795 ms
12  ae1.bdr1.sing.sin.aarnet.net.au (113.197.15.234)  91.851 ms  91.662 ms  91.883 ms
13  138.44.226.7 (138.44.226.7)  258.751 ms  258.654 ms  258.666 ms
14  janet-gw.mx1.lon.uk.geant.net (62.40.124.198)  258.966 ms  259.313 ms  259.216 ms
15  ae29.londpg-sbr2.ja.net (146.97.33.2)  259.245 ms  259.732 ms  259.695 ms
16  ae31.erdiss-sbr2.ja.net (146.97.33.22)  263.374 ms  263.508 ms  263.447 ms
17  ae29.manckh-sbr2.ja.net (146.97.33.42)  265.372 ms  265.181 ms  265.094 ms
18  ae24.lanclu-rbr1.ja.net (146.97.38.58)  267.241 ms  267.254 ms  267.269 ms
19  lancaster-university.ja.net (194.81.46.2)  278.798 ms  278.738 ms  284.053 ms
20  is-border01.bfw01.rtr.lancs.ac.uk (148.88.253.202)  267.954 ms  267.945 ms  268.046 ms
21  bfw01.iss-servers.is-core01.rtr.lancs.ac.uk (148.88.250.98)  276.213 ms  272.672 ms  269.797 ms
22  * * *
23  www.lancs.ac.uk (148.88.65.80)  267.781 ms !X  267.724 ms !X  267.865 ms !X
```

Answer:

Paths from my machine to these three destinations diverge from 138.44.5.0, it is Asia Pacific Network Information Centre (APNIC) from whois which links Australia to the overseas routers.

From the map, we can tell japan is closest to Australia compared to USA and UK, but it takes 16 hops from Australia to japan which is not the minimum hops from the three tests. Therefore, we could not draw the conclusion that the number of hops on each path proportional the physical distance.

```
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
Comment:
Comment:        ** IMPORTANT NOTE: APNIC is the Regional Internet Registry
Comment:        for the Asia Pacific region.  APNIC does not operate networks
Comment:        using this IP address range and is not able to investigate
Comment:        spam or abuse reports relating to these addresses.  For more
Comment:        help, refer to http://www.apnic.net/apnic-info/whois_search2/abuse-and-spamming
Ref:            https://rdap.arin.net/registry/ip/138.44.0.0

ResourceLink:  http://wq.apnic.net/whois-search/static/search.html
ResourceLink:  whois.apnic.net
```

3. 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?

Answer:

From http://www.speedtest.com.sg/tr.php to my IP address

```
traceroute to 129.94.242.118 (129.94.242.118), 30 hops max, 60 byte packets
 1  ge2-8.r01.sin01.ne.com.sg (202.150.221.169)  0.149 ms  0.173 ms  0.192 ms
 2  10.11.34.146 (10.11.34.146)  0.412 ms  0.553 ms  0.569 ms
 3  aarnet.sgix.sg (103.16.102.67)  223.476 ms  223.490 ms  223.504 ms
 4  et-5-1-0.pe1.brwy.nsw.aarnet.net.au (113.197.15.5)  213.309 ms  213.284 ms  213.315 ms
 5  138.44.5.1 (138.44.5.1)  203.839 ms  204.065 ms  203.859 ms
 6  libcr1-te-1-5.gw.unsw.edu.au (149.171.255.102)  203.874 ms  203.793 ms  204.076 ms
 7  libudnex1-po-1.gw.unsw.edu.au (149.171.255.166)  202.625 ms  202.377 ms ombudnex1-po-1.gw.unsw.edu.au (149.171.255.202
 8  ufw1-ae-1-3154.gw.unsw.edu.au (149.171.253.36)  208.387 ms  208.438 ms  208.680 ms
 9  129.94.39.23 (129.94.39.23)  208.785 ms  208.875 ms  208.514 ms
10  * * *
11  * * *
12  * * *
13  * * *
14  * * *
15  * * *
16  * * *
17  * * *
18  * * *
19  * * *
20  * * *
21  * * *
22  * * *
23  * * *
24  * * *
25  * * *
26  * * *
27  * * *
28  * * *
29  * * *
30  * * *
```

From my IP address to http://www.speedtest.com.sg/tr.php

```
z5187469@vx5:/tmp_amd/reed/export/reed/1/z5187469$ traceroute www.speedtest.com.sg/tr.php
www.speedtest.com.sg/tr.php: Name or service not known
Cannot handle "host" cmdline arg `www.speedtest.com.sg/tr.php' on position 1 (argc 1)
z5187469@vx5:/tmp_amd/reed/export/reed/1/z5187469$ 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)  0.119 ms  0.099 ms  0.085 ms
 2  129.94.39.17 (129.94.39.17)  0.866 ms  0.821 ms  0.777 ms
 3  libudnex1-vl-3154.gw.unsw.edu.au (149.171.253.34)  1.372 ms ombudnex1-vl-3154.gw.unsw.edu.au (149.171.253.35)  1.264 ms libudnex
1-vl-3154.gw.unsw.edu.au (149.171.253.34)  1.608 ms
 4  ombcr1-po-6.gw.unsw.edu.au (149.171.255.169)  1.076 ms libcr1-po-5.gw.unsw.edu.au (149.171.255.165)  1.074 ms libcr1-po-6.gw.uns
w.edu.au (149.171.255.201)  1.073 ms
 5  unswbr1-te-2-13.gw.unsw.edu.au (149.171.255.105)  1.200 ms unswbr1-te-1-9.gw.unsw.edu.au (149.171.255.101)  1.133 ms  1.134 ms
 6  138.44.5.0 (138.44.5.0)  1.248 ms  1.295 ms  1.292 ms
 7  et-0-3-0.pe1.alxd.nsw.aarnet.net.au (113.197.15.153)  1.658 ms  11.782 ms  11.767 ms
 8  xe-0-2-7.bdr1.a.lax.aarnet.net.au (202.158.194.173)  147.620 ms  147.579 ms  147.587 ms
 9  singtel.as7473.any2ix.coresite.com (206.72.210.63)  147.816 ms  147.823 ms  147.839 ms
10  203.208.173.81 (203.208.173.81)  334.082 ms
 203.208.171.117 (203.208.171.117)  148.008 ms 203.208.182.153 (203.208.182.153)  333.550 ms
11  203.208.177.110 (203.208.177.110)  330.433 ms  330.395 ms 203.208.151.233 (203.208.151.233)  235.101 ms
12  203.208.182.253 (203.208.182.253)  326.685 ms  334.799 ms  319.606 ms
13  203.208.177.110 (203.208.177.110)  330.114 ms  330.106 ms 202-150-221-170.rev.ne.com.sg (202.150.221.170)  213.195 ms
```

From https://www.telstra.net/cgi-bin/trace to my IP address

```
 1  gigabitethernet3-3.exi2.melbourne.telstra.net (203.50.77.53)  0.356 ms  0.329 ms  0.239 ms
 2  bundle-ether3-100.win-core10.melbourne.telstra.net (203.50.80.129)  1.987 ms  1.602 ms  2.116 ms
 3  bundle-ether12.ken-core10.sydney.telstra.net (203.50.11.122)  12.105 ms  12.099 ms  12.982 ms
 4  bundle-ether1.ken-edge903.sydney.telstra.net (203.50.11.173)  12.106 ms  11.972 ms  12.984 ms
 5  aar3533567.lnk.telstra.net (139.130.0.78)  11.606 ms  11.598 ms  11.734 ms
 6  et-7-1-0.pe1.brwy.nsw.aarnet.net.au (113.197.15.13)  13.232 ms  11.847 ms  11.732 ms
 7  138.44.5.1 (138.44.5.1)  12.107 ms  12.099 ms  12.109 ms
 8  ombcr1-te-1-5.gw.unsw.edu.au (149.171.255.106)  12.109 ms  12.098 ms  12.109 ms
 9  libudnex1-po-2.gw.unsw.edu.au (149.171.255.198)  12.357 ms  12.348 ms  12.359 ms
10  ufw1-ae-1-3154.gw.unsw.edu.au (149.171.253.36)  12.730 ms  12.723 ms  12.733 ms
11  129.94.39.23 (129.94.39.23)  12.855 ms  12.847 ms  12.858 ms
```

From my IP address to https://www.telstra.net/cgi-bin/trace

```
z5187469@vx5:/tmp_amd/reed/export/reed/1/z5187469$ 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)  0.076 ms  0.064 ms  0.068 ms
 2  129.94.39.17 (129.94.39.17)  0.825 ms  0.839 ms  0.846 ms
 3  ombudnex1-vl-3154.gw.unsw.edu.au (149.171.253.35)  1.567 ms libudnex1-vl-3154.gw.unsw.edu.au (149.171.253.34)  1.
468 ms ombudnex1-vl-3154.gw.unsw.edu.au (149.171.253.35)  1.555 ms
 4  libcr1-po-6.gw.unsw.edu.au (149.171.255.201)  1.090 ms  1.107 ms  1.131 ms
 5  unswbr1-te-2-13.gw.unsw.edu.au (149.171.255.105)  1.111 ms  1.109 ms unswbr1-te-1-9.gw.unsw.edu.au (149.171.255.1
01)  1.108 ms
 6  138.44.5.0 (138.44.5.0)  1.233 ms  1.358 ms  1.356 ms
 7  et-1-1-0.pe1.rsby.nsw.aarnet.net.au (113.197.15.12)  2.904 ms  2.517 ms  2.609 ms
 8  xe-0-0-3.bdr1.rsby.nsw.aarnet.net.au (113.197.15.31)  1.551 ms  1.506 ms  1.513 ms
 9  HundredGigE0-1-0-4.ken-edge903.sydney.telstra.net (139.130.0.77)  2.026 ms  2.087 ms  2.176 ms
10  bundle-ether17.ken-core10.sydney.telstra.net (203.50.11.172)  3.878 ms  3.047 ms  3.231 ms
11  bundle-ether10.win-core10.melbourne.telstra.net (203.50.11.123)  14.729 ms bundle-ether17.chw-core10.sydney.telst
ra.net (203.50.11.176)  3.106 ms  2.654 ms
12  bundle-ether8.exi-core10.melbourne.telstra.net (203.50.11.125)  13.114 ms  14.675 ms  14.653 ms
13  bundle-ether2.exi-ncprouter101.melbourne.telstra.net (203.50.11.209)  13.207 ms  15.285 ms  15.191 ms
14  www.telstra.net (203.50.5.178)  12.743 ms  12.557 ms  12.722 ms
```

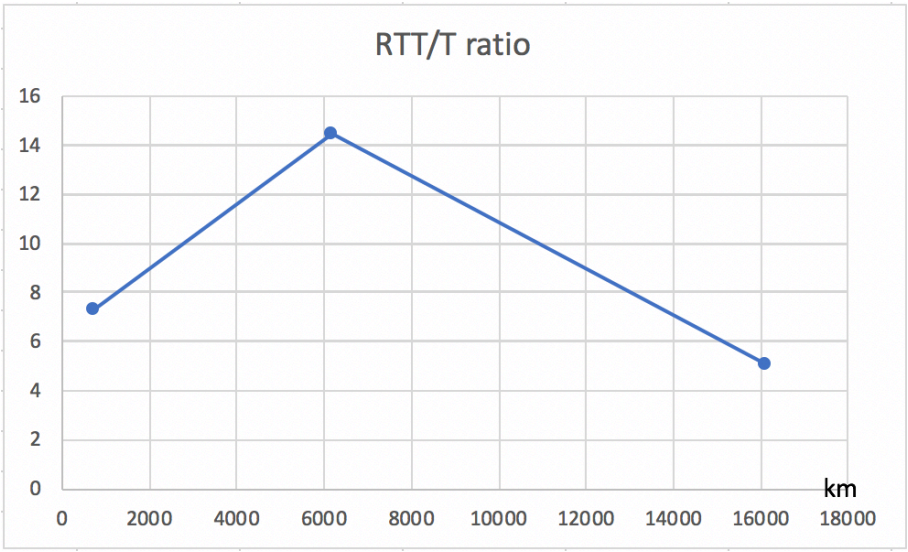
http://www.speedtest.com.sg/tr.php (202.150.221.170) and https://www.telstra.net/cgi-bin/trace (203.50.5.178) are chosen to run the test. The reverse path does not go through the same routers as the forward path from observation. There are common routers between the forward and the reverse path with different IP addresses as routing selects optimal path and there is no set path for the packet.

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 x 10 8 m/s. Note that the shortest possible time will simply be the distance divided by the propagation speed. Plot a graph where the x-axis represents the distance to each city (i.e. Brisbane, Manila and Berlin), and the y-axis represents the ratio between the minimum delay (i.e. RTT) as measured by the ping program (select the values for 50 byte packets) and the shortest possible time T to reach that city from UNSW. (Note that the y-values are no smaller than 2 since it takes at least 2*T time for any packet to reach the destination from UNSW and get back). Can you think of at least two reasons why the y-axis values that you plot are greater than 2?

Answer:

From unsw to	Distance(km)	Shortest possible time(ms)	RTT(ms)	RTT/T ratio
UQ	717	2.39	17.5	7.32217573
DLSU	6170	20.57	298	14.4871172
TU Berlin	16105	53.68	273	5.085693



One of the reason why the ratio is greater than two is that, T is the shortest time for a packet to reach that location from UNSW, since ping sends a packet from UNSW and receives a signal back which both takes at least time T, the minimal time of RTT is 2T assuming no delay and traveling with light speed. However, the signal does not travel in the vacuum with light speed in real life, and there are many possible delays such as processing, queuing, transmission and propagation delays.

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

The delay to destinations is not constant from the graph plotted due to the queueing delay. Each router has its own traffic flow dynamically to reduce overload.

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

   No, it is not in Switzerland as all the routers are in NSW or AU.

```
z5187469@vx5:/tmp_amd/reed/export/reed/1/z5187469$ traceroute www.epfl.ch
traceroute to www.epfl.ch (104.20.228.42), 30 hops max, 60 byte packets
 1  cserouter1-server.cse.unsw.EDU.AU (129.94.242.251)  0.079 ms  0.061 ms  0.068 ms
 2  129.94.39.17 (129.94.39.17)  0.885 ms  0.890 ms  0.820 ms
 3  libudnex1-vl-3154.gw.unsw.edu.au (149.171.253.34)  1.492 ms ombudnex1-vl-3154.gw.unsw.edu.au
(149.171.253.35)  1.374 ms libudnex1-vl-3154.gw.unsw.edu.au (149.171.253.34)  1.481 ms
 4  libcr1-po-5.gw.unsw.edu.au (149.171.255.165)  1.073 ms ombcr1-po-6.gw.unsw.edu.au (149.171.255.169)
1.093 ms libcr1-po-5.gw.unsw.edu.au (149.171.255.165)  1.087 ms
 5  unswbr1-te-1-9.gw.unsw.edu.au (149.171.255.101)  1.177 ms unswbr1-te-2-13.gw.unsw.edu.au
(149.171.255.105)  1.145 ms  1.194 ms
 6  138.44.5.0 (138.44.5.0)  1.372 ms  1.208 ms  1.231 ms
 7  ae2.bdr1.msc4.nsw.aarnet.net.au (113.197.15.77)  1.503 ms  1.519 ms  1.590 ms
 8  as4826.bdr1.msc4.nsw.aarnet.net.au (138.44.10.45)  4.314 ms  3.551 ms  3.490 ms
 9  be107.cor02.syd04.nsw.vocus.network (114.31.192.82)  2.215 ms  2.137 ms
be107.cor01.syd11.nsw.vocus.network (114.31.192.80)  2.185 ms
10  be100.bdr02.syd03.nsw.vocus.network (114.31.192.39)  2.419 ms be101.bdr02.syd03.nsw.vocus.network
(114.31.192.37)  2.804 ms be100.bdr02.syd03.nsw.vocus.network (114.31.192.39)  2.506 ms
11  as13335.bdr02.syd03.nsw.VOCUS.net.au (175.45.124.197)  2.640 ms  2.612 ms  2.626 ms
12  104.20.228.42 (104.20.228.42)  1.647 ms  1.659 ms  1.620 ms
```

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 relies on the packet size and the rest does not.