Lab Exercise 1: Tools of the Trade

Exercise 1: nslookup

Question 1 :

Which is the IP address of the Google site (www.google.com)? In your opinion, what is the reason of having several IP addresses as an output?

Solution 1 :

IP : 172.217.167.68

The reason of having several IP addresses as an output is because when we use ping with host name, the IP address is fetched from a DNS server.

Question 2 :

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

Solution 2 :

Command : nslookup 127.0.0.1

Name = localhost

This is fetching the IP address and the name of the local machine.

Exercise 2: Use ping to test host reachability

Question 1 :

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

Solution 1 :

HOSTS	REACHABLE	REACHABLE BY WEB SERVER
www.cse.unsw.edu.au	Yes	-
www.getfittest.com.au	No, unknown host	No
www.mit.edu	Yes	-
www.intel.com.au	Yes	-
www.tpg.com.au	Yes	-
www.hola.hp	No, unknown host	Yes
www.amazon.com	Yes	-
www.tsinghua.edu.cn	Yes	-
www.kremlin.ru	Yes	-
8.8.8.8	Yes	-

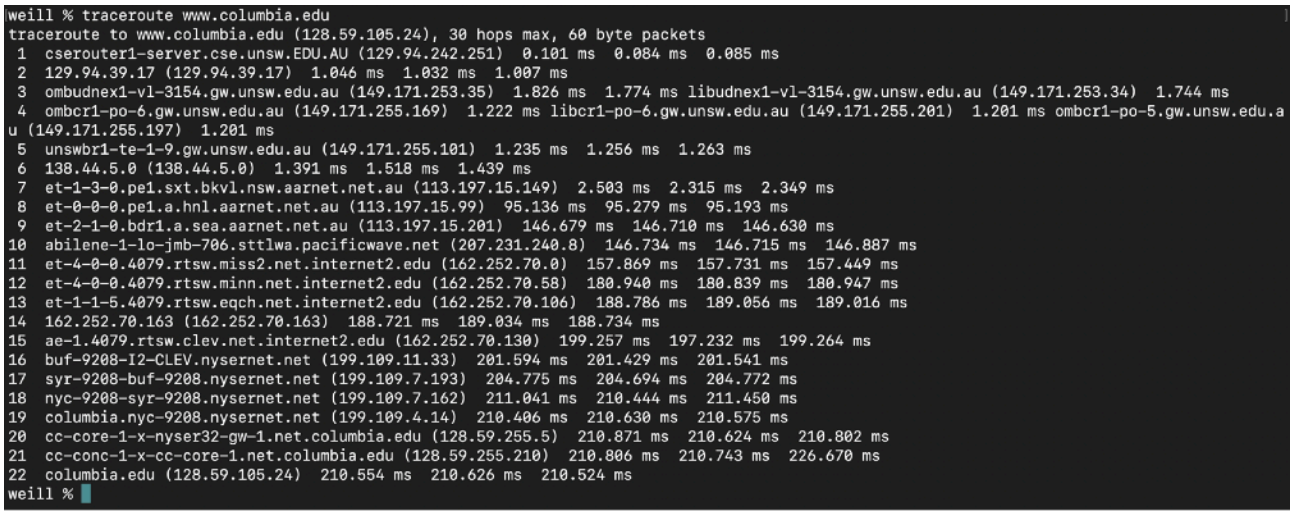
The websites that are not reachable might be because of the reason that the DNS could not be found or it is due to the reason that the DNS cache keeps a record of sites that have been recently visited on the computer. If that gets corrupted, the computer may have issues opening sites that were previously accessible without problems.

The reason can also be that the website has been blocked by the firewall.

Exercise 3: Use trace route to understand network topology

Question 1 :

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



(i) How many routers are there between your workstation and www.columbia.edu?

Solution (i) :

21

(ii) How many routers along the path are part of the UNSW network?

Solution (ii) :

4 routers

(iii) Between which two routers do packets cross the Pacific Ocean?

Solution (iii) :

Between 9 and 10

Question 2 : Run traceroute from your machine to the following destinations:

(i) www.ucla.edu

```
weill % 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  0.141 ms  0.123 ms
 2  129.94.39.17 (129.94.39.17)  1.048 ms  1.095 ms  1.074 ms
 3  libudnex1-vl-3154.gw.unsw.edu.au (149.171.253.34)  2.036 ms ombudnex1-vl-3154.gw.unsw.edu.au (149.171.253.35)  1.588 ms libudnex1-vl-31
54.gw.unsw.edu.au (149.171.253.34)  1.981 ms
 4  libcr1-po-6.gw.unsw.edu.au (149.171.255.201)  1.276 ms ombcr1-po-5.gw.unsw.edu.au (149.171.255.197)  200.219 ms ombcr1-po-6.gw.unsw.edu
.au (149.171.255.169)  200.057 ms
 5  unswbr1-te-1-9.gw.unsw.edu.au (149.171.255.101)  1.254 ms  1.282 ms  1.296 ms
 6  138.44.5.0 (138.44.5.0)  1.596 ms  1.576 ms  1.461 ms
 7  et-1-3-0.pe1.sxt.bkvl.nsw.aarnet.net.au (113.197.15.149)  2.150 ms  2.364 ms  2.321 ms
 8  et-0-0-0.pe1.a.hnl.aarnet.net.au (113.197.15.99)  95.343 ms  95.268 ms  95.340 ms
 9  et-2-1-0.bdr1.a.sea.aarnet.net.au (113.197.15.201)  146.777 ms  146.769 ms  146.733 ms
10  cenichpr-1-is-jmb-778.snvaca.pacificwave.net (207.231.245.129)  163.713 ms  163.585 ms  164.130 ms
11  hpr-lax-hpr3--svl-hpr3-100ge.cenic.net (137.164.25.73)  171.285 ms  171.277 ms  171.144 ms
12  * * *
13  bd11f1.anderson--cr001.anderson.ucla.net (169.232.4.6)  171.598 ms bd11f1.anderson--cr00f2.csb1.ucla.net (169.232.4.4)  171.649 ms bd11
f1.anderson--cr001.anderson.ucla.net (169.232.4.6)  171.754 ms
14  cr00f1.anderson--dr00f2.csb1.ucla.net (169.232.4.55)  171.778 ms  171.742 ms cr00f2.csb1--dr00f2.csb1.ucla.net (169.232.4.53)  172.508
ms
15  * * *
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27  * * *
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30  * * *
weill %
```

(ii) www.u-tokyo.ac.jp

```
weill % 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)  0.110 ms  0.139 ms  0.123 ms
 2  129.94.39.17 (129.94.39.17)  1.087 ms  1.143 ms  1.121 ms
 3  libudnex1-vl-3154.gw.unsw.edu.au (149.171.253.34)  1.569 ms  1.973 ms  1.705 ms
 4  libcr1-po-5.gw.unsw.edu.au (149.171.255.165)  1.234 ms ombcr1-po-6.gw.unsw.edu.au (149.171.255.169)  1.325 ms  1.339 ms
 5  unswbr1-te-2-13.gw.unsw.edu.au (149.171.255.105)  1.265 ms unswbr1-te-1-9.gw.unsw.edu.au (149.171.255.101)  1.296 ms unswbr1-te-2-13.gw
.unsw.edu.au (149.171.255.105)  1.619 ms
 6  138.44.5.0 (138.44.5.0)  1.896 ms  1.991 ms  2.129 ms
 7  et-0-3-0.pe1.bkvl.nsw.aarnet.net.au (113.197.15.147)  2.200 ms  1.916 ms  1.906 ms
 8  ge-4_0_0.bb1.a.pao.aarnet.net.au (202.158.194.177)  156.290 ms  156.215 ms  156.252 ms
 9  paloalto0.iij.net (198.32.176.24)  158.064 ms  157.950 ms  158.018 ms
10  osk004bb01.IIJ.Net (58.138.88.189)  271.144 ms  271.477 ms  271.622 ms
11  osk004ix51.IIJ.Net (58.138.106.130)  279.654 ms  280.177 ms osk004ix51.IIJ.Net (58.138.106.126)  289.948 ms
12  210.130.135.130 (210.130.135.130)  288.771 ms  279.768 ms  279.736 ms
13  124.83.228.58 (124.83.228.58)  290.071 ms  280.149 ms  288.864 ms
14  124.83.252.178 (124.83.252.178)  277.267 ms  277.286 ms  277.257 ms
15  158.205.134.26 (158.205.134.26)  285.728 ms  294.472 ms  285.693 ms
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28  * * *
29  * * *
30  * * *
weill %
```
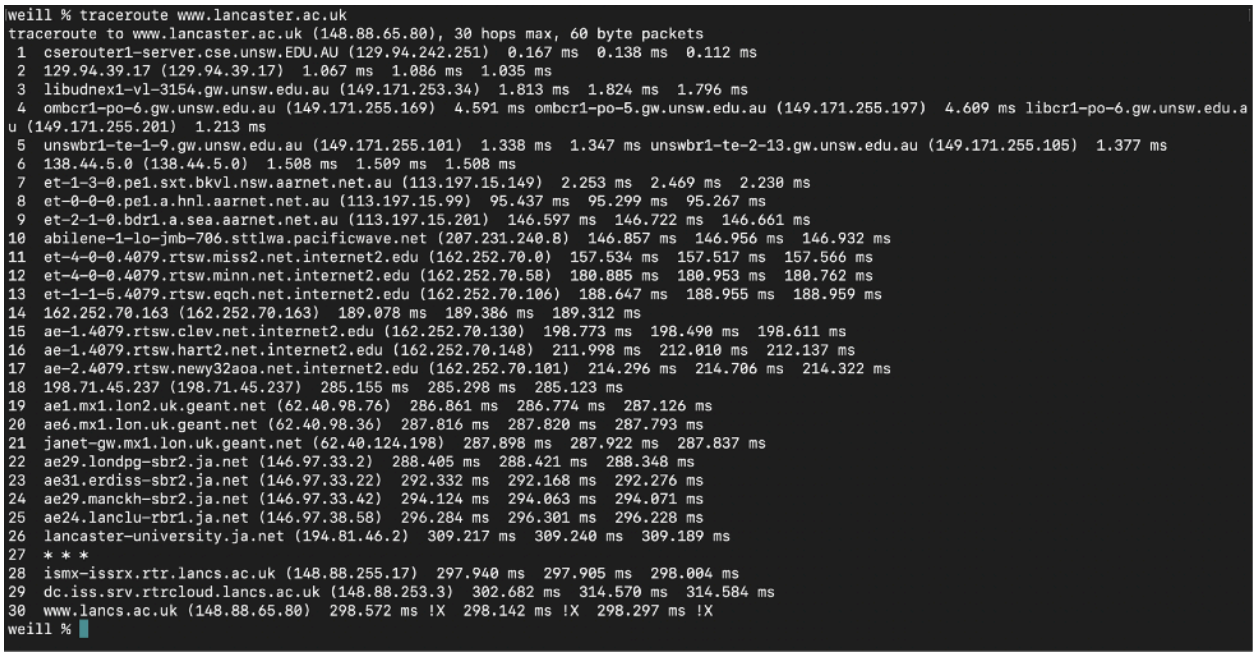

(iii)www.lancaster.ac.uk



```
weill % 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)  0.167 ms  0.138 ms  0.112 ms
 2  129.94.39.17 (129.94.39.17)  1.067 ms  1.086 ms  1.035 ms
 3  libudnex1-vl-3154.gw.unsw.edu.au (149.171.253.34)  1.813 ms  1.824 ms  1.796 ms
 4  ombcr1-po-6.gw.unsw.edu.au (149.171.255.169)  4.591 ms ombcr1-po-5.gw.unsw.edu.au (149.171.255.197)  4.609 ms libcr1-po-6.gw.unsw.edu.a
u (149.171.255.201)  1.213 ms
 5  unswbr1-te-1-9.gw.unsw.edu.au (149.171.255.101)  1.338 ms  1.347 ms unswbr1-te-2-13.gw.unsw.edu.au (149.171.255.105)  1.377 ms
 6  138.44.5.0 (138.44.5.0)  1.508 ms  1.509 ms  1.508 ms
 7  et-1-3-0.pe1.sxt.bkvl.nsw.aarnet.net.au (113.197.15.149)  2.253 ms  2.469 ms  2.230 ms
 8  et-0-0-0.pe1.a.hnl.aarnet.net.au (113.197.15.99)  95.437 ms  95.299 ms  95.267 ms
 9  et-2-1-0.bdr1.a.sea.aarnet.net.au (113.197.15.201)  146.597 ms  146.722 ms  146.661 ms
10  abilene-1-lo-jmb-706.sttlwa.pacificwave.net (207.231.240.8)  146.857 ms  146.956 ms  146.932 ms
11  et-4-0-0.4079.rtsw.miss2.net.internet2.edu (162.252.70.0)  157.534 ms  157.517 ms  157.566 ms
12  et-4-0-0.4079.rtsw.minn.net.internet2.edu (162.252.70.58)  180.885 ms  180.953 ms  180.762 ms
13  et-1-1-5.4079.rtsw.eqch.net.internet2.edu (162.252.70.106)  188.647 ms  188.955 ms  188.959 ms
14  162.252.70.163 (162.252.70.163)  189.078 ms  189.386 ms  189.312 ms
15  ae-1.4079.rtsw.clev.net.internet2.edu (162.252.70.130)  198.773 ms  198.490 ms  198.611 ms
16  ae-1.4079.rtsw.hart2.net.internet2.edu (162.252.70.148)  211.998 ms  212.010 ms  212.137 ms
17  ae-2.4079.rtsw.newy32aoa.net.internet2.edu (162.252.70.101)  214.296 ms  214.706 ms  214.322 ms
18  198.71.45.237 (198.71.45.237)  285.155 ms  285.298 ms  285.123 ms
19  ae1.mx1.lon2.uk.geant.net (62.40.98.76)  286.861 ms  286.774 ms  287.126 ms
20  ae6.mx1.lon.uk.geant.net (62.40.98.36)  287.816 ms  287.820 ms  287.793 ms
21  janet-gw.mx1.lon.uk.geant.net (62.40.124.198)  287.898 ms  287.922 ms  287.837 ms
22  ae29.londpg-sbr2.ja.net (146.97.33.2)  288.405 ms  288.421 ms  288.348 ms
23  ae31.erdiss-sbr2.ja.net (146.97.33.22)  292.332 ms  292.168 ms  292.276 ms
24  ae29.manckh-sbr2.ja.net (146.97.33.42)  294.124 ms  294.063 ms  294.071 ms
25  ae24.lanclu-rbr1.ja.net (146.97.38.58)  296.284 ms  296.301 ms  296.228 ms
26  lancaster-university.ja.net (194.81.46.2)  309.217 ms  309.240 ms  309.189 ms
27  * * *
28  ismx-issrx.rtr.lancs.ac.uk (148.88.255.17)  297.940 ms  297.905 ms  298.004 ms
29  dc.iss.srv.rtrcloud.lancs.ac.uk (148.88.253.3)  302.682 ms  314.570 ms  314.584 ms
30  www.lancs.ac.uk (148.88.65.80)  298.572 ms !X  298.142 ms !X  298.297 ms !X
weill %
```

(a) At which router do the paths from your machine to these three destinations diverge?

Solution (a) :

113.197.15.99

(b) 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).

Solution (b) :

The address is in Australia and it's the AARNet Network Operation Center.

(c) Is the number of hops on each path proportional the physical distance?

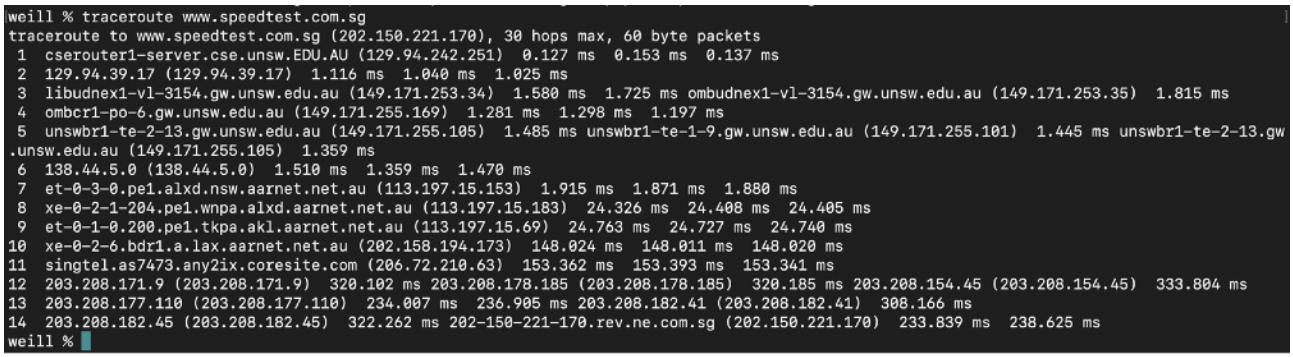
Solution (c) :

The link suggests that the number of hops on each path is not proportional to the physical distance because in case of u-tokyo the hops are more than ucla but the distance is shorter than ucla.

Question 3 :

Run traceroute from both these servers towards your machine and in the reverse direction (i.e. from your machine to these servers).

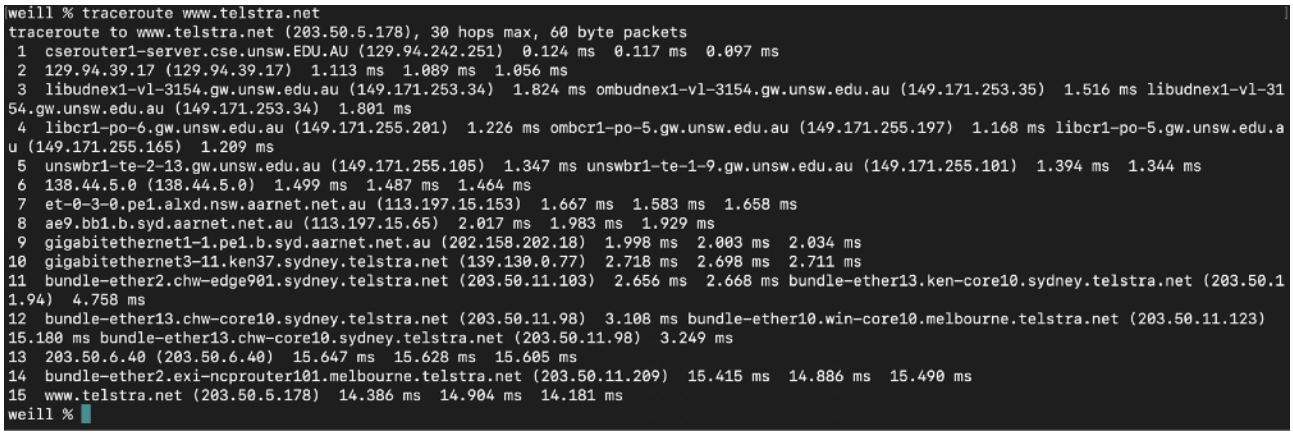
(i) http://www.speedtest.com.sg/tr.php



```
weill % 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)  0.127 ms  0.153 ms  0.137 ms
 2  129.94.39.17 (129.94.39.17)  1.116 ms  1.040 ms  1.025 ms
 3  libudnex1-vl-3154.gw.unsw.edu.au (149.171.253.34)  1.580 ms  1.725 ms ombudnex1-vl-3154.gw.unsw.edu.au (149.171.253.35)  1.815 ms
 4  ombcr1-po-6.gw.unsw.edu.au (149.171.255.169)  1.281 ms  1.298 ms  1.197 ms
 5  unswbr1-te-2-13.gw.unsw.edu.au (149.171.255.105)  1.485 ms unswbr1-te-1-9.gw.unsw.edu.au (149.171.255.101)  1.445 ms unswbr1-te-2-13.gw
.unsw.edu.au (149.171.255.105)  1.359 ms
 6  138.44.5.0 (138.44.5.0)  1.510 ms  1.359 ms  1.470 ms
 7  et-0-3-0.pe1.alxd.nsw.aarnet.net.au (113.197.15.153)  1.915 ms  1.871 ms  1.880 ms
 8  xe-0-2-1-204.pe1.wnpa.alxd.aarnet.net.au (113.197.15.183)  24.326 ms  24.408 ms  24.405 ms
 9  et-0-1-0.200.pe1.tkpa.akl.aarnet.net.au (113.197.15.69)  24.763 ms  24.727 ms  24.740 ms
10  xe-0-2-6.bdr1.a.lax.aarnet.net.au (202.158.194.173)  148.024 ms  148.011 ms  148.020 ms
11  singtel.as7473.any2ix.coresite.com (206.72.210.63)  153.362 ms  153.393 ms  153.341 ms
12  203.208.171.9 (203.208.171.9)  320.102 ms 203.208.178.185 (203.208.178.185)  320.185 ms 203.208.154.45 (203.208.154.45)  333.804 ms
13  203.208.177.110 (203.208.177.110)  234.007 ms  236.905 ms 203.208.182.41 (203.208.182.41)  308.166 ms
14  203.208.182.45 (203.208.182.45)  322.262 ms 202-150-221-170.rev.ne.com.sg (202.150.221.170)  233.839 ms  238.625 ms
weill %
```

Traceroute form home to www.speedtest.com.sg : 14 hops
Traceroute form www.speedtest.com.sg to home : 12 hops

(ii) https://www.telstra.net/cgi-bin/trace



```
weill % 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)  0.124 ms  0.117 ms  0.097 ms
 2  129.94.39.17 (129.94.39.17)  1.113 ms  1.089 ms  1.056 ms
 3  libudnex1-vl-3154.gw.unsw.edu.au (149.171.253.34)  1.824 ms ombudnex1-vl-3154.gw.unsw.edu.au (149.171.253.35)  1.516 ms libudnex1-vl-31
54.gw.unsw.edu.au (149.171.253.34)  1.801 ms
 4  libcr1-po-6.gw.unsw.edu.au (149.171.255.201)  1.226 ms ombcr1-po-5.gw.unsw.edu.au (149.171.255.197)  1.168 ms libcr1-po-5.gw.unsw.edu.a
u (149.171.255.165)  1.209 ms
 5  unswbr1-te-2-13.gw.unsw.edu.au (149.171.255.105)  1.347 ms unswbr1-te-1-9.gw.unsw.edu.au (149.171.255.101)  1.394 ms  1.344 ms
 6  138.44.5.0 (138.44.5.0)  1.499 ms  1.487 ms  1.464 ms
 7  et-0-3-0.pe1.alxd.nsw.aarnet.net.au (113.197.15.153)  1.667 ms  1.583 ms  1.658 ms
 8  ae9.bb1.b.syd.aarnet.net.au (113.197.15.65)  2.017 ms  1.983 ms  1.929 ms
 9  gigabitethernet1-1.pe1.b.syd.aarnet.net.au (202.158.202.18)  1.998 ms  2.003 ms  2.034 ms
10  gigabitethernet3-11.ken37.sydney.telstra.net (139.130.0.77)  2.718 ms  2.698 ms  2.711 ms
11  bundle-ether2.chw-edge901.sydney.telstra.net (203.50.11.103)  2.656 ms  2.668 ms bundle-ether13.ken-core10.sydney.telstra.net (203.50.1
1.94)  4.758 ms
12  bundle-ether13.chw-core10.sydney.telstra.net (203.50.11.98)  3.108 ms bundle-ether10.win-core10.melbourne.telstra.net (203.50.11.123)
15.180 ms bundle-ether13.chw-core10.sydney.telstra.net (203.50.11.98)  3.249 ms
13  203.50.6.40 (203.50.6.40)  15.647 ms  15.628 ms  15.605 ms
14  bundle-ether2.exi-ncprouter101.melbourne.telstra.net (203.50.11.209)  15.415 ms  14.886 ms  15.490 ms
15  www.telstra.net (203.50.5.178)  14.386 ms  14.904 ms  14.181 ms
weill %
```

Traceroute form home to www.telstra.net : 13 hops
Traceroute form www.telstra.net to home : 12 hops

From the observations above we can say that the reverse routers are not the same as forward routers.This is because each routers has its own set of rules and hence produces different paths.

Exercise 4: Use ping to gain insights into network performance

Question 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, Singapore 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?

Solution 1 :

Speed of light : 3 x 10(^8) m/s ~ 300,000 km/s

For www.uq.edu.au, the IP address is 130.102.131.123

Organisation name : University of Queensland

Address : Brisbane, Australia

Distance from UNSW : 925 km

Shortest possible time T for a packet to reach Queensland from UNSW : 925/(3 X 10^8) ~ 3.08ms

Minimum delay time (for 50 packages) : 16.613

For www.nus.edu.sg, the IP address is 137.132.21.27. Organisation name :

National University of Singapore Address : Singapore

Distance from UNSW : 6298 km

Shortest possible time T for a packet to reach Singapore from UNSW : ~ 21ms

Minimum delay time (for 50 packages) : 141.841

For www.tu-berlin.de , the IP address is 130.149.7.201

Organisation name : TU Berlin, campus network

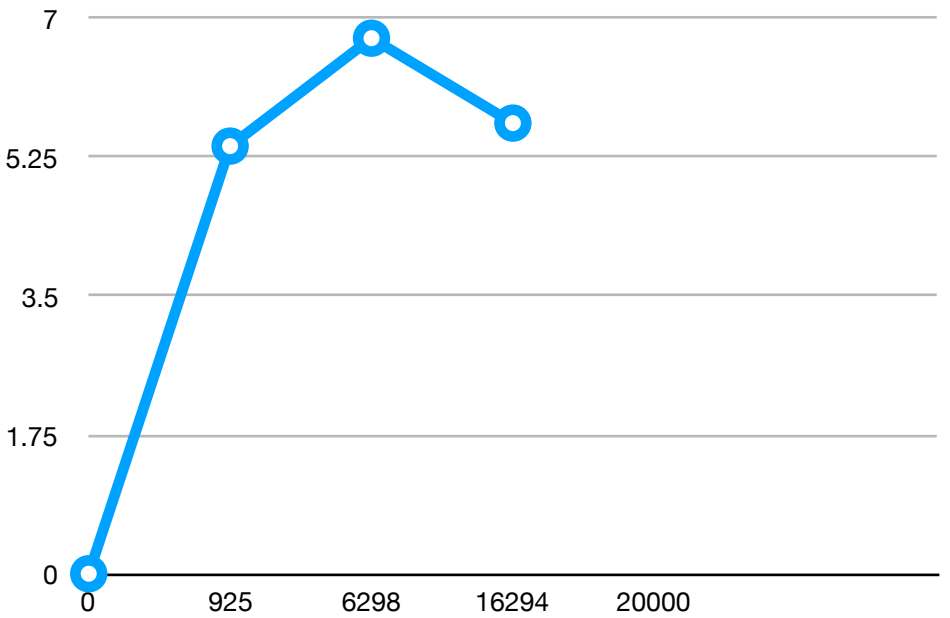
Address : Berlin,Germany

Distance from UNSW : 16294 km

Shortest possible time T for a packet to reach UK from UNSW : ~ 54ms

Minimum delay time (for 50 packages) : 307.141

The ratio between the minimum delay (i.e. RTT) as measured by the ping program and the shortest possible time T to reach that city from UNSW are 5.39 , 6.75 and 5.68 respectively.



X-axis : Distance(km)

Y-axis : Ratio(minimum delay/by ping)

(i) Can you think of at least two reasons why the y-axis values that you plot are greater than 2?

Solution (i) :

The y-axis values that you plot are greater than 2 because the round trip time is counting the time for a packet to travel from one place to another and then wait for the response.
It gets the response, whereas T is the shortest time it takes to reach a place. So, RTT would be at least twice or as big as T.

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

Solution (ii) :

The delay to the destinations varies over time and this is because of packet switching. The delay does affect the delay time but not a significant difference.

(iii) 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?

Solution (iii) :

The propagation delay, transmission delay, processing delay and queuing delay are the measured delays.
Transmission delay(bits/second) is how long it takes to get ‘all’ the bits the wire in the first place and Propagation delay is how long it takes ‘one' bit to travel from one end of the wire to the other. The size of the package does matter in these cases as both of them require to work with bits.

Processing delay is the delay based on how long it takes the router to figure out where to send the packet and Queuing delay is a delay based on how long the packet has to sit around in the router. Therefore, the size of the package does not matter in these kind of delays as it depends on how busy the wire is.