COMP3331 LAB 1
Abanob Tawfik
Z5075490

Contents

Exercise 1: nslookup

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?

(IP addresses are in bold)
Using the nslookup command on the google website in windows command prompt returned the following results

Name: www.google.com
Addresses: **2404:6800:4006:808::2004 ← IP address**
216.58.200.100 ← IP address

another usage on Linux VM terminal returned the following results

Name: www.google.com
Address: **172.217.25.36 ← IP address**

When the following URL was entered into a browser https://(IP_ADDRESS), there was a redirection to the google home page.

another observation that can be made was that waiting approximately 5-10 minutes, the IP address supplied would change between those two. The reason I think of having multiple IP addresses as output is that there are many servers for google, and each server has its own unique IP address. The reason I think the IP changes is that the host is communicating with a different server of google potentially due to routing optimisation for google servers.

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

Using the nslookup command we can find the domain name of an IP address by using
Nslookup (IP address)
When performed the following output was returned
Name: localhost
Address: 127.0.0.1
Localhost in networking terms refers to my computer being currently used. The special attribute to the IP address 127.0.0.1 is that it is the IP address that will be reserved for the local host or your machine.
(extra this is where the following tech joke comes from)
There's no place like 127.0.0.1 ← home

Exercise 2: Use ping to test host reachability

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

www.cse.unsw.edu.au

when pinging the CSE website for UNSW, the packets had reached the host, however there was no reply in the default timeout of 1 second, the reason will be stated below in the second answer. The host is reachable in this case. The URL when entered into the browser had redirected to the cse website. Figure 1 displays the result from pinging the CSE website.

```
C:\Users\Abs Tawfik>ping www.cse.unsw.edu.au

Pinging www.cse.unsw.edu.au [129.94.242.51] with 32 bytes of data:
Request timed out.
Request timed out.
Request timed out.
Request timed out.

Ping statistics for 129.94.242.51:
    Packets: Sent = 4, Received = 0, Lost = 4 (100% loss),
```

Figure 1 Result from pinging CSE website

www.getfittest.com.au

when pinging getfittest, there was no domain under that name and the following result showed up. Figure 2 displays the error message from the ping request.

```
C:\Users\Abs Tawfik>ping www.getfittest.com.au
Ping request could not find host www.getfittest.com.au. Please check the name and try again.
```

Figure 2 Error message from ping request

When the URL was entered into the browser the following error was received. Figure 3 shows the browser error from attempting to access the URL.

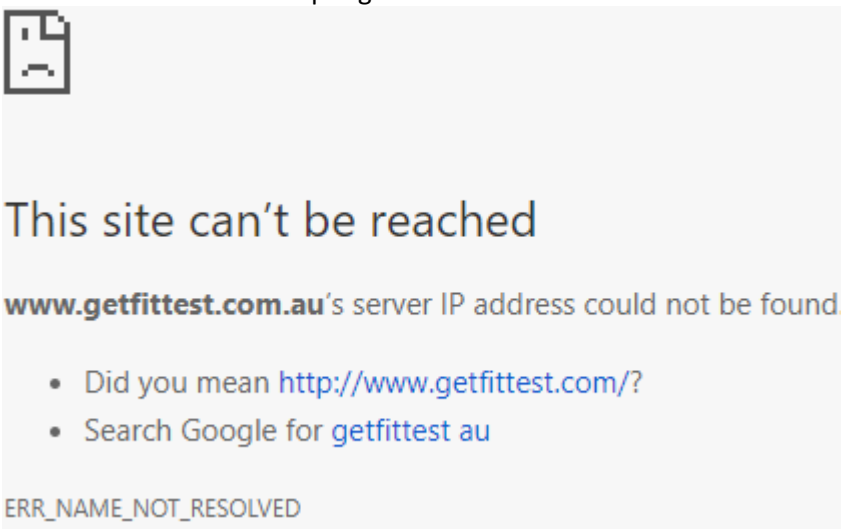


Figure 3 browser error from accessing the invalid URL

This error was resolved when performing the ping command on www.getfittest.com without the .au.

www.mit.edu

when pinging the MIT website, the packets had reached the host and there was a reply that was received. The host is reachable in this case. The web URL had redirected to the MIT website. Figure 4 displays the result from pinging the MIT website.

```
C:\Users\Abs Tawfik>ping www.mit.edu

Pinging e9566.dscb.akamaiedge.net [118.215.113.86] with 32 bytes of data:
Reply from 118.215.113.86: bytes=32 time=7ms TTL=59
Reply from 118.215.113.86: bytes=32 time=8ms TTL=59
Reply from 118.215.113.86: bytes=32 time=7ms TTL=59
Reply from 118.215.113.86: bytes=32 time=9ms TTL=59

Ping statistics for 118.215.113.86:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 7ms, Maximum = 9ms, Average = 7ms
```

Figure 4 the result from pinging the MIT website

www.intel.com.au

when pinging the intel website (Australian domain), the packets had reached the host and there was a reply that was received. The host is reachable in this case. The web URL had redirected to the intel website. Figure 5 displays the result from pinging the intel website.

```
C:\Users\Abs Tawfik>ping www.intel.com.au

Pinging e117.b.akamaiedge.net [125.56.176.143] with 32 bytes of data:
Reply from 125.56.176.143: bytes=32 time=9ms TTL=59
Reply from 125.56.176.143: bytes=32 time=7ms TTL=59
Reply from 125.56.176.143: bytes=32 time=8ms TTL=59
Reply from 125.56.176.143: bytes=32 time=11ms TTL=59

Ping statistics for 125.56.176.143:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 7ms, Maximum = 11ms, Average = 8ms
```

Figure 5 the result from pinging the intel website

www.tpg.com.au

when pinging the tpg website (Australian domain), the packets had reached the host and there was a reply that was received. The host is reachable in this case. The web URL had re-directed to the tpg website. Figure 6 displays the result from pinging the tpg website.

```
C:\Users\Abs Tawfik>ping www.tpg.com.au

Pinging www.tpg.com.au [203.26.27.38] with 32 bytes of data:
Reply from 203.26.27.38: bytes=32 time=10ms TTL=118
Reply from 203.26.27.38: bytes=32 time=60ms TTL=118
Reply from 203.26.27.38: bytes=32 time=9ms TTL=118
Reply from 203.26.27.38: bytes=32 time=12ms TTL=118

Ping statistics for 203.26.27.38:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 9ms, Maximum = 60ms, Average = 22ms
```

Figure 6 the result from pinging the intel website

www.hola.hp

when pinging hola there was no domain under that name and the following result showed up. Figure 7 shows the error message when attempting the ping request.

```
C:\Users\Abs Tawfik>ping www.hola.hp
Ping request could not find host www.hola.hp. Please check the name and try again.
```

Figure 7 error message from ping request

Entering the URL in a browser would constantly redirect to a google search displayed in Figure 8.

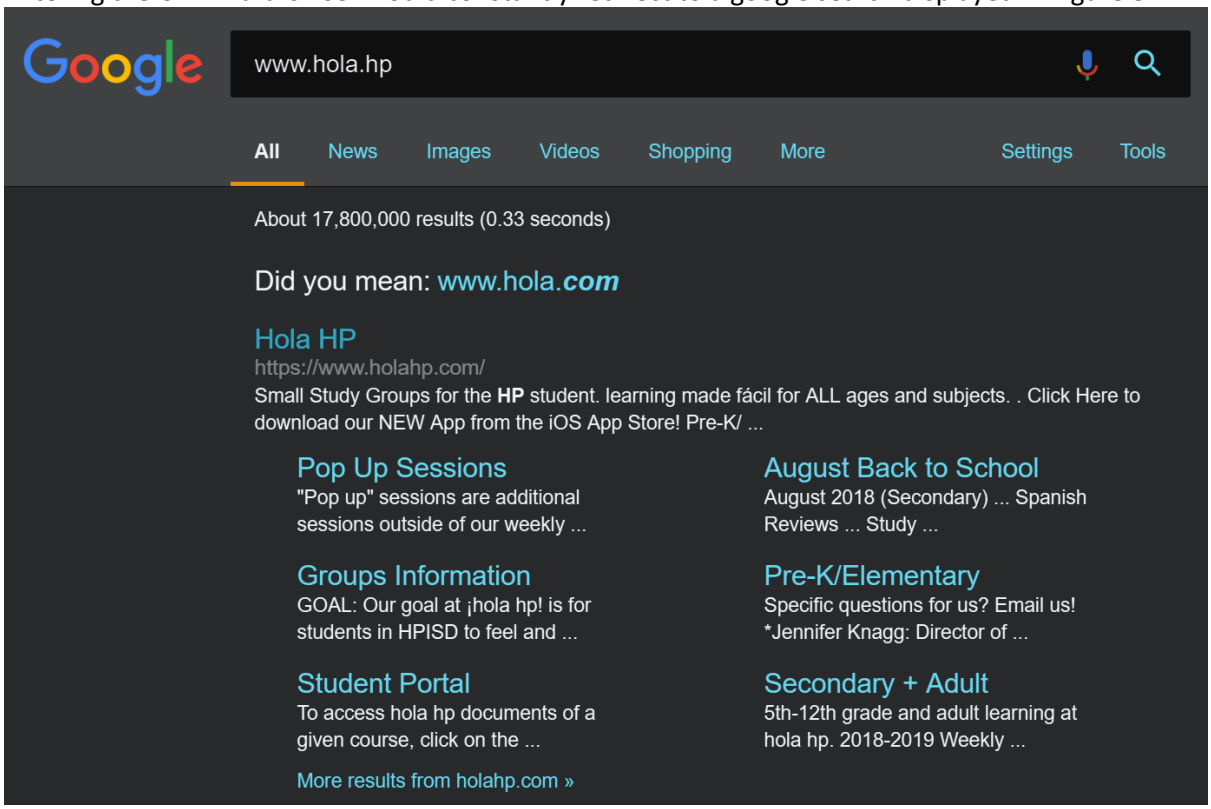


Figure 8 google re-direction from attempting to enter URL into browser

This error could simply be resolved by changing the URL to www.holahp.com

www.amazon.com

when pinging the amazon website, the packets had reached the host and there was a reply that was received. The host is reachable in this case. The web URL had re-directed to the amazon website. Figure 9 displays the result from pinging amazon's website.

```
C:\Users\Abs Tawfik>ping www.amazon.com

Pinging d3ag4hukkh62yn.cloudfront.net [54.230.133.148] with 32 bytes of data
Reply from 54.230.133.148: bytes=32 time=9ms TTL=247
Reply from 54.230.133.148: bytes=32 time=10ms TTL=247
Reply from 54.230.133.148: bytes=32 time=10ms TTL=247
Reply from 54.230.133.148: bytes=32 time=16ms TTL=247

Ping statistics for 54.230.133.148:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 9ms, Maximum = 16ms, Average = 11ms
```

Figure 9 result from pinging the amazon website

www.tsinghua.edu.cn

when pinging the Tsinghua website, the packets had reached the host and there was a reply that was received. The host is reachable in this case. The web URL had re-directed to the Tsinghua website. Figure 10 displays the result from pinging the Tsinghua website.

```
C:\Users\Abs Tawfik>ping www.tsinghua.edu.cn

Pinging www.d.tsinghua.edu.cn [166.111.4.100] with 32 bytes of data:
Reply from 166.111.4.100: bytes=32 time=164ms TTL=234
Reply from 166.111.4.100: bytes=32 time=165ms TTL=234
Reply from 166.111.4.100: bytes=32 time=161ms TTL=234
Reply from 166.111.4.100: bytes=32 time=164ms TTL=234

Ping statistics for 166.111.4.100:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 161ms, Maximum = 165ms, Average = 163ms
```

Figure 10 result from pinging the Tsinghua website

www.kremlin.ru

when pinging the Kremlin website, the packets had reached the host, however there was no reply in the default timeout of 1 second. When the URL was entered into a browser, it had redirected to a Russian website of some sort. Figure 11 displays the result from pinging the Kremlin website.

```
C:\Users\Abs Tawfik>ping www.kremlin.ru

Pinging www.kremlin.ru [95.173.136.71] with 32 bytes of data:
Request timed out.
Request timed out.
Request timed out.
Request timed out.

Ping statistics for 95.173.136.71:
    Packets: Sent = 4, Received = 0, Lost = 4 (100% loss),
```

Figure 11 result from pinging the Kremlin website

8.8.8.8

When pinging the IP address 8.8.8.8 the packets had reached the host and there was a reply that was received. The host is reachable in this case. When the URL https://8.8.8.8 was entered into a browser, there was a redirection to the google website with the search bar (home page). This is the IP address for Google's Public DNS. Figure 12 displays the result from pinging the IP address 8.8.8.8.

```
C:\Users\Abs Tawfik>ping 8.8.8.8

Pinging 8.8.8.8 with 32 bytes of data:
Reply from 8.8.8.8: bytes=32 time=12ms TTL=119
Reply from 8.8.8.8: bytes=32 time=9ms TTL=119
Reply from 8.8.8.8: bytes=32 time=17ms TTL=119
Reply from 8.8.8.8: bytes=32 time=9ms TTL=119

Ping statistics for 8.8.8.8:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 9ms, Maximum = 17ms, Average = 11ms
```

Figure 12 result from pinging the IP address 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.

In these cases, all the hosts were reachable except for www.getfittest.com.au and www.hola.hp. These hosts do not exist, and when entered into a browser (as shown above) resulted with either a error that the site could not be found, or a google search recommendation for the actual hola website. These errors were due to the fact that the hosts should have been instead www.getfittest.com and www.holahp.com. This had resolved the issue and those hosts were reachable. In some cases, the host was reached however the was no reply from the host within the default timeout of one second resulting in a request timeout. As stated in a stack overflow answer the request timeout could be due to network congestion, routing errors or packet loss. Reasons why a host could be unreachable would be due to having no available route from the local host to the destination host, however this was not observed with the hosts given.

Exercise 3: Use traceroute to understand network topology

Run traceroute on your machine to www.columbia.edu

The result from the traceroute is displayed below in Figure 13

```
C:\Users\Abs Tawfik>tracert www.columbia.edu

Tracing route to www.wwwr53.cc.columbia.edu [128.59.105.24]
over a maximum of 30 hops:

  1    <1 ms    <1 ms    <1 ms  192.168.0.1
  2    27 ms    31 ms    12 ms  10.243.128.1
  3     8 ms    11 ms    15 ms  58.160.249.1
  4    10 ms    21 ms     8 ms  bundle-ether4.chw-edge901.sydney.telstra.net [203.50.12.108]
  5    13 ms    24 ms    11 ms  bundle-ether13.chw-core10.sydney.telstra.net [203.50.11.98]
  6    11 ms    12 ms    12 ms  bundle-ether1.oxf-gw11.sydney.telstra.net [203.50.6.93]
  7    11 ms    17 ms    11 ms  bundle-ether1.sydo-core03.sydney.reach.com [203.50.13.98]
  8   199 ms   197 ms   196 ms  i-73.paix-core02.telstraglobal.net [202.84.247.45]
  9   195 ms   205 ms   199 ms  i-92.paix02.telstraglobal.net [202.84.247.41]
 10   196 ms   196 ms   231 ms  liberty_global-peer.eqnx03.pr.telstraglobal.net [134.159.63.85]
 11   196 ms   203 ms   202 ms  be2016.ccr22.sfo01.atlas.cogentco.com [154.54.0.177]
 12   211 ms   212 ms   219 ms  be3110.ccr21.slc01.atlas.cogentco.com [154.54.44.142]
 13   223 ms   222 ms   223 ms  be3038.ccr22.den01.atlas.cogentco.com [154.54.42.98]
 14   233 ms   234 ms   235 ms  be3036.ccr22.mci01.atlas.cogentco.com [154.54.31.90]
 15   246 ms   253 ms   244 ms  be2832.ccr42.ord01.atlas.cogentco.com [154.54.44.170]
 16   252 ms   254 ms   253 ms  be2718.ccr22.cle04.atlas.cogentco.com [154.54.7.130]
 17   265 ms   265 ms   264 ms  be2890.ccr42.jfk02.atlas.cogentco.com [154.54.82.246]
 18   265 ms   264 ms   265 ms  be2897.rcr24.jfk01.atlas.cogentco.com [154.54.84.214]
 19   299 ms   317 ms   264 ms  38.122.8.210
 20   265 ms   265 ms   265 ms  cc-core-1-x-nyser32-gw-1.net.columbia.edu [128.59.255.5]
 21   269 ms   269 ms   265 ms  cc-conc-1-x-cc-core-1.net.columbia.edu [128.59.255.210]
 22   264 ms   264 ms   265 ms  columbia.university [128.59.105.24]

Trace complete.
```

Figure 13 result from performing traceroute on columbia.edu

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

There were 22 routers between my local host (at my home) and the destination host.

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

There were no routers along the path that were apart of the UNSW network since this was run off my local machine which has a Telstra connection. Assuming this was run off the cse server, the Telstra networks would be replaced by the UNSW network.

Between which two routers do packets cross the Pacific Ocean?

Using ping to compare round trip time between **bundle-ether1.sydo-core03.sydney.reach.com [203.50.13.98]** which averaged 17ms, and then a sudden jump to 196ms at router **i-73.paix-core02.telstraglobal.net [202.84.247.45]**, shows the packets cross the Pacific Ocean between those two routers.

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

This was the following result of running traceroute

(i) Figure 14 displays the traceroute to UCLA

```
C:\Users\Abs Tawfik>tracert www.ucla.edu

Tracing route to gateway.lb.it.ucla.edu [164.67.228.152]
over a maximum of 30 hops:

  1    <1 ms    <1 ms    <1 ms  192.168.0.1
  2    16 ms    11 ms    10 ms  10.243.128.1
  3    10 ms    14 ms     9 ms  58.160.249.1
  4    10 ms    19 ms    10 ms  bundle-ether4.chw-edge901.sydney.telstra.net [203.50.12.108]
  5    13 ms    22 ms    21 ms  bundle-ether13.chw-core10.sydney.telstra.net [203.50.11.98]
  6    12 ms    14 ms    12 ms  bundle-ether1.oxf-gw11.sydney.telstra.net [203.50.6.93]
  7    13 ms    19 ms    14 ms  bundle-ether1.sydo-core03.sydney.reach.com [203.50.13.98]
  8   198 ms   196 ms   211 ms  i-73.paix-core02.telstraglobal.net [202.84.247.45]
  9   218 ms   199 ms   198 ms  i-92.paix02.telstraglobal.net [202.84.247.41]
 10     *        *        *     Request timed out.
 11   201 ms   201 ms   200 ms  64.57.21.5
 12   201 ms   202 ms   198 ms  dc-svl-agg8--svl-agg4-100ge-#2.cenic.net [137.164.11.31]
 13   199 ms   199 ms   198 ms  dc-lax-agg8--svl-agg8--100ge--#2.cenic.net [137.164.11.20]
 14   194 ms   192 ms   194 ms  dc-lax-agg6--lax-agg8-100ge-#2.cenic.net [137.164.11.6]
 15     *        *        *     Request timed out.
 16   198 ms   199 ms   199 ms  bd11f1.anderson--cr00f2.csb1.ucla.net [169.232.4.4]
 17   197 ms   203 ms   197 ms  cr00f2.csb1--dr00f2.csb1.ucla.net [169.232.4.53]
 18     *        *        *     Request timed out.
 19   197 ms   194 ms   194 ms  6513-1vlan134.ais.ucla.edu [164.67.134.252]
 20   201 ms   201 ms   198 ms  gateway.lb.it.ucla.edu [164.67.228.152]

Trace complete.
```

Figure 14 result from traceroute to ucla

(ii) UNIVERSITY OF TOKYO (note unsuccessful completion past hop #13) this was attempted 5 times, each attempt unable to finish (even on a CSE machine). Figure 15 displays the result from the traceroute to Tokyo university.

```
C:\Users\Abs Tawfik>tracert www.u-tokyo.ac.jp

Tracing route to www.u-tokyo.ac.jp [210.152.243.234]
over a maximum of 30 hops:

  1     1 ms    <1 ms    <1 ms  192.168.0.1
  2     7 ms     8 ms     9 ms  10.243.128.1
  3    10 ms    12 ms    15 ms  58.160.249.1
  4    12 ms    12 ms     9 ms  bundle-ether4.chw-edge901.sydney.telstra.net [203.50.12.108]
  5    13 ms    12 ms    11 ms  bundle-ether13.chw-core10.sydney.telstra.net [203.50.11.98]
  6    11 ms    23 ms    16 ms  bundle-ether1.oxf-gw11.sydney.telstra.net [203.50.6.93]
  7    16 ms    10 ms     9 ms  bundle-ether1.sydo-core03.sydney.reach.com [203.50.13.98]
  8   125 ms   126 ms   125 ms  i-0-3-0-1.siko-core04.telstraglobal.net [202.84.138.10]
  9   139 ms   142 ms   139 ms  i-91.joua01.telstraglobal.net [202.47.216.50]
 10     *        *        *     Request timed out.
 11   163 ms   161 ms   161 ms  124.83.228.78
 12   144 ms   142 ms   155 ms  124.83.252.250
 13   144 ms   152 ms   155 ms  158.205.134.26
 14     *        *        *     Request timed out.
 15     *        *        *     Request timed out.
 16     *        *        *     Request timed out.
 17     *        *        *     Request timed out.
 18     *        *        *     Request timed out.
 19     *        *        *     Request timed out.
 20     *        *        *     Request timed out.
 21     *        *        *     Request timed out.
 22     *        *        *     Request timed out.
 23     *        *        *     Request timed out.
 24     *        *        *     Request timed out.
 25     *        *        *     Request timed out.
 26     *        *        *     Request timed out.
 27     *        *        *     Request timed out.
 28     *        *        *     Request timed out.
 29     *        *        *     Request timed out.
 30     *        *        *     Request timed out.

Trace complete.
```

Figure 15 result from traceroute to University Of Tokyo

(iii) LANCASTER UNIVERSITY Figure 16 displays the result from the traceroute to Lancaster university.

```
C:\Users\Abs Tawfik>tracert www.lancaster.ac.uk

Tracing route to www.lancaster.ac.uk [148.88.65.80]
over a maximum of 30 hops:

  1    <1 ms     2 ms     1 ms  192.168.0.1
  2     7 ms     8 ms    11 ms  10.243.128.1
  3     8 ms     9 ms    13 ms  58.160.249.1
  4    27 ms    18 ms    10 ms  bundle-ether4.chw-edge901.sydney.telstra.net [203.50.12.108]
  5    14 ms    10 ms    11 ms  bundle-ether13.chw-core10.sydney.telstra.net [203.50.11.98]
  6    16 ms    11 ms    10 ms  bundle-ether1.oxf-gw11.sydney.telstra.net [203.50.6.93]
  7    45 ms    20 ms    11 ms  bundle-ether1.sydo-core03.sydney.reach.com [203.50.13.98]
  8     9 ms     9 ms    12 ms  i-0-1-0-16.sydo-core04.bi.telstraglobal.net [202.84.222.58]
  9   158 ms   157 ms   198 ms  i-84.eqnx-core02.telstraglobal.net [202.84.247.37]
 10   224 ms   221 ms   224 ms  i-14808.ny8a-core01.telstraglobal.net [202.40.148.98]
 11   328 ms     *      331 ms  i-10448.ulco-core02.telstraglobal.net [202.84.249.173]
 12   333 ms   328 ms   332 ms  i-91.ulco01.telstraglobal.net [202.40.148.34]
 13     *        *        *     Request timed out.
 14   286 ms   288 ms   323 ms  ae23.londhx-sbr1.ja.net [146.97.35.165]
 15   285 ms   289 ms   286 ms  ae29.londpg-sbr2.ja.net [146.97.33.2]
 16   342 ms   335 ms   333 ms  ae31.erdiss-sbr2.ja.net [146.97.33.22]
 17   293 ms   292 ms   295 ms  ae29.manckh-sbr2.ja.net [146.97.33.42]
 18   346 ms   344 ms   344 ms  ae24.lanclu-rbr1.ja.net [146.97.38.58]
 19     *        *        *     Request timed out.
 20   341 ms   343 ms   342 ms  ismx-issrx.rtr.lancs.ac.uk [148.88.255.17]
 21   437 ms   448 ms   386 ms  dc.iss.srv.rtrcloud.lancs.ac.uk [148.88.253.3]
 22   296 ms   328 ms   300 ms  www.lancs.ac.uk [148.88.65.80]

Trace complete.
```

Figure 16 the result from the traceroute to Lancaster University

At which router do the paths from your machine to these three destinations diverge? Find out further details about this router.

All these paths diverge at the following router **bundle-ether1.sydo-core03.sydney.reach.com [203.50.13.98].** using the whois command this IP address is linked to Telstra (the ISP). This router seemed to be the link between Australia and overseas routers, each of these websites are located in California/Tokyo/UK, and they all crossed through the reach.com router before they were split to go on different paths.

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

Using this as a sample size is not sufficient enough to draw any conclusions, however from what was observed the following mapping of the destination addresses in figure 17.

Figure 17 a mapping of all the host destinations involved in the traceroute

There were two additional hops to reach Lancaster University which is clearly as shown in the diagram further in distance from the local host, however Tokyo university which was the closest was unable to be reached. Using a bit of google searching the following distances were discovered (not exact just distances to the universities however the servers will be relatively close)
Local host → UCLA: 12067km
Local host → Tokyo University: 7815km
Local host → Lancaster University: 16965km
Whilst ignoring the anomaly of Tokyo university (most likely due to ping requests being blocked) the greater distance between Lancaster university and UCLA resulted in an increasing number of hops, however the sample size is too small to draw any conclusions.

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).

(i) Figure 18 displays the traceroute from Singapore speed test → local host

```
traceroute to 61.9.194.49 (61.9.194.49), 30 hops max, 60 byte packets
 1  ge2-8.r01.sin01.ne.com.sg (202.150.221.169)  0.145 ms  0.166 ms  0.181 ms
 2  gi0-0-0-5.ccr21.sin01.atlas.cogentco.com (154.18.2.1)  0.801 ms  0.838 ms  0.896 ms
 3  be3406.ccr41.lax04.atlas.cogentco.com (154.54.84.21)  173.196 ms  173.071 ms  173.309 ms
 4  be3360.ccr42.lax01.atlas.cogentco.com (154.54.25.149)  176.719 ms be3271.ccr41.lax01.atlas.cogentco.com (154.54.42.101)  172.956
 5  be3359.ccr41.lax05.atlas.cogentco.com (154.54.3.70)  172.971 ms  176.723 ms  176.764 ms
 6  reach.lax05.atlas.cogentco.com (154.54.10.134)  171.760 ms  174.599 ms  174.454 ms
 7  i-92.1wlt-core02.telstraglobal.net (202.84.253.81)  175.899 ms  170.832 ms  175.906 ms
 8  i-46.sydo-core04.telstraglobal.net (202.84.136.210)  201.062 ms  200.384 ms  201.428 ms
 9  bundle-ether3.oxf-gw10.sydney.telstra.net (203.50.13.93)  204.071 ms  199.727 ms  201.445 ms
10  bundle-ether2.oxf-gw11.sydney.telstra.net (203.50.6.95)  200.335 ms  204.499 ms  200.329 ms
11  bundle-ether1.chw-core10.sydney.telstra.net (203.50.6.92)  200.576 ms  205.065 ms  204.862 ms
12  bundle-ether1.chw-edge901.sydney.telstra.net (203.50.11.99)  199.837 ms  204.788 ms  199.793 ms
13  * * *
14  * * *
15  * * *
16  * * *
17  * * *
18  * * *
19  * * *
20  * * *
21  * * *
22  * * *
23  * * 203.50.12.109 (203.50.12.109)  201.084 ms !X

Traceroute Completed.
```

Figure 18 traceroute result from Singapore speed test to local host

(i) Figure 19 displays the traceroute from local host → Singapore speed test

```
C:\Users\Abs Tawfik>tracert 202.150.221.170

Tracing route to 202-150-221-170.rev.ne.com.sg [202.150.221.170]
over a maximum of 30 hops:

  1    <1 ms    <1 ms    <1 ms  192.168.0.1
  2    12 ms     9 ms    22 ms  10.243.128.1
  3    21 ms    11 ms    10 ms  58.160.249.1
  4    17 ms    12 ms    27 ms  bundle-ether4.chw-edge901.sydney.telstra.net [203.50.12.108]
  5    12 ms    13 ms    10 ms  bundle-ether13.chw-core10.sydney.telstra.net [203.50.11.98]
  6    15 ms    10 ms    12 ms  bundle-ether1.oxf-gw11.sydney.telstra.net [203.50.6.93]
  7    12 ms     9 ms    11 ms  bundle-ether2.oxf-gw10.sydney.telstra.net [203.50.6.94]
  8    15 ms    12 ms    19 ms  bundle-ether1.sydo-core04.sydney.reach.com [203.50.13.94]
  9    16 ms    15 ms    12 ms  i-0-1-0-48.sydo-core03.bi.telstraglobal.net [202.84.222.65]
 10    63 ms    69 ms    66 ms  i-15303.pthp-core02.telstraglobal.net [202.84.140.33]
 11   106 ms   108 ms   102 ms  i-15053.sgpl-core02.telstraglobal.net [202.84.140.38]
 12   105 ms   106 ms   104 ms  i-92.sgpl01.telstraglobal.net [202.84.224.194]
 13   103 ms   107 ms   104 ms  unknown.telstraglobal.net [210.176.138.174]
 14   110 ms   106 ms   109 ms  203.118.15.133
 15   103 ms   105 ms   102 ms  203.118.2.26
 16   118 ms   104 ms   101 ms  an-atl-int11.starhub.net.sg [203.118.15.82]
 17   104 ms   105 ms   101 ms  203.117.6.210
 18   106 ms   103 ms   103 ms  202-150-221-170.rev.ne.com.sg [202.150.221.170]

Trace complete.
```

Figure 19 traceroute result from local host to Singapore speed test

(ii) Figure 20 displays the traceroute from telstra.net → local host

```
1  gigabitethernet3-3.exi1.melbourne.telstra.net (203.50.77.49)  0.361 ms  0.282 ms  0.245 ms
2  bundle-ether3-100.exi-core10.melbourne.telstra.net (203.50.80.1)  2.868 ms  1.673 ms  2.119 ms
3  bundle-ether12.chw-core10.sydney.telstra.net (203.50.11.124)  13.862 ms  14.418 ms  14.861 ms
4  bundle-ether1.chw-edge901.sydney.telstra.net (203.50.11.99)  13.238 ms  28.659 ms  13.238 ms
```

Figure 20 traceroute result from telstra.net to local host

(iii) Figure 21 displays the traceroute from local host → telstra.net

```
C:\Users\Abs Tawfik>tracert 203.50.5.178

Tracing route to www.telstra.net [203.50.5.178]
over a maximum of 30 hops:

  1     1 ms     1 ms    <1 ms  192.168.0.1
  2    16 ms     9 ms    10 ms  10.243.128.1
  3    14 ms    10 ms    11 ms  58.160.249.1
  4    12 ms    13 ms    13 ms  bundle-ether4.chw-edge901.sydney.telstra.net [203.50.12.108]
  5    17 ms    12 ms    10 ms  bundle-ether13.chw-core10.sydney.telstra.net [203.50.11.98]
  6    34 ms    24 ms    23 ms  bundle-ether8.exi-core10.melbourne.telstra.net [203.50.11.125]
  7    28 ms    21 ms    24 ms  gigabitethernet5-0.exi-service1.melbourne.telstra.net [203.50.80.7]
  8    24 ms    21 ms    41 ms  www.telstra.net [203.50.5.178]

Trace complete.
```

Figure 21 traceroute result from local host to telstra.net

What are the IP addresses of the two servers that you have chosen?

For option one, the IP address used was **61.9.194.49** for traceroute from these servers to my machine, this was found by using nslookup on www.speedtest.com.sg shown below in Figure 22

```
C:\Users\Abs Tawfik>nslookup www.speedtest.com.sg
Server:  dns-cust.cht.bigpond.net.au
Address:  61.9.194.49

Non-authoritative answer:
Name:    www.speedtest.com.sg
Addresses:  2406:f400:8:8::2
          202.150.221.170
```

Figure 22 nslookup for the Singapore speed test website

The first address is the address used by my machine to server for communication.
For the address of the server for Singapore speed test the address **202.150.221.170** was used to traceroute in the reverse direction.

For option two, the IP address used was **61.9.194.49** for traceroute from these servers to my machine, this was found by using nslookup on www.telstra.net shown below in Figure 23

```
C:\Users\Abs Tawfik>nslookup www.telstra.net
Server:  dns-cust.cht.bigpond.net.au
Address:  61.9.194.49

Non-authoritative answer:
Name:    www.telstra.net
Address:  203.50.5.178
```

Figure 23 nslookup for the telstra.net

For the address of the server for telestra.net the address **203.50.5.178** was used to traceroute in the reverse direction.

Does the reverse path go through the same routers as the forward path?

The reverse path and forward path for both situations are not the same, however there are common routers between the trace paths.

If you observe common routers between the forward and the reverse path, do you also observe the same IP addresses? Why or why not?

Below is the list of common routers for the forward-reverse paths of
(I) with corresponding IP addresses

- **bundle-ether4.chw-edge901.sydney.telstra.net [203.50.12.108]**
- **bundle-ether13.chw-core10.sydney.telstra.net [203.50.11.98]**
- **bundle-ether1.oxf-gw11.sydney.telstra.net [203.50.6.93]**
- **bundle-ether2.oxf-gw10.sydney.telstra.net [203.50.6.94]**

Similarly, for (ii) the forward-reverse path common routers were

- **bundle-ether4.chw-edge901.sydney.telstra.net [203.50.12.108]**
- **bundle-ether13.chw-core10.sydney.telstra.net [203.50.11.98]**
- **bundle-ether8.exi-core10.melbourne.telstra.net [203.50.11.125]**
- **gigabitethernet5-0.exi-service1.melbourne.telstra.net [203.50.80.7]**

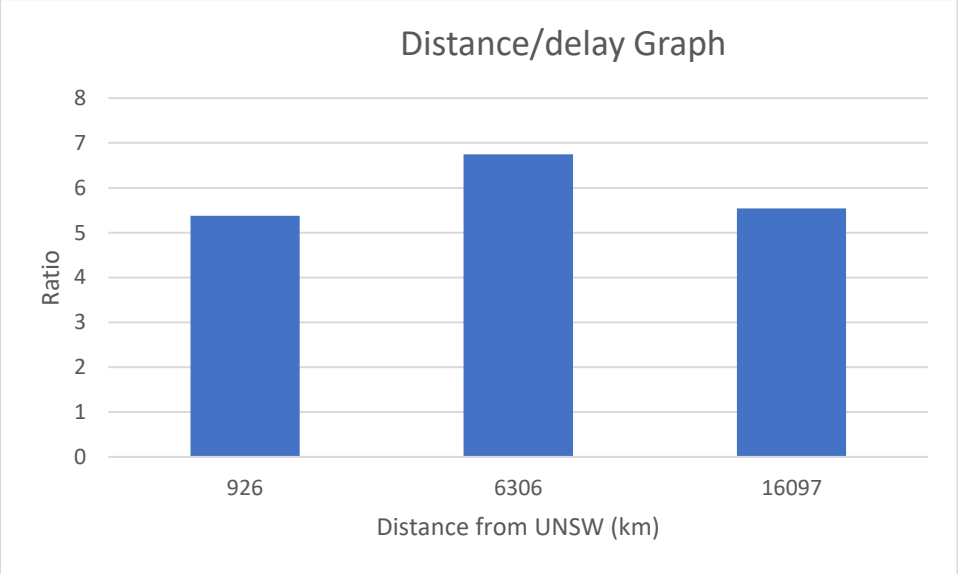
in each case where a similar router was used (different bundle-ether number in some cases) the IP addresses were different and this is due to the routing path always choosing the most optimal path for the packet to destination since there are multiple versions of the server, this is in place to avoid congestion. There is no set path for the packet.

Exercise 4: Use ping to gain insights into network performance

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 ⁸m/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. Adelaide, 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).

(please check appendix to see screenshot of excel data used)

The following below is a graph showing the correlation between distance and delay.



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

Reasons why the y-axis values that were plotted were greater than 2 was that, T is the shortest time possible for a packet to reach the destination from UNSW, since ping sends a packet (this takes T seconds minimum), and UNSW receives a signal back (this takes T seconds minimum) the minimum time possible assuming no delay and packets travel at the speed of light is 2T. however this is only true in a perfect vacuum situation and does not account for delays. There are many sources of delay including the delay in processing the packet for routing (overhead), queueing delay in situations where routers have traffic, transmission delay which is dependant on the speed of the network and in this case, we assume propagation delay which is the time T since we assume the packets travel at the speed of light, however this is not always true. Another reason would be that there could be interference for the transmitted signal and outside sources of disturbances such as noise. 2T assumes perfect conditions with no delay.

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

The delay to destination did not remain constant and varied over time and this is due to the queueing delay of the routers. Each router had it's own traffic so this impacted the delays, between each hop to the destination.

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?

The following delays were dependant on packet size

- transmission delay → (size of packet)/bandwidth rate

the following delays were independent on packet size

- propagation delay → dependant on physical distance and how fast message travels in a medium!
- Processing delay → constant overhead delay for routing/finding path for packet
- queueing delay → congestion dependant on how many packets you have queueing and the traffic intensity of the router. Not dependant on size rather than how many packets

References

Petchirajan, 2018, ping response "Request timed out." vs "Destination Host unreachable", [ONLINE] Available from:

https://stackoverflow.com/questions/22110622/ping-response-request-timed-out-vs-destination-host-unreachable

[Accessed 26 July 2018]

Appendix

Data used in Excel Spreadsheet for graph

City	Distance From UNSW to Server (km)	T	min delay 50b packet	ratio
Adelaide	926	3.086667	16.595	5.37635
Singapore	6306	21.02	141.864	6.749
Berlin	16097	53.65667	297.434	5.54328