COMP3331 Computer Networks and Applications
Lab Exercise 01: Tools of the Trade

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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?
   - IP address is 129.94.242. Multiple address records for a single host lookup is commonly known as round-robin DNS which allows high-availability and load-sharing. (https://serverfault.com/questions/590277/why-does-nslookup-return-two-or-more-ip-address-for-yahoo-com-or-microsoft-com)
2. Find out name of the IP address 127.0.0.1. What is special about this IP address?
   - Localhost. The address is used to establish an IP connection to the same machine or computer being used by the end-user. (http://www.tech-faq.com/127-0-0-1.html)

Exercise 2: Use ping to test host reachability

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

- www.unsw.edu.au : Yes.
- www.getfittest.com.au : No. It's an unknown host. Not reachable from web browser as well.
- www.mit.edu : Yes.
- www.intel.com.au : Yes.
- www.tpg.com.au : Yes.
- www.hola.hp : No. It's an unknown host. Not reachable from web browser as well.
- www.amazon.com : Yes.
- www.tsinghua.edu.cn : Yes.
- www.kremlin.ru : No. 100% packet loss. Didn't answer to the request. But is reachable from web browser.
- 8.8.8.8 : Yes.

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.

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.
   - There are 22 routers (number of hops - 1) between my workstation and www.columbia.edu. The first five routers are part of the UNSW network as we can see from their hostnames. The packets cross the Pacific Ocean between 7th and 8th router (Round trip time significantly increases at this point).

```
wagner % 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)  0.216 ms  0.136 ms  0.142 ms
 2  129.94.39.17 (129.94.39.17)  0.905 ms  0.860 ms  0.868 ms
 3  ombudnex1-vl-3154.gw.unsw.edu.au (149.171.253.35)  1.396 ms  1.755 ms  1.702 ms
 4  libcr1-po-6.gw.unsw.edu.au (149.171.255.201)  1.045 ms libcr1-po-5.gw.unsw.edu.au (149.171.255.165)
 1.155 ms  1.087 ms
 5  unswbr1-te-1-9.gw.unsw.edu.au (149.171.255.101)  1.131 ms  1.134 ms unswbr1-te-2-13.gw.unsw.edu.au (
149.171.255.105)  1.095 ms
 6  138.44.5.0 (138.44.5.0)  1.284 ms  1.379 ms  1.292 ms
 7  et-1-3-0.pe1.sxt.bkvl.nsw.aarnet.net.au (113.197.15.149)  2.110 ms  2.164 ms  2.120 ms
 8  et-0-0-0.pe1.a.hnl.aarnet.net.au (113.197.15.99)  95.192 ms  95.285 ms  95.104 ms
 9  et-2-1-0.bdr1.a.sea.aarnet.net.au (113.197.15.201)  146.594 ms  146.559 ms  146.488 ms
10  abilene-1-lo-jmb-706.sttlwa.pacificwave.net (207.231.240.8)  146.688 ms  146.677 ms  146.621 ms
11  et-4-0-0.4079.rtsw.miss2.net.internet2.edu (162.252.70.0)  157.343 ms  157.343 ms  157.427 ms
12  et-4-0-0.4079.rtsw.minn.net.internet2.edu (162.252.70.58)  180.695 ms  180.533 ms  180.451 ms
13  et-1-1-5.4079.rtsw.eqch.net.internet2.edu (162.252.70.106)  188.725 ms  194.806 ms  194.732 ms
14  ae-0.4079.rtsw3.eqch.net.internet2.edu (162.252.70.163)  188.836 ms  192.273 ms  192.152 ms
15  ae-1.4079.rtsw.clev.net.internet2.edu (162.252.70.130)  197.378 ms  197.188 ms  197.089 ms
16  buf-9208-I2-CLEV.nysernet.net (199.109.11.33)  201.423 ms  201.534 ms  201.357 ms
17  syr-9208-buf-9208.nysernet.net (199.109.7.193)  204.596 ms  205.681 ms  205.400 ms
18  nyc111-9204-syr-9208.nysernet.net (199.109.7.94)  273.082 ms  264.636 ms  213.896 ms
19  nyc-9208-nyc111-9204.nysernet.net (199.109.7.165)  213.923 ms  213.857 ms  214.071 ms
20  columbia.nyc-9208.nysernet.net (199.109.4.14)  213.963 ms  213.922 ms  213.974 ms
21  cc-core-1-x-nyser32-gw-1.net.columbia.edu (128.59.255.5)  214.015 ms  214.158 ms  214.144 ms
22  cc-conc-1-x-cc-core-1.net.columbia.edu (128.59.255.21)  214.219 ms  217.761 ms  214.206 ms
23  p-i-r.org (128.59.105.24)  214.180 ms  214.288 ms  214.273 ms
wagner %
```

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/

   - The paths diverges at 138.44.5.0. (AARNET)
   AARNET is an Internet Service Provider that provides Internet services to the Australian education and research communities and their research partners.
   The number of hops is not proportional to the physical distance. We clearly know that Tokyo is closer from Sydney compared to UK, but it has more number of hops.

(i) www.ucla.edu

```
▶ traceroute -w 10 www.ucla.edu
traceroute to gateway.lb.it.ucla.edu (164.67.228.152), 64 hops max, 52 byte packets
 1  * * *
 2  ufw1-ae-1-3161.gw.unsw.edu.au (149.171.253.92)  2.487 ms  1.534 ms  1.566 ms
 3  libwdr1-vl-3090.gw.unsw.edu.au (149.171.253.66)  1.857 ms  1.865 ms  1.789 ms
 4  ombcr1-te-4-5.gw.unsw.edu.au (149.171.255.77)  1.950 ms  2.178 ms  2.005 ms
 5  unswbr1-te-2-13.gw.unsw.edu.au (149.171.255.105)  2.068 ms  2.195 ms  2.026 ms
 6  138.44.5.0 (138.44.5.0)  2.193 ms  4.481 ms  3.113 ms
 7  et-1-3-0.pe1.sxt.bkvl.nsw.aarnet.net.au (113.197.15.149)  3.354 ms  3.313 ms  3.274 ms
 8  et-0-0-0.pe1.a.hnl.aarnet.net.au (113.197.15.99)  96.234 ms  96.259 ms  151.978 ms
 9  et-2-1-0.bdr1.a.sea.aarnet.net.au (113.197.15.201)  147.837 ms  147.728 ms  147.875 ms
10  cenichpr-1-is-jmb-778.snvaca.pacificwave.net (207.231.245.129)  164.976 ms  164.203 ms
164.834 ms
11  hpr-lax-hpr3--svl-hpr3-100ge.cenic.net (137.164.25.73)  161.150 ms  161.178 ms  161.222
ms
12  * * *
13  bd11f1.anderson--cr00f2.csb1.ucla.net (169.232.4.4)  161.642 ms
    bd11f1.anderson--cr001.anderson.ucla.net (169.232.4.6)  161.979 ms  532.783 ms
14  cr00f2.csb1--dr00f2.csb1.ucla.net (169.232.4.53)  162.425 ms  162.458 ms
    cr00f1.anderson--dr00f2.csb1.ucla.net (169.232.4.55)  162.839 ms
15  * * *
16  * * *
17  * * *
18  * * *
19  * * *
20  * * *
21  * * *
22  * * *
23  * * *
24  * * *
25  * * *
26  * * *
27  * * *
28  * * *
29  * * *
30  * * *
```

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

```
▶ traceroute -w 10 www.u-tokyo.ac.jp
traceroute to www.u-tokyo.ac.jp (210.152.243.234), 64 hops max, 52 byte packets
 1  * * *
 2  ufw1-ae-1-3161.gw.unsw.edu.au (149.171.253.92)  4.973 ms  1.965 ms  1.598 ms
 3  libwdr1-vl-3090.gw.unsw.edu.au (149.171.253.66)  2.206 ms  5.418 ms  2.043 m
s
 4  libcr1-te-4-5.gw.unsw.edu.au (149.171.255.89)  2.182 ms  2.440 ms  2.960 ms
 5  unswbr1-te-1-9.gw.unsw.edu.au (149.171.255.101)  2.689 ms  2.307 ms  2.234 m
s
 6  138.44.5.0 (138.44.5.0)  2.257 ms  2.372 ms  2.577 ms
 7  et-0-3-0.pe1.bkvl.nsw.aarnet.net.au (113.197.15.147)  4.127 ms  3.573 ms  3.
223 ms
 8  ge-4_0_0.bb1.a.pao.aarnet.net.au (202.158.194.177)  175.861 ms  175.919 ms
175.696 ms
 9  paloalto0.iij.net (198.32.176.24)  177.350 ms  177.946 ms  178.463 ms
10  osk004bb01.iij.net (58.138.88.189)  589.973 ms
    osk004bb00.iij.net (58.138.88.185)  409.539 ms  404.158 ms
11  osk004ip57.iij.net (58.138.106.162)  409.560 ms
    osk004ip57.iij.net (58.138.106.166)  290.483 ms
    osk004ip57.iij.net (58.138.106.162)  361.715 ms
12  210.130.135.130 (210.130.135.130)  408.617 ms  340.212 ms  307.055 ms
13  124.83.228.58 (124.83.228.58)  409.603 ms  408.970 ms  409.655 ms
14  124.83.252.178 (124.83.252.178)  409.645 ms  409.122 ms  409.565 ms
15  158.205.134.26 (158.205.134.26)  409.564 ms  409.389 ms  409.879 ms
16  * * *
17  * * *
18  * * *
19  * * *
20  * * *
21  * * *
22  * * *
23  * * *
24  * * *
25  * * *
26  * * *
27  * * *
28  * * *
29  * * *
30  * * *
```

(iii) www.lancaster.ac.uk

```
wagner % 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)  0.258 ms  0.230 ms  0.191 ms
 2  129.94.39.17 (129.94.39.17)  0.916 ms  0.893 ms  0.888 ms
 3  libudnex1-vl-3154.gw.unsw.edu.au (149.171.253.34)  1.652 ms  1.627 ms ombudnex1-vl-3154.gw.unsw.edu.
au (149.171.253.35)  1.329 ms
 4  ombcr1-po-5.gw.unsw.edu.au (149.171.255.197)  1.151 ms  1.114 ms  1.093 ms
 5  unswbr1-te-2-13.gw.unsw.edu.au (149.171.255.105)  1.136 ms  1.120 ms  1.151 ms
 6  138.44.5.0 (138.44.5.0)  1.254 ms  1.456 ms  1.429 ms
 7  et-2-0-5.bdr1.sing.sin.aarnet.net.au (113.197.15.233)  92.602 ms  92.634 ms  92.651 ms
 8  138.44.226.7 (138.44.226.7)  257.106 ms  257.064 ms  256.971 ms
 9  janet-gw.mx1.lon.uk.geant.net (62.40.124.198)  256.309 ms  256.370 ms  256.331 ms
10  ae29.londpg-sbr2.ja.net (146.97.33.2)  258.661 ms  258.565 ms  258.562 ms
11  ae31.erdiss-sbr2.ja.net (146.97.33.22)  260.503 ms  260.487 ms  260.437 ms
12  ae29.manckh-sbr2.ja.net (146.97.33.42)  263.548 ms  262.582 ms  262.350 ms
13  ae24.lanclu-rbr1.ja.net (146.97.38.58)  264.705 ms  264.787 ms  264.660 ms
14  lancaster-university.ja.net (194.81.46.2)  280.727 ms  279.538 ms  279.471 ms
15  is-border01.bfw01.rtr.lancs.ac.uk (148.88.253.202)  265.158 ms  265.161 ms  265.151 ms
16  bfw01.iss-servers.is-core01.rtr.lancs.ac.uk (148.88.250.98)  273.430 ms  271.884 ms  271.917 ms
17  * * *
18  www.lancs.ac.uk (148.88.65.80)  265.260 ms !X  265.183 ms !X  265.306 ms !X
```

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?

(i) Traceroute from speedtest.com towards my machine / from my machine towards speedtest.com

```
traceroute to 129.94.8.255 (129.94.8.255), 30 hops max, 60 byte packets
 1  ge2-8.r01.sin01.ne.com.sg (202.150.221.169)  0.197 ms  0.221 ms  0.238 ms
 2  10.15.62.210 (10.15.62.210)  0.250 ms  0.260 ms  0.268 ms
 3  aarnet.sgix.sg (103.16.102.67)  211.712 ms  211.664 ms  211.681 ms
 4  et-7-3-0.pe1.nsw.brwy.aarnet.net.au (113.197.15.232)  209.452 ms  209.432 ms  209.455 ms
 5  138.44.5.1 (138.44.5.1)  204.775 ms  204.716 ms  204.667 ms
 6  ombcr1-te-1-5.gw.unsw.edu.au (149.171.255.106)  209.239 ms  209.184 ms  209.218 ms
 7  libwdr1-te-1-2.gw.unsw.edu.au (149.171.255.78)  202.201 ms  202.271 ms  202.280 ms
 8  cfwl-ae-1-3090.gw.unsw.edu.au (149.171.253.68)  202.807 ms  202.837 ms  202.794 ms
 9  * * *
10  * * *
11  * * *
12  * * *
13  * * *
14  * * *
15  * * *
16  * * *
17  * * *
18  * * *
19  * * *
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25  * * *
26  * * *
27  * * *
28  * * *
29  * * *
30  * * *

Traceroute Completed.
```

```
~/Desktop
▶ traceroute -m 30 -w 10 www.speedtest.com
traceroute to www.speedtest.com (209.15.13.134), 30 hops max, 52 byte packets
 1  * * *
 2  ufw1-ae-1-3161.gw.unsw.edu.au (149.171.253.92)  2.509 ms  1.706 ms  1.662 ms
 3  libwdr1-vl-3090.gw.unsw.edu.au (149.171.253.66)  1.825 ms  1.933 ms  2.056 m
s
 4  ombcr1-te-4-5.gw.unsw.edu.au (149.171.255.77)  2.051 ms  2.098 ms  1.910 ms
 5  unswbr1-te-2-13.gw.unsw.edu.au (149.171.255.105)  2.056 ms  1.943 ms  1.964
ms
 6  138.44.5.0 (138.44.5.0)  4.871 ms  2.281 ms  2.173 ms
 7  et-0-3-0.pe1.bkvl.nsw.aarnet.net.au (113.197.15.147)  2.855 ms  2.902 ms  2.
827 ms
 8  xe-0-2-5.bdr1.b.sea.aarnet.net.au (202.158.194.121)  144.973 ms  144.735 ms
 144.933 ms
 9  xe-0-0-23-2.a01.sttlwa01.us.bb.gin.ntt.net (198.104.202.61)  145.298 ms  145
.312 ms  144.986 ms
10  ae-2.r04.sttlwa01.us.bb.gin.ntt.net (129.250.5.85)  145.216 ms  145.317 ms
145.299 ms
11  sea-b2-link.telia.net (213.248.70.12)  148.367 ms  144.893 ms  153.706 ms
12  chi-b21-link.telia.net (62.115.117.49)  246.939 ms  215.141 ms  296.778 ms
13  toro-b1-link.telia.net (62.115.118.231)  306.878 ms  306.992 ms  307.161 ms
14  peer1-ic-309065-toro-b1.c.telia.net (213.248.103.86)  307.151 ms  307.039 ms
  307.266 ms
15  * * *
16  * * *
17  * * *
18  * * *
19  * * *
20  * * *
21  * * *
22  * * *
23  * * *
24  * * *
25  * * *
26  * * *
27  * * *
28  * * *
29  * * *
30  * * *
```

(ii) Traceroute from testltra.net towards my machine / from my machine towards telstra.net

```
 1  gigabitethernet3-3.exi2.melbourne.telstra.net (203.50.77.53)  0.377 ms  0.204 ms  0.241 ms
 2  bundle-ether3-100.win-core10.melbourne.telstra.net (203.50.80.129)  1.235 ms  1.603 ms  1.991 ms
 3  bundle-ether12.ken-core10.sydney.telstra.net (203.50.11.122)  13.481 ms  14.093 ms  12.734 ms
 4  bundle-ether1.ken-edge901.sydney.telstra.net (203.50.11.95)  11.986 ms  12.098 ms  12.112 ms
 5  aarnet6.lnk.telstra.net (139.130.0.78)  11.734 ms  11.599 ms  11.608 ms
 6  xe-5-2-2.pe1.brwy.nsw.aarnet.net.au (113.197.15.32)  11.861 ms  12.346 ms  11.861 ms
 7  138.44.5.1 (138.44.5.1)  11.987 ms  11.973 ms  11.986 ms
 8  ombcr1-te-1-5.gw.unsw.edu.au (149.171.255.106)  12.110 ms  11.972 ms  12.359 ms
 9  libwdr1-te-1-2.gw.unsw.edu.au (149.171.255.78)  12.111 ms  12.099 ms  11.984 ms
10  cfw1-ae-1-3090.gw.unsw.edu.au (149.171.253.68)  12.610 ms  12.597 ms  12.611 ms
```

```
▶ traceroute www.telstra.net
traceroute to www.telstra.net (203.50.5.178), 64 hops max, 52 byte packets
 1  * * *
 2  ufw1-ae-1-3161.gw.unsw.edu.au (149.171.253.92)  2.198 ms  1.859 ms  1.546 ms
 3  libwdr1-vl-3090.gw.unsw.edu.au (149.171.253.66)  1.849 ms  1.777 ms  1.800 ms
 4  libcr1-te-4-5.gw.unsw.edu.au (149.171.255.89)  1.832 ms  2.064 ms  1.882 ms
 5  unswbr1-te-1-9.gw.unsw.edu.au (149.171.255.101)  2.325 ms  2.321 ms  2.331 ms
 6  138.44.5.0 (138.44.5.0)  2.171 ms  2.331 ms  2.124 ms
 7  xe-0-0-0.bdr1.rsby.nsw.aarnet.net.au (113.197.15.33)  2.457 ms  2.586 ms  64.895 ms
 8  gigabitethernet3-11.ken37.sydney.telstra.net (139.130.0.77)  4.237 ms  2.931 ms  2.997 ms
 9  bundle-ether2.chw-edge901.sydney.telstra.net (203.50.11.103)  3.502 ms
    bundle-ether13.ken-core10.sydney.telstra.net (203.50.11.94)  4.816 ms
    bundle-ether2.chw-edge901.sydney.telstra.net (203.50.11.103)  3.613 ms
10  bundle-ether10.win-core10.melbourne.telstra.net (203.50.11.123)  15.452 ms
    bundle-ether13.chw-core10.sydney.telstra.net (203.50.11.98)  5.385 ms  3.934 ms
11  bundle-ether8.exi-core10.melbourne.telstra.net (203.50.11.125)  15.270 ms  16.292 ms  14.261 ms
12  bundle-ether2.exi-ncprouter101.melbourne.telstra.net (203.50.11.209)  14.250 ms  14.621 ms  14.237 ms
13  www.telstra.net (203.50.5.178)  13.819 ms  13.836 ms  14.156 ms
```

Other traceroute servers form www.traceroute.org
Server 1: HiNet (AS3462), ip address: 203.69.42.196
Server 2: EBIX (AS17709), ip address: 211.76.96.235

- No, they did not go through the same route and the ip were different as well. From my hypothesis, this is because each package is choosing their best route when they get to the router, which is one of the advantage of packet switching.

(iii) Traceroute from HiNet towards my machine / from my machine towards HiNet

Traceroute Result (129.94.8.255) :

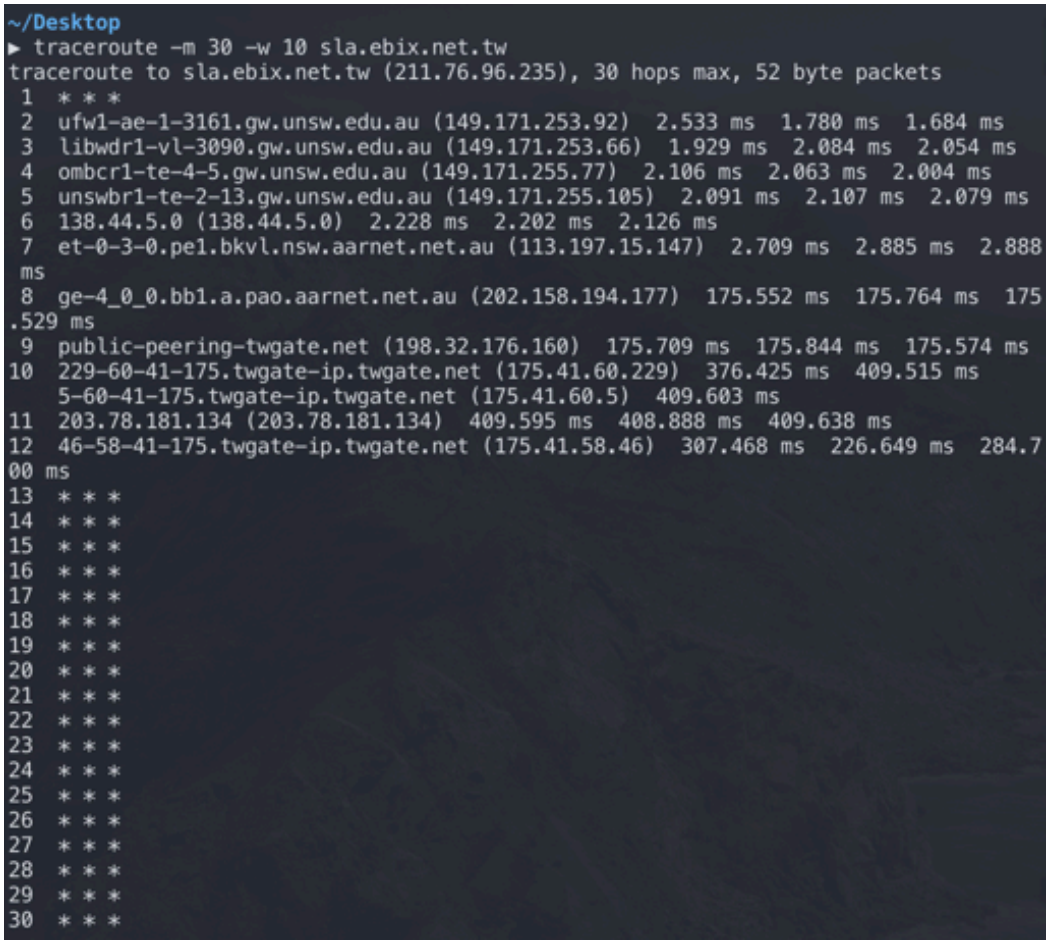
```
Type escape sequence to abort.
Tracing the route to uniwide-pat-pool-129-94-8-255.gw.unsw.edu.au (129.94.8.255)

  1 TPDB-3516.hinet.net (210.65.161.22) 4 msec 0 msec 0 msec
  2 TPDT-3012.hinet.net (220.128.2.146) 8 msec 4 msec 0 msec
  3 tpdt-3022.hinet.net (220.128.27.6) 0 msec 0 msec 0 msec
  4 r4103-s2.tp.hinet.net (220.128.2.109) 4 msec 4 msec 0 msec
  5 r4003-s2.tp.hinet.net (220.128.3.249) 0 msec 0 msec
    r4003-s2.tp.hinet.net (220.128.3.145) 4 msec
  6 ntt-hk-gw.hinet.net (211.72.233.93) 24 msec
    211-72-233-73.HINET-IP.hinet.net (211.72.233.73) 24 msec
    ntt-hk-gw.hinet.net (211.72.233.93) 24 msec
  7 ae-10.r24.tkokhk01.hk.bb.gin.ntt.net (129.250.6.93) 28 msec 24 msec 24 msec
  8 ae-6.r20.sngpsi07.sg.bb.gin.ntt.net (129.250.7.66) 60 msec 64 msec 60 msec
  9 ae-1.r01.sngpsi07.sg.bb.gin.ntt.net (129.250.3.100) 60 msec 60 msec
    ae-1.r00.sngpsi07.sg.bb.gin.ntt.net (129.250.3.82) 64 msec
 10 ae-1.a01.sngpsi03.sg.bb.gin.ntt.net (129.250.7.83) 68 msec
    ae-2.a01.sngpsi03.sg.bb.gin.ntt.net (129.250.7.85) 64 msec 72 msec
 11 xe-0-0-6-2.a01.sngpsi03.sg.ce.gin.ntt.net (116.51.27.146) 220 msec 220 msec 220 msec
 12 et-7-3-0.pe1.nsw.brwy.aarnet.net.au (113.197.15.232) 228 msec 228 msec 228 msec
 13 138.44.5.1 228 msec 228 msec 228 msec
 14 ombcr1-te-1-5.gw.unsw.edu.au (149.171.255.106) 228 msec 228 msec 228 msec
 15 ombwdr1-te-1-2.gw.unsw.edu.au (149.171.255.82) 228 msec 228 msec 228 msec
 16 cfw1-ae-1-3090.gw.unsw.edu.au (149.171.253.68) 224 msec 220 msec 220 msec
 17  *  *  *
 18  *  *  *
 19  *  *  *
 20  *  *  *
 21  *  *  *
 22  *  *  *
 23  *  *  *
 24  *  *  *
 25  *  *  *
 26  *  *  *
 27  *  *  *
 28  *  *  *
 29  *  *  *
 30  *  *  *
```

```
▶ traceroute -m 30 -w 10 traceroute.hinet.net
traceroute to traceroute.hinet.net (203.69.42.196), 30 hops max, 52 byte packets
 1  * * *
 2  ufw1-ae-1-3161.gw.unsw.edu.au (149.171.253.92)  5.103 ms  1.684 ms  1.513 ms
 3  libwdr1-vl-3090.gw.unsw.edu.au (149.171.253.66)  2.073 ms  1.997 ms  2.176 ms
 4  ombcr1-te-4-5.gw.unsw.edu.au (149.171.255.77)  2.493 ms  2.809 ms  2.592 ms
 5  unswbr1-te-2-13.gw.unsw.edu.au (149.171.255.105)  2.070 ms  2.102 ms  2.291 ms
 6  138.44.5.0 (138.44.5.0)  2.170 ms  2.119 ms  2.285 ms
 7  et-0-3-0.pe1.bkvl.nsw.aarnet.net.au (113.197.15.147)  2.817 ms  5.148 ms  3.707 ms
 8  ge-4_0_0.bb1.a.pao.aarnet.net.au (202.158.194.177)  175.859 ms  175.672 ms  175.618 ms
 9  pa-r11.hinet.net (198.32.176.195)  176.023 ms  175.901 ms  176.136 ms
10  r11-la.us.hinet.net (202.39.84.30)  176.366 ms  175.922 ms  176.151 ms
11  r4002-s2.tp.hinet.net (211.72.108.238)  364.369 ms  409.174 ms  409.483 ms
12  r4102-s2.tp.hinet.net (220.128.6.82)  322.869 ms
    r4102-s2.tp.hinet.net (220.128.6.86)  409.429 ms  313.398 ms
13  tpdb-3021.hinet.net (220.128.13.94)  300.871 ms
    tpdt-3022.hinet.net (220.128.7.70)  306.935 ms
    tpdb-3021.hinet.net (220.128.13.94)  279.497 ms
14  chch-3032.hinet.net (220.128.19.181)  306.388 ms
    tchn-3021.hinet.net (220.128.16.61)  306.948 ms
    chch-3032.hinet.net (220.128.19.181)  236.898 ms
15  tchn-3011.hinet.net (220.128.16.73)  273.603 ms
    chch-3031.hinet.net (220.128.19.82)  306.821 ms  262.001 ms
16  tcwh-3301.hinet.net (220.128.16.113)  239.682 ms  233.929 ms
    tcwh-3301.hinet.net (220.128.18.109)  241.144 ms
17  203-75-72-249.hinet-ip.hinet.net (203.75.72.249)  292.413 ms  240.643 ms  271.152 ms
18  * * *
19  * * *
20  * * *
21  * * *
22  * * *
23  * * *
24  * * *
25  * * *
26  * * *
27  * * *
28  * * *
29  * * *
30  * * *
```

(iv) Traceroute from EBIX towards my machine / from my machine towards EBIX

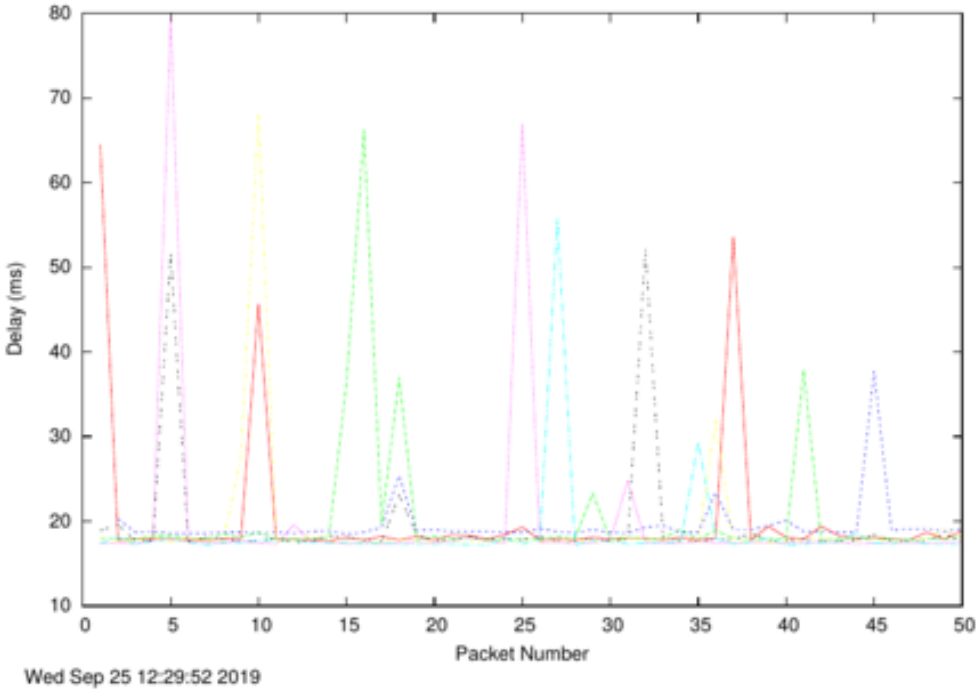
```
 1 211.76.96.254  0.329 ms  0.296 ms  0.305 ms
 2 211.76.96.166  0.432 ms  0.393 ms  0.398 ms
 3 210.176.136.13  1.527 ms  1.332 ms  1.265 ms
 4 202.84.225.146  4.382 ms  3.986 ms  3.988 ms
 5 202.84.138.73  16.221 ms  17.195 ms  16.968 ms
 6 202.84.141.109  44.745 ms  45.002 ms  45.263 ms
 7 202.84.219.173  44.210 ms  44.619 ms  44.566 ms
 8 202.147.33.174  210.755 ms  210.707 ms  210.685 ms
 9 113.197.15.232  208.637 ms  208.602 ms  208.592 ms
10 138.44.5.1  210.565 ms  210.567 ms  210.599 ms
11 149.171.255.102  220.030 ms  210.713 ms  210.744 ms
12 149.171.255.90  221.475 ms  221.451 ms  221.433 ms
13 149.171.253.68  221.838 ms  221.793 ms  221.947 ms
14 * * *
15 * * *
16 * * *
17 * * *
18 * * *
19 * * *
20 * * *
21 * * *
22 * * *
23 * * *
24 * * *
25 * * *
```



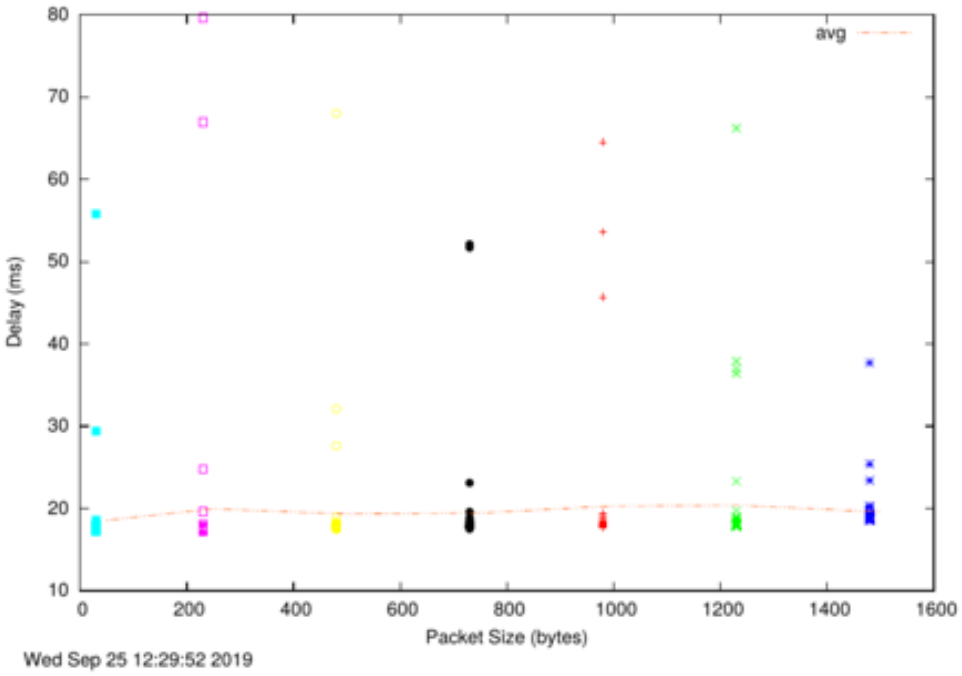
Exercise 4: Use ping to gain insights into network performance

A. www.uq.edu.au

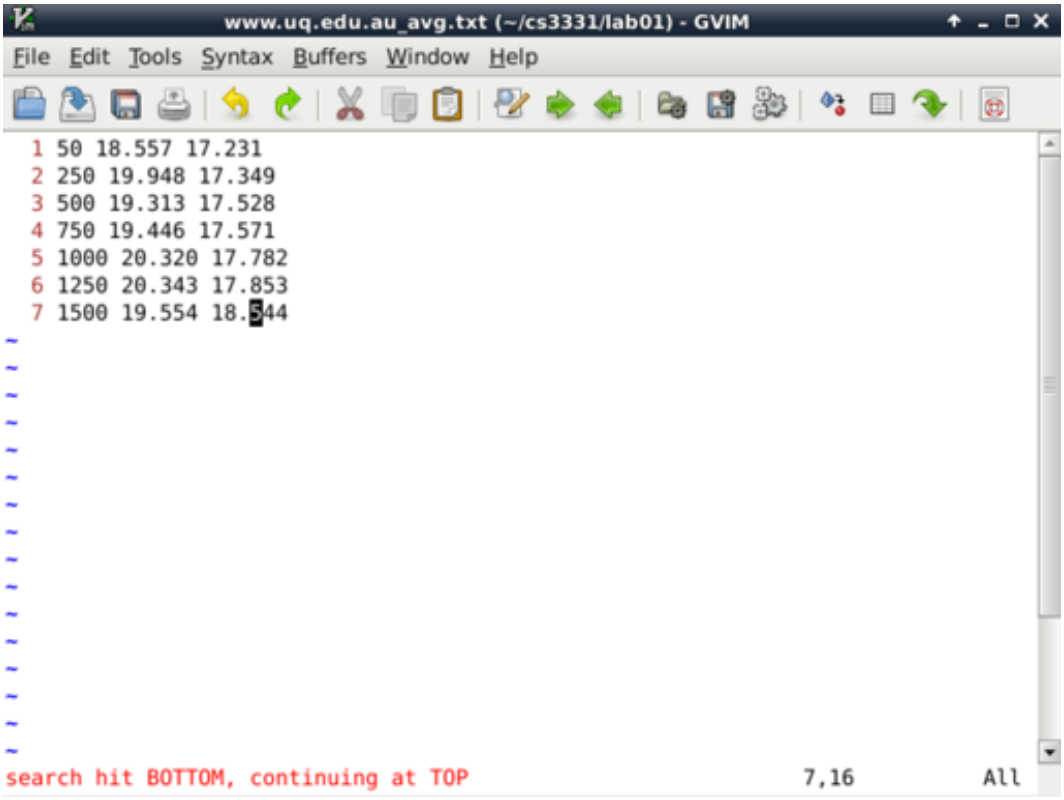
(i) destination_delay



(ii) destination_scatter

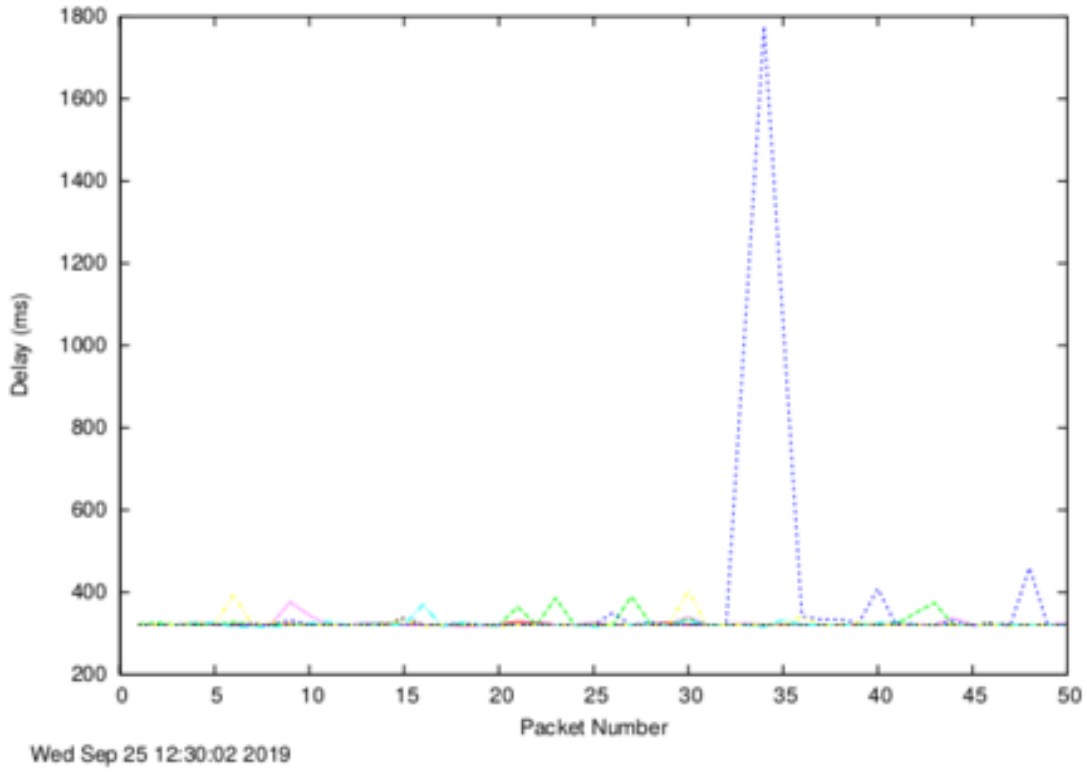


(iii) destination_average

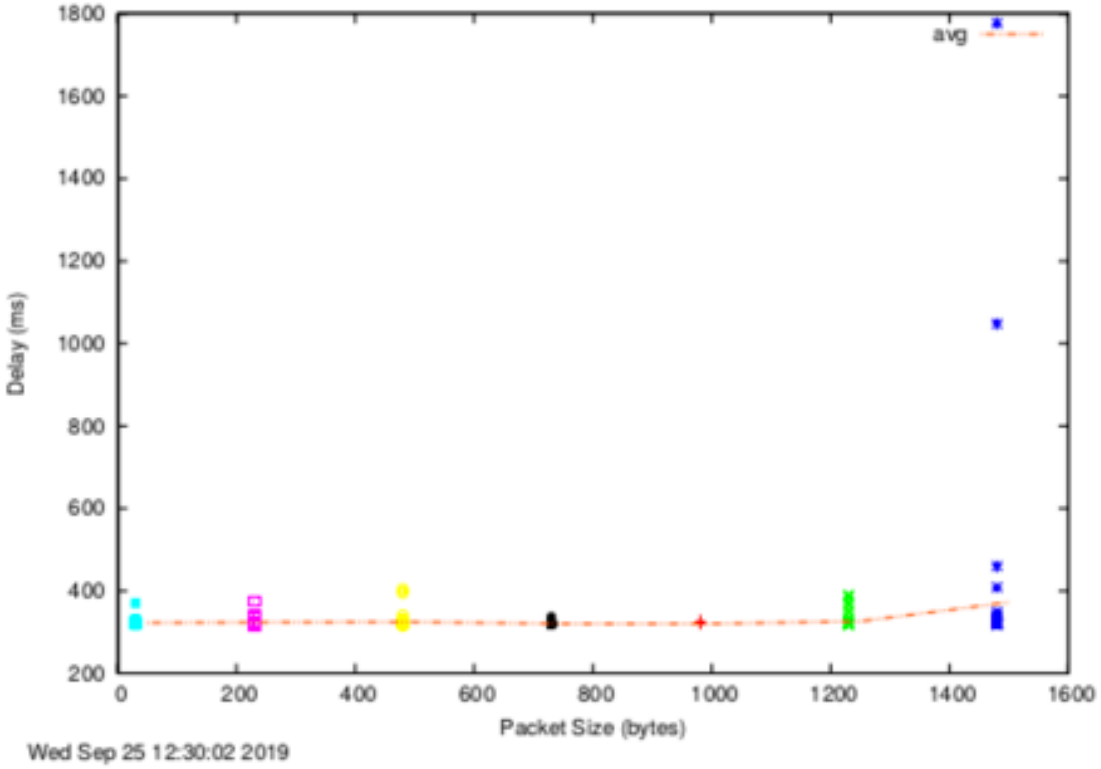


B.www.dlsu.edu.ph

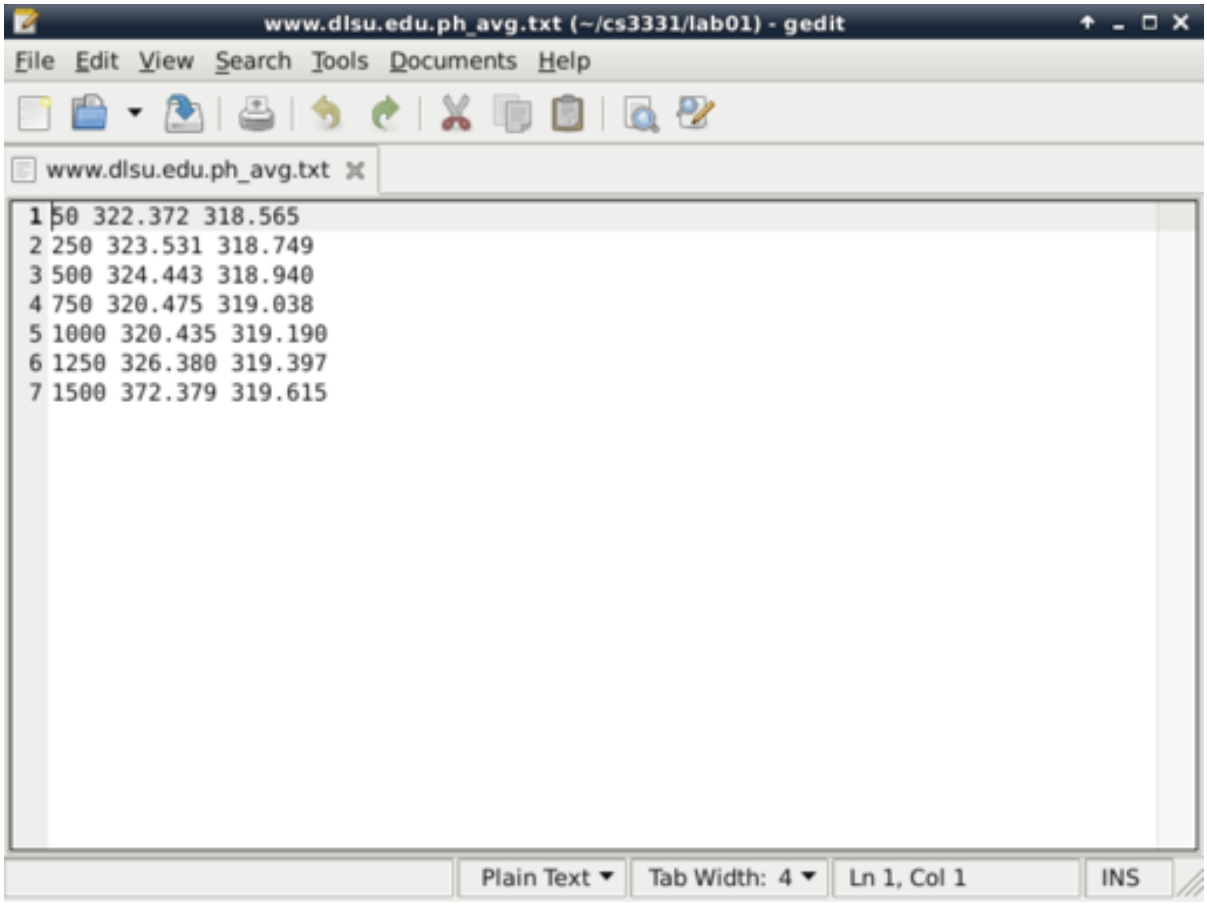
(i) destination_delay



(ii) destination_scatter

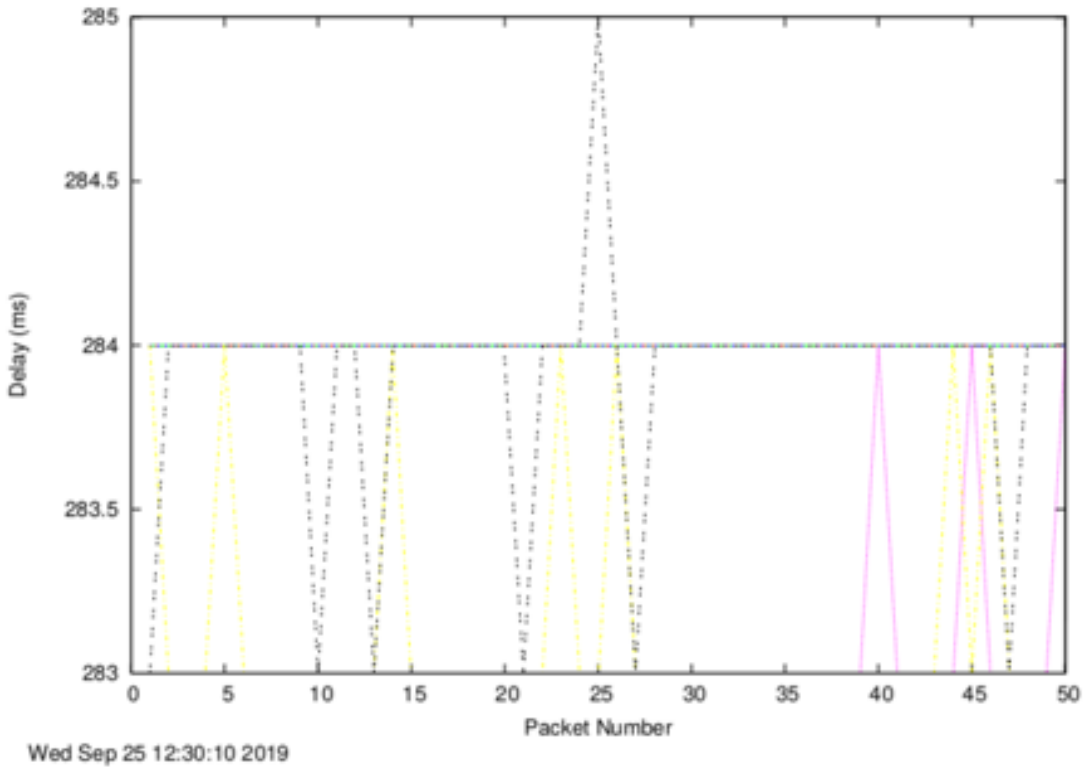


(iii) destination_average

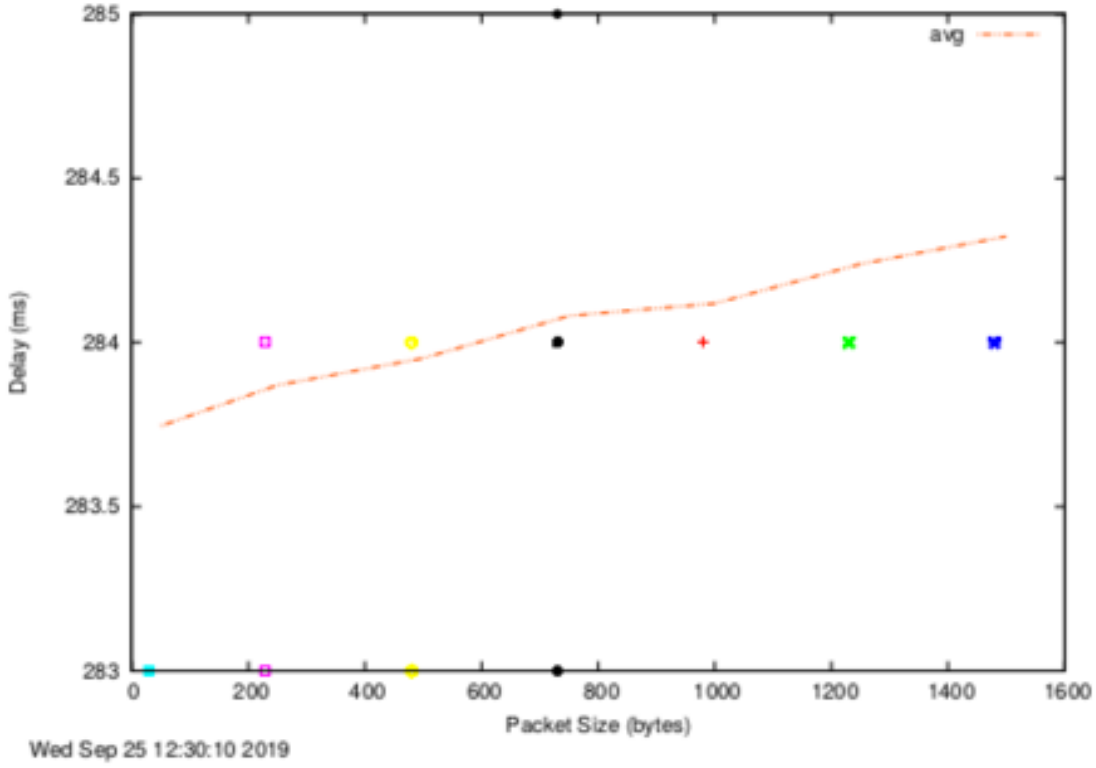


C. www.tu-berlin.de

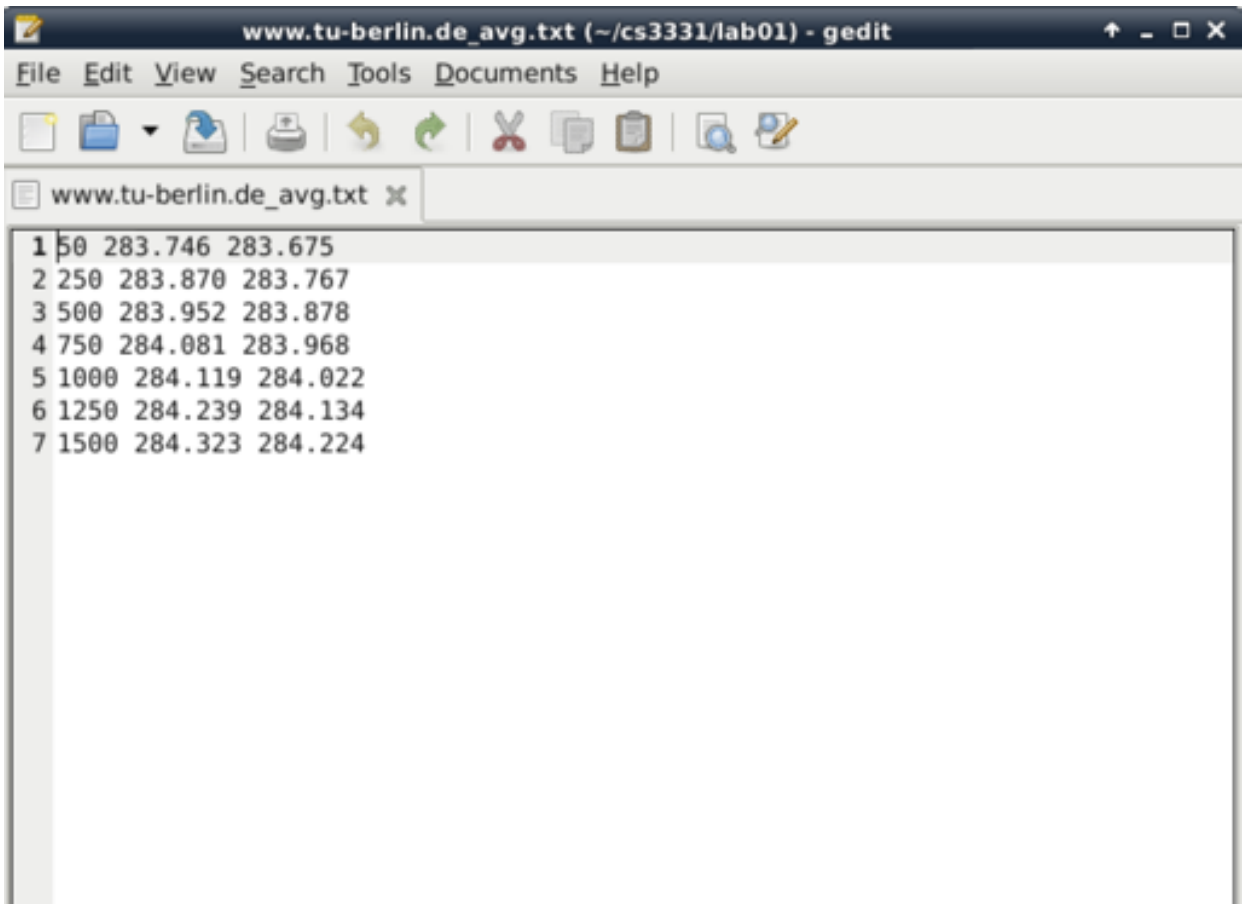
(i) destination_delay



(ii) destination_scatter



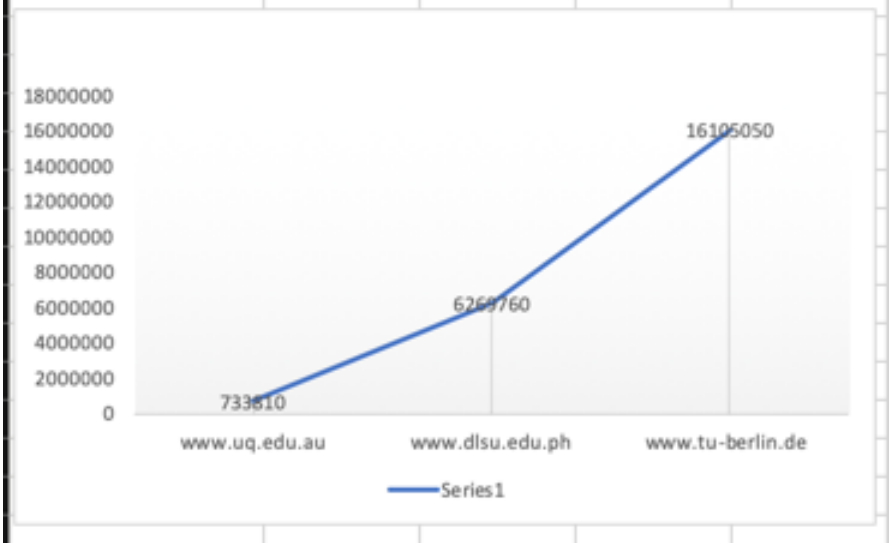
(iii) destination_average



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?**
   - The physical wire cannot be placed exactly same as the shortest path.
   - The actual speed cannot be as fast as the speed of light.
   - The total delay includes propagation delay, transmission delay, processing delay and queuing delay. However, we are only considering propagation in this case where the rest of the delays cannot be always zero.

	Physical Distance	Shortest Possible Time
www.uq.edu.au	733810m	0.00244603333
www.dlsu.edu.ph	6269760m	0.0208992
www.tu-berlin.de	16105050m	0.0536835

	distnace	ratio
www.uq.edu.au	733810	7044.4665
www.dlsu.edu.ph	6269760	15242.9279
www.tu-berlin.de	16105050	5284.212



2. Is the delay to the destinations constant or does it vary over time? Explain why.
- It will vary over time because the queueing delay will vary for every package.

3. Explore where the website for www.epfl.ch is hosted. Is it in Switzerland?
- Yes. We can know this by running whois command.

```
▶ whois  www.epfl.ch
% IANA WHOIS server
% for more information on IANA, visit http://www.iana.org
% This query returned 1 object

refer:        whois.nic.ch

domain:       CH

organisation: SWITCH The Swiss Education & Research Network
address:      Werdstrasse 2
address:      Zurich  CH-8021
address:      Switzerland

contact:      administrative
name:         SWITCH TLD Administration
organisation: SWITCH The Swiss Education & Research Network
address:      Werdstrasse 2
address:      Zurich  CH-8021
address:      Switzerland
phone:        +41 44 268 15 40
fax-no:       +41 44 268 15 78
e-mail:       tld-admin@switch.ch

contact:      technical
name:         DNS Operations
organisation: SWITCH The Swiss Education & Research Network
address:      Werdstrasse 2
address:      Zurich  CH-8021
address:      Switzerland
phone:        +41 44 268 15 40
fax-no:       +41 44 268 15 78
e-mail:       dns-operation@switch.ch
```

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?

- Depends on packet size: transmission delay
- Does not depend on packet size: propagation delay, processing delay, queueing delay

Queueing delay depends on the queue, how many packets are there in the system.
Transmission delay depends on the size of the packet, how long the packet is. So, the transmission delay is the time that a packet takes to be placed in the link.
Propagation delay which is the time that a packet takes to move in the link, which depends on the speed of light
Processing delay is like the time it takes to read the packet. The packet is arrived at destination and is waiting for processing, that's the processing delay.