COMP9331 LAB 01

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Exercise 1: nslookup

1. Which is the IP address of the website www.koala.com.au? In your opinion, what is the reason of having several IP addresses as an output?

   ```
   wagner % nslookup www.koala.com.au
   Server:    129.94.242.2
   Address:   129.94.242.2#53

   Non-authoritative answer:
   Name: www.koala.com.au
   Address: 104.18.61.21
   Name: www.koala.com.au
   Address: 172.67.219.46
   Name: www.koala.com.au
   Address: 104.18.60.21
   ```

   - According to `nslookup` command, the IP address of website www.koala.com.au are "104.18.61.21", "172.67.219.46" and "104.18.60.21"
   - In order to achive load balancing, company provides several accessible IP addresses and each address corresponds to a web server. Client can connects any one of them. DNS will pick an IP address that is geographically closest to the client which can improve access speed.

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

   ```
   wagner % nslookup 127.0.0.1
   Server:    129.94.242.2
   Address:   129.94.242.2#53

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

   - The name is "localhost"
   - 127.0.0.1 is Loopback Address. The local loopback mechanism may be used to run a network service on a host without requiring a physical network interface, or without making the service accessible from the networks the computer may be connected to. (From wikipedia)

Exercise 2: Use ping to test host reachability

- **Reachable web:** `www.unsw.edu.au`, www.mit.edu, www.intel.com.au, www.tpg.com.au, www.amazon.com, www.tsinghua.edu.cn, 8.8.8.8

  Unreachable web: www.getfittest.com.au, www.hola.hp, www.kremlin.ru and www.hola.hp does not exist. We cannot open them.

- We can open www.kremlin.ru, but there is no ping. Perhaps for some security reasons, some web cannot access from replying to ICMP request packets by `ping` command.

Exercise 3: Use traceroute to understand network topology

1. Run `traceroute` on machine to www.columbia.edu

```
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)  0.132 ms  0.136 ms  0.114 ms
 2  129.94.39.17 (129.94.39.17)  0.863 ms  0.850 ms  0.824 ms
 3  ombudnex1-vl-3154.gw.unsw.edu.au (149.171.253.35)  1.369 ms libudnex1-vl-3154.gw.unsw.edu.au (149.171.253.34)  1.584 ms  1.426 ms
 4  ombcr1-po-5.gw.unsw.edu.au (149.171.255.197)  1.013 ms libcr1-po-5.gw.unsw.edu.au (149.171.255.165)  1.124 ms ombcr1-po-5.gw.unsw.edu.au (149.171.255.197)  1.079 ms
 5  unswbr1-te-2-13.gw.unsw.edu.au (149.171.255.105)  1.325 ms unswbr1-te-1-9.gw.unsw.edu.au (149.171.255.101)  1.200 ms  1.177 ms
 6  138.44.5.0 (138.44.5.0)  1.301 ms  1.277 ms  1.287 ms
 7  et-1-3-0.pe1.sxt.bkvl.nsw.aarnet.net.au (113.197.15.149)  1.988 ms  1.887 ms  1.933 ms
 8  et-0-0-0.pe1.a.hnl.aarnet.net.au (113.197.15.99)  95.326 ms  95.451 ms  95.372 ms
 9  et-2-1-0.bdr1.a.sea.aarnet.net.au (113.197.15.201)  146.901 ms  146.802 ms  146.861 ms
10  abilene-1-lo-jmb-706.sttlwa.pacificwave.net (207.231.240.8)  159.765 ms  159.737 ms  159.789 ms
11  ae-1.4079.rtsw.minn.net.internet2.edu (162.252.70.173)  192.480 ms  192.558 ms  192.480 ms
12  ae-1.4079.rtsw.eqch.net.internet2.edu (162.252.70.106)  200.494 ms  200.192 ms  200.020 ms
13  ae-0.4079.rtsw3.eqch.net.internet2.edu (162.252.70.163)  200.347 ms  201.833 ms  201.829 ms
14  ae-1.4079.rtsw.clev.net.internet2.edu (162.252.70.130)  206.163 ms  206.216 ms  206.199 ms
15  buf-9208-I2-CLEV.nysernet.net (199.109.11.33)  209.520 ms  209.596 ms  209.557 ms
16  syr-9208-buf-9208.nysernet.net (199.109.7.193)  213.572 ms  213.726 ms  213.503 ms
17  nyc111-9204-syr-9208.nysernet.net (199.109.7.94)  222.161 ms  222.241 ms  221.971 ms
18  nyc-9208-nyc111-9204.nysernet.net (199.109.7.165)  222.076 ms  222.185 ms  222.282 ms
19  columbia.nyc-9208.nysernet.net (199.109.4.14)  222.730 ms  222.676 ms  224.342 ms
20  cc-core-1-x-nyser32-gw-1.net.columbia.edu (128.59.255.5)  223.762 ms  222.271 ms  222.221 ms
21  cc-conc-1-x-cc-core-1.net.columbia.edu (128.59.255.21)  223.109 ms  223.092 ms  223.180 ms
22  neurotheory.columbia.edu (128.59.105.24)  222.215 ms  222.258 ms  222.161 ms
wagner %
```

- According to `traceroute` command, there are 22 hops.

  Therefore, there are 21 routers between my workstation and www.columbia.edu.

- There are 5 routers are part of the UNSW network.

- From the graph:

  ```
  7  et-1-3-0.pe1.sxt.bkvl.nsw.aarnet.net.au (113.197.15.149)
  1.988 ms  1.887 ms  1.933 ms
  8  et-0-0-0.pe1.a.hnl.aarnet.net.au (113.197.15.99)  95.326 ms
  95.451 ms  95.372 ms
  9  et-2-1-0.bdr1.a.sea.aarnet.net.au (113.197.15.201)  146.901
  ms  146.802 ms  146.861 ms
  ```

  The 7, 8 and 9 hops have huge trip time. Therefore, we can infer that (7-8 and 8-9 between 113.197.15.149 and 113.197.15.201) there are two routers cross the Pacific Ocean.

2. Run `traceroute` from machine to the following destinations

   (i) www.ucla.edu

```
wagner % 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)  0.119 ms  0.101 ms  0.094 ms
 2  129.94.39.17 (129.94.39.17)  0.820 ms  1.001 ms  0.811 ms
 3  ombudnex1-vl-3154.gw.unsw.edu.au (149.171.253.35)  1.544 ms  1.539 ms libudnex1-vl-3154.gw.unsw.edu.au (149.171.253.34)  9.471 ms
 4  ombcr1-po-5.gw.unsw.edu.au (149.171.255.197)  1.103 ms  1.090 ms libcr1-po-5.gw.unsw.edu.au (149.171.255.165)  1.088 ms
 5  unswbr1-te-2-13.gw.unsw.edu.au (149.171.255.105)  1.161 ms  1.189 ms unswbr1-te-1-9.gw.unsw.edu.au (149.171.255.101)  1.178 ms
 6  138.44.5.0 (138.44.5.0)  1.482 ms  1.383 ms  1.374 ms
 7  et-1-3-0.pe1.sxt.bkvl.nsw.aarnet.net.au (113.197.15.149)  2.001 ms  1.912 ms  1.811 ms
 8  et-0-0-0.pe1.a.hnl.aarnet.net.au (113.197.15.99)  95.326 ms  95.247 ms  95.336 ms
 9  et-2-1-0.bdr1.a.sea.aarnet.net.au (113.197.15.201)  146.829 ms  146.768 ms  146.795 ms
10  cenichpr-1-is-jmb-778.snvaca.pacificwave.net (207.231.245.129)  164.160 ms  163.269 ms  164.025 ms
11  svl-agg10-hpr--svl-hpr3--100ge.cenic.net (137.164.25.106)  164.631 ms  164.255 ms  164.199 ms
12  hpr-lax-agg10--svl-agg10-100ge.cenic.net (137.164.25.73)  160.445 ms  160.428 ms  159.678 ms
13  * * *
14  bd11f1.anderson--cr00f2.csb1.ucla.net (169.232.4.4)  162.526 ms  161.132 ms  161.124 ms
15  cr00f2.csb1--rtr11f4.mathsci.ucla.net (169.232.8.181)  160.297 ms  161.113 ms  161.002 ms
16  * * *
17  * * *
18  * * *
19  * * *
20  * * *
21  * * *
22  * * *
23  * * *
24  * * *
25  * * *
26  * * *
27  * * *
28  * * *
29  * * *
30  * * *
```

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

```
wagner % 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  0.097 ms  0.105 ms
 2  129.94.39.17 (129.94.39.17)  0.835 ms  0.865 ms  0.886 ms
 3  libudnex1-vl-3154.gw.unsw.edu.au (149.171.253.34)  1.314 ms ombudnex1-vl-3154.gw.unsw.edu.au (149.171.253.35)  1.828 ms  1.790 ms
 4  ombcr1-po-5.gw.unsw.edu.au (149.171.255.197)  1.105 ms libcr1-po-6.gw.unsw.edu.au (149.171.255.201)  1.052 ms ombcr1-po-6.gw.unsw.edu.au (149.171.255.169)  1.090 ms
 5  unswbr1-te-1-9.gw.unsw.edu.au (149.171.255.101)  1.124 ms unswbr1-te-2-13.gw.unsw.edu.au (149.171.255.105)  1.197 ms  1.121 ms
 6  138.44.5.0 (138.44.5.0)  1.292 ms  1.368 ms  1.344 ms
 7  et-0-3-0.pe1.bkvl.nsw.aarnet.net.au (113.197.15.147)  3.776 ms  3.254 ms  3.292 ms
 8  ge-4_0_0.bb1.a.pao.aarnet.net.au (202.158.194.177)  157.500 ms  157.504 ms  157.383 ms
 9  paloalto0.iij.net (198.32.176.24)  156.641 ms  156.682 ms  156.784 ms
10  osk004bb00.IIJ.Net (58.138.88.185)  287.170 ms osk004bb01.IIJ.Net (58.138.88.189)  269.448 ms osk004bb00.IIJ.Net (58.138.88.185)  287.148 ms
11  osk004ip57.IIJ.Net (58.138.106.162)  277.975 ms osk004ip57.IIJ.Net (58.138.106.166)  278.002 ms osk004ip57.IIJ.Net (58.138.106.162)  277.962 ms
12  210.130.135.130 (210.130.135.130)  278.073 ms  269.286 ms  269.232 ms
13  124.83.228.58 (124.83.228.58)  269.269 ms  270.239 ms  270.179 ms
14  124.83.252.178 (124.83.252.178)  275.296 ms  284.081 ms  284.070 ms
15  158.205.134.26 (158.205.134.26)  293.004 ms  292.981 ms  292.990 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)  0.103 ms  0.154 ms  0.134 ms
 2  129.94.39.17 (129.94.39.17)  1.012 ms  0.949 ms  0.969 ms
 3  libudnex1-vl-3154.gw.unsw.edu.au (149.171.253.34)  1.400 ms  1.665 ms  1.429 ms
 4  ombcr1-po-6.gw.unsw.edu.au (149.171.255.169)  1.605 ms  1.269 ms  1.555 ms
 5  unswbr1-te-1-9.gw.unsw.edu.au (149.171.255.101)  1.116 ms unswbr1-te-2-13.gw.unsw.edu.au (149.171.255.105)  1.151 ms unswbr1-te-1-9.gw.unsw.edu.au (149.171.255.101)  1.156 ms
 6  138.44.5.0 (138.44.5.0)  1.246 ms  1.330 ms  1.324 ms
 7  et-2-0-5.bdr1.sing.sin.aarnet.net.au (113.197.15.233)  92.756 ms  92.569 ms  92.771 ms
 8  138.44.226.7 (138.44.226.7)  256.772 ms  256.673 ms  256.633 ms
 9  janet-gw.mx1.lon.uk.geant.net (62.40.124.198)  256.750 ms  256.727 ms  256.719 ms
10  ae29.londpg-sbr2.ja.net (146.97.33.2)  257.125 ms  257.167 ms  257.026 ms
11  ae31.erdiss-sbr2.ja.net (146.97.33.22)  260.884 ms  260.923 ms  260.858 ms
12  ae29.manckh-sbr2.ja.net (146.97.33.42)  262.773 ms  262.897 ms  262.849 ms
13  ae25.manckh-ban1.ja.net (146.97.35.50)  262.739 ms  262.862 ms  262.812 ms
14  lancaster-uni.ja.net (146.97.40.178)  278.330 ms  278.101 ms  278.086 ms
15  * * *
16  * * *
17  * * *
18  * * *
19  * * *
20  * * *
21  * * *
22  * * *
23  * * *
24  * * *
25  * * *
26  * * *
27  * * *
28  * * *
29  * * *
30  * * *
```

- According to three pictures, we can see that 1-6 hops are same, started from 7th hops, the IP addresses are different. Hence, path diverging occurs from 6th router. The IP is 138.44.5.0.

  The details of this IP:

  ```
  wagner % whois 138.44.5.0

  #
  # ARIN WHOIS data and services are subject to the Terms of Use
  # available at:
  https://www.arin.net/resources/registry/whois/tou/
  #
  # If you see inaccuracies in the results, please report at
  ```

```
#
https://www.arin.net/resources/registry/whois/inaccuracy_report
ing/
#
# Copyright 1997-2020, American Registry for Internet Numbers,
Ltd.
#


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


OrgName:        Asia Pacific Network Information Centre
OrgId:          APNIC
```

```
Address:        PO Box 3646
City:           South Brisbane
StateProv:      QLD
PostalCode:     4101
Country:        AU
RegDate:
Updated:        2012-01-24
Ref:            https://rdap.arin.net/registry/entity/APNIC


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


OrgTechHandle: AWC12-ARIN
OrgTechName:    APNIC Whois Contact
OrgTechPhone:  +61 7 3858 3188
OrgTechEmail:  search-apnic-not-arin@apnic.net
OrgTechRef:    https://rdap.arin.net/registry/entity/AWC12-ARIN


OrgAbuseHandle: AWC12-ARIN
OrgAbuseName:   APNIC Whois Contact
OrgAbusePhone:  +61 7 3858 3188
OrgAbuseEmail:  search-apnic-not-arin@apnic.net
OrgAbuseRef:    https://rdap.arin.net/registry/entity/AWC12-
ARIN


#
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# available at:
https://www.arin.net/resources/registry/whois/tou/
#
# If you see inaccuracies in the results, please report at
#
https://www.arin.net/resources/registry/whois/inaccuracy_report
ing/
#
# Copyright 1997-2020, American Registry for Internet Numbers,
Ltd.
#


Found a referral to whois.apnic.net.

% [whois.apnic.net]
% Whois data copyright terms
 http://www.apnic.net/db/dbcopyright.html
```

```
% Information related to '138.44.0.0 - 138.44.255.255'

% Abuse contact for '138.44.0.0 - 138.44.255.255' is
'abuse@aarnet.edu.au'

inetnum:        138.44.0.0 - 138.44.255.255
netname:        AARNET
descr:          Australian Academic and Research Network
descr:          Building 9
descr:          Banks Street
country:        AU
org:            ORG-AAAR1-AP
admin-c:        SM6-AP
tech-c:         ANOC-AP
abuse-c:        AA1638-AP
status:         ALLOCATED PORTABLE
remarks:        -+-+-+-+-+-+-+-+-+-+-+-++-+-+-+-+-+-+-+-+-+-
+-+-+-+
remarks:        This object can only be updated by APNIC
hostmasters.
remarks:        To update this object, please contact APNIC
remarks:        hostmasters and include your organisation's
account
remarks:        name in the subject line.
remarks:        -+-+-+-+-+-+-+-+-+-+-+-++-+-+-+-+-+-+-+-+-+-
+-+-+-+
notify:         irrcontact@aarnet.edu.au
mnt-by:         APNIC-HM
mnt-lower:      MAINT-AARNET-AP
mnt-routes:     MAINT-AARNET-AP
mnt-irt:        IRT-AARNET-AU
last-modified:  2020-06-22T05:22:11Z
source:         APNIC

irt:            IRT-AARNET-AU
address:        AARNet Pty Ltd
address:        26 Dick Perry Avenue
address:        Kensington, Western Australia
address:        Australia
e-mail:         abuse@aarnet.edu.au
abuse-mailbox:  abuse@aarnet.edu.au
admin-c:        SM6-AP
tech-c:         ANOC-AP
auth:           # Filtered
remarks:        abuse@aarnet.edu.au was validated on 2020-06-22
mnt-by:         MAINT-AARNET-AP
last-modified:  2020-06-22T05:21:20Z
source:         APNIC
```

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

role:           ABUSE AARNETAU
address:        AARNet Pty Ltd
address:        26 Dick Perry Avenue
address:        Kensington, Western Australia
address:        Australia
country:        ZZ
phone:          +000000000
e-mail:         abuse@aarnet.edu.au
admin-c:        SM6-AP
tech-c:         ANOC-AP
nic-hdl:        AA1638-AP
remarks:        Generated from irt object IRT-AARNET-AU
abuse-mailbox:  abuse@aarnet.edu.au
mnt-by:         APNIC-ABUSE
last-modified:  2020-06-22T05:22:10Z
source:         APNIC

role:           AARNet Network Operations Centre
remarks:
address:        AARNet Pty Ltd
address:        GPO Box 1559
address:        Canberra
address:        ACT  2601
country:        AU
phone:          +61 1300 275 662
phone:          +61 2 6222 3555
remarks:
e-mail:         noc@aarnet.edu.au
remarks:
remarks:        Send abuse reports to abuse@aarnet.edu.au
remarks:        Please include timestamps and offset to UTC in
logs
remarks:        Peering requests to peering@aarnet.edu.au
remarks:
admin-c:        SM6-AP
tech-c:         BM-AP
```

```
nic-hdl:        ANOC-AP
mnt-by:         MAINT-AARNET-AP
last-modified:  2010-06-30T13:16:48Z
source:         APNIC

person:         Steve Maddocks
remarks:        Director Operations
address:        AARNet Pty Ltd
address:        26 Dick Perry Avenue
address:        Kensington
address:        Perth
address:        WA  6151
country:        AU
phone:          +61-8-9289-2210
fax-no:         +61-2-6222-7509
e-mail:         steve.maddocks@aarnet.edu.au
nic-hdl:        SM6-AP
mnt-by:         MAINT-AARNET-AP
last-modified:  2011-02-01T08:37:06Z
source:         APNIC

% Information related to '138.44.5.0/24AS7575'

route:          138.44.5.0/24
origin:         AS7575
descr:          Australian Academic and Research Network
                Building 9
                Banks Street
mnt-by:         MAINT-AARNET-AP
last-modified:  2019-04-03T03:55:51Z
source:         APNIC

% This query was served by the APNIC Whois Service version
1.88.15-SNAPSHOT (WHOIS-NODE4)
```

- No,

  The distance between AU and UK is 15,195

  The distance between AU and JP is 6,848

  (Source from google)

  Access www.u-tokyo.ac.jp experienced 15 hops, but access www.lancaster.ac.uk experienced 14 hops.

3. Several servers distributed around the world

```
wagner % nslookup www.speedtest.com.sg
Server:     129.94.242.2
Address:    129.94.242.2#53

Non-authoritative answer:
Name: www.speedtest.com.sg
Address: 202.150.221.170
```

```
wagner % nslookup www.telstra.net
Server:     129.94.242.2
Address:    129.94.242.2#53

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

- www.speedtest.com.sg IP addresses is 202.150.221.170

  www.telstra.net IP addresses is 203.50.5.178

- Through `/sbin/ifconfig`, I can check my IP address is 129.94.242.19

```
wagner % /sbin/ifconfig
eth0       Link encap:Ethernet   HWaddr 00:50:56:8f:00:a9
           inet addr:129.94.242.19  Bcast:129.94.242.255  Mask:255.255.255.0
           inet6 addr: fe80::250:56ff:fe8f:a9/64 Scope:Link
           UP BROADCAST RUNNING MULTICAST  MTU:1500  Metric:1
           RX packets:644693906 errors:0 dropped:7321 overruns:0 frame:0
           TX packets:957865735 errors:0 dropped:0 overruns:0 carrier:0
           collisions:0 txqueuelen:1000
           RX bytes:261569384692 (243.6 GiB)  TX bytes:959402926571 (893.5 GiB)
```

(1). Check forward path

www.speedtest.com.sg:

```
wagner % 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)  0.106 ms  0.127 ms  0.107 ms
 2  129.94.39.17 (129.94.39.17)  0.867 ms  0.833 ms  0.878 ms
 3  libudnex1-vl-3154.gw.unsw.edu.au (149.171.253.34)  1.565 ms  1.560 ms ombudnex1-vl-3154.gw.unsw.edu.au (149.171.253.35)  1.418 ms
 4  ombcr1-po-5.gw.unsw.edu.au (149.171.255.197)  1.049 ms libcr1-po-5.gw.unsw.edu.au (149.171.255.165)  1.099 ms  1.092 ms
 5  unswbr1-te-1-9.gw.unsw.edu.au (149.171.255.101)  1.213 ms  1.244 ms unswbr1-te-2-13.gw.unsw.edu.au (149.171.255.105)  1.248 ms
 6  138.44.5.0 (138.44.5.0)  1.328 ms  1.418 ms  1.391 ms
 7  et-0-3-0.pe1.alxd.nsw.aarnet.net.au (113.197.15.153)  1.813 ms  2.177 ms  2.188 ms
 8  xe-0-2-7.bdr1.a.lax.aarnet.net.au (202.158.194.173)  147.799 ms  147.758 ms  147.748 ms
 9  singtel.as7473.any2ix.coresite.com (206.72.210.63)  147.814 ms  147.726 ms  147.762 ms
10  203.208.171.117 (203.208.171.117)  148.153 ms  147.950 ms  148.108 ms
11  203.208.177.110 (203.208.177.110)  328.581 ms  326.401 ms  333.742 ms
12  * * *
13  202-150-221-170.rev.ne.com.sg (202.150.221.170)  213.881 ms 203.208.158.185 (203.208.158.185)  331.597 ms 203.208.177.110 (203.208.177.110)  337.062 ms
```

www.telstra.net

```
wagner % 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)  0.111 ms  0.143 ms  0.120 ms
 2  129.94.39.17 (129.94.39.17)  0.895 ms  0.928 ms  0.881 ms
 3  libudnex1-vl-3154.gw.unsw.edu.au (149.171.253.34)  2.700 ms  2.337 ms  2.534 ms
 4  libcr1-po-6.gw.unsw.edu.au (149.171.255.201)  14.558 ms ombcr1-po-6.gw.unsw.edu.au (149.171.255.169)  1.152 ms ombcr1-po-5.gw.unsw.edu.au (149.171.255.197)  1.142 ms
 5  unswbr1-te-2-13.gw.unsw.edu.au (149.171.255.105)  1.160 ms unswbr1-te-1-9.gw.unsw.edu.au (149.171.255.101)  1.187 ms  1.214 ms
 6  138.44.5.0 (138.44.5.0)  1.288 ms  1.331 ms  1.320 ms
 7  et-1-1-0.pe1.rsby.nsw.aarnet.net.au (113.197.15.12)  1.807 ms  1.733 ms  1.719 ms
 8  xe-0-0-3.bdr1.rsby.nsw.aarnet.net.au (113.197.15.31)  1.584 ms  1.488 ms  1.455 ms
 9  HundredGigE0-1-0-4.ken-edge903.sydney.telstra.net (139.130.0.77)  2.240 ms  2.105 ms  2.357 ms
10  bundle-ether2.chw-edge903.sydney.telstra.net (203.50.11.175)  2.541 ms bundle-ether17.ken-core10.sydney.telstra.net (203.50.11.172)  2.428 ms bundle-ether2.chw-edge903.sydney.telstra.net (203.50.11.175)  2.66
    6 ms
11  bundle-ether17.chw-core10.sydney.telstra.net (203.50.11.176)  2.769 ms bundle-ether10.win-core10.melbourne.telstra.net (203.50.11.123)  15.288 ms  14.987 ms
12  bundle-ether8.exi-core10.melbourne.telstra.net (203.50.11.125)  15.103 ms  16.838 ms  16.771 ms
13  bundle-ether2.exi-ncprouter101.melbourne.telstra.net (203.50.11.209)  14.150 ms  14.705 ms  14.194 ms
14  www.telstra.net (203.50.5.178)  14.267 ms  13.566 ms  14.389 ms
```

(2). Check reverse path

www.speedtest.com.sg:

```
traceroute to 129.94.242.19 (129.94.242.19), 30 hops max, 60 byte packets
 1  ge2-8.r01.sin01.ne.com.sg (202.150.221.169)  0.137 ms  0.147 ms  0.151 ms
 2  10.11.34.146 (10.11.34.146)  0.365 ms  0.448 ms  0.506 ms
 3  aarnet.sgix.sg (103.16.102.67)  213.558 ms  213.567 ms  213.530 ms
 4  et-7-3-0.pe1.nsw.brwy.aarnet.net.au (113.197.15.232)  209.152 ms  209.186 ms  209.168 ms
 5  138.44.5.1 (138.44.5.1)  213.772 ms  213.688 ms  213.778 ms
 6  ombcr1-te-1-5.gw.unsw.edu.au (149.171.255.106)  211.642 ms  211.628 ms  211.607 ms
 7  libudnex1-po-2.gw.unsw.edu.au (149.171.255.198)  212.785 ms  213.214 ms  213.256 ms
 8  ufw1-ae-1-3154.gw.unsw.edu.au (149.171.253.36)  212.244 ms  212.329 ms  212.301 ms
 9  129.94.39.23 (129.94.39.23)  210.131 ms  210.052 ms  210.071 ms
10  * * *
11  * * *
12  * * *
13  * * *
```

www.telstra.net

```
 1  gigabitethernet3-3.exi2.melbourne.telstra.net (203.50.77.53)  0.279 ms  0.202 ms  0.243 ms
 2  bundle-ether3-100.win-core10.melbourne.telstra.net (203.50.80.129)  2.362 ms  1.727 ms  2.116 ms
 3  bundle-ether12.ken-core10.sydney.telstra.net (203.50.11.122)  12.610 ms  12.346 ms  12.735 ms
 4  bundle-ether1.ken-edge903.sydney.telstra.net (203.50.11.173)  11.985 ms  11.847 ms  14.111 ms
 5  aar3533567.lnk.telstra.net (139.130.0.78)  29.848 ms  35.958 ms  27.601 ms
 6  et-7-1-0.pe1.brwy.nsw.aarnet.net.au (113.197.15.13)  12.111 ms  11.847 ms  11.737 ms
 7  138.44.5.1 (138.44.5.1)  12.109 ms  11.974 ms  11.985 ms
 8  libcr1-te-1-5.gw.unsw.edu.au (149.171.255.102)  12.111 ms  12.101 ms  11.982 ms
 9  ombudnex1-po-1.gw.unsw.edu.au (149.171.255.202)  12.358 ms  12.221 ms  12.236 ms
10  ufw1-ae-1-3154.gw.unsw.edu.au (149.171.253.36)  12.735 ms  12.723 ms  12.611 ms
11  129.94.39.23 (129.94.39.23)  12.860 ms  12.851 ms  12.857 ms
```

According to **forward path** and **reverse path**, we can find that they do not choose the same routers. In order to avoid traffic porblem, DNS will pick different path following load balancing.

Exercise 4: Use ping to gain insights into network performance

1. Through google map:

The distance between UNSW and Brisbane is $738.81 km$

The distance between UNSW and Serdang is $6,606.01 km$

The distace between UNSW and Berlin is $16,099.98 km$

Hence, the time of delay is:

$T_{Brisbane} = (738.81 \times 10^3) \div (3 \times 10^8) \approx 2.46 ms$

$T_{Serdang} = (6606.01 \times 10^3) \div (3 \times 10^8) \approx 22.02 ms$

$T_{Berlin} = (16099.98 \times 10^3) \div (3 \times 10^8) \approx 53.67 ms$

According to the file of `runping.sh`, the minimum RTT Ping program are:

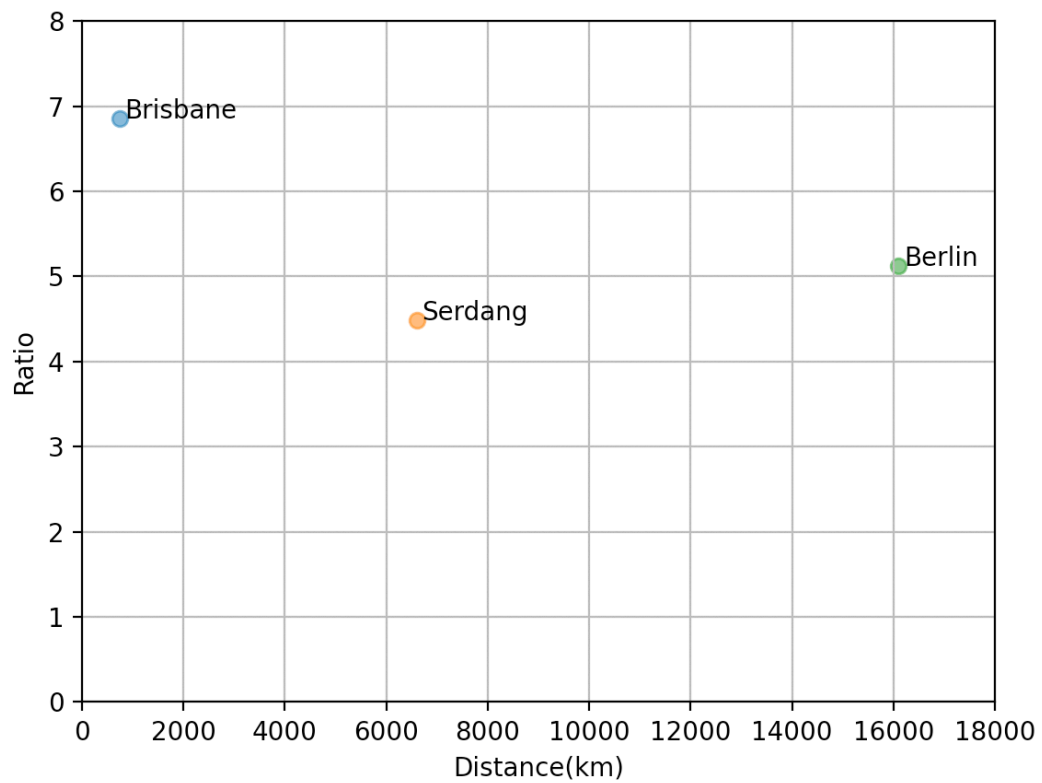$minRTT_{Brisbane} = 16.880 ms$

$minRTT_{Serdang} = 98.806 ms$

$minRTT_{Berlin} = 274.700 ms$

Therefore, the ratio are:

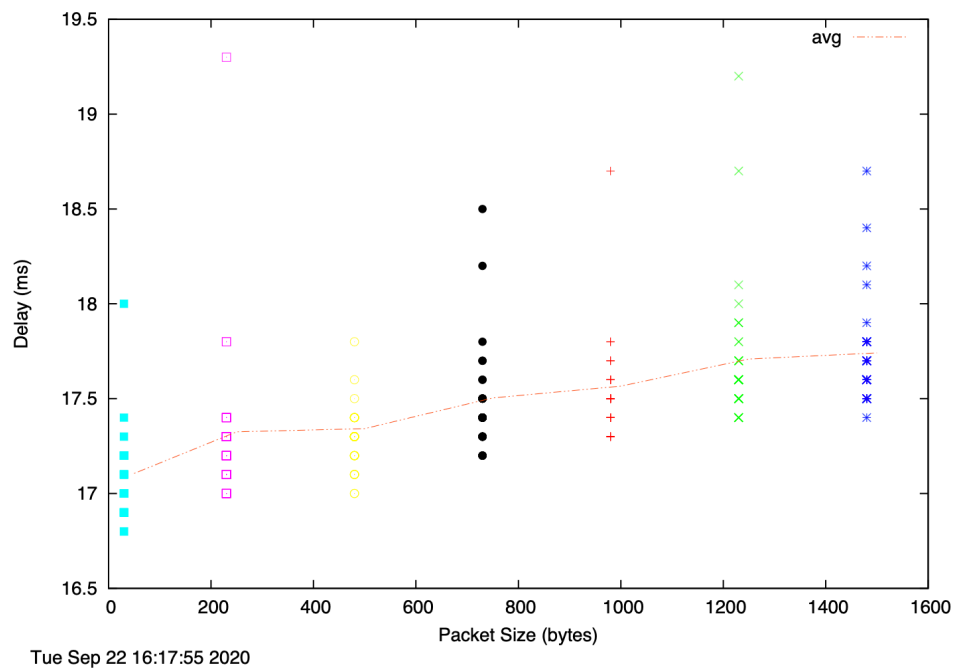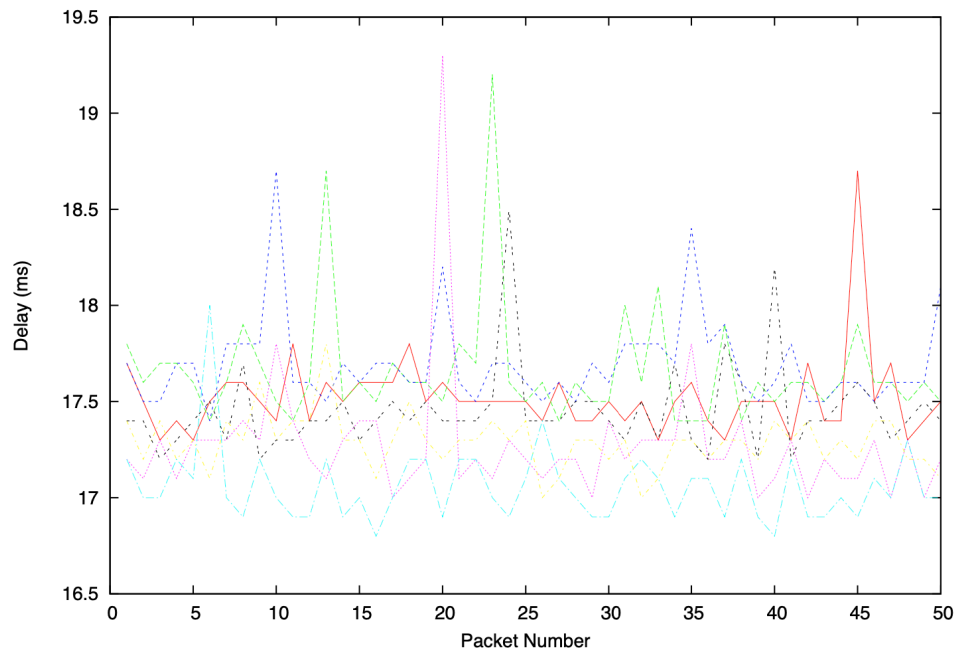$R_{Brisbane} = 6.86$

$R_{Serdang} = 4.48$

$R_{Berlin} = 5.12$

o The reasons of the y-axis values that the plot are greater than 2:

a) The speed of packet moves has loss in physical media (not vacuum)

b) The physical cables are not laid in a straight line

c) Total nodal delay contains nodal processing delay, queeing delay, transmission delay and propagation delay. It does not be considered.
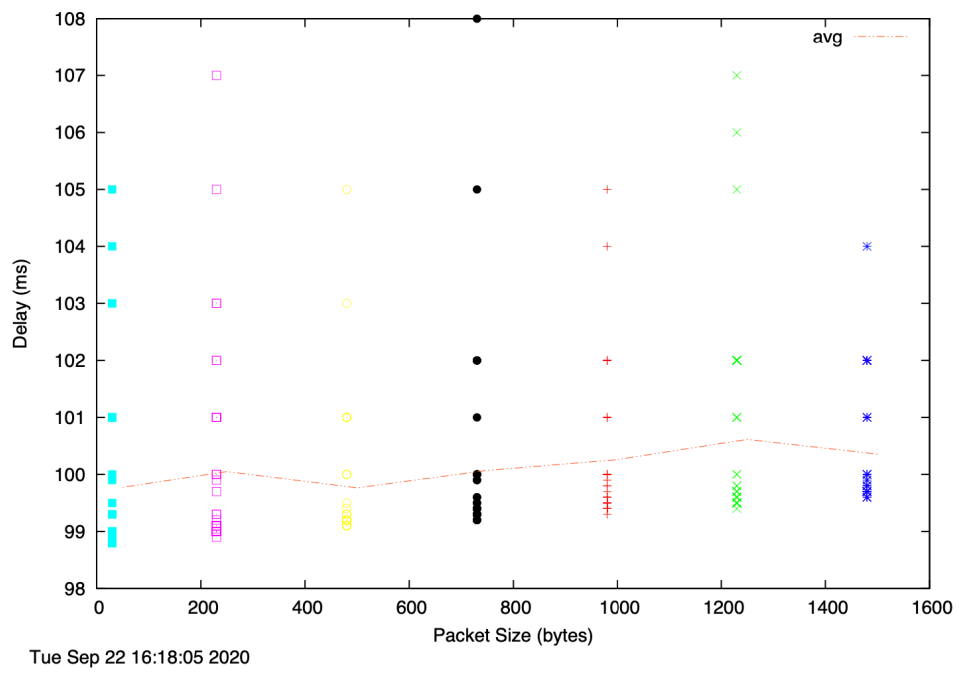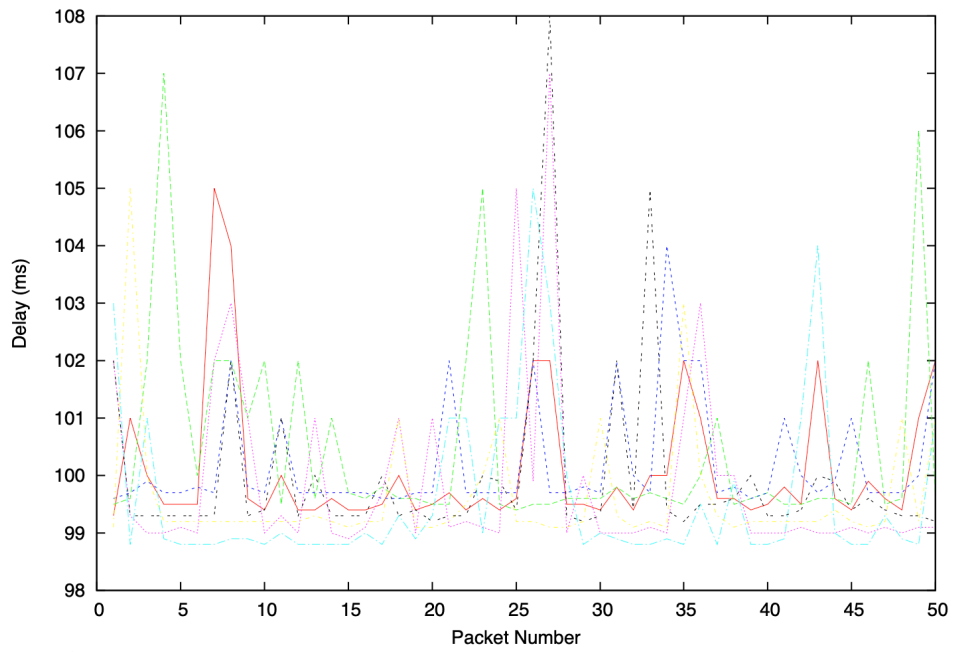
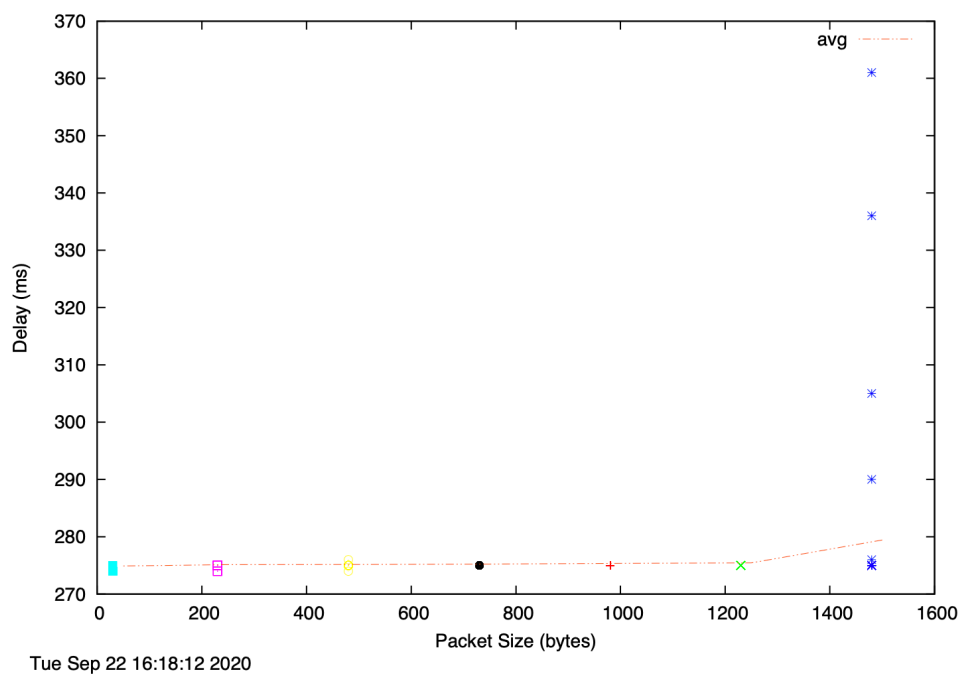2. The delay to the destinations is vary over time.
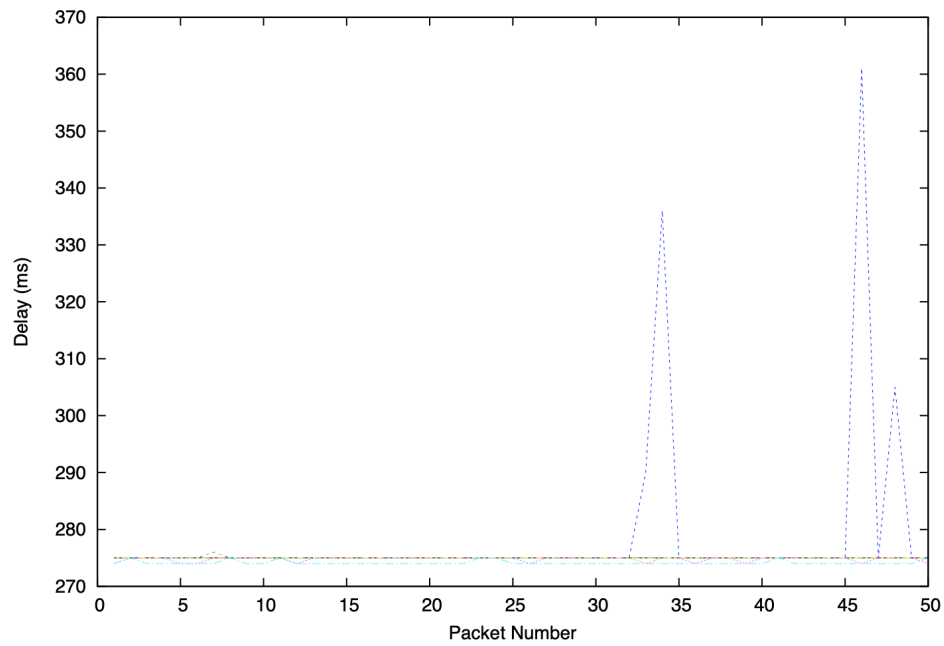
The graphs show that:

(i) www.uq.edu.au

Tue Sep 22 16:17:55 2020

Tue Sep 22 16:17:55 2020

(ii) www.upm.edu.my

Tue Sep 22 16:18:05 2020

Tue Sep 22 16:18:05 2020

(iii) www.tu-berlin.de

Tue Sep 22 16:18:12 2020

Tue Sep 22 16:18:12 2020

- Through curve graph, these show that the delay to the destinations randomly varies over time. This is mainly due to changing processing delay and queuing delay
- Through Scatter plot graph, the size of packets may not have correlation with time delay. The delay could couased by lower bandwidth in some channels.

3. www.epfl.ch

```
wagner % nslookup www.epfl.ch
Server:    2001:8003:2475:7600::1
Address:   2001:8003:2475:7600::1#53

Non-authoritative answer:
www.epfl.ch    canonical name = www.epfl.ch.cdn.cloudflare.net.
Name: www.epfl.ch.cdn.cloudflare.net
Address: 104.20.228.42
Name: www.epfl.ch.cdn.cloudflare.net
Address: 172.67.2.106
Name: www.epfl.ch.cdn.cloudflare.net
Address: 104.20.229.42
```

According to the IP addresses,

| 104.20.228.42 | **Lookup IP Address** |

Details for 104.20.228.42

IP: 104.20.228.42
Decimal: 1746199594
Hostname: 104.20.228.42
ASN: 13335
ISP: Cloudflare
Organization: Cloudflare
Services: None detected
Assignment: [Likely Static IP](#)
Blacklist: **Click to Check Blacklist Status**
Continent: North America
Country: United States 🇺🇸
Latitude: 37.751 (37° 45′ 3.60″ N)
Longitude: -97.822 (97° 49′ 19.20″ W)

The IP addresses of www.epfl.ch are located in Unitide States, not in Switzerland.

4. **Propagation delay** depends on the length of channel. It does not depend on packet size.

   Transmission delay depends on the length of data frames. It relates on packet size.

   Processing delay need to process packets, so it depend on packet size.

   Queuing delay is time the packet spends in routing queues. It relates on packet size.

   Hence,

   Depend on the packet size: Transmission delay, Processing delay and Queuing delay

Not depend on the packet size: Propagation delay