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 for having several IP addresses as an output?
2. Find out the name of the IP address 127.0.0.1. What is special about this IP address?

Q1:

```
z5192519@weaver:~$ 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: 104.21.45.210
Name:   www.koala.com.au
Address: 172.67.219.46
```

The reason for having several IP addresses is that multiple servers have been established for the same website, and these servers have different IP addresses.

Q2:

```
z5192519@weaver:~$ 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 of IP 127.0.0.1 is localhost. The special place of it is that it is the IP address of your own machine and it’s non-routable. For this IP, it usually be used to send and receive packets locally, and that can help for testing purpose.

Exercise 2: Use ping to test host reachability

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

Reachable	Unreachable
www.unsw.edu.au z5192519@weaver:~/COMP3331/Lab/Lab01$ ping www.unsw.edu.au PING cdn.prod65.unsw.adobecqms.net (13.35.138.92) 56(84) bytes of data. 64 bytes from server-13-35-138-92.syd1.r.cloudfront.net (13.35.138.92): icmp_seq=1 ttl=244 time=1.04 ms 64 bytes from server-13-35-138-92.syd1.r.cloudfront.net (13.35.138.92): icmp_seq=2 ttl=244 time=1.06 ms 64 bytes from server-13-35-138-92.syd1.r.cloudfront.net (13.35.138.92): icmp_seq=3 ttl=244 time=1.12 ms 64 bytes from server-13-35-138-92.syd1.r.cloudfront.net (13.35.138.92): icmp_seq=4 ttl=244 time=1.20 ms ^C --- cdn.prod65.unsw.adobecqms.net ping statistics --- 4 packets transmitted, 4 received, 0% packet loss, time 3003ms rtt min/avg/max/mdev = 1.047/1.109/1.202/0.059 ms	www.getfittest.com.au z5192519@weaver:~/COMP3331/Lab/Lab01$ ping www.getfittest.com.au ping: unknown host www.getfittest.com.au
www.mit.edu z5192519@weaver:~/COMP3331/Lab/Lab01$ ping www.mit.edu PING e9566.dscb.akamaiedge.net (23.38.252.41) 56(84) bytes of data. 64 bytes from a23-38-252-41.deploy.static.akamaitechnologies.com (23.38.252.41): icmp_seq=1 ttl=56 time=1.18 ms 64 bytes from a23-38-252-41.deploy.static.akamaitechnologies.com (23.38.252.41): icmp_seq=2 ttl=56 time=1.22 ms 64 bytes from a23-38-252-41.deploy.static.akamaitechnologies.com (23.38.252.41): icmp_seq=3 ttl=56 time=1.21 ms 64 bytes from a23-38-252-41.deploy.static.akamaitechnologies.com (23.38.252.41): icmp_seq=4 ttl=56 time=1.17 ms ^C --- e9566.dscb.akamaiedge.net ping statistics --- 4 packets transmitted, 4 received, 0% packet loss, time 3003ms rtt min/avg/max/mdev = 1.172/1.198/1.225/0.047 ms	www.hola.hp z5192519@weaver:~/COMP3331/Lab/Lab01$ ping www.hola.hp ping: unknown host www.hola.hp
www.intel.com.au z5192519@weaver:~/COMP3331/Lab/Lab01$ ping www.intel.com.au PING e19235.dsca.akamaiedge.net (104.98.21.56) 56(84) bytes of data. 64 bytes from a104-98-21-56.deploy.static.akamaitechnologies.com (104.98.21.56): icmp_seq=1 ttl=56 time=1.17 ms 64 bytes from a104-98-21-56.deploy.static.akamaitechnologies.com (104.98.21.56): icmp_seq=2 ttl=56 time=1.21 ms 64 bytes from a104-98-21-56.deploy.static.akamaitechnologies.com (104.98.21.56): icmp_seq=3 ttl=56 time=1.19 ms 64 bytes from a104-98-21-56.deploy.static.akamaitechnologies.com (104.98.21.56): icmp_seq=4 ttl=56 time=1.24 ms ^C --- e19235.dsca.akamaiedge.net ping statistics --- 4 packets transmitted, 4 received, 0% packet loss, time 3003ms rtt min/avg/max/mdev = 1.178/1.207/1.240/0.048 ms	www.kremlin.ru z5192519@weber:~$ ping www.kremlin.ru PING www.kremlin.ru (95.173.136.71) 56(84) bytes of data. ^C --- www.kremlin.ru ping statistics --- 5 packets transmitted, 0 received, 100% packet loss, time 4097ms
www.tpg.com.au z5192519@weaver:~/COMP3331/Lab/Lab01$ ping www.tpg.com.au PING www.tpg.com.au.cdn.cloudflare.net (104.18.10.61) 56(84) bytes of data. 64 bytes from 104.18.10.61: icmp_seq=1 ttl=56 time=1.58 ms 64 bytes from 104.18.10.61: icmp_seq=2 ttl=56 time=1.94 ms 64 bytes from 104.18.10.61: icmp_seq=3 ttl=56 time=1.97 ms 64 bytes from 104.18.10.61: icmp_seq=4 ttl=56 time=1.62 ms ^C --- www.tpg.com.au.cdn.cloudflare.net ping statistics --- 4 packets transmitted, 4 received, 0% packet loss, time 3003ms rtt min/avg/max/mdev = 1.584/1.783/1.978/0.183 ms	
www.amazon.com z5192519@weaver:~/COMP3331/Lab/Lab01$ ping www.amazon.com PING www-amazon-com.customer.fastly.net (162.219.225.118) 56(84) bytes of data. 64 bytes from 162.219.225.118: icmp_seq=1 ttl=56 time=1.21 ms 64 bytes from 162.219.225.118: icmp_seq=2 ttl=56 time=1.26 ms 64 bytes from 162.219.225.118: icmp_seq=3 ttl=56 time=1.22 ms 64 bytes from 162.219.225.118: icmp_seq=4 ttl=56 time=1.22 ms ^C --- www-amazon-com.customer.fastly.net ping statistics --- 4 packets transmitted, 4 received, 0% packet loss, time 3003ms rtt min/avg/max/mdev = 1.219/1.232/1.263/0.046 ms	
www.tsinghua.edu.cn z5192519@weaver:~/COMP3331/Lab/Lab01$ ping www.tsinghua.edu.cn PING www.tsinghua.edu.cn (166.111.4.100) 56(84) bytes of data. 64 bytes from www.tsinghua.edu.cn (166.111.4.100): icmp_seq=1 ttl=42 time=159 ms 64 bytes from www.tsinghua.edu.cn (166.111.4.100): icmp_seq=2 ttl=42 time=159 ms 64 bytes from www.tsinghua.edu.cn (166.111.4.100): icmp_seq=3 ttl=42 time=159 ms 64 bytes from www.tsinghua.edu.cn (166.111.4.100): icmp_seq=4 ttl=42 time=159 ms ^C --- www.tsinghua.edu.cn ping statistics --- 4 packets transmitted, 4 received, 0% packet loss, time 3004ms rtt min/avg/max/mdev = 159.820/159.873/159.957/0.288 ms	
8.8.8.8 z5192519@weaver:~/COMP3331/Lab/Lab01$ ping 8.8.8.8 PING 8.8.8.8 (8.8.8.8) 56(84) bytes of data. 64 bytes from 8.8.8.8: icmp_seq=1 ttl=115 time=1.26 ms 64 bytes from 8.8.8.8: icmp_seq=2 ttl=115 time=1.19 ms 64 bytes from 8.8.8.8: icmp_seq=3 ttl=115 time=1.22 ms 64 bytes from 8.8.8.8: icmp_seq=4 ttl=115 time=1.27 ms ^C --- 8.8.8.8 ping statistics --- 4 packets transmitted, 4 received, 0% packet loss, time 3003ms rtt min/avg/max/mdev = 1.194/1.238/1.274/0.054 ms	

For www.getfittest.com.au and www.hola.hp , they do not exit.

For www.kremlin.ru, it is unreachable because it is a governmental website and they disable their network from replying to ICMP echo request packets which used by 'ping'. The reason behind is for security measure.

Exercise 3: Use traceroute to understand the network topology

Q1:

```
z5192519@weber:~$ 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)  0.088 ms  0.084 ms  0.090 ms
 2  129.94.39.17 (129.94.39.17)  0.922 ms  0.841 ms  0.856 ms
 3  ombudnex1-vl-3154.gw.unsw.edu.au (149.171.253.35)  1.696 ms  1.643 ms libudnex1-vl-3154.gw.unsw.edu.au (149.171.253.34)  1.394 ms
 4  ombcr1-po-5.gw.unsw.edu.au (149.171.255.197)  1.176 ms libcr1-po-6.gw.unsw.edu.au (149.171.255.201)  1.117 ms ombcr1-po-6.gw.unsw.edu.au (149.171.255.169)  1.205 ms
 5  unswbr1-te-1-9.gw.unsw.edu.au (149.171.255.101)  1.254 ms unswbr1-te-2-13.gw.unsw.edu.au (149.171.255.105)  1.269 ms  1.269 ms
 6  138.44.5.0 (138.44.5.0)  1.319 ms  1.344 ms  1.346 ms
 7  et-1-1-0.pe1.mcqp.nsw.aarnet.net.au (113.197.15.4)  2.468 ms  2.039 ms  2.159 ms
 8  et-0_0_2.bdr1.guam.gum.aarnet.net.au (113.197.14.137)  71.556 ms  71.565 ms  71.472 ms
 9  138.44.228.5 (138.44.228.5)  184.865 ms  184.839 ms  184.864 ms
10  ae-7.4078.rtsw.losa.net.internet2.edu (163.253.0.149)  191.934 ms  191.685 ms  191.593 ms
11  ae-1.4079.rtsw.salt.net.internet2.edu (162.252.70.115)  196.126 ms  196.169 ms  196.003 ms
12  ae-5.4079.rtsw.kans.net.internet2.edu (162.252.70.144)  219.123 ms  219.143 ms  219.149 ms
13  ae-3.4079.rtsw.chic.net.internet2.edu (162.252.70.140)  228.480 ms  228.618 ms  228.672 ms
14  ae-9.4070.rtsw3.eqch.net.internet2.edu (64.57.28.105)  228.583 ms  228.753 ms bundle-ether1.4078.core2.chic.net.internet2.edu (163.253.0.134)  236.053 ms
15  163.253.2.19 (163.253.2.19)  237.589 ms  235.568 ms  235.480 ms
16  163.253.2.16 (163.253.2.16)  237.324 ms  237.172 ms  237.174 ms
17  buf-9208-I2-CLEV.nysernet.net (199.109.11.33)  237.911 ms  237.980 ms  237.872 ms
18  syr-55a1-buf-9208.nysernet.net (199.109.7.213)  241.551 ms  241.353 ms  241.384 ms
19  nyc32-55a1-syr-55a1.nysernet.net (199.109.7.206)  246.784 ms  246.518 ms  246.873 ms
20  nyc32-9208-nyc32-55a1.nysernet.net (199.109.7.201)  246.433 ms  246.434 ms  246.358 ms
21  columbia.nyc-9208.nysernet.net (199.109.4.14)  246.338 ms  246.311 ms  246.346 ms
22  cc-core-1-x-nyser32-gw-1.net.columbia.edu (128.59.255.5)  284.131 ms  283.368 ms  260.095 ms
23  cc-conc-1-x-cc-core-1.net.columbia.edu (128.59.255.21)  246.670 ms  246.677 ms  267.778 ms
24  old.columbia.university (128.59.105.24)  246.736 ms  246.635 ms  246.671 ms
```

1. The output of traceroute shows that there are 24 routers between my machine and Columbia server.
2. Cause the first router is a CSE router, which is still inside the CSE workstation. So, there are 23 routers from the workstation to the Columbia server.
3. The first 5 routers have hostnames with “unsw.edu.au”, so they are part of the UNSW networking.
4. According to the data, there is a huge ping difference between 8-9 and 9-10, I guess that transoceanic transmission occurs between these three routers.

```
z5192519@weber:~$ dig -x 138.44.5.0

; <<>> DiG 9.9.5-9+deb8u19-Debian <<>> -x 138.44.5.0
;; global options: +cmd
;; Got answer:
;; ->>HEADER<<- opcode: QUERY, status: NXDOMAIN, id: 51436
;; flags: qr rd ra; QUERY: 1, ANSWER: 0, AUTHORITY: 1, ADDITIONAL: 1

;; OPT PSEUDOSECTION:
; EDNS: version: 0, flags:; udp: 4096
;; QUESTION SECTION:
;0.5.44.138.in-addr.arpa.       IN      PTR

;; AUTHORITY SECTION:
5.44.138.in-addr.arpa.  2580    IN      SOA     ns1.aarnet.net.au. hostmaster.aarnet.edu.au. 2017121509 10800 600 1209600 3600

;; Query time: 0 msec
;; SERVER: 129.94.242.2#53(129.94.242.2)
;; WHEN: Sun Sep 26 12:02:25 AEST 2021
;; MSG SIZE  rcvd: 127
```

By using command “dig -x 138.44.5.0” , we can find that the information about the ninth router contains the word AARNet. So both 8th router and 9th router belong to AARNet (Australian Academic and Research Network). The 10th router contains the words rtsw.losa, so I guess that it is located in Los Angeles. After consulting the website (https://routerproxy.net.internet2.edu/routerproxy/), it is confirmed that it does locate in Los Angeles, CA. Therefore, the 9th and 10th router do the packets cross the Pacific Ocean.

Q2:

www.ucla.edu

```
z5192519@weber:~$ 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)  0.077 ms  0.076 ms  0.084 ms
 2  129.94.39.17 (129.94.39.17)  0.918 ms  0.924 ms  0.933 ms
 3  libudnex1-vl-3154.gw.unsw.edu.au (149.171.253.34)  1.696 ms ombudnex1-vl-3154.gw.unsw.edu.au (149.171.253.35)  2.768 ms libudnex1-vl-3154.gw.unsw.edu.au (149.171.253.34)  1.648 ms
 4  ombcr1-po-6.gw.unsw.edu.au (149.171.255.169)  1.225 ms libcr1-po-5.gw.unsw.edu.au (149.171.255.165)  1.229 ms ombcr1-po-6.gw.unsw.edu.au (149.171.255.169)  1.242 ms
 5  unswbr1-te-2-13.gw.unsw.edu.au (149.171.255.105)  1.435 ms  1.439 ms unswbr1-te-1-9.gw.unsw.edu.au (149.171.255.101)  1.450 ms
 6  138.44.5.0 (138.44.5.0)  1.522 ms  1.311 ms  1.312 ms
 7  et-0-3-0.pe1.bkvl.nsw.aarnet.net.au (113.197.15.147)  3.742 ms  3.713 ms  3.787 ms
 8  ge-4_0_0.bb1.a.pao.aarnet.net.au (202.158.194.177)  155.217 ms  155.170 ms  155.170 ms
 9  paloalto0.iij.net (198.32.176.24)  156.608 ms  156.382 ms  156.478 ms
10  osk004bb01.IIJ.Net (58.138.88.189)  266.756 ms  266.746 ms  267.089 ms
11  osk004ip57.IIJ.Net (58.138.106.194)  276.441 ms  276.201 ms  276.284 ms
12  210.130.135.130 (210.130.135.130)  276.421 ms  276.581 ms  286.278 ms
13  124.83.228.58 (124.83.228.58)  286.259 ms  286.086 ms  276.717 ms
14  124.83.252.178 (124.83.252.178)  282.361 ms  282.330 ms  274.465 ms
15  158.205.134.26 (158.205.134.26)  304.534 ms  282.347 ms  282.360 ms
16  * * *
17  * * *
18  * * *
19  * * *
20  * * *
21  * * *
22  * * *
23  * * *
24  * * *
25  * * *
26  * * *
27  * * *
28  * * *
29  * * *
30  * * *
```

www.u-tokyo.ac.jp

```
z5192519@weber:~$ traceroute www.ucla.edu
traceroute to www.ucla.edu (13.226.230.6), 30 hops max, 60 byte packets
 1  cserouter1-server.cse.unsw.EDU.AU (129.94.242.251)  0.093 ms  0.087 ms  0.091 ms
 2  129.94.39.17 (129.94.39.17)  0.922 ms  0.975 ms  0.875 ms
 3  ombudnex1-vl-3154.gw.unsw.edu.au (149.171.253.35)  2.151 ms  2.112 ms  1.613 ms
 4  libcr1-po-6.gw.unsw.edu.au (149.171.255.201)  1.262 ms libcr1-po-5.gw.unsw.edu.au (149.171.255.165)  1.320 ms ombcr1-po-6.gw.unsw.edu.au (149.171.255.169)  1.302 ms
 5  unswbr1-te-2-13.gw.unsw.edu.au (149.171.255.105)  1.307 ms  1.310 ms  1.320 ms
 6  138.44.5.0 (138.44.5.0)  5.581 ms  4.656 ms  4.671 ms
 7  et-0-3-0.pe1.bkvl.nsw.aarnet.net.au (113.197.15.147)  1.682 ms  2.430 ms  2.433 ms
 8  xe-0-2-5.bdr1.b.sea.aarnet.net.au (202.158.194.121)  143.691 ms  143.748 ms  143.776 ms
 9  xe-4-1-1.mpr1.sea1.us.above.net (64.125.193.129)  144.425 ms  144.377 ms  144.503 ms
10  ae27.cs1.sea1.us.eth.zayo.com (64.125.29.0)  181.776 ms ae28.cs2.sea1.us.eth.zayo.com (64.125.29.104)  159.677 ms ae27.cs1.sea1.us.eth.zayo.com (64.125.29.0)  181.758 ms
11  ae3.cs2.sjc2.us.eth.zayo.com (64.125.29.40)  159.378 ms ae3.cs1.sjc2.us.eth.zayo.com (64.125.29.42)  163.717 ms ae3.cs2.sjc2.us.eth.zayo.com (64.125.29.40)  159.917 ms
12  ae2.cs2.lax112.us.eth.zayo.com (64.125.28.197)  159.002 ms ae2.cs1.lax112.us.eth.zayo.com (64.125.28.145)  161.819 ms *
13  * * *
14  99.83.64.190 (99.83.64.190)  159.077 ms  159.181 ms  159.092 ms
15  150.222.234.53 (150.222.234.53)  175.388 ms 150.222.234.51 (150.222.234.51)  159.668 ms 150.222.234.47 (150.222.234.47)  159.702 ms
16  54.239.102.95 (54.239.102.95)  159.575 ms 54.239.102.212 (54.239.102.212)  159.027 ms 54.239.102.210 (54.239.102.210)  160.106 ms
17  52.93.92.99 (52.93.92.99)  160.858 ms 52.93.92.109 (52.93.92.109)  159.181 ms 150.222.252.77 (150.222.252.77)  162.820 ms
18  * * *
19  * * *
20  * * *
21  * * *
22  * * *
23  150.222.101.126 (150.222.101.126)  163.739 ms 150.222.101.28 (150.222.101.28)  159.340 ms 150.222.101.124 (150.222.101.124)  163.693 ms
24  150.222.232.47 (150.222.232.47)  159.444 ms 150.222.232.43 (150.222.232.43)  158.696 ms  158.670 ms
25  150.222.232.37 (150.222.232.37)  158.704 ms * *
26  * * *
27  * * *
28  * * *
29  * * *
30  server-13-226-230-6.lax50.r.cloudfront.net (13.226.230.6)  159.690 ms  159.658 ms *
```

www.lancaster.ac.uk

```
z5192519@weber:~$ 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)  0.084 ms  0.079 ms  0.065 ms
 2  129.94.39.17 (129.94.39.17)  0.858 ms  0.891 ms  0.944 ms
 3  ombudnex1-vl-3154.gw.unsw.edu.au (149.171.253.35)  1.448 ms libudnex1-vl-3154.gw.unsw.edu.au (149.171.253.34)  1.706 ms ombudnex1-vl-3154.gw.unsw.edu.au (149.171.253.35)  2.271 ms
 4  ombcr1-po-5.gw.unsw.edu.au (149.171.255.197)  1.195 ms libcr1-po-5.gw.unsw.edu.au (149.171.255.165)  1.244 ms libcr1-po-6.gw.unsw.edu.au (149.171.255.201)  1.348 ms
 5  unswbr1-te-1-9.gw.unsw.edu.au (149.171.255.101)  1.258 ms unswbr1-te-2-13.gw.unsw.edu.au (149.171.255.105)  1.272 ms unswbr1-te-1-9.gw.unsw.edu.au (149.171.255.101)  1.278 ms
 6  138.44.5.0 (138.44.5.0)  1.391 ms  3.896 ms  3.895 ms
 7  et-2-0-5.bdr1.sing.sin.aarnet.net.au (113.197.15.233)  93.017 ms  92.687 ms  92.646 ms
 8  138.44.226.7 (138.44.226.7)  259.545 ms  259.553 ms  259.512 ms
 9  janet-gw.mx1.lon.uk.geant.net (62.40.124.198)  259.915 ms  259.879 ms  259.848 ms
10  ae29.londpg-sbr2.ja.net (146.97.33.2)  260.337 ms  260.397 ms  260.358 ms
11  ae31.erdiss-sbr2.ja.net (146.97.33.22)  269.301 ms  263.983 ms  263.877 ms
12  ae29.manckh-sbr2.ja.net (146.97.33.42)  266.733 ms  265.843 ms  265.819 ms
13  ae25.manckh-ban1.ja.net (146.97.35.50)  265.896 ms  265.877 ms  265.945 ms
14  lancaster-uni.ja.net (146.97.40.178)  288.690 ms  288.698 ms  288.708 ms
15  * * *
16  * * *
17  * * *
18  * * *
19  * * *
20  * * *
21  * * *
22  * * *
23  * * *
24  * * *
25  * * *
26  * * *
27  * * *
28  * * *
29  * * *
30  * * *
```

From the three diagrams, we can find that 1-6 routers are the same. So the first 7 hops are identical on all 3 paths. In that case, these three paths diverge at (138.44.5.0) router.

No, there is no proportional relationship. As we can see that Tokyo takes more hops than Los Angeles, however, Tokyo is much closer to Sydney.

Q3:

IP address of my local machine: 129.94.242.53.

IP address of www.telstra.net : 203.50.5.178

```
 1  gigabitethernet3-3.exi2.melbourne.telstra.net (203.50.77.53)  0.810 ms  0.847 ms  0.744 ms
 2  TenGigE0-0-0-21.win-dlr20.melbourne.telstra.net (203.50.233.148)  0.870 ms  0.738 ms  0.620 ms
 3  bundle-ether30.win-core10.melbourne.telstra.net (203.50.11.248)  1.620 ms  1.488 ms  2.369 ms
 4  bundle-ether12.ken-core10.sydney.telstra.net (203.50.11.122)  12.987 ms  12.356 ms  12.863 ms
 5  bundle-ether1.ken-edge903.sydney.telstra.net (203.50.11.173)  16.611 ms  12.856 ms  13.113 ms
 6  139.130.0.78 (139.130.0.78)  11.738 ms  11.608 ms  11.614 ms
 7  et-7-1-0.pe1.brwy.nsw.aarnet.net.au (113.197.15.13)  11.863 ms  11.857 ms  11.864 ms
 8  138.44.5.1 (138.44.5.1)  12.113 ms  12.107 ms  11.990 ms
 9  ombcr1-te-1-5.gw.unsw.edu.au (149.171.255.106)  12.236 ms  11.981 ms  11.988 ms
10  ombudnex1-po-2.gw.unsw.edu.au (149.171.255.170)  19.983 ms  12.483 ms  12.738 ms
11  ufw1-ae-1-3154.gw.unsw.edu.au (149.171.253.36)  12.738 ms  12.732 ms  12.738 ms
12  129.94.39.23 (129.94.39.23)  12.864 ms  12.857 ms  12.863 ms
```

```
z5192519@weber:~$ 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)  0.131 ms  0.117 ms  0.104 ms
 2  129.94.39.17 (129.94.39.17)  0.942 ms  0.933 ms  0.945 ms
 3  ombudnex1-vl-3154.gw.unsw.edu.au (149.171.253.35)  1.770 ms  2.390 ms  2.363 ms
 4  ombcr1-po-6.gw.unsw.edu.au (149.171.255.169)  1.164 ms libcr1-po-5.gw.unsw.edu.au (149.171.255.165)  1.113 ms ombcr1-po-5.gw.unsw.edu.au (149.171.255.197)  1.158 ms
 5  unswbr1-te-2-13.gw.unsw.edu.au (149.171.255.105)  1.273 ms  1.275 ms unswbr1-te-1-9.gw.unsw.edu.au (149.171.255.101)  1.285 ms
 6  138.44.5.0 (138.44.5.0)  2.699 ms  1.671 ms  1.654 ms
 7  et-1-1-0.pe1.rsby.nsw.aarnet.net.au (113.197.15.12)  1.782 ms  2.102 ms  2.087 ms
 8  xe-0-0-3.bdr1.rsby.nsw.aarnet.net.au (113.197.15.31)  126.597 ms  126.573 ms  126.590 ms
 9  139.130.0.77 (139.130.0.77)  2.305 ms  2.309 ms  2.314 ms
10  bundle-ether17.ken-core10.sydney.telstra.net (203.50.11.172)  2.430 ms bundle-ether2.chw-edge903.sydney.telstra.net (203.50.11.175)  2.329 ms bundle-ether17.ken-core10.sydney.telstra.net (203.50.11.172)  3.212 ms
11  bundle-ether10.win-core10.melbourne.telstra.net (203.50.11.123)  14.139 ms  13.382 ms  13.386 ms
12  bundle-ether8.exi-core10.melbourne.telstra.net (203.50.11.125)  15.989 ms bundle-ether1-2.exi-core10.melbourne.telstra.net (203.50.6.40)  15.926 ms  15.868 ms
13  203.50.11.209 (203.50.11.209)  16.727 ms  14.405 ms  17.025 ms
14  www.telstra.net (203.50.5.178)  14.377 ms  14.305 ms  14.392 ms
```

Path1 : Telstra.net → 139.130.0.78 → 138.44.5.1 → 129.94.39.23 → Local

Path2 : Local → 138.44.5.0 → 139.130.0.77 → 203.50.11.209 → Telstra.net

IP address of my local machine: 129.94.242.53.

IP address of www.speedtest.com.sg : 202.150.221.170

```
traceroute to 129.94.242.53 (129.94.242.53), 30 hops max, 60 byte packets
 1  ge2-8.r01.sin01.ne.com.sg (202.150.221.169)  0.136 ms  0.145 ms  0.158 ms
 2  10.11.34.146 (10.11.34.146)  0.396 ms  0.466 ms  0.533 ms
 3  aarnet.sgix.sg (103.16.102.67)  206.866 ms  206.917 ms  206.894 ms
 4  et-7-3-0.pe1.nsw.brwy.aarnet.net.au (113.197.15.232)  209.215 ms  209.106 ms  209.121 ms
 5  138.44.5.1 (138.44.5.1)  215.015 ms  214.957 ms  214.880 ms
 6  ombcr1-te-1-5.gw.unsw.edu.au (149.171.255.106)  211.722 ms  211.596 ms  211.605 ms
 7  ombudnex1-po-2.gw.unsw.edu.au (149.171.255.170)  215.683 ms  215.787 ms  215.809 ms
 8  ufw1-ae-1-3154.gw.unsw.edu.au (149.171.253.36)  212.355 ms  212.387 ms  212.391 ms
 9  129.94.39.23 (129.94.39.23)  210.133 ms  210.009 ms  210.023 ms
10  * * *
```

```
z5192519@weber:~$ 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)  0.085 ms  0.116 ms  0.123 ms
 2  129.94.39.17 (129.94.39.17)  0.969 ms  0.958 ms  0.951 ms
 3  libudnex1-vl-3154.gw.unsw.edu.au (149.171.253.34)  1.648 ms  1.660 ms ombudnex1-vl-3154.gw.unsw.edu.au (149.171.253.35)  1.416 ms
 4  ombcr1-po-6.gw.unsw.edu.au (149.171.255.169)  1.361 ms ombcr1-po-5.gw.unsw.edu.au (149.171.255.197)  1.217 ms libcr1-po-5.gw.unsw.edu.au (149.171.255.165)  2.235 ms
 5  unswbr1-te-1-9.gw.unsw.edu.au (149.171.255.101)  1.258 ms  1.258 ms  1.268 ms
 6  138.44.5.0 (138.44.5.0)  1.458 ms  1.658 ms  1.640 ms
 7  et-0-3-0.pe1.alxd.nsw.aarnet.net.au (113.197.15.153)  1.707 ms  1.716 ms  1.739 ms
 8  xe-0-2-7.bdr1.a.lax.aarnet.net.au (202.158.194.173)  147.627 ms  147.683 ms  147.683 ms
 9  singtel.as7473.any2ix.coresite.com (206.72.210.63)  147.837 ms  147.762 ms  147.833 ms
10  203.208.171.117 (203.208.171.117)  148.846 ms  148.900 ms  148.968 ms
11  203.208.172.145 (203.208.172.145)  243.573 ms 203.208.153.121 (203.208.153.121)  239.541 ms 203.208.172.145 (203.208.172.145)  243.560 ms
12  203.208.182.253 (203.208.182.253)  331.038 ms 203.208.158.17 (203.208.158.17)  326.042 ms *
13  203.208.158.185 (203.208.158.185)  326.012 ms  326.855 ms  326.031 ms
14  203.208.177.110 (203.208.177.110)  331.480 ms * 202-150-221-170.rev.ne.com.sg (202.150.221.170)  209.084 ms
```

Path1 : speedtest.com → 10.11.34.146 → 138.44.5.1 → 129.94.39.23 → Local

Path2 : Local → 129.94.39.17 → 138.44.5.0 → 203.208.171.117 → 203.208.177.110 → speedtest.com

After observing, we can clearly find that the paths are totally different and asymmetric.

For the shared routers:

the first case has (139.130.0.78 and 139.130.0.77).

the second case have (138.44.5.0 and 138.44.5.1) , (129.94.39.23 and 129.94.39.17), etc.

The reason behind should be : different IP addresses of one router can be allocated with different tasks and interfaces. So that the router is working bidirectional.

Exercise 4: Use ping to gain insights into network performance

Q1: 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, Serdang 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?

Distance :

Sydney – Brisbane: 733km

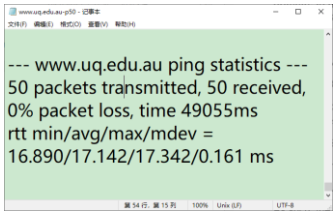
Sydney – Manila: 6267km

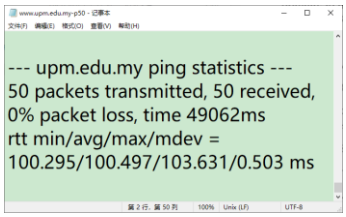
Sydney – Berlin: 16094km

As propagation speed is 3*10^8m/s, the shortest possible time for these 3 places are:

Brisbane : 2.44ms Manila: 20.89ms Berlin:53.65ms

Based on the *avg.txt files(as shown below), the min RTT (50 packets) of these 3 places are:

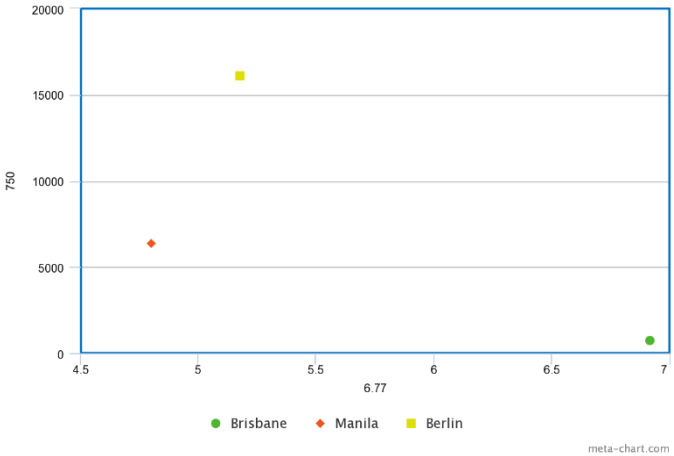




Brisbane : 16.89ms Manila: 100.295ms Berlin: 277.888ms

Hence, the ratio of these 3 places are:

Brisbane : 6.92 , Manila: 4.80 , Berlin:5.18

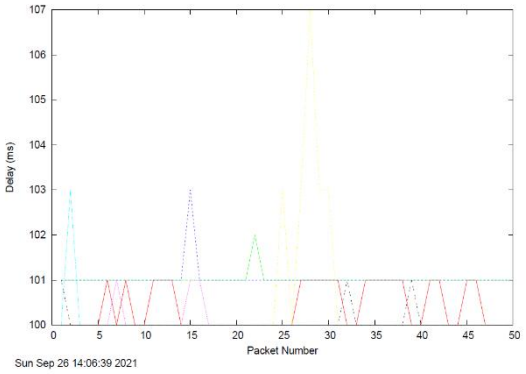


For the reasons that make these ratios > 2, maybe:

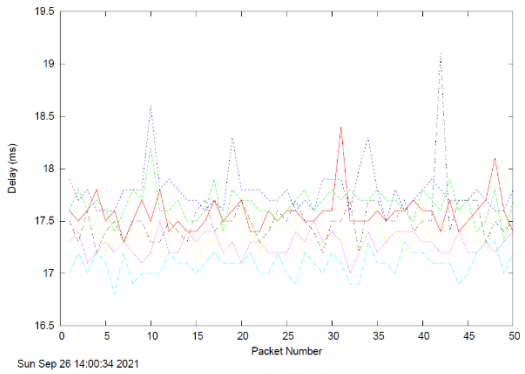
1. Packets need to be transmitted along multiple cables, hops and routers, rather than directly to the destination.
2. The transmission delay and queueing delay should also be taken into account.
3. The propagation speed can't reach the light speed in reality.
4. The paths that ISP leads may not be the shortest routing path.

Q2: Is the delay to the destinations constant or does it vary over time? Explain why.

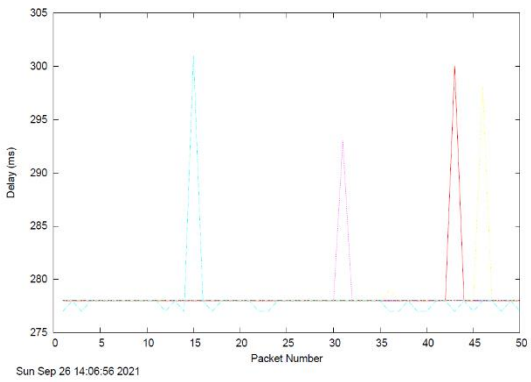
www.uq.edu.au_delay.pdf



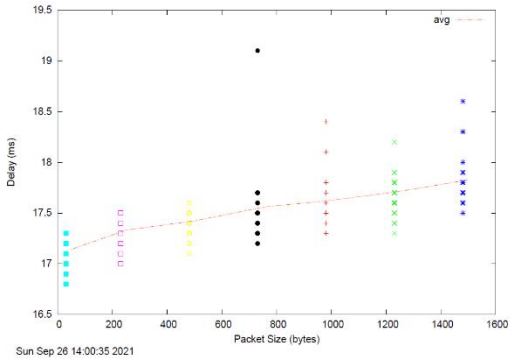
www.upm.edu.my_delay.pdf



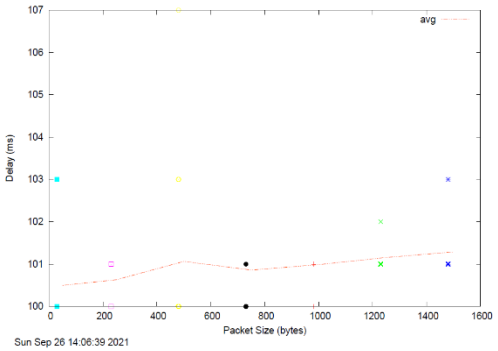
www.tu-berlin.de_delay.pdf



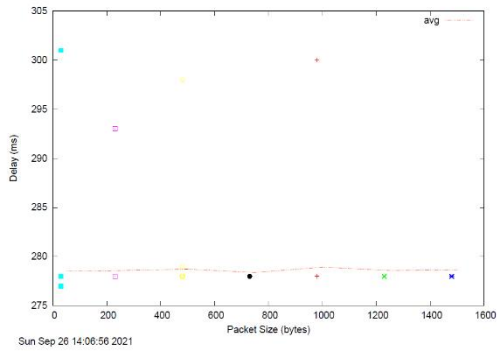
www.uq.edu.au_scatter.pdf



www.upm.edu.my_scatter.pdf



www.tu-berlin.de_scatter.pdf



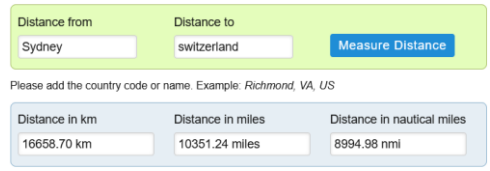
From the scatters, we can clearly find out that, there is no significant increase for the delay-packet line in the vertical direction. So the 3 delay-packet lines are all nearly constant, which means that the average delay does not seem to vary much for the different packet sizes.

For the reason behind:

1. As the destinations are all far away, the propagation delay may take the major part in the overall delay, and it could be significantly higher than the transmission delay(which is depended on the packet size).
2. Similarly, the queueing delay can also be significantly higher than the transmission delay. That means the network traffic conditions may have maintained a similar level of congestion during the test time.

Q3: Explore where the website for www.epfl.ch is hosted. Is it in Switzerland?

```
z5192519@weber:~$ ping www.epfl.ch
PING www.epfl.ch.cdn.cloudflare.net (104.20.229.42) 56(84) bytes of data.
64 bytes from 104.20.229.42: icmp_seq=1 ttl=56 time=1.27 ms
64 bytes from 104.20.229.42: icmp_seq=2 ttl=56 time=1.30 ms
64 bytes from 104.20.229.42: icmp_seq=3 ttl=56 time=1.29 ms
64 bytes from 104.20.229.42: icmp_seq=4 ttl=56 time=1.65 ms
^C
--- www.epfl.ch.cdn.cloudflare.net ping statistics ---
4 packets transmitted, 4 received, 0% packet loss, time 3004ms
rtt min/avg/max/mdev = 1.270/1.382/1.656/0.158 ms
```




```
z5192519@weber:~$ traceroute www.epfl.ch
traceroute to www.epfl.ch (104.20.229.42), 30 hops max, 60 byte packets
 1  cserouter1-server.cse.unsw.EDU.AU (129.94.242.251)  0.098 ms  0.067 ms  0.064 ms
 2  129.94.39.17 (129.94.39.17)  0.888 ms  0.906 ms  0.906 ms
 3  libudnex1-vl-3154.gw.unsw.edu.au (149.171.253.34)  1.859 ms ombudnex1-vl-3154.gw.unsw.edu.au (149.171.253.35)  1.744 ms libudnex1-vl-3154.gw.unsw.edu.au (149.171.253.34)  1.831 ms
 4  libcr1-po-6.gw.unsw.edu.au (149.171.255.201)  1.166 ms ombcr1-po-5.gw.unsw.edu.au (149.171.255.197)  1.120 ms libcr1-po-5.gw.unsw.edu.au (149.171.255.165)  1.080 ms
 5  unswbr1-te-1-9.gw.unsw.edu.au (149.171.255.101)  1.180 ms  1.193 ms  1.261 ms
 6  138.44.5.0 (138.44.5.0)  1.324 ms  1.255 ms  1.260 ms
 7  et-0-1-0.bdr1.msct.nsw.aarnet.net.au (113.197.15.109)  1.584 ms  1.526 ms  1.519 ms
 8  as13335.nsw.ix.asn.au (218.100.52.11)  3.273 ms  3.235 ms  3.188 ms
 9  104.20.229.42 (104.20.229.42)  1.709 ms  1.744 ms  1.757 ms
```

No, it isn't. By using Ping and traceroute, we can clearly find that it has a very low RTT, which is much shorter that the possible time calculated from distance.

Q4: 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 propagation delay doesn't relay on the packet size but the length of physical link, also the propagation speed. (dprop = d/s).
- The queuing delay is the time waiting at output link for transmission, and it only depends on congestion level of router. So, it doesn't depend on the packet size.
- The transmission delay depends on the packet size, and also the link transmission rate(bps). (dtrans = L/R).
- The nodal processing delay can depend on the packet size, as the larger packet may require longer time to be processed. But typically, this vary should be very small. So for a fixed packet size, it could still be taken as constant.