

# Comp9331 lab1 answer

## Exercise 1: nslookup

1.

```
z5319476@vx05:~/Desktop/9331lab1$ nslookup www.telstra.com.au
Server:      129.94.242.2
Address:     129.94.242.2#53

Non-authoritative answer:
www.telstra.com.au canonical name = d2l3pjybjlbg01.cloudfront.net.
Name:   d2l3pjybjlbg01.cloudfront.net
Address: 18.64.50.120
Name:   d2l3pjybjlbg01.cloudfront.net
Address: 18.64.50.29
Name:   d2l3pjybjlbg01.cloudfront.net
Address: 18.64.50.27
Name:   d2l3pjybjlbg01.cloudfront.net
Address: 18.64.50.49
Name:   d2l3pjybjlbg01.cloudfront.net
Address: 2600:9000:261d:d000:17:876d:b540:93a1
Name:   d2l3pjybjlbg01.cloudfront.net
Address: 2600:9000:261d:de00:17:876d:b540:93a1
Name:   d2l3pjybjlbg01.cloudfront.net
Address: 2600:9000:261d:fc00:17:876d:b540:93a1
Name:   d2l3pjybjlbg01.cloudfront.net
Address: 2600:9000:261d:2a00:17:876d:b540:93a1
Name:   d2l3pjybjlbg01.cloudfront.net
Address: 2600:9000:261d:4c00:17:876d:b540:93a1
Name:   d2l3pjybjlbg01.cloudfront.net
Address: 2600:9000:261d:4600:17:876d:b540:93a1
Name:   d2l3pjybjlbg01.cloudfront.net
Address: 2600:9000:261d:a200:17:876d:b540:93a1
Name:   d2l3pjybjlbg01.cloudfront.net
Address: 2600:9000:261d:3000:17:876d:b540:93a1
```

the IPv4 addresses of the website [www.telstra.com.au](http://www.telstra.com.au) are 18.64.50.120, 18.64.50.29, 18.64.50.27, 18.64.50.49. Because multiple IP address allow incoming requests to be distributed across several servers which can improve the balance the load (load balancing) and enhance the performance and speed of the website.

2.

```
z5319476@vx05:~/Desktop/9331lab1$ nslookup 127.0.0.1
1.0.0.127.in-addr.arpa name = localhost.
```

The name of the IP address 127.0.0.1 is localhost. When I try to connect to 127.0.0.1, I am connecting to the local host, i.e., My own computer. It's used to establish an IP connection to the same machine or computer that the request originated from. We often use localhost to test our software and applications.

## Exercise 2: Use ping to test host reachability (2 marks. 0.2 per each host)

Reachable:

[www.google.co.uk](http://www.google.co.uk) is reachable.

```
z5319476@vx05:~/Desktop/9331lab1$ ping www.google.co.uk
PING www.google.co.uk (142.250.66.195) 56(84) bytes of data.
64 bytes from syd09s23-in-f3.1e100.net (142.250.66.195): icmp_seq=1 ttl=115 time=11.7 ms
64 bytes from syd09s23-in-f3.1e100.net (142.250.66.195): icmp_seq=2 ttl=115 time=14.0 ms
```

[www.columbia.edu](http://www.columbia.edu) is reachable.

```
z5319476@vx05:~/Desktop/9331lab1$ ping www.columbia.edu
PING source.failover.cc.columbia.edu (128.59.105.24) 56(84) bytes of data.
64 bytes from columbiauniversity.net (128.59.105.24): icmp_seq=1 ttl=233 time=247 ms
64 bytes from columbiauniversity.net (128.59.105.24): icmp_seq=2 ttl=233 time=247 ms
```

[www.wikipedia.org](http://www.wikipedia.org) is reachable.

```
z5319476@vx05:~/Desktop/9331lab1$ ping www.wikipedia.org
PING dyna.wikimedia.org (103.102.166.224) 56(84) bytes of data.
64 bytes from text-lb.eqsin.wikimedia.org (103.102.166.224): icmp_seq=1 ttl=56 time=93.1 ms
64 bytes from text-lb.eqsin.wikimedia.org (103.102.166.224): icmp_seq=2 ttl=56 time=93.1 ms
```

[hhh.gs](http://hhh.gs) is reachable.

```
z5319476@vx05:~/Desktop/9331lab1$ ping hhh.gs
PING hhh.gs (103.120.80.144) 56(84) bytes of data.
64 bytes from 103.120.80.144: icmp_seq=1 ttl=50 time=211 ms
64 bytes from 103.120.80.144: icmp_seq=2 ttl=50 time=210 ms
```

[yes.no](http://yes.no) is reachable.

```
z5319476@vx12:~/Desktop/9331lab1$ ping yes.no
PING yes.no (162.241.218.145) 56(84) bytes of data.
64 bytes from box5569.bluehost.com (162.241.218.145): icmp_seq=1 ttl=51 time=281 ms
64 bytes from box5569.bluehost.com (162.241.218.145): icmp_seq=2 ttl=51 time=281 ms
```

[one.one.one.one](http://one.one.one.one) is reachable.

```
z5319476@vx12:~/Desktop/9331lab1$ ping one.one.one.one
PING one.one.one.one (1.0.0.1) 56(84) bytes of data.
64 bytes from one.one.one.one (1.0.0.1): icmp_seq=1 ttl=55 time=2.13 ms
64 bytes from one.one.one.one (1.0.0.1): icmp_seq=2 ttl=55 time=1.78 ms
```

[theguardian.com](http://theguardian.com) is reachable.

```
z5319476@vx12:~/Desktop/9331lab1$ ping theguardian.com
PING theguardian.com (151.101.129.111) 56(84) bytes of data.
64 bytes from 151.101.129.111 (151.101.129.111): icmp_seq=1 ttl=56 time=1.29 ms
64 bytes from 151.101.129.111 (151.101.129.111): icmp_seq=2 ttl=56 time=1.39 ms
```

[xn--i-7iq.ws](#) is reachable.

```
ping: warning: icmp: command name or service not known
z5319476@vx12:~/Desktop/9331lab1$ ping xn--i-7iq.ws
PING i7iq.ws (132.148.137.119) 56(84) bytes of data:
64 bytes from 119.137.148.132.host.secureserver.net (132.148.137.119): icmp_seq=1 ttl=48 time=267 ms
64 bytes from 119.137.148.132.host.secureserver.net (132.148.137.119): icmp_seq=2 ttl=48 time=267 ms
```

### Unreachable:

[ec.ho](#) is unreachable because the host ec.ho does not exist.

```
z5319476@vx12:~/Desktop/9331lab1$ ping ec.ho
ping: ec.ho: Name or service not known
```

[defence.gov.au](#) is unreachable. I can't receive a response from that host. The firewall configuration on it may block ICMP requests, including Ping requests. The system administrators disable responses to Ping requests to enhance network security or reduce network load.

## Exercise 3: Use traceroute to understand the network topology (4 marks)

1. Run traceroute on your machine to **usi.ch** (NOT [www.usi.ch](#) )

1.

```
z5319476@vx05:~/Desktop/9331lab1$ traceroute usi.ch
traceroute to usi.ch (195.176.55.64), 30 hops max, 60 byte packets
 1 cserouter1-server.orchestra.cse.unsw.EDU.AU (129.94.242.251) 0.047 ms 0.048 ms 0.078 ms
 2 129.94.39.17 (129.94.39.17) 0.873 ms 0.840 ms 0.879 ms
 3 172.17.31.154 (172.17.31.154) 2.205 ms 1.504 ms 1.471 ms
 4 172.17.17.9 (172.17.17.9) 1.066 ms 172.17.17.45 (172.17.17.45) 1.157 ms 1.173 ms
 5 172.17.17.102 (172.17.17.102) 1.199 ms 172.17.17.110 (172.17.17.110) 1.204 ms 172.17.17.102 (172.17.17.102) 1.106 ms
 6 138.44.5.0 (138.44.5.0) 1.455 ms 1.704 ms 1.667 ms
 7 et-1-1-0.pe1.rsby.nsw.aarnet.net.au (113.197.15.12) 1.777 ms 1.626 ms 1.780 ms
 8 xe-1-1-0.pe1.eskp.nsw.aarnet.net.au (113.197.15.199) 2.848 ms 3.103 ms 2.930 ms
 9 et-0-3-0.pe1.prka.sa.aarnet.net.au (113.197.15.42) 20.152 ms 20.215 ms 19.964 ms
10 et-0-3-0.pe1.knsg.wa.aarnet.net.au (113.197.15.45) 46.218 ms 46.067 ms 46.238 ms
11 et-1-0-5.bdr1.sing.sin.aarnet.net.au (113.197.15.231) 92.217 ms 92.160 ms 92.169 ms
12 138.44.226.7 (138.44.226.7) 256.490 ms 256.391 ms 256.352 ms
13 ae2.mx1.lon2.uk.geant.net (62.40.98.65) 270.981 ms 270.997 ms 270.928 ms
14 ae8.mx1.par.fr.geant.net (62.40.98.107) 263.267 ms 263.812 ms 263.609 ms
15 ae7.mx1.gen.ch.geant.net (62.40.98.238) 270.462 ms 270.910 ms 270.472 ms
16 swice1-100ge-0-3-0-1.switch.ch (62.40.124.22) 272.814 ms 272.265 ms 272.254 ms
17 swilG2-400GE-0-0-0-0.switch.ch (130.59.38.70) 276.495 ms 277.034 ms 276.980 ms
18 swilG1-B1.switch.ch (130.59.36.77) 275.094 ms 274.655 ms 274.854 ms
19 lu-pop1-bkb02-100g-1-0-48.usi.ch (195.176.176.210) 274.841 ms 274.838 ms 275.286 ms
20 ma-pop1-dcfw01.net.ti-edu.ch (195.176.176.34) 274.580 ms 275.071 ms 274.618 ms
21 selenio.ti-edu.ch (195.176.55.64) 275.888 ms 275.973 ms 275.672 ms
```

There are 20 routers between my workstation and usi.ch from the output because in the last hop the packet has been sent to the destination. There are 2 routers along

the path are part of the UNSW network which are the first router (129.94.242.251) and the second router (129.94.39.17) according to their hostnames.

2. the first router outside of Australia appears to be

**138.44.226.7 (138.44.226.7)**

because from the output information, it can be seen that the round-trip time (RTT) of the 12th router has significantly increased compared to the 11th router.

```
 9 et-0-3-0.pe1.prka.sa.aarnet.net.au (113.197.15.42) 21.247 ms 21.266 ms 21.405 ms
10 et-0-3-0.pe1.knsg.wa.aarnet.net.au (113.197.15.45) 45.972 ms 45.887 ms 46.104 ms
11 et-1_0_5.bdr1.sing.sin.aarnet.net.au (113.197.15.231) 92.530 ms 94.996 ms 95.004 ms
12 138.44.226.7 (138.44.226.7) 256.224 ms 256.125 ms 256.094 ms
```

3. the first router in Europe/UK is **ae2.mx1.lon2.uk.geant.net(62.40.98.65)** because we can know this router is located in UK according to the part of hostname 'lon2.uk'.

## 2.

jhu.edu:

```
z5319476@vx05:~/Desktop/9331lab1$ traceroute jhu.edu
traceroute to jhu.edu (128.220.192.230), 30 hops max, 60 byte packets
 1 cserouter1-server.orchestra.cse.unsw.EDU.AU (129.94.242.251) 0.044 ms 0.055 ms 0.045 ms
 2 129.94.39.17 (129.94.39.17) 0.926 ms 0.844 ms 0.860 ms
 3 172.17.31.154 (172.17.31.154) 2.151 ms 1.559 ms 2.105 ms
 4 172.17.17.45 (172.17.17.45) 1.255 ms 172.17.17.9 (172.17.17.9) 1.198 ms 172.17.17.45 (172.17.17.45) 1.216 ms
 5 172.17.17.110 (172.17.17.110) 1.194 ms 172.17.17.102 (172.17.17.102) 1.163 ms 172.17.17.110 (172.17.17.110) 1.238 ms
 6 138.44.5.0 (138.44.5.0) 1.366 ms 1.352 ms 1.362 ms
 7 et-0-3-0.pe1.bkvl.nsw.aarnet.net.au (113.197.15.147) 1.694 ms 1.821 ms 1.748 ms
 8 113.197.15.151 (113.197.15.151) 71.525 ms 71.528 ms 71.495 ms
 9 138.44.228.5 (138.44.228.5) 185.239 ms 185.260 ms 185.325 ms
10 fourhundredge-0-0-0-2.4079.core2.salt.net.internet2.edu (163.253.1.115) 243.776 ms 243.736 ms 243.771 ms
11 fourhundredge-0-0-0-0.4079.core2.denv.net.internet2.edu (163.253.1.168) 244.040 ms 244.125 ms 244.001 ms
12 fourhundredge-0-0-0-0.4079.core2.kans.net.internet2.edu (163.253.1.251) 244.903 ms 244.948 ms 244.832 ms
13 fourhundredge-0-0-0-0.4079.core1.chic.net.internet2.edu (163.253.2.28) 243.987 ms 243.423 ms 243.380 ms
14 fourhundredge-0-0-0-0.4079.core1.eqch.net.internet2.edu (163.253.1.207) 244.619 ms 243.186 ms 243.256 ms
15 fourhundredge-0-0-0-0.4079.core1.clev.net.internet2.edu (163.253.1.210) 245.532 ms 244.578 ms 244.610 ms
16 fourhundredge-0-0-0-3.4079.core1.ashb.net.internet2.edu (163.253.1.122) 243.647 ms 243.608 ms 243.593 ms
17 et-0-1-8-1275.ashb-core.maxgigapop.net (206.196.177.2) 242.469 ms 243.383 ms 242.435 ms
18 206.196.178.141 (206.196.178.141) 242.329 ms 242.323 ms 242.394 ms
19 addr16212925394.testippl.jhmi.edu (162.129.253.94) 242.366 ms addr16212925332.testippl.jhmi.edu (162.129.253.32) 242.294 ms 242.268 ms
20 162.129.255.245 (162.129.255.245) 244.763 ms 244.833 ms 244.782 ms
21 * * *
22 * * *
23 * * *
24 * * *
25 collaborate.johnshopkins.edu (128.220.192.230) 248.471 ms 248.594 ms 249.384 ms
```

usp.br:

```
z5319476@vx05:~/Desktop/9331lab1$ traceroute usp.br
traceroute to usp.br (200.144.248.41), 30 hops max, 60 byte packets
 1 cserouter1-server.orchestra.cse.unsw.EDU.AU (129.94.242.251) 0.065 ms 0.075 ms 0.065 ms
 2 129.94.39.17 (129.94.39.17) 0.883 ms 0.893 ms 0.826 ms
 3 172.17.31.154 (172.17.31.154) 1.620 ms 1.632 ms 2.036 ms
 4 172.17.17.45 (172.17.17.45) 1.391 ms 1.356 ms 1.367 ms
 5 172.17.17.110 (172.17.17.110) 1.160 ms 172.17.17.102 (172.17.17.102) 1.110 ms 1.184 ms
 6 138.44.5.0 (138.44.5.0) 1.736 ms 1.415 ms 1.580 ms
 7 et-1-1-0-pe1.mcqp.nsw.aarnet.net.au (113.197.15.4) 2.987 ms 2.755 ms 2.764 ms
 8 et-0-0-2-bdr1.guam.gum.aarnet.net.au (113.197.14.137) 71.436 ms 71.474 ms 71.493 ms
 9 138.44.228.5 (138.44.228.5) 186.138 ms 185.996 ms 186.088 ms
10 fourhundredge-0-0-0-19.4079.core2.losa.net.internet2.edu (163.253.1.47) 232.348 ms 232.367 ms fourhundredge-0-0-0-20.4079.core2.losa.net.internet2.edu (163.253.1.49) 232.257 ms
11 fourhundredge-0-0-0-0.4079.core2.elpa.net.internet2.edu (163.253.1.202) 232.315 ms 232.266 ms 233.000 ms
12 fourhundredge-0-0-0-0.4079.core1.elpa.net.internet2.edu (163.253.1.74) 232.339 ms fourhundredge-0-0-0-21.4079.core1.elpa.net.internet2.edu (163.253.1.70) 231.917 ms fourhundredge-0-0-0-22.4079.core1.elpa.net.internet2.edu (163.253.1.72) 231.842 ms
13 fourhundredge-0-0-0-0.4079.core1.hous.net.internet2.edu (163.253.2.39) 232.279 ms 231.119 ms 230.795 ms
14 fourhundredge-0-0-0-0.4079.core1.houh.net.internet2.edu (163.253.2.24) 232.015 ms 233.130 ms 233.061 ms
15 fourhundredge-0-0-0-0.4079.core1.pens.net.internet2.edu (163.253.2.35) 231.896 ms 232.710 ms 232.775 ms
16 fourhundredge-0-0-0-0.4079.core1.jack.net.internet2.edu (163.253.1.0) 232.077 ms 231.998 ms 231.950 ms
17 64.57.28.62 (64.57.28.62) 236.705 ms 236.649 ms 236.727 ms
18 mia2-mia1.bkb.rnp.br (200.143.252.26) 237.303 ms 237.084 ms 237.139 ms
19 cce2-mia2-monet.bkb.rnp.br (170.79.213.46) 301.097 ms 300.952 ms 303.127 ms
20 sp2-cce2-tisparkle.bkb.rnp.br (170.79.213.3) 344.051 ms 343.920 ms 343.848 ms
21 as28571.saopaulo.sp.ix.br (187.16.220.3) 344.870 ms 344.863 ms 344.839 ms
22 e72361-sp2-r06-nx-swc.uspnet.usp.br (143.107.249.38) 342.879 ms 342.729 ms 342.650 ms
23 * * *
24 * * *
25 * * *
26 * * *
27 * * *
28 * * *
29 * * *
30 * * *
```

ed.ac.uk:

```
z5319476@vx05:~/Desktop/9331lab1$ traceroute ed.ac.uk
traceroute to ed.ac.uk (129.215.97.20), 30 hops max, 60 byte packets
 1 cserouter1-server.orchestra.cse.unsw.EDU.AU (129.94.242.251) 0.051 ms 0.063 ms 0.053 ms
 2 129.94.39.17 (129.94.39.17) 0.928 ms 0.884 ms 0.908 ms
 3 172.17.31.154 (172.17.31.154) 2.046 ms 1.611 ms 2.001 ms
 4 172.17.17.9 (172.17.17.9) 1.301 ms 1.264 ms 1.281 ms
 5 172.17.17.102 (172.17.17.102) 1.272 ms 172.17.17.110 (172.17.17.110) 1.122 ms 172.17.17.102 (172.17.17.102) 1.277 ms
 6 138.44.5.0 (138.44.5.0) 1.762 ms 1.443 ms 1.454 ms
 7 et-1-1-0-pe1.mcqp.nsw.aarnet.net.au (113.197.15.4) 4.647 ms 4.349 ms 4.197 ms
 8 et-0-3-0-pe1.eskp.nsw.aarnet.net.au (113.197.15.3) 2.989 ms 2.868 ms 3.012 ms
 9 et-0-3-0-pe1.prka.sa.aarnet.net.au (113.197.15.42) 20.374 ms 20.388 ms 20.428 ms
10 et-0-3-0-pe1.knsg.wa.aarnet.net.au (113.197.15.45) 46.078 ms 46.129 ms 46.042 ms
11 et-1-0-5-bdr1.sing.sin.aarnet.net.au (113.197.15.231) 92.420 ms 92.418 ms 92.357 ms
12 138.44.226.7 (138.44.226.7) 264.858 ms 262.960 ms 262.848 ms
13 ae2.mx1.lon2.uk.geant.net (62.40.98.65) 256.880 ms 256.824 ms 256.823 ms
14 janet-bckp-gw.mx1.lon2.uk.geant.net (62.40.125.58) 257.724 ms 257.809 ms 257.806 ms
15 ae31.erdiss-sbr2.ja.net (146.97.33.22) 261.662 ms 265.190 ms 264.968 ms
16 ae29.manckh-sbr2.ja.net (146.97.33.42) 263.157 ms 263.757 ms 263.700 ms
17 ae31.glasss-sbr1.ja.net (146.97.33.54) 267.808 ms 268.738 ms 268.152 ms
18 ae29.edinat-rbr2.ja.net (146.97.38.38) 269.668 ms 268.780 ms 269.217 ms
19 ae25.edinkb-rbr2.ja.net (146.97.74.34) 270.656 ms 270.663 ms 282.419 ms
20 university-of-edinburgh.ja.net (146.97.156.78) 269.374 ms 269.302 ms 269.225 ms
21 remote.net.ed.ac.uk (192.41.103.209) 269.367 ms 269.135 ms 269.128 ms
22 * * *
23 * * *
24 * * *
25 * * *
26 * * *
27 * * *
28 * * *
29 * * *
30 * * *
```

1. We can see that the first 6 hops are almost same on all 3 paths. The 3 paths differ in the next hop following the 138.44.5.0 router. Therefore, at 138.44.5.0, the paths from my machine to these three destinations diverge.
2. No, the number of hops is clearly not proportional to the physical distance because the path to usp.br is shorter than that to jhu.edu and the number of hops for usp.br(30) is larger than that(25) of jhu.edu.

3. the IP addresses of the two servers that you have chosen is [www.as13030.net](http://www.as13030.net) and

[www.net.princeton.edu](http://www.net.princeton.edu).

IP address of my laptop: 172.34.25.2

My laptop to [www.as13030.net](http://www.as13030.net):

```
z5319476@vx10:~/Desktop$ traceroute www.as13030.net
traceroute to www.as13030.net (213.144.137.198), 30 hops max, 60 byte packets
 1 cserouter1-server.orchestra.cse.unsw.EDU.AU (129.94.242.251) 0.050 ms 0.060 ms 0.048 ms
 2 129.94.39.17 (129.94.39.17) 0.915 ms 0.813 ms 0.911 ms
 3 172.17.31.154 (172.17.31.154) 1.618 ms 1.589 ms 1.982 ms
 4 172.17.17.9 (172.17.17.9) 1.148 ms 1.182 ms 1.153 ms
 5 172.17.17.102 (172.17.17.102) 1.250 ms 172.17.17.110 (172.17.17.110) 1.299 ms 172.17.17.102 (172.17.17.102) 1.277 ms
 6 138.44.5.0 (138.44.5.0) 1.716 ms 1.453 ms 1.458 ms
 7 et-0-3-0.pe1.bkvl.nsw.aarnet.net.au (113.197.15.147) 3.358 ms 3.044 ms 3.046 ms
 8 xe-0-2-5.bdr1.b.sea.aarnet.net.au (202.158.194.121) 140.750 ms 140.675 ms 140.686 ms
 9 xe-4-1-1.mpr1.sea1.us.above.net (64.125.193.129) 140.995 ms 140.906 ms 140.862 ms
10 ae27.cs1.sea1.us.eth.zayo.com (64.125.29.0) 262.981 ms 263.017 ms 263.020 ms
11 * * *
12 * * *
13 * * *
14 ae4.mpr1.lhr15.uk.zip.zayo.com (64.125.28.195) 262.806 ms 263.131 ms 263.058 ms
15 linx-1.init7.net (195.66.224.175) 263.761 ms 263.666 ms 263.792 ms
16 r2lon2.core.init7.net (5.180.135.248) 263.765 ms 263.956 ms 263.782 ms
17 r2fra3.core.init7.net (5.180.135.129) 274.971 ms 274.726 ms 274.845 ms
18 r1fra3.core.init7.net (80.81.192.67) 275.900 ms 275.685 ms 287.094 ms
19 r2zrh2.core.init7.net (5.180.135.172) 281.025 ms 280.238 ms 280.307 ms
20 r2zrh5.core.init7.net (5.180.135.233) 280.297 ms 280.216 ms 280.143 ms
21 r1glb3.core.init7.net (5.180.135.68) 280.650 ms 280.742 ms 280.746 ms
22 r1zrh10.core.init7.net (5.180.135.58) 280.361 ms 280.265 ms 280.297 ms
23 r1win9.core.init7.net (5.180.135.57) 280.827 ms 280.764 ms 280.879 ms
24 r1win7.core.init7.net (5.180.135.24) 280.915 ms 281.161 ms 281.310 ms
25 r1win1.core.init7.net (5.180.134.123) 280.908 ms 280.849 ms 280.874 ms
26 r2win7.core.init7.net (5.180.134.124) 281.184 ms 281.238 ms 281.290 ms
27 * * *
28 * * *
29 * * *
30 * * *
```

[www.as13030.net](http://www.as13030.net) to my laptop:

```
traceroute to 172.34.25.2 (172.34.25.2), 30 hops max, 60 byte packets
 1 r2win7.core.init7.net (213.144.137.193) [AS13030] 1.140 ms 1.354 ms 1.606 ms
 2 r1win1.core.init7.net (5.180.134.125) [AS13030] 1.155 ms 1.545 ms 1.933 ms
 3 r1win7.core.init7.net (5.180.134.122) [AS13030] 1.028 ms 1.263 ms 1.568 ms
 4 r1win9.core.init7.net (5.180.135.25) [AS13030] 0.928 ms 1.100 ms 1.415 ms
 5 r1zrh10.core.init7.net (5.180.135.56) [AS13030] 1.357 ms 1.631 ms 1.977 ms
 6 r1glb3.core.init7.net (5.180.135.59) [AS13030] 1.304 ms 1.589 ms 1.904 ms
 7 r2zrh5.core.init7.net (5.180.135.69) [AS13030] 1.530 ms 1.850 ms 1.440 ms
 8 r2zrh2.core.init7.net (5.180.135.232) [AS13030] 13.451 ms 13.599 ms 13.940 ms
 9 * * *
10 xe-1-2-0.mpr1.fra4.de.above.net (80.81.194.26) [*] 13.481 ms 13.468 ms 13.449 ms
11 ae12.cs1.fra6.de.eth.zayo.com (64.125.26.172) [*] 100.031 ms 100.023 ms *
12 ae2.cs1.ams17.nl.eth.zayo.com (64.125.29.59) [*] 99.895 ms * *
13 * * *
14 ae10.cs1.lhr15.uk.eth.zayo.com (64.125.29.17) [*] 99.594 ms 99.583 ms 99.567 ms
15 * * *
16 * * *
17 * * *
18 ae6.mcs1.ord2.us.eth.zayo.com (64.125.31.51) [*] 100.218 ms 99.993 ms 99.985 ms
19 * * *
20 * * *
```



## My laptop to www.net.princeton.edu:

```
z5319476@vx10:~/Desktop$ traceroute www.net.princeton.edu
traceroute to www.net.princeton.edu (128.112.128.55), 30 hops max, 60 byte packets
 1 cserouter1-server.orchestra.cse.unsw.EDU.AU (129.94.242.251) 0.054 ms 0.069 ms 0.059 ms
 2 129.94.39.17 (129.94.39.17) 0.846 ms 0.864 ms 0.872 ms
 3 172.17.31.154 (172.17.31.154) 2.052 ms 2.021 ms 1.751 ms
 4 172.17.17.45 (172.17.17.45) 1.144 ms 1.164 ms 172.17.17.9 (172.17.17.9) 1.196 ms
 5 172.17.17.102 (172.17.17.102) 1.435 ms 1.258 ms 1.433 ms
 6 138.44.5.0 (138.44.5.0) 1.810 ms 1.461 ms 1.446 ms
 7 et-1-1-0.pe1.mcqp.nsw.aarnet.net.au (113.197.15.4) 1.839 ms 1.773 ms 1.752 ms
 8 et-0-0-2.bdr1.guam.gum.aarnet.net.au (113.197.14.137) 71.604 ms 71.613 ms 71.620 ms
 9 138.44.228.5 (138.44.228.5) 186.094 ms 186.112 ms 186.000 ms
10 fourhundredge-0-0-0-2.4079.core2.salt.net.internet2.edu (163.253.1.115) 248.816 ms 248.622 ms 248.573 ms
11 fourhundredge-0-0-0-21.4079.core1.salt.net.internet2.edu (163.253.1.28) 248.035 ms fourhundredge-0-0-0-22.4079.core1.salt.net.internet2.edu (163.253.1.30) 248.093 ms fourhundredge-0-0-0-21.4079.core1.salt.net.internet2.edu (163.253.1.28) 249.857 ms
12 fourhundredge-0-0-0-0.4079.core1.denv.net.internet2.edu (163.253.1.170) 247.403 ms 249.043 ms 249.000 ms
13 fourhundredge-0-0-0-0.4079.core1.kans.net.internet2.edu (163.253.1.243) 247.256 ms 247.318 ms 247.308 ms
14 fourhundredge-0-0-0-22.4079.core2.chic.net.internet2.edu (163.253.1.97) 248.539 ms fourhundredge-0-0-0-3.4079.core2.chic.net.internet2.edu (163.253.1.244) 247.956 ms 247.944 ms
15 fourhundredge-0-0-0-3.4079.core2.eqch.net.internet2.edu (163.253.2.19) 248.822 ms 249.838 ms 249.840 ms
16 fourhundredge-0-0-0-0.4079.core2.clev.net.internet2.edu (163.253.2.16) 247.429 ms 248.620 ms 248.527 ms
17 fourhundredge-0-0-0-3.4079.core2.ashb.net.internet2.edu (163.253.1.138) 248.090 ms 247.890 ms 249.411 ms
18 fourhundredge-0-0-0-1.4079.core1.phil.net.internet2.edu (163.253.1.137) 247.926 ms 249.605 ms 247.625 ms
19 163.253.5.9 (163.253.5.9) 246.866 ms 249.098 ms 248.567 ms
20 172.96.130.54 (172.96.130.54) 247.196 ms 247.057 ms 247.717 ms
21 fw-border-87-router.princeton.edu (204.153.48.2) 247.503 ms 247.540 ms 247.654 ms
22 rtr-core-east-router.princeton.edu (128.112.12.9) 248.048 ms 247.875 ms 248.026 ms
23 core-ns-router.princeton.edu (128.112.12.226) 248.952 ms 248.670 ms 248.522 ms
24 www.net.princeton.edu (128.112.128.55) 248.032 ms 247.928 ms 247.911 ms
```

## www.net.princeton.edu to my laptop:

tracing path from www.net.princeton.edu to 172.34.25.2 ...

```
traceroute to 172.34.25.2 (172.34.25.2), 30 hops max, 40 byte packets
 1 128.112.128.2 1.098 ms 0.756 ms 3.040 ms
 2 128.112.12.229 0.789 ms 0.719 ms 0.609 ms
 3 128.112.12.14 1.071 ms 1.033 ms 0.972 ms
 4 204.153.48.253 1.396 ms 1.357 ms 1.324 ms
 5 172.96.130.49 4.293 ms 3.802 ms 4.233 ms
 6 198.71.47.232 5.403 ms 5.868 ms 6.151 ms
 7 163.253.2.149 5.561 ms 5.965 ms 4.153 ms
 8 162.252.69.209 3.011 ms 2.697 ms 2.628 ms
 9 * * *
10 * * *
11 64.125.24.83 22.522 ms 22.215 ms 64.125.31.51 19.509 ms
12 * * *
13 * * *
14 * * *
15 * * *
16 * * *
17 * * *
18 * * *
19 * * *
20 * * *
21 * * *
22 * * *
23 * * *
24 * * *
25 * * *
26 * * *
27 * * *
28 * * *
29 * * *
30 * * *
```

Done.

We can clearly see through the pictures the reverse path go through some same routers

as the forward path, such as 'r1win7.core.init7.net'.

However, I did not observe the same IP addresses. I think it is common because to achieve better load balancing, the management station may allow data packet to pass through independent route and sometimes the router may have different IP addresses.

#### Exercise 4: Use ping to gain insights into network performance (4 marks)

1. The approximate physical distance between UNSW and **Charles Darwin University** is 377.34km.

The approximate physical distance between UNSW and **Universidade de São Paulo (USP)** is 13491.79km.

The approximate physical distance between UNSW and **The University of Edinburgh** is 16880.15km.

shortest possible time  $T$  for a packet from UNSW to **Charles Darwin University** is  $377.34 / (3 \times 10^8 \text{ m/s}) = 1.2578\text{ms}$

shortest possible time  $T$  for a packet from UNSW to **Universidade de São Paulo (USP)** is  $13491.79 / (3 \times 10^8 \text{ m/s}) = 44.97\text{ms}$

shortest possible time  $T$  for a packet from UNSW to **The University of Edinburgh** is  $16880.15 / (3 \times 10^8 \text{ m/s}) = 56.27\text{ms}$

2. The 50-byte packets RTT to **Charles Darwin University** from the avg.txt file is 54.426ms.  
The 50-byte packets RTT to **Universidade de São Paulo (USP)** from the avg.txt file is 344.794ms.

The 50-byte packets RTT to **The University of Edinburgh** from the avg.txt file is 268.877ms.

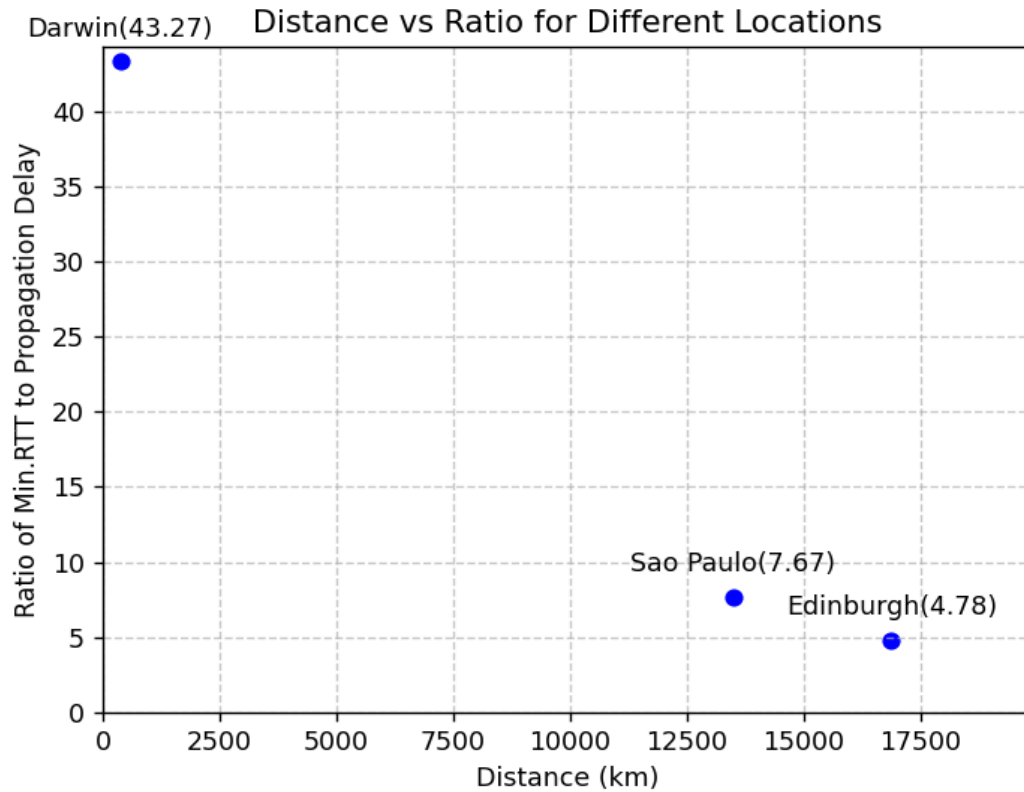
the ratio for **Charles Darwin University** is 43.27.

the ratio for **Universidade de São Paulo (USP)** is 7.67.

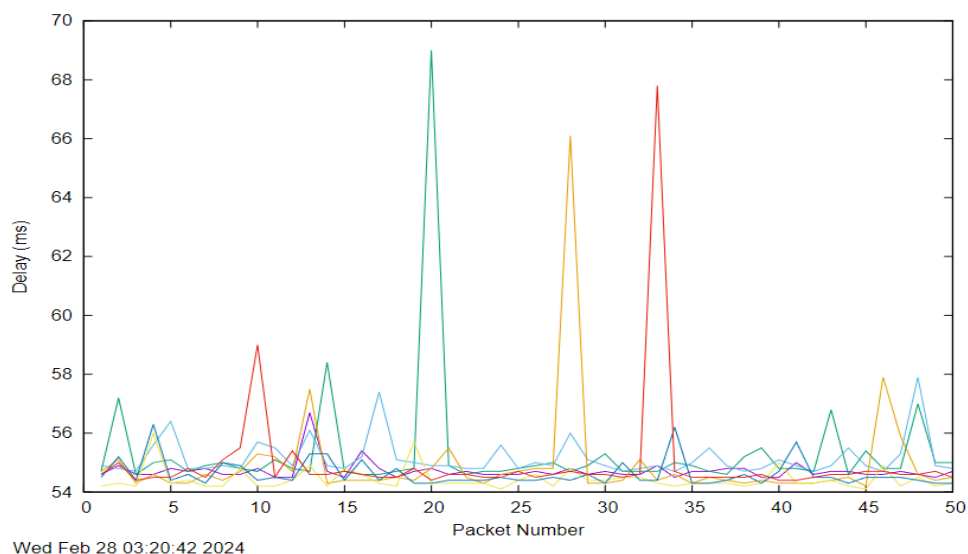
the ratio for **The University of Edinburgh** is 4.78.

the following picture:

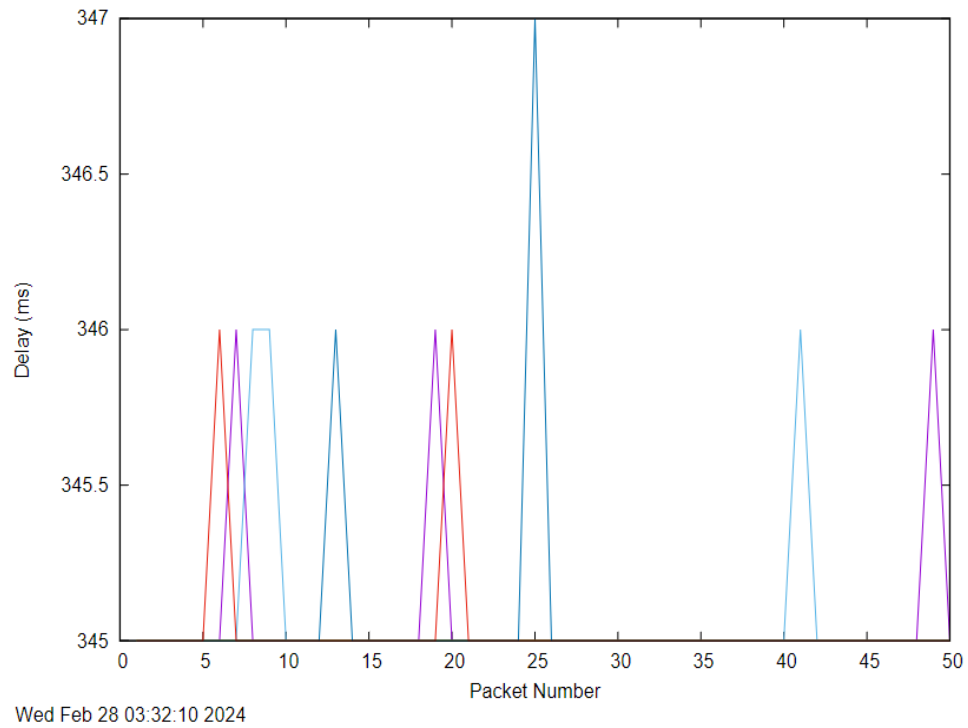




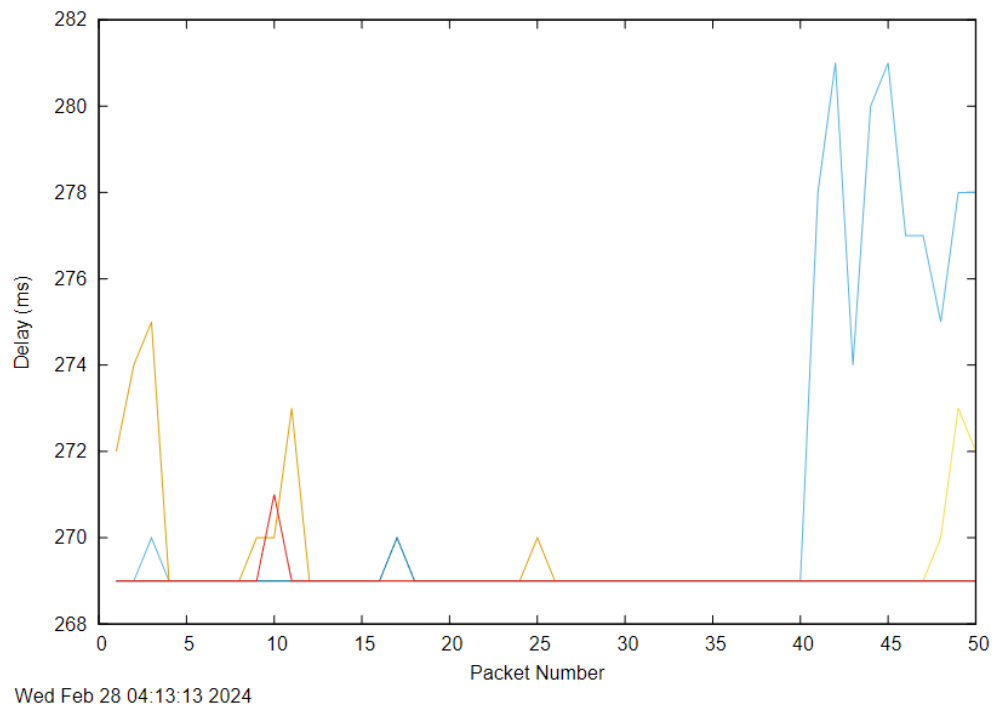
3. (i) Because the network path is not a straight-line transmission, which means that data packets are not directly transmitted, but are transmitted through multiple devices and connection paths in the network.  
 (ii) There may be low bandwidth links in the network, so the speed of transmission will be slow.  
 (iii) Network communication is usually carried out through the network of ISP. They may choose some relatively long paths to transmit packets, which increases the distance and time of transmission.
4. Firstly, we got some pictures which show the change of delay for different packet number.  
**cdu.edu.au**



usp.br



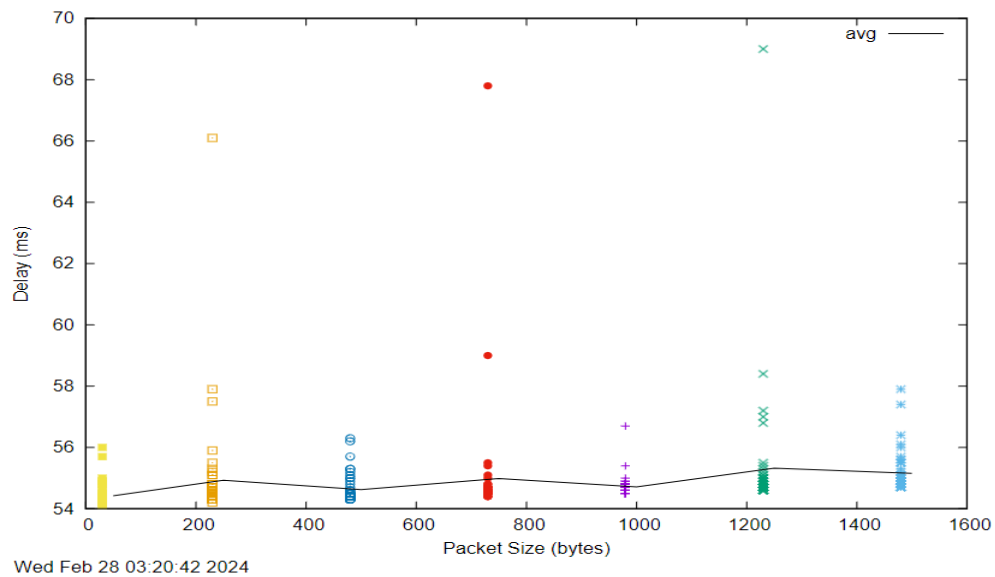
ed.ac.uk



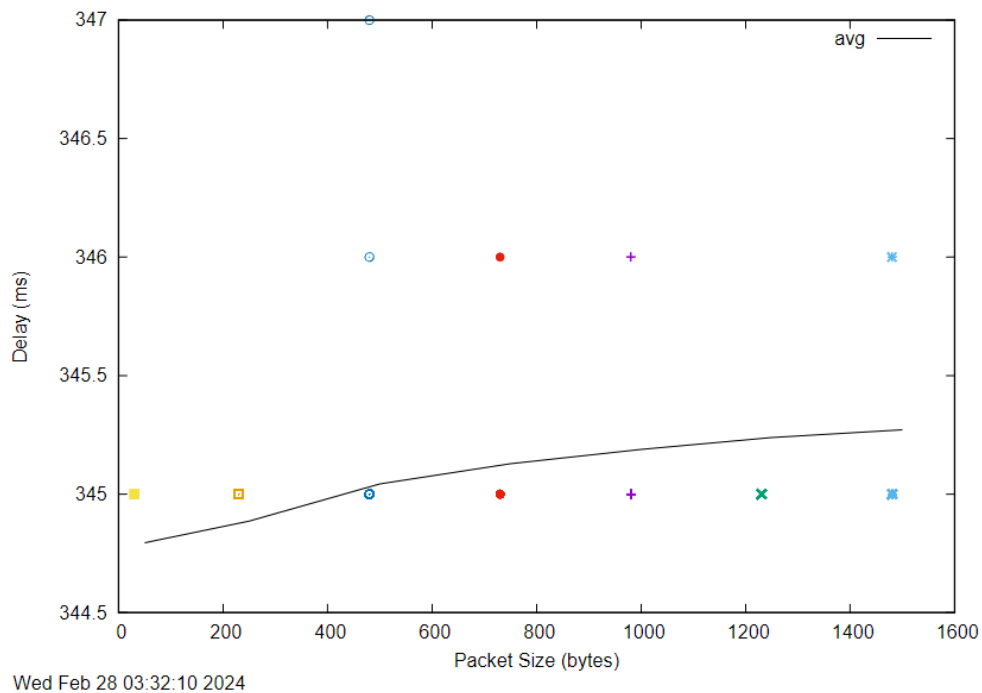
We can see from these plots that the delay varies over time. In network, packets may encounter different processing and queuing times during transmission, which may vary

5. The following plots show the delay for different packet size.

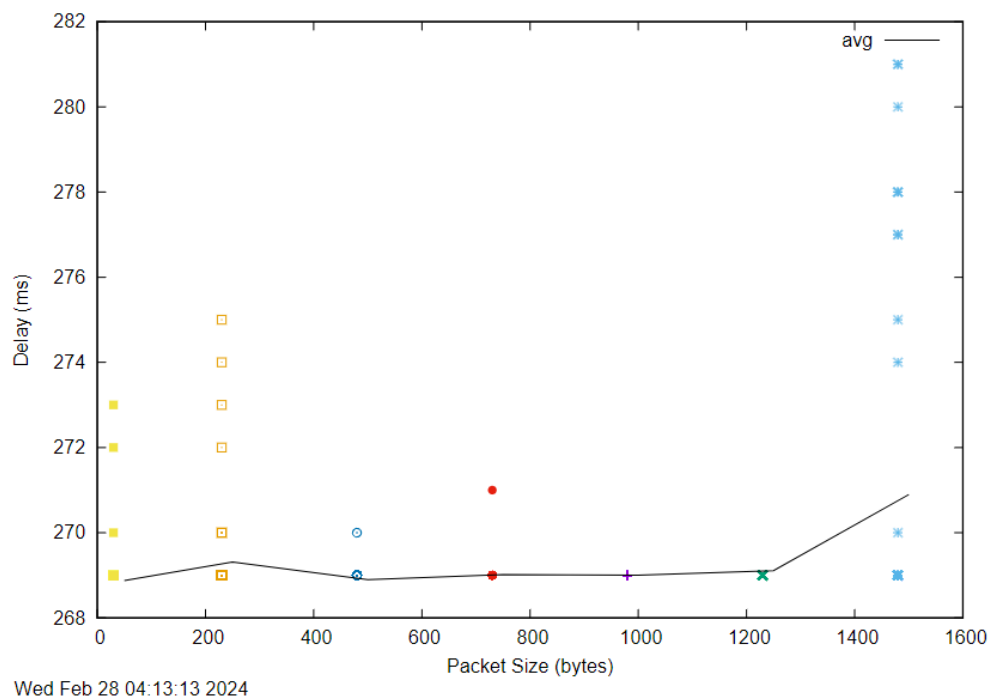
cdu.edu.au



usp.br



ed.ac.uk



**Propagation delay** is usually not related to the size of the data packet, but rather to the physical distance (or connection method) of the network connection.

**Transmission latency** typically varies due to changes in packet size, which is directly proportional to the packet size.

**Processing delay** is affected by the size of the data packet. Processing delay refers to the time required for network devices to process data packets. Therefore, the larger the data packet, the longer the processing delay, but the change in delay will be relatively small.

**Queuing delay** is usually independent of packet size and mainly depends on the level of congestion in the network.