Exercise 1

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?

```
z5238059@vx8:/tmp_amd/cage/export/cage/5/z5238059$ 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: 104.18.60.21
```

The IP address of the website www.koala.com.au is 104.18.61.21 and 104.18.60.21.

In my opinion, the reason of having several IP addresses as an output is the website has two IP addresses. This is because that it can be for load balancing or redundancy, or to serve web pages based on the user location.

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

```
z5238059@vx5:/tmp_amd/cage/export/cage/5/z5238059$ nslookup 127.0.0.1
Server:         129.94.242.45
Address:        129.94.242.45#53

1.0.0.127.in-addr.arpa  name = localhost.

z5238059@vx5:/tmp_amd/cage/export/cage/5/z5238059$ nslookup localhost
Server:         129.94.242.45
Address:        129.94.242.45#53

Name:   localhost.orchestra.cse.unsw.EDU.AU
Address: 127.0.0.1
```

127.0.0.1 is considered as localhost address.

Exercise 2

- www.unsw.edu.au

```
z5238059@vx5:/tmp_amd/cage/export/cage/5/z5238059$ ping -c 4 www.unsw.edu.au
PING www.unsw.edu.au (202.58.60.194) 56(84) bytes of data.
64 bytes from 202.58.60.194: icmp_req=1 ttl=242 time=24.7 ms
64 bytes from 202.58.60.194: icmp_req=2 ttl=242 time=24.3 ms
64 bytes from 202.58.60.194: icmp_req=3 ttl=242 time=24.6 ms
64 bytes from 202.58.60.194: icmp_req=4 ttl=242 time=24.3 ms

--- www.unsw.edu.au ping statistics ---
4 packets transmitted, 4 received, 0% packet loss, time 3004ms
rtt min/avg/max/mdev = 24.302/24.506/24.766/0.256 ms
```

- www.getfittest.com.au

```
z5238059@vx8:/tmp_amd/cage/export/cage/5/z5238059$ ping www.getfittest.com.au
ping: unknown host www.getfittest.com.au
```

This is a wrong website URL and it cannot be accessed by a browser, so ping also cannot access it.

- www.mit.edu

```
z5238059@vx5:/tmp_amd/cage/export/cage/5/z5238059$ ping -c 4 www.mit.edu
PING e9566.dscb.akamaiedge.net (104.98.31.173) 56(84) bytes of data.
64 bytes from a104-98-31-173.deploy.static.akamaitechnologies.com (104.98.31.173
): icmp_req=1 ttl=56 time=1.26 ms
64 bytes from a104-98-31-173.deploy.static.akamaitechnologies.com (104.98.31.173
): icmp_req=2 ttl=56 time=1.14 ms
64 bytes from a104-98-31-173.deploy.static.akamaitechnologies.com (104.98.31.173
): icmp_req=3 ttl=56 time=1.22 ms
64 bytes from a104-98-31-173.deploy.static.akamaitechnologies.com (104.98.31.173
): icmp_req=4 ttl=56 time=1.17 ms

--- e9566.dscb.akamaiedge.net ping statistics ---
4 packets transmitted, 4 received, 0% packet loss, time 3004ms
rtt min/avg/max/mdev = 1.148/1.202/1.263/0.056 ms
```

- www.intel.com.au

```
z5238059@vx5:/tmp_amd/cage/export/cage/5/z5238059$ ping -c 4 www.intel.com.au
PING e19235.dsca.akamaiedge.net (104.74.52.132) 56(84) bytes of data.
64 bytes from a104-74-52-132.deploy.static.akamaitechnologies.com (104.74.52.132
): icmp_req=1 ttl=56 time=1.35 ms
64 bytes from a104-74-52-132.deploy.static.akamaitechnologies.com (104.74.52.132
): icmp_req=2 ttl=56 time=1.17 ms
64 bytes from a104-74-52-132.deploy.static.akamaitechnologies.com (104.74.52.132
): icmp_req=3 ttl=56 time=1.46 ms
64 bytes from a104-74-52-132.deploy.static.akamaitechnologies.com (104.74.52.132
): icmp_req=4 ttl=56 time=1.20 ms

--- e19235.dsca.akamaiedge.net ping statistics ---
4 packets transmitted, 4 received, 0% packet loss, time 3004ms
rtt min/avg/max/mdev = 1.173/1.300/1.467/0.121 ms
```

- www.tpg.com.au

```
z5238059@vx5:/tmp_amd/cage/export/cage/5/z5238059$ ping -c 4 www.tpg.com.au
PING www.tpg.com.au (203.26.27.38) 56(84) bytes of data.
64 bytes from www.tpg.com.au (203.26.27.38): icmp_req=1 ttl=118 time=30.4 ms
64 bytes from www.tpg.com.au (203.26.27.38): icmp_req=2 ttl=118 time=29.9 ms
64 bytes from www.tpg.com.au (203.26.27.38): icmp_req=3 ttl=118 time=29.7 ms
64 bytes from www.tpg.com.au (203.26.27.38): icmp_req=4 ttl=118 time=29.8 ms

--- www.tpg.com.au ping statistics ---
4 packets transmitted, 4 received, 0% packet loss, time 3004ms
rtt min/avg/max/mdev = 29.798/30.009/30.429/0.330 ms
```

- www.hola.hp

```
z5238059@vx8:/tmp_amd/cage/export/cage/5/z5238059$ ping -c 4 www.hola.hp
ping: unknown host www.hola.hp
```

As same as www.getfittest.com.au, it's a non-existent web address.

- www.amazon.com

```
z5238059@vx5:/tmp_amd/cage/export/cage/5/z5238059$ ping -c 4 www.amazon.com
PING d3ag4hukkh62yn.cloudfront.net (13.35.141.74) 56(84) bytes of data.
64 bytes from server-13-35-141-74.syd1.r.cloudfront.net (13.35.141.74): icmp_req
=1 ttl=244 time=1.09 ms
64 bytes from server-13-35-141-74.syd1.r.cloudfront.net (13.35.141.74): icmp_req
=2 ttl=244 time=1.34 ms
64 bytes from server-13-35-141-74.syd1.r.cloudfront.net (13.35.141.74): icmp_req
=3 ttl=244 time=1.26 ms
64 bytes from server-13-35-141-74.syd1.r.cloudfront.net (13.35.141.74): icmp_req
=4 ttl=244 time=1.08 ms

--- d3ag4hukkh62yn.cloudfront.net ping statistics ---
4 packets transmitted, 4 received, 0% packet loss, time 3003ms
rtt min/avg/max/mdev = 1.082/1.195/1.340/0.111 ms
```

- www.tsinghua.edu.cn

```
z5238059@vx5:/tmp_amd/cage/export/cage/5/z5238059$ ping -c 4 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_req=1 ttl=44 time=248 ms
64 bytes from www.tsinghua.edu.cn (166.111.4.100): icmp_req=2 ttl=44 time=248 ms
64 bytes from www.tsinghua.edu.cn (166.111.4.100): icmp_req=3 ttl=44 time=248 ms
64 bytes from www.tsinghua.edu.cn (166.111.4.100): icmp_req=4 ttl=44 time=248 ms

--- www.tsinghua.edu.cn ping statistics ---
4 packets transmitted, 4 received, 0% packet loss, time 3004ms
rtt min/avg/max/mdev = 248.529/248.586/248.620/0.036 ms
```

- www.kremlin.ru

```
z5238059@vx5:/tmp_amd/cage/export/cage/5/z5238059$ ping -c 4 www.kremlin.ru
PING www.kremlin.ru (95.173.136.71) 56(84) bytes of data.

--- www.kremlin.ru ping statistics ---
4 packets transmitted, 0 received, 100% packet loss, time 3051ms
```

It's a correct URL but a government website, so there are 100% packet loss. For political reasons and security, we can access using a browser but not using ping.

- 8.8.8.8

```
z5238059@vx5:/tmp_amd/cage/export/cage/5/z5238059$ ping -c 4 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_req=1 ttl=53 time=1.54 ms
64 bytes from 8.8.8.8: icmp_req=2 ttl=53 time=1.61 ms
64 bytes from 8.8.8.8: icmp_req=3 ttl=53 time=1.62 ms
64 bytes from 8.8.8.8: icmp_req=4 ttl=53 time=1.56 ms

--- 8.8.8.8 ping statistics ---
4 packets transmitted, 4 received, 0% packet loss, time 3005ms
rtt min/avg/max/mdev = 1.544/1.586/1.628/0.052 ms
```

Exercise 3

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.

```
z5238059@vx5:/tmp_amd/cage/export/cage/5/z5238059$ 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)  0.152 ms  0.137 ms  0.122 ms
 2  129.94.39.17 (129.94.39.17)  0.891 ms  0.921 ms  0.882 ms
 3  ombudnex1-vl-3154.gw.unsw.edu.au (149.171.253.35)  1.452 ms libudnex1-vl-3154.gw.unsw.edu.au (149.171.253.34)  1.596 ms  1.
615 ms
 4  libcr1-po-5.gw.unsw.edu.au (149.171.255.165)  1.106 ms ombcr1-po-6.gw.unsw.edu.au (149.171.255.169)  1.152 ms ombcr1-po-5.g
w.unsw.edu.au (149.171.255.197)  1.157 ms
 5  unswbr1-te-1-9.gw.unsw.edu.au (149.171.255.101)  1.190 ms  1.215 ms unswbr1-te-2-13.gw.unsw.edu.au (149.171.255.105)  1.245
 ms
 6  138.44.5.0 (138.44.5.0)  19.872 ms  19.094 ms  19.119 ms
 7  et-1-3-0.pe1.sxt.bkvl.nsw.aarnet.net.au (113.197.15.149)  2.218 ms  2.161 ms  2.114 ms
 8  et-0-0-0.pe1.a.hnl.aarnet.net.au (113.197.15.99)  95.055 ms  95.012 ms  95.030 ms
 9  et-2-1-0.bdr1.a.sea.aarnet.net.au (113.197.15.201)  146.925 ms  146.913 ms  146.877 ms
10  abilene-1-lo-jmb-706.sttlwa.pacificwave.net (207.231.240.8)  154.019 ms  153.936 ms  153.788 ms
11  ae-1.4079.rtsw.minn.net.internet2.edu (162.252.70.173)  179.754 ms  179.874 ms  179.813 ms
12  ae-1.4079.rtsw.eqch.net.internet2.edu (162.252.70.106)  188.126 ms  188.128 ms  188.118 ms
13  ae-0.4079.rtsw3.eqch.net.internet2.edu (162.252.70.163)  190.328 ms  215.498 ms  214.737 ms
14  ae-1.4079.rtsw.clev.net.internet2.edu (162.252.70.130)  196.388 ms  196.309 ms  196.363 ms
15  buf-9208-I2-CLEV.nysernet.net (199.109.11.33)  200.594 ms  200.670 ms  200.658 ms
16  syr-9208-buf-9208.nysernet.net (199.109.7.193)  203.824 ms  203.867 ms  203.741 ms
17  nyc111-9204-syr-9208.nysernet.net (199.109.7.94)  212.984 ms  213.338 ms  213.011 ms
18  nyc-9208-nyc111-9204.nysernet.net (199.109.7.165)  212.997 ms  213.156 ms  213.070 ms
19  columbia.nyc-9208.nysernet.net (199.109.4.14)  212.972 ms  212.997 ms  213.015 ms
20  cc-core-1-x-nyser32-gw-1.net.columbia.edu (128.59.255.5)  213.263 ms  213.191 ms  213.385 ms
21  cc-conc-1-x-cc-core-1.net.columbia.edu (128.59.255.21)  213.449 ms  213.308 ms  213.400 ms
22  ccnmtl.columbia.edu (128.59.105.24)  213.228 ms  213.141 ms  213.254 ms
```

There are 22 routers between my workstation and www.columbia.edu .
Considering the routers which are part of the UNSW network, we can see that some routers have names while others don't, especially the sixth, so I use *dig -x* to check if it belongs to UNSW network:

```
z5238059@vx5:/tmp_amd/cage/export/cage/5/z5238059$ dig -x 138.44.5.0

; <<>> DiG 9.9.5-9+deb8u18-Debian <<>> -x 138.44.5.0
;; global options: +cmd
;; Got answer:
;; ->>HEADER<<- opcode: QUERY, status: NXDOMAIN, id: 34004
;; 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.  3302    IN      SOA     ns1.aarnet.net.au. hostmaster.aa
rnet.edu.au. 2017121507 10800 600 1209600 3600

;; Query time: 0 msec
;; SERVER: 129.94.242.45#53(129.94.242.45)
;; WHEN: Sat Feb 29 15:31:37 AEDT 2020
;; MSG SIZE  rcvd: 127
```

Obviously, it is not a part of UNSW network, therefore only first **five** routers along the path are part of the UNSW network.

Packets cross the Pacific Ocean are between 7th router and 8th router, because the time it takes has suddenly increased(from about 2 ms to nearly 95 ms). We can observe more clearly by using ping:

```
z5238059@vx5:/tmp_amd/cage/export/cage/5/z5238059$ ping -c 4 113.197.15.149
PING 113.197.15.149 (113.197.15.149) 56(84) bytes of data.
64 bytes from 113.197.15.149: icmp_req=1 ttl=58 time=2.24 ms
64 bytes from 113.197.15.149: icmp_req=2 ttl=58 time=2.17 ms
64 bytes from 113.197.15.149: icmp_req=3 ttl=58 time=2.13 ms
64 bytes from 113.197.15.149: icmp_req=4 ttl=58 time=2.03 ms

--- 113.197.15.149 ping statistics ---
4 packets transmitted, 4 received, 0% packet loss, time 3004ms
rtt min/avg/max/mdev = 2.033/2.147/2.247/0.077 ms
z5238059@vx5:/tmp_amd/cage/export/cage/5/z5238059$ ping -c 4 113.197.15.99
PING 113.197.15.99 (113.197.15.99) 56(84) bytes of data.
64 bytes from 113.197.15.99: icmp_req=1 ttl=57 time=95.0 ms
64 bytes from 113.197.15.99: icmp_req=2 ttl=57 time=94.9 ms
64 bytes from 113.197.15.99: icmp_req=3 ttl=57 time=94.9 ms
64 bytes from 113.197.15.99: icmp_req=4 ttl=57 time=94.9 ms

--- 113.197.15.99 ping statistics ---
4 packets transmitted, 4 received, 0% packet loss, time 3000ms
rtt min/avg/max/mdev = 94.947/94.987/95.043/0.220 ms
```

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 the geographical location of a server using the following tool - http://www.yougetsignal.com/tools/network-location/

(i) www.ucla.edu

```
z5238059@vx5:/tmp_amd/cage/export/cage/5/z5238059$ 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)  0.139 ms  0.122 ms  0.111 ms
 2  129.94.39.17 (129.94.39.17)  0.889 ms  0.842 ms  0.876 ms
 3  ombudnex1-vl-3154.gw.unsw.edu.au (149.171.253.35)  1.479 ms libudnex1-vl-3154.gw.unsw.edu.au (149.171.253.34)  1.565 ms  1.
587 ms
 4  ombcr1-po-6.gw.unsw.edu.au (149.171.255.169)  1.096 ms libcr1-po-6.gw.unsw.edu.au (149.171.255.201)  1.158 ms libcr1-po-5.g
w.unsw.edu.au (149.171.255.165)  1.084 ms
 5  unswbr1-te-1-9.gw.unsw.edu.au (149.171.255.101)  1.161 ms unswbr1-te-2-13.gw.unsw.edu.au (149.171.255.105)  1.177 ms unswbr
1-te-1-9.gw.unsw.edu.au (149.171.255.101)  1.222 ms
 6  138.44.5.0 (138.44.5.0)  1.276 ms  1.390 ms  1.337 ms
 7  et-1-3-0.pe1.sxt.bkvl.nsw.aarnet.net.au (113.197.15.149)  2.244 ms  2.159 ms  2.106 ms
 8  et-0-0-0.pe1.a.hnl.aarnet.net.au (113.197.15.99)  95.120 ms  95.008 ms  95.050 ms
 9  et-2-1-0.bdr1.a.sea.aarnet.net.au (113.197.15.201)  146.902 ms  146.909 ms  146.899 ms
10  cenichpr-1-is-jmb-778.snvaca.pacificwave.net (207.231.245.129)  164.016 ms  163.437 ms  163.395 ms
11  hpr-lax-hpr3--svl-hpr3-100ge.cenic.net (137.164.25.73)  160.109 ms  160.823 ms  160.794 ms
12  * * *
13  bd11f1.anderson--cr001.anderson.ucla.net (169.232.4.6)  161.027 ms bd11f1.anderson--cr00f2.csb1.ucla.net (169.232.4.4)  162
.253 ms  162.154 ms
14  cr00f1.anderson--rtr12f4.mathsci.ucla.net (169.232.8.187)  160.630 ms  161.149 ms cr00f1.anderson--rtr11f4.mathsci.ucla.net
 (169.232.8.185)  160.611 ms
15  * * *
16  * * *
17  * * *
18  * * *
19  * * *
20  * * *
21  * * *
22  * * *
23  * * *
24  * * *
25  * * *
26  * * *
27  * * *
28  * * *
29  * * *
30  * * *
```

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

```
z5238059@vx5:/tmp_amd/cage/export/cage/5/z5238059$ 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)  0.103 ms  0.083 ms  0.053 ms
 2  129.94.39.17 (129.94.39.17)  0.808 ms  0.837 ms  0.793 ms
 3  libudnex1-vl-3154.gw.unsw.edu.au (149.171.253.34)  1.527 ms  1.486 ms ombudnex1-vl-3154.gw.unsw.edu.au (149.171.253.35)  1.
475 ms
 4  ombcr1-po-5.gw.unsw.edu.au (149.171.255.197)  1.101 ms  1.107 ms libcr1-po-5.gw.unsw.edu.au (149.171.255.165)  1.076 ms
 5  unswbr1-te-2-13.gw.unsw.edu.au (149.171.255.105)  1.099 ms  1.132 ms unswbr1-te-1-9.gw.unsw.edu.au (149.171.255.101)  1.140
 ms
 6  138.44.5.0 (138.44.5.0)  1.457 ms  1.251 ms  1.271 ms
 7  et-0-3-0.pe1.bkvl.nsw.aarnet.net.au (113.197.15.147)  3.694 ms  3.304 ms  3.363 ms
 8  ge-4_0_0.bb1.a.pao.aarnet.net.au (202.158.194.177)  155.011 ms  154.969 ms  154.975 ms
 9  paloalto0.iij.net (198.32.176.24)  156.415 ms  156.420 ms  156.485 ms
10  osk004bb00.IIJ.Net (58.138.88.185)  287.066 ms osk004bb01.IIJ.Net (58.138.88.189)  269.309 ms osk004bb00.IIJ.Net (58.138.88
.185)  286.925 ms
11  osk004ip57.IIJ.Net (58.138.106.162)  277.991 ms osk004ip57.IIJ.Net (58.138.106.166)  269.180 ms osk004ip57.IIJ.Net (58.138.
106.162)  277.913 ms
12  210.130.135.130 (210.130.135.130)  304.532 ms  301.971 ms  301.935 ms
13  124.83.228.58 (124.83.228.58)  279.531 ms  293.234 ms  293.177 ms
14  124.83.252.178 (124.83.252.178)  293.299 ms  293.212 ms  293.197 ms
15  158.205.134.26 (158.205.134.26)  292.983 ms  292.978 ms  284.122 ms
16  * * *
17  * * *
18  * * *
19  * * *
20  * * *
21  * * *
22  * * *
23  * * *
24  * * *
25  * * *
26  * * *
27  * * *
28  * * *
29  * * *
30  * * *
```

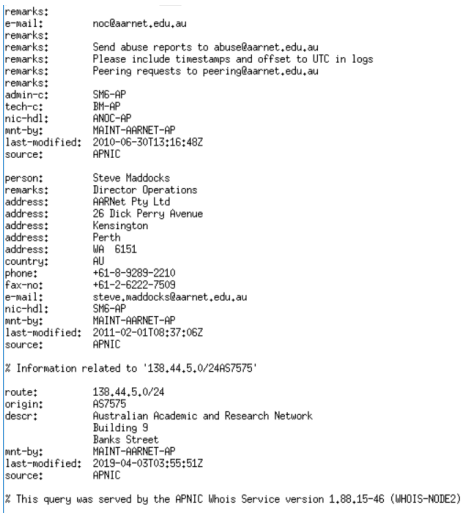
(iii) www.lancaster.ac.uk

```
z5238059@vx5:/tmp_amd/cage/export/cage/5/z5238059$ 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)  0.083 ms  0.068 ms  0.070 ms
 2  129.94.39.17 (129.94.39.17)  0.934 ms  0.928 ms  0.860 ms
 3  libudnex1-vl-3154.gw.unsw.edu.au (149.171.253.34)  1.605 ms ombudnex1-vl-3154.gw.unsw.edu.au (149.171.253.35)  14.242 ms li
budnex1-vl-3154.gw.unsw.edu.au (149.171.253.34)  1.588 ms
 4  libcr1-po-6.gw.unsw.edu.au (149.171.255.201)  1.237 ms  1.124 ms  1.151 ms
 5  unswbr1-te-1-9.gw.unsw.edu.au (149.171.255.101)  1.162 ms unswbr1-te-2-13.gw.unsw.edu.au (149.171.255.105)  1.206 ms unswbr
1-te-1-9.gw.unsw.edu.au (149.171.255.101)  1.180 ms
 6  138.44.5.0 (138.44.5.0)  1.382 ms  1.298 ms  1.286 ms
 7  et-2-0-5.bdr1.sing.sin.aarnet.net.au (113.197.15.233)  92.761 ms  92.508 ms  92.516 ms
 8  138.44.226.7 (138.44.226.7)  259.981 ms  259.938 ms  259.950 ms
 9  janet-gw.mx1.lon.uk.geant.net (62.40.124.198)  260.087 ms  260.033 ms  260.079 ms
10  ae29.londpg-sbr2.ja.net (146.97.33.2)  281.150 ms  281.092 ms  281.053 ms
11  ae31.erdiss-sbr2.ja.net (146.97.33.22)  264.334 ms  264.175 ms  264.098 ms
12  ae29.manckh-sbr2.ja.net (146.97.33.42)  266.334 ms  266.234 ms  266.054 ms
13  ae24.lanclu-rbr1.ja.net (146.97.38.58)  268.432 ms  268.387 ms  268.429 ms
14  lancaster-university.ja.net (194.81.46.2)  280.357 ms  280.306 ms  280.312 ms
15  is-border01.bfw01.rtr.lancs.ac.uk (148.88.253.202)  268.918 ms  269.033 ms  268.885 ms
16  bfw01.iss-servers.is-core01.rtr.lancs.ac.uk (148.88.250.98)  274.073 ms  271.887 ms  270.577 ms
17  * * *
18  www.lancs.ac.uk (148.88.65.80)  269.067 ms !X  269.030 ms !X  269.221 ms !X
```

Diverge router should be 138.44.5.0, because after it, the routers in the paths are totally different. More details about this router are:

```
z5238059@vx5:/tmp_amd/cage/export/cage/5/z5238059$ 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_reporting/
#
# 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

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

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

#
# 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_reporting/
#
# 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-AARI-AP
admin-c:        SMS-AP
tech-c:         ANOC-AP
notify:         irrcontact@aarnet.edu.au
mnt-by:         APNIC-HM
```

```
mnt-lower:      MAINT-AARNET-AP
mnt-routes:     MAINT-AARNET-AP
mnt-irt:        IRT-AARNET-AU
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:        +++++++++++++++++++++++++++++++++++++++++++++++
last-modified:  2017-10-09T13:02:43Z
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 2019-12-03
mnt-by:         MAINT-AARNET-AP
last-modified:  2019-12-03T21:30:31Z
source:         APNIC

organisation:   ORG-AAR1-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:           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 1.88.15-46 (WHOIS-NODE2)
```

The hop count does **not** correlate strongly with geographical distance.

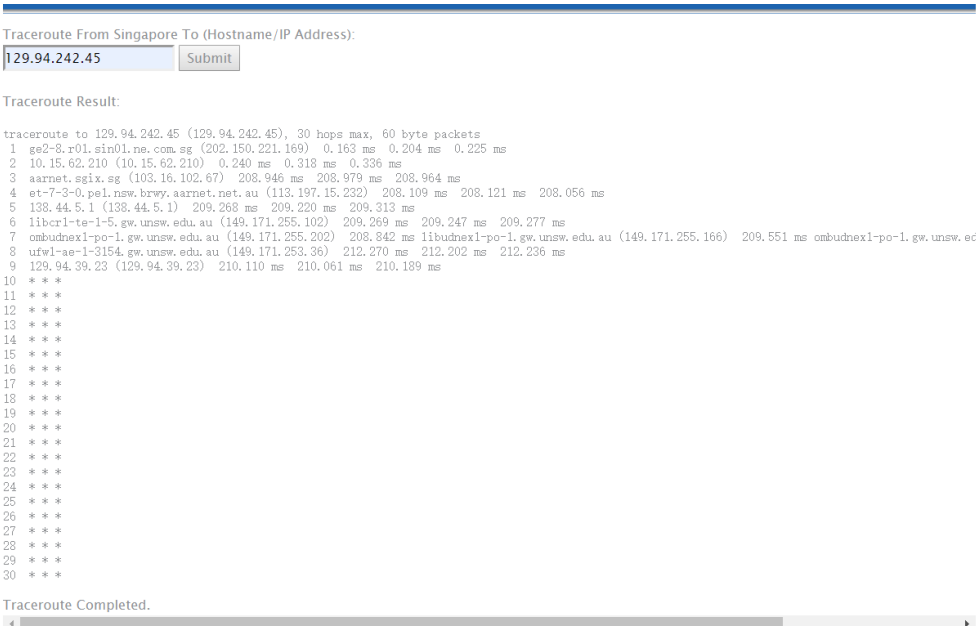
Using *nslookup* to find the IP address and then using http://www.yougetsignal.com/tools/network-location/, we can get the physical distance of each path from CSE:

```
z5238059@vx5:/tmp_amd/cage/export/cage/5/z5238059$ nslookup www.ucla.edu
Server:         129.94.242.45
Address:        129.94.242.45#53

Non-authoritative answer:
www.ucla.edu    canonical name = gateway.lb.it.ucla.edu.
Name:   gateway.lb.it.ucla.edu
Address: 164.67.228.152

z5238059@vx5:/tmp_amd/cage/export/cage/5/z5238059$ nslookup www.u-tokyo.ac.jp
Server:         129.94.242.45
Address:        129.94.242.45#53

Non-authoritative answer:
Name:   www.u-tokyo.ac.jp
Address: 210.152.243.234

z5238059@vx5:/tmp_amd/cage/export/cage/5/z5238059$ nslookup www.lancaster.ac.uk
Server:         129.94.242.45
Address:        129.94.242.45#53

Non-authoritative answer:
lancaster.ac.uk dname = lancs.ac.uk.
www.lancaster.ac.uk     canonical name = www.lancs.ac.uk.
Name:   www.lancs.ac.uk
Address: 148.88.65.80
```

URL	IP Address	Physical distance (approximately)	Hop count
www.ucla.edu	164.67.228.152	7499.0 miles	30
www.u-tokyo.ac.jp	210.152.243.234	4908.7miles	30
www.lancaster.ac.uk	148.88.65.80	10569.8miles	30

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) http://www.speedtest.com.sg/tr.php



reverse direction:

```
z5238059@vx5:/tmp_amd/cage/export/cage/5/z5238059$ 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)  0.148 ms  0.135 ms  0.122 ms
 2  129.94.39.17 (129.94.39.17)  0.841 ms  0.870 ms  0.826 ms
 3  libudnex1-vl-3154.gw.unsw.edu.au (149.171.253.34)  1.491 ms  1.436 ms ombudnex1-vl-3154.gw.unsw.edu.au (149.171.253.3
5)  1.555 ms
 4  libcr1-po-6.gw.unsw.edu.au (149.171.255.201)  1.075 ms ombcr1-po-5.gw.unsw.edu.au (149.171.255.197)  1.112 ms ombcr1-
po-6.gw.unsw.edu.au (149.171.255.169)  1.144 ms
 5  unswbr1-te-2-13.gw.unsw.edu.au (149.171.255.105)  1.170 ms unswbr1-te-1-9.gw.unsw.edu.au (149.171.255.101)  1.204 ms
 1.102 ms
 6  138.44.5.0 (138.44.5.0)  1.358 ms  1.718 ms  1.650 ms
 7  et-0-3-0.pe1.alxd.nsw.aarnet.net.au (113.197.15.153)  1.658 ms  1.720 ms  1.727 ms
 8  xe-0-2-7.bdr1.a.lax.aarnet.net.au (202.158.194.173)  147.600 ms  147.609 ms  147.561 ms
 9  singtel.as7473.any2ix.coresite.com (206.72.210.63)  149.698 ms  149.562 ms  149.570 ms
10  203.208.171.117 (203.208.171.117)  148.017 ms  148.105 ms 203.208.173.81 (203.208.173.81)  332.861 ms
11  203.208.172.145 (203.208.172.145)  242.531 ms 203.208.177.110 (203.208.177.110)  319.823 ms  321.131 ms
12  203.208.158.17 (203.208.158.17)  329.591 ms 203.208.182.253 (203.208.182.253)  327.451 ms *
13  203.208.177.110 (203.208.177.110)  314.947 ms 202-150-221-170.rev.ne.com.sg (202.150.221.170)  212.424 ms 203.208.177
.110 (203.208.177.110)  309.962 ms
```

(ii)https://www.telstra.net/cgi-bin/trace

Traceroute

This traceroute commences from **www.telstra.net**, within **AS 1221**.

Enter the desired destination host.domain or IPv4 or IPv6 address: 129.94.242.45

```
 1  gigabitethernet3-3.exi2.melbourne.telstra.net (203.50.77.53)  0.362 ms  0.205 ms  0.242 ms
 2  bundle-ether3-100.win-core10.melbourne.telstra.net (203.50.80.129)  2.613 ms  1.603 ms  2.118 ms
 3  bundle-ether12.ken-core10.sydney.telstra.net (203.50.11.122)  13.232 ms  12.097 ms  12.860 ms
 4  bundle-ether1.ken-edge901.sydney.telstra.net (203.50.11.95)  11.983 ms  11.847 ms  11.986 ms
 5  aarnet6.lnk.telstra.net (139.130.0.78)  11.734 ms  11.848 ms  11.736 ms
 6  xe-5-2-2.pe1.brwy.nsw.aarnet.net.au (113.197.15.32)  11.860 ms  11.848 ms  11.860 ms
 7  138.44.5.1 (138.44.5.1)  12.108 ms  12.352 ms  12.110 ms
 8  ombcr1-te-1-5.gw.unsw.edu.au (149.171.255.106)  12.234 ms  11.974 ms  12.110 ms
 9  ombudnex1-po-2.gw.unsw.edu.au (149.171.255.170)  12.362 ms  12.349 ms  12.358 ms
10  ufw1-ae-1-3154.gw.unsw.edu.au (149.171.253.36)  12.734 ms  12.724 ms  12.736 ms
11  129.94.39.23 (129.94.39.23)  12.858 ms  12.851 ms  12.985 ms
```

There are other traceroute sites listed here.

The traceroute CGI source can be found via:
carpeNet

reverse direction:

```
z5238059@vx5:/tmp_amd/cage/export/cage/5/z5238059$ 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)  0.102 ms  0.095 ms  0.084 ms
 2  129.94.39.17 (129.94.39.17)  0.854 ms  0.792 ms  0.842 ms
 3  libudnex1-vl-3154.gw.unsw.edu.au (149.171.253.34)  1.511 ms ombudnex1-vl-3154.gw.unsw.edu.au (149.171.253.35)  1.378
ms libudnex1-vl-3154.gw.unsw.edu.au (149.171.253.34)  1.515 ms
 4  ombcr1-po-5.gw.unsw.edu.au (149.171.255.197)  1.073 ms libcr1-po-6.gw.unsw.edu.au (149.171.255.201)  1.086 ms libcr1-
po-5.gw.unsw.edu.au (149.171.255.165)  1.088 ms
 5  unswbr1-te-1-9.gw.unsw.edu.au (149.171.255.101)  24.187 ms  24.195 ms unswbr1-te-2-13.gw.unsw.edu.au (149.171.255.105
)  24.185 ms
 6  138.44.5.0 (138.44.5.0)  1.383 ms  1.221 ms  1.327 ms
 7  xe-0-0-0.bdr1.rsby.nsw.aarnet.net.au (113.197.15.33)  1.655 ms  1.681 ms  1.684 ms
 8  gigabitethernet3-11.ken37.sydney.telstra.net (139.130.0.77)  2.381 ms  2.291 ms  2.382 ms
 9  bundle-ether13.ken-core10.sydney.telstra.net (203.50.11.94)  4.164 ms bundle-ether2.chw-edge901.sydney.telstra.net (2
03.50.11.103)  2.247 ms  2.256 ms
10  bundle-ether13.chw-core10.sydney.telstra.net (203.50.11.98)  3.937 ms  3.833 ms  2.778 ms
11  203.50.6.40 (203.50.6.40)  15.155 ms bundle-ether8.exi-core10.melbourne.telstra.net (203.50.11.125)  14.244 ms  13.61
6 ms
12  bundle-ether2.exi-ncprouter101.melbourne.telstra.net (203.50.11.209)  13.477 ms  12.993 ms  13.272 ms
13  www.telstra.net (203.50.5.178)  12.635 ms  12.653 ms  12.590 ms
```

The IP addresses of the two servers that I have chosen are 202.150.221.170 and 203.50.5.178.

```
z5238059@vx5:/tmp_amd/cage/export/cage/5/z5238059$ nslookup www.speedtest.com.sg
Server:         129.94.242.45
Address:        129.94.242.45#53

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

z5238059@vx5:/tmp_amd/cage/export/cage/5/z5238059$ nslookup www.telstra.net
Server:         129.94.242.45
Address:        129.94.242.45#53

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

The reverse path go through some same routers as the forward path, but it is not the same IP address. In my opinion, this is because that different IP address can prevent routing loops which effectively reduce blocking and ensure load balancing, making runs more logically.

Exercise 4

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?

Firstly, check their IP address by using *nelookup*.

```
z5238059@vx5:/tmp_amd/cage/export/cage/5/z5238059$ nslookup www.uq.edu.au
Server:         129.94.242.45
Address:        129.94.242.45#53

Non-authoritative answer:
Name:   www.uq.edu.au
Address: 130.102.184.3

z5238059@vx5:/tmp_amd/cage/export/cage/5/z5238059$ nslookup www.dlsu.edu.ph
Server:         129.94.242.45
Address:        129.94.242.45#53

Non-authoritative answer:
Name:   www.dlsu.edu.ph
Address: 103.231.241.180

z5238059@vx5:/tmp_amd/cage/export/cage/5/z5238059$ nslookup www.tu-berlin.de
Server:         129.94.242.45
Address:        129.94.242.45#53

Non-authoritative answer:
Name:   www.tu-berlin.de
Address: 130.149.7.201
```

And then using https://www.yougetsignal.com/tools/network-location/ to get their physical distance from UNSW. There are 1183.8miles, 3891.64miles and 10013.1miles respectively.

Secondly, calculate the shortest possible time T:

$$T_{uq} = \frac{(1183.8miles \times 1609.344)m}{3 \times 10^8 m/s} \approx 6.35ms$$

$$T_{dlsu} = \frac{(3891.64miles \times 1609.344)m}{3 \times 10^8 m/s} \approx 13.87ms$$

$$T_{berlin} = \frac{(10013.1miles \times 1609.344)m}{3 \times 10^8 m/s} \approx 53.72ms$$

Therefore, according to the minimum delay for 50 byte packets:

```
PING www.uq.edu.au (130.102.184.3) 22(50) bytes of data.
30 bytes from cilr.uq.edu.au (130.102.184.3): icmp_req=1 ttl=239 time=16.9 ms
30 bytes from cilr.uq.edu.au (130.102.184.3): icmp_req=2 ttl=239 time=16.8 ms
30 bytes from cilr.uq.edu.au (130.102.184.3): icmp_req=3 ttl=239 time=16.5 ms
30 bytes from cilr.uq.edu.au (130.102.184.3): icmp_req=4 ttl=239 time=16.7 ms
30 bytes from cilr.uq.edu.au (130.102.184.3): icmp_req=5 ttl=239 time=16.9 ms
30 bytes from cilr.uq.edu.au (130.102.184.3): icmp_req=6 ttl=239 time=16.9 ms
30 bytes from cilr.uq.edu.au (130.102.184.3): icmp_req=7 ttl=239 time=17.1 ms
30 bytes from cilr.uq.edu.au (130.102.184.3): icmp_req=8 ttl=239 time=16.9 ms
30 bytes from cilr.uq.edu.au (130.102.184.3): icmp_req=9 ttl=239 time=16.9 ms
30 bytes from cilr.uq.edu.au (130.102.184.3): icmp_req=10 ttl=239 time=17.2 ms
30 bytes from cilr.uq.edu.au (130.102.184.3): icmp_req=11 ttl=239 time=17.2 ms
30 bytes from cilr.uq.edu.au (130.102.184.3): icmp_req=12 ttl=239 time=17.1 ms
30 bytes from cilr.uq.edu.au (130.102.184.3): icmp_req=13 ttl=239 time=17.1 ms
30 bytes from cilr.uq.edu.au (130.102.184.3): icmp_req=14 ttl=239 time=16.8 ms
30 bytes from cilr.uq.edu.au (130.102.184.3): icmp_req=15 ttl=239 time=16.9 ms
30 bytes from cilr.uq.edu.au (130.102.184.3): icmp_req=16 ttl=239 time=17.0 ms
30 bytes from cilr.uq.edu.au (130.102.184.3): icmp_req=17 ttl=239 time=17.0 ms
30 bytes from cilr.uq.edu.au (130.102.184.3): icmp_req=18 ttl=239 time=16.8 ms
30 bytes from cilr.uq.edu.au (130.102.184.3): icmp_req=19 ttl=239 time=17.0 ms
30 bytes from cilr.uq.edu.au (130.102.184.3): icmp_req=20 ttl=239 time=16.7 ms
30 bytes from cilr.uq.edu.au (130.102.184.3): icmp_req=21 ttl=239 time=16.8 ms
30 bytes from cilr.uq.edu.au (130.102.184.3): icmp_req=22 ttl=239 time=17.1 ms
30 bytes from cilr.uq.edu.au (130.102.184.3): icmp_req=23 ttl=239 time=17.2 ms
30 bytes from cilr.uq.edu.au (130.102.184.3): icmp_req=24 ttl=239 time=16.9 ms
30 bytes from cilr.uq.edu.au (130.102.184.3): icmp_req=25 ttl=239 time=17.0 ms
30 bytes from cilr.uq.edu.au (130.102.184.3): icmp_req=26 ttl=239 time=16.9 ms
30 bytes from cilr.uq.edu.au (130.102.184.3): icmp_req=27 ttl=239 time=17.0 ms
30 bytes from cilr.uq.edu.au (130.102.184.3): icmp_req=28 ttl=239 time=16.8 ms
30 bytes from cilr.uq.edu.au (130.102.184.3): icmp_req=29 ttl=239 time=17.0 ms
30 bytes from cilr.uq.edu.au (130.102.184.3): icmp_req=30 ttl=239 time=16.9 ms
30 bytes from cilr.uq.edu.au (130.102.184.3): icmp_req=31 ttl=239 time=17.3 ms
30 bytes from cilr.uq.edu.au (130.102.184.3): icmp_req=32 ttl=239 time=17.3 ms
30 bytes from cilr.uq.edu.au (130.102.184.3): icmp_req=33 ttl=239 time=17.0 ms
30 bytes from cilr.uq.edu.au (130.102.184.3): icmp_req=34 ttl=239 time=17.0 ms
30 bytes from cilr.uq.edu.au (130.102.184.3): icmp_req=35 ttl=239 time=17.1 ms
30 bytes from cilr.uq.edu.au (130.102.184.3): icmp_req=36 ttl=239 time=16.8 ms
30 bytes from cilr.uq.edu.au (130.102.184.3): icmp_req=37 ttl=239 time=17.1 ms
```

```
PING www.dlsu.edu.ph (103.231.241.180) 22(50) bytes of data.
30 bytes from 103.231.241.180: icmp_req=1 ttl=114 time=319 ms
30 bytes from 103.231.241.180: icmp_req=2 ttl=114 time=320 ms
30 bytes from 103.231.241.180: icmp_req=3 ttl=114 time=318 ms

--- www.dlsu.edu.ph ping statistics ---
3 packets transmitted, 3 received, 0% packet loss, time 48671ms
rtt min/avg/max/mdev = 318.857/319.347/320.109/0.546 ms
```

```
PING www.tu-berlin.de (130.149.7.201) 22(50) bytes of data.
30 bytes from www.tu-berlin.de (130.149.7.201): icmp_req=1 ttl=240 time=287 ms
30 bytes from www.tu-berlin.de (130.149.7.201): icmp_req=2 ttl=240 time=287 ms
30 bytes from www.tu-berlin.de (130.149.7.201): icmp_req=3 ttl=240 time=287 ms
30 bytes from www.tu-berlin.de (130.149.7.201): icmp_req=4 ttl=240 time=287 ms
30 bytes from www.tu-berlin.de (130.149.7.201): icmp_req=5 ttl=240 time=287 ms
30 bytes from www.tu-berlin.de (130.149.7.201): icmp_req=6 ttl=240 time=287 ms
30 bytes from www.tu-berlin.de (130.149.7.201): icmp_req=7 ttl=240 time=287 ms
30 bytes from www.tu-berlin.de (130.149.7.201): icmp_req=8 ttl=240 time=287 ms
30 bytes from www.tu-berlin.de (130.149.7.201): icmp_req=9 ttl=240 time=287 ms
30 bytes from www.tu-berlin.de (130.149.7.201): icmp_req=10 ttl=240 time=287 ms
30 bytes from www.tu-berlin.de (130.149.7.201): icmp_req=11 ttl=240 time=287 ms
30 bytes from www.tu-berlin.de (130.149.7.201): icmp_req=12 ttl=240 time=287 ms
30 bytes from www.tu-berlin.de (130.149.7.201): icmp_req=13 ttl=240 time=287 ms
30 bytes from www.tu-berlin.de (130.149.7.201): icmp_req=14 ttl=240 time=287 ms
30 bytes from www.tu-berlin.de (130.149.7.201): icmp_req=15 ttl=240 time=287 ms
30 bytes from www.tu-berlin.de (130.149.7.201): icmp_req=16 ttl=240 time=287 ms
30 bytes from www.tu-berlin.de (130.149.7.201): icmp_req=17 ttl=240 time=287 ms
30 bytes from www.tu-berlin.de (130.149.7.201): icmp_req=18 ttl=240 time=287 ms
30 bytes from www.tu-berlin.de (130.149.7.201): icmp_req=19 ttl=240 time=287 ms
30 bytes from www.tu-berlin.de (130.149.7.201): icmp_req=20 ttl=240 time=287 ms
30 bytes from www.tu-berlin.de (130.149.7.201): icmp_req=21 ttl=240 time=287 ms
30 bytes from www.tu-berlin.de (130.149.7.201): icmp_req=22 ttl=240 time=287 ms
30 bytes from www.tu-berlin.de (130.149.7.201): icmp_req=23 ttl=240 time=287 ms
30 bytes from www.tu-berlin.de (130.149.7.201): icmp_req=24 ttl=240 time=288 ms
30 bytes from www.tu-berlin.de (130.149.7.201): icmp_req=25 ttl=240 time=287 ms
30 bytes from www.tu-berlin.de (130.149.7.201): icmp_req=26 ttl=240 time=287 ms
30 bytes from www.tu-berlin.de (130.149.7.201): icmp_req=27 ttl=240 time=287 ms
30 bytes from www.tu-berlin.de (130.149.7.201): icmp_req=28 ttl=240 time=287 ms
30 bytes from www.tu-berlin.de (130.149.7.201): icmp_req=29 ttl=240 time=287 ms
30 bytes from www.tu-berlin.de (130.149.7.201): icmp_req=30 ttl=240 time=287 ms
30 bytes from www.tu-berlin.de (130.149.7.201): icmp_req=31 ttl=240 time=287 ms
30 bytes from www.tu-berlin.de (130.149.7.201): icmp_req=32 ttl=240 time=287 ms
30 bytes from www.tu-berlin.de (130.149.7.201): icmp_req=33 ttl=240 time=287 ms
30 bytes from www.tu-berlin.de (130.149.7.201): icmp_req=34 ttl=240 time=287 ms
30 bytes from www.tu-berlin.de (130.149.7.201): icmp_req=35 ttl=240 time=287 ms
30 bytes from www.tu-berlin.de (130.149.7.201): icmp_req=36 ttl=240 time=287 ms
30 bytes from www.tu-berlin.de (130.149.7.201): icmp_req=37 ttl=240 time=287 ms
30 bytes from www.tu-berlin.de (130.149.7.201): icmp_req=38 ttl=240 time=287 ms
30 bytes from www.tu-berlin.de (130.149.7.201): icmp_req=39 ttl=240 time=287 ms
30 bytes from www.tu-berlin.de (130.149.7.201): icmp_req=40 ttl=240 time=287 ms
30 bytes from www.tu-berlin.de (130.149.7.201): icmp_req=41 ttl=240 time=287 ms
30 bytes from www.tu-berlin.de (130.149.7.201): icmp_req=42 ttl=240 time=287 ms
30 bytes from www.tu-berlin.de (130.149.7.201): icmp_req=43 ttl=240 time=287 ms
30 bytes from www.tu-berlin.de (130.149.7.201): icmp_req=44 ttl=240 time=287 ms
30 bytes from www.tu-berlin.de (130.149.7.201): icmp_req=45 ttl=240 time=287 ms
30 bytes from www.tu-berlin.de (130.149.7.201): icmp_req=46 ttl=240 time=287 ms
30 bytes from www.tu-berlin.de (130.149.7.201): icmp_req=47 ttl=240 time=287 ms
30 bytes from www.tu-berlin.de (130.149.7.201): icmp_req=48 ttl=240 time=287 ms
30 bytes from www.tu-berlin.de (130.149.7.201): icmp_req=49 ttl=240 time=287 ms
30 bytes from www.tu-berlin.de (130.149.7.201): icmp_req=50 ttl=240 time=287 ms
```

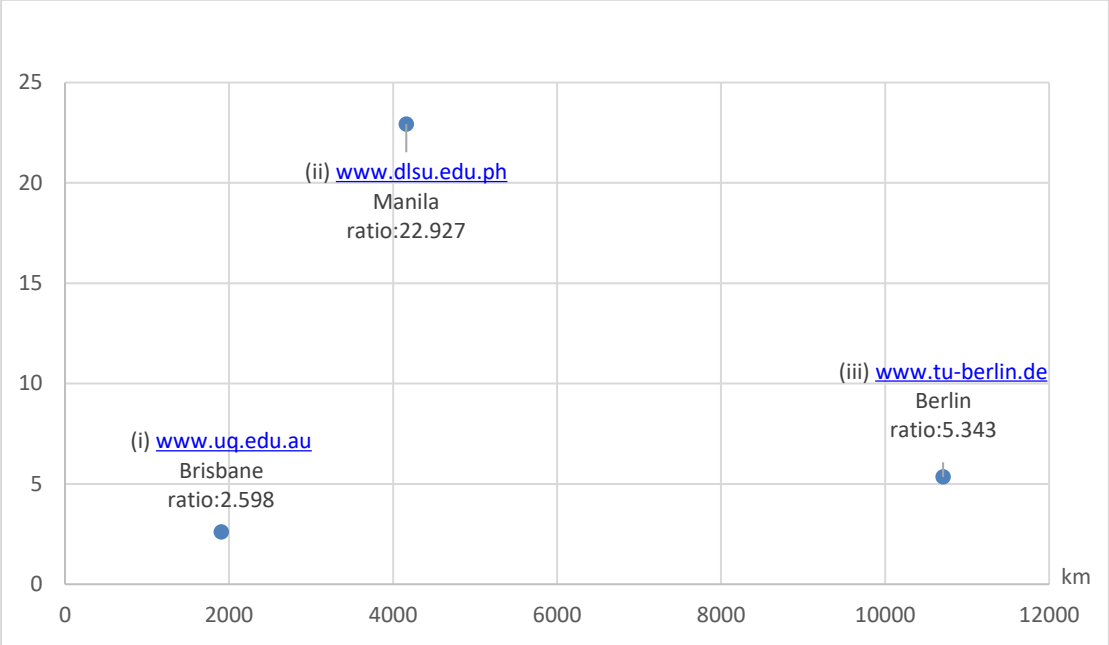
We can get the ratio between the minimum delay and T are:

$$r_{uq} = \frac{16.5ms}{6.35ms} \approx 2.598$$

$$r_{dlsu} = \frac{318ms}{13.87ms} \approx 22.927$$

$$r_{berlin} = \frac{287ms}{53.72ms} \approx 5.343$$

Plot a graph:



The reasons why y-axis values are greater than 2:

(1) routers in the path cost time to process delay;

(2) it also has queuing delay.

ratio=2 should be an ideal state because of no delay.

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

The delay should vary over time, because it is consist of nodal processing delay, queuing delay, transmission delay and propagation delay, and among them, the queuing delay will change with the congestion of the entire network.

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

It is not in Switzerland.

When I use website https://www.nic.ch/whois/, I find this website is registered in Switzerland, but it is not mean it is hosted in Switzerland. Using *traceroute* can get its really IP address:

```
z5238059@vx5:/tmp_amd/cage/export/cage/5/z5238059$ 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)  0.177 ms  0.167 ms  0.15
5 ms
 2  129.94.39.17 (129.94.39.17)  0.907 ms  0.910 ms  0.916 ms
 3  libudnex1-vl-3154.gw.unsw.edu.au (149.171.253.34)  2.915 ms  2.838 ms  2.855
 ms
 4  ombcr1-po-6.gw.unsw.edu.au (149.171.255.169)  1.178 ms  1.196 ms  1.212 ms
 5  unswbr1-te-1-9.gw.unsw.edu.au (149.171.255.101)  1.315 ms unswbr1-te-2-13.gw
.unsw.edu.au (149.171.255.105)  1.337 ms  1.342 ms
 6  138.44.5.0 (138.44.5.0)  1.390 ms  2.266 ms  2.261 ms
 7  113.197.15.101 (113.197.15.101)  1.309 ms  1.329 ms  1.334 ms
 8  as4826.sydney.megaport.com (103.26.68.248)  2.106 ms  2.351 ms  2.440 ms
 9  be-111.cor01.syd11.nsw.vocus.net.au (175.45.72.32)  1.778 ms  1.730 ms BE-11
0.cor02.syd04.nsw.VOCUS.net.au (175.45.72.30)  1.693 ms
10  BE-101.bdr02.syd03.nsw.VOCUS.net.au (114.31.192.37)  2.445 ms  2.547 ms  2.0
75 ms
11  as13335.bdr02.syd03.nsw.VOCUS.net.au (175.45.124.197)  5.821 ms  6.032 ms  6
.122 ms
12  104.20.229.42 (104.20.229.42)  1.464 ms  1.473 ms  1.597 ms
```

It's 104.20.229.42, and then use *whois* to find it is in 101 Townsend Street, San Francisco, US:

```
z5238059@vx5:/tmp_amd/cage/export/cage/5/z5238059$ whois 104.20.229.42

#
# 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_reporting/
#
# Copyright 1997-2020, American Registry for Internet Numbers, Ltd.
#


NetRange:       104.16.0.0 - 104.31.255.255
CIDR:           104.16.0.0/12
NetName:        CLOUDFLARENET
NetHandle:      NET-104-16-0-0-1
Parent:         NET104 (NET-104-0-0-0-0)
NetType:        Direct Assignment
OriginAS:       AS13335
Organization:   Cloudflare, Inc. (CLOUD14)
RegDate:        2014-03-28
Updated:        2017-02-17
Comment:        All Cloudflare abuse reporting can be done via https://www.cloud
flare.com/abuse
Ref:            https://rdap.arin.net/registry/ip/104.16.0.0


OrgName:        Cloudflare, Inc.
OrgId:          CLOUD14
Address:        101 Townsend Street
City:           San Francisco
StateProv:      CA
PostalCode:     94107
Country:        US
RegDate:        2010-07-09
Updated:        2019-09-25
Ref:            https://rdap.arin.net/registry/entity/CLOUD14
```

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?

The only one that depend on the packet size is transmission delay, because transmission delay is equal to L/R. L is the number of bits of a packet and R is the rate of transmission (say in bits per second).