

## Exercise 1: nslookup

1. Which is the IP address of the Google site ( [www.google.com](http://www.google.com) )? In your opinion, what is the reason of having several IP addresses as an output?

ANS:

### **Output at Appendix 7 & 8**

Google has only one IP address in above output as it is a policy decided by Google to only reply the server closest to our location. From research, 216.58.203.100 is located in California, USA while hosting a few websites including Google.

We observe that a busy site like [www.youtube.com](http://www.youtube.com) has several IP addresses. This is actually because the site is replicated between multiple web servers on different hosts. Each set of IP address in the output is then correspond to a certain host. As all requests from all hosts to this site are not concentrated in a single server, the DNS server is able to service every request per IP.

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

ANS:

### **Output at Appendix 9**

For every computer device, 127.0.0.1 is always considered as the local machine, which is itself. It is a internal interface used by the machine to identify when local packets need to be sent. TCP/IP uses the IP to differentiate when to send packets locally instead of using network.

## Exercise 2: Use ping to test host reachability

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

- [www.cse.unsw.edu.au](http://www.cse.unsw.edu.au) is alive
- [www.getfittest.com.au](http://www.getfittest.com.au) does not exist
- [www.mit.edu](http://www.mit.edu) is alive
- [www.intel.com.au](http://www.intel.com.au) is alive
- [www.tpg.com.au](http://www.tpg.com.au) is alive
- [www.hola.hp](http://www.hola.hp) does not exist
- [www.amazon.com](http://www.amazon.com) is alive
- [www.tsinghua.edu.cn](http://www.tsinghua.edu.cn) is alive
- [www.kremlin.ru](http://www.kremlin.ru) no answer but reachable from web browser
- [8.8.8.8](http://8.8.8.8) is alive

**If you observe that some hosts are not reachable, then can you explain why? Check if the addresses unreachable by the ping command are reachable from the Web browser.**

Some are not reachable as they simply do not exist, the rest does not support ICMP protocol that ping is using. As it is general for malicious Denial of Service attacks, where multiple hosts ping the web server continuously and utilising all its Bandwidth.

## Exercise 3: Use traceroute to understand network topology

**Note: Include all traceroute outputs in your report.**

**Output at Appendix 1- 6**

1.

ANS:

\*Referring to output (1) from Appendix at end of the report.

Around 22 routers between UNSW workstation to [www.columbia.edu](http://www.columbia.edu). 4 of them are along path of UNSW network. Between line 7 and line 8 of the output results, the “Round Trip Time” RTTs differ by a few hundreds in magnitude, hence it is assumed to have crossed the Pacific Ocean.

2.

ANS:

\*Referring to output (2, 5, 6) from Appendix at end of the report.

After every line 6 of trace route output “138.44.5.0 (138.44.5.0)”, the directions diverged.

The router is owned by Asia Pacific Network Information Centre (APNIC). Number of hops is  $15 \times 3 \approx 45$  for “Tokyo University” and  $16 \times 3 \approx 48$  for “UCLA” and 6 routers for “Lancaster University”. The hops are different in the same geographic location, hence it is not proportional.

3.

ANS:

\*Referring to output **(3, 4, 10, 11)** from Appendix at end of the report.

Different IP addresses can be observed even if a path is crossed back and forth. It is common practice for service provider to distribute connections across multiple routers, dealing with requests coming in and out. In “traceroute” output for at (4) at line 10 and output (11) at line 1, we observe common routers being accessed twice under name “gigabitethernet1” and “gigabitethernet3” with different IP addresses, the fact that they are different is because they symbolise the name of the router interfaces instead of router itself. Hence there can multiple interfaces per router, which indicates the paths to and from the destinations are not necessarily the same.

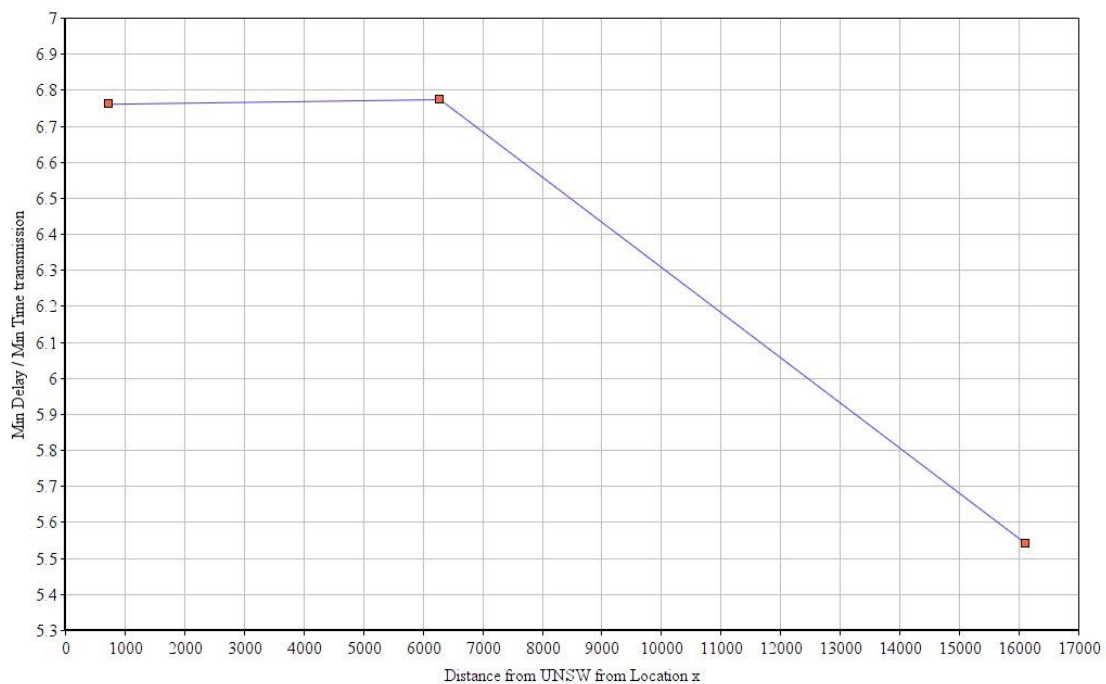
#### Exercise 4: Use ping to gain insights into network performance

1.

ANS:

Location	X (distance from UNSW: km)	(T) Min Time (s) ( $X/3 \cdot 10^8$ )	Min Delay "RTT" (ms)	Y (ratio: RTT/T)
UQ (Queensland)	734	0.0024466667	16.542	6.761035422
NUS (Singapore)	6286	0.0209533333	141.936	6.773910277
TUB (Berlin)	16105	0.0536833333	297.521	5.542148401

Distance from UNSW vs (RTT/T)



Ping time is time including transmission and response received at sender, so it is heavily dependent of data processing time and transmission delay. Assuming response packet ad load packet is of same length, RTT is always  $2 \cdot$  time took to deliver packet + processing delay. The other possible reasons is that Queue-Delay at router or propagation delay might occur.

2.

ANS:

From the “average.txt” of all 3 locations, we observe 6 different packet sizes and their delay time. The plots depicts variability of the delay response over time which is usually constant, mostly due to transmission delay as the delay increase slightly as packets size increase. However there is still anomalies, most probably due to network traffic. Overall we can conclude that the distance or hops between routers does not necessarily affect the delay as packets are transferred.

3.

ANS:

Propagation delay is mostly caused by the physical links such as cable used for transmission. Transmission delay is affected by the proportionality of the packets' size and normally stays fixed if a packet size is fixed. Processing delay however is dependent on size of the packets although it has minimal effect if packet size is unchanged. Queuing delay is however hard to control as it is largely dependent on network traffic.

## Appendix:

1.

traceroute to www.wwwr53.cc.columbia.edu (128.59.105.24), 64 hops max

```
1  * * *
2  129.94.254.172 (wfw1-ae-1-3062.gw.unsw.edu.au) 5.770ms 682.101ms *
3  129.94.254.178 (libwdr1-vl-3063.gw.unsw.edu.au) 5.805ms 3.180ms 1.268ms
4  149.171.255.77 (ombcr1-te-4-5.gw.unsw.edu.au) 2.134ms 6.088ms 1.392ms
5  149.171.255.105 (unswbr1-te-2-13.gw.unsw.edu.au) 2.700ms 110.712ms 1.687ms
6  138.44.5.0 (138.44.5.0) 3.030ms 1262.698ms 922.418ms
7  113.197.15.149 (et-1-3-0.pe1.sxt.bkvl.nsw.aarnet.net.au) 155.992ms 7.209ms 7.721ms
8  113.197.15.99 (et-0-0-0.pe1.a.hnl.aarnet.net.au) 195.424ms 166.753ms 144.989ms
9  113.197.15.201 (et-2-1-0.bdr1.a.sea.aarnet.net.au) 172.601ms 429.383ms 152.006ms
10 207.231.240.8 (abilene-1-lo-jmb-706.sttlwa.pacificwave.net) 512.025ms 157.538ms
    459.063ms
11 162.252.70.0 (et-4-0-0.4079.rtsw.miss2.net.internet2.edu) 168.659ms 244.810ms 171.281ms
12 162.252.70.58 (et-4-0-0.4079.rtsw.minn.net.internet2.edu) 188.368ms 182.619ms 188.485ms
13 162.252.70.106 (et-1-1-2.4079.rtsw.eqch.net.internet2.edu) 196.713ms 199.839ms 221.858ms
14 162.252.70.130 (ae-1.4079.rtsw.clev.net.internet2.edu) 199.126ms 197.571ms 213.155ms
15 199.109.11.33 (buf-9208-I2-CLEV.nysernet.net) 202.394ms 201.607ms 201.549ms
16 199.109.7.193 (syr-9208-buf-9208.nysernet.net) 207.173ms 205.795ms 205.428ms
17 199.109.7.162 (nyc-9208-syr-9208.nysernet.net) 210.847ms 211.503ms 211.415ms
18 199.109.4.14 (columbia.nyc-9208.nysernet.net) 433.124ms 211.651ms 210.824ms
19 128.59.255.10 (nyser111-gw-1-x-nyser32-gw-1.net.columbia.edu) 214.780ms 211.356ms
    499.431ms
20 128.59.255.13 (phi-core-1-x-nyser111-gw-1.net.columbia.edu) 214.197ms 213.101ms
    249.703ms
21 128.59.255.214 (cc-conc-1-x-phi-core-1.net.columbia.edu) 211.567ms 211.833ms 213.106ms
22 128.59.105.24 (columbiauniversity.net) 212.321ms 210.944ms 212.186ms
```

2.

traceroute to www.lancaster.ac.uk (148.88.65.80), 64 hops max

```
1 * * *
2 129.94.254.172 (wfw1-ae-1-3062.gw.unsw.edu.au) 4.305ms 1.048ms *
3 129.94.254.178 (libwdr1-vl-3063.gw.unsw.edu.au) 4.140ms 1.146ms 1.188ms
4 149.171.255.77 (ombcr1-te-4-5.gw.unsw.edu.au) 1.800ms 1.249ms 1.345ms
5 149.171.255.105 (unswbr1-te-2-13.gw.unsw.edu.au) 2.451ms 4.578ms 2.736ms
6 138.44.5.0 (138.44.5.0) 3.691ms 1.311ms 1.223ms
7 113.197.15.149 (et-1-3-0.pe1.sxt.bkvl.nsw.aarnet.net.au) 5.209ms 4.691ms 3.557ms
8 113.197.15.99 (et-0-0-0.pe1.a.hnl.aarnet.net.au) 100.622ms 96.199ms 96.092ms
9 113.197.15.201 (et-2-1-0.bdr1.a.sea.aarnet.net.au) 147.904ms 148.653ms 147.402ms
10 207.231.240.8 (abilene-1-lo-jmb-706.sttlwa.pacificwave.net) 151.435ms 147.471ms
147.549ms
11 162.252.70.0 (et-4-0-0.4079.rtsw.miss2.net.internet2.edu) 158.690ms 158.459ms 158.728ms
12 162.252.70.58 (et-4-0-0.4079.rtsw.minn.net.internet2.edu) 182.510ms 181.371ms 183.033ms
13 162.252.70.106 (et-1-1-2.4079.rtsw.eqch.net.internet2.edu) 191.051ms 189.725ms 192.173ms
14 162.252.70.130 (ae-1.4079.rtsw.clev.net.internet2.edu) 198.977ms 200.158ms 206.935ms
15 162.252.70.54 (et-2-0-0.4079.rtsw.ashb.net.internet2.edu) 212.613ms 205.951ms 205.586ms
16 162.252.70.136 (ae-2.4079.rtsw.wash.net.internet2.edu) 206.266ms 205.772ms 205.902ms
17 62.40.124.44 (internet2.mx1.lon.uk.geant.net) 280.707ms 281.252ms 280.955ms
18 62.40.124.198 (janet-gw.mx1.lon.uk.geant.net) 281.201ms 280.586ms 280.692ms
19 146.97.33.2 (ae29.londpg-sbr2.ja.net) 282.509ms 281.864ms 283.642ms
20 146.97.33.22 (ae31.erdiss-sbr2.ja.net) 302.750ms 295.553ms 284.913ms
21 146.97.33.42 (ae29.manckh-sbr2.ja.net) 297.051ms 288.006ms 286.493ms
22 146.97.38.58 (ae24.lanclu-rbr1.ja.net) 290.483ms 294.658ms 293.712ms
23 * * *
24 148.88.255.17 (ismx-issrx.rtr.lancs.ac.uk) 300.917ms 317.810ms 292.965ms
25 148.88.253.3 (dc.iss.srv.rtrcloud.lancs.ac.uk) 309.646ms 307.802ms 299.083ms
26 148.88.65.80 (www.lancs.ac.uk) 291.529ms !* 289.734ms !* 289.515ms !*
```

3.

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) 0.164 ms 0.156 ms 0.145 ms
2 129.94.39.17 (129.94.39.17) 1.067 ms 1.049 ms 1.004 ms
3 libudnex1-vl-3154.gw.unsw.edu.au (149.171.253.34) 1.849 ms 1.508 ms 1.630 ms
4 libcr1-po-5.gw.unsw.edu.au (149.171.255.165) 1.289 ms ombcr1-po-6.gw.unsw.edu.au
(149.171.255.169) 1.213 ms 1.232 ms
5 unswbr1-te-2-13.gw.unsw.edu.au (149.171.255.105) 1.334 ms unswbr1-te-1-9.gw.unsw.edu.au
(149.171.255.101) 1.267 ms unswbr1-te-2-13.gw.unsw.edu.au (149.171.255.105) 1.357 ms
6 138.44.5.0 (138.44.5.0) 1.463 ms 1.431 ms 1.460 ms
7 et-0-3-0.pe1.alxd.nsw.aarnet.net.au (113.197.15.153) 1.799 ms 1.679 ms 1.661 ms
8 xe-0-2-1-204.pe1.wnpa.alxd.aarnet.net.au (113.197.15.183) 24.363 ms 24.259 ms xe-0-0-
3.pe1.wnpa.akl.aarnet.net.au (113.197.15.67) 24.193 ms
9 et-0-1-0.200.pe1.tkpa.akl.aarnet.net.au (113.197.15.69) 30.940 ms 30.881 ms 30.853 ms
10 xe-0-2-6.bdr1.a.lax.aarnet.net.au (202.158.194.173) 147.966 ms 147.996 ms 147.942 ms
11 singtel.as7473.any2ix.coresite.com (206.72.210.63) 314.209 ms 314.303 ms 314.343 ms
12 203.208.172.173 (203.208.172.173) 314.753 ms 314.840 ms 338.725 ms
13 203.208.153.121 (203.208.153.121) 327.645 ms 203.208.177.110 (203.208.177.110) 327.740
ms 318.406 ms
14 202-150-221-170.rev.ne.com.sg (202.150.221.170) 340.890 ms 338.966 ms 203.208.182.45
(203.208.182.45) 329.837 ms
```

4.

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) 0.160 ms 0.160 ms 0.153 ms
2 129.94.39.17 (129.94.39.17) 1.078 ms 1.102 ms 1.074 ms
3 ombudnex1-vl-3154.gw.unsw.edu.au (149.171.253.35) 1.811 ms 1.680 ms 2.030 ms
4 ombcr1-po-6.gw.unsw.edu.au (149.171.255.169) 1.292 ms 1.402 ms ombcr1-po-gw.unsw.edu.au
  (149.171.255.197) 1.292 ms
5 unswbr1-te-1-9.gw.unsw.edu.au (149.171.255.101) 1.394 ms 1.420 ms 1.421 ms
6 138.44.5.0 (138.44.5.0) 1.549 ms 1.510 ms 1.482 ms
7 et-0-3-0.pe1.bkvl.nsw.aarnet.net.au (113.197.15.147) 1.827 ms 1.787 ms 1.757 ms
8 ae9.bb1.a.syd.aarnet.net.au (113.197.15.57) 2.038 ms 2.041 ms 2.113 ms
9 gigabitethernet1-1.pe1.b.syd.aarnet.net.au (202.158.202.18) 2.258 ms 2.306 ms 2.361 ms
10 gigabitethernet3-11.ken37.sydney.telstra.net (139.130.0.77) 2.844 ms 3.048 ms 3.104 ms
11 bundle-ether13.ken-core10.sydney.telstra.net (203.50.11.94) 4.923 ms 4.952 ms 4.629 ms
12 bundle-ether10.win-core10.melbourne.telstra.net (203.50.11.123) 15.319 ms 15.272 ms 15.181
   ms
13 gigabitethernet5-0.exi-service2.melbourne.telstra.net (203.50.80.132) 13.960 ms 13.996 ms
   13.959 ms
14 * * *
15 * * *
16 * * *
17 * * *
18 * * *
19 * * *
20 * * *
21 * * *
22 * * *
23 * * *
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25 * * *
26 * * *
27 * * *
28 * * *
29 * * *
30 * * *
```



5.

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) 0.168 ms 0.153 ms 0.128 ms
2  129.94.39.17 (129.94.39.17) 1.053 ms 1.026 ms 0.968 ms
3  ombudnex1-vl-3154.gw.unsw.edu.au (149.171.253.35) 1.822 ms 1.549 ms 1.990 ms
4  ombcr1-po-5.gw.unsw.edu.au (149.171.255.197) 1.154 ms 1.213 ms 1.256 ms
5  unswbr1-te-1-9.gw.unsw.edu.au (149.171.255.101) 1.260 ms unswbr1-te-2-13.gw.unsw.edu.au
   (149.171.255.105) 1.276 ms 1.337 ms
6  138.44.5.0 (138.44.5.0) 1.334 ms 1.331 ms 1.419 ms
7  et-0-3-0.pe1.bkvl.nsw.aarnet.net.au (113.197.15.147) 1.918 ms 1.877 ms 1.875 ms
8  ge-4_0_0.bb1.a.pao.aarnet.net.au (202.158.194.177) 156.208 ms 156.206 ms 156.166 ms
9  paloalto0.iiij.net (198.32.176.24) 158.276 ms 158.381 ms 158.499 ms
10 osk004bb01.IIJ.Net (58.138.88.189) 271.241 ms osk004bb00.IIJ.Net (58.138.88.185) 263.981
    ms 264.098 ms
11 osk004ix51.IIJ.Net (58.138.106.126) 263.634 ms osk004ix51.IIJ.Net (58.138.106.130) 267.430
    ms osk004ix51.IIJ.Net (58.138.106.126) 263.601 ms
12 210.130.135.130 (210.130.135.130) 263.634 ms 267.298 ms 267.278 ms
13 124.83.228.78 (124.83.228.78) 267.283 ms 267.394 ms 271.028 ms
14 124.83.252.250 (124.83.252.250) 273.759 ms 273.840 ms 270.286 ms
15 158.205.134.26 (158.205.134.26) 270.064 ms 273.874 ms 273.822 ms
16 * * *
17 * * *
18 * * *
19 * * *
20 * * *
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25 * * *
26 * * *
27 * * *
28 * * *
29 * * *
30 * * *
```

6.

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) 0.126 ms 0.101 ms 0.131 ms
2  129.94.39.17 (129.94.39.17) 1.055 ms 1.011 ms 1.055 ms
3  libudnex1-vl-3154.gw.unsw.edu.au (149.171.253.34) 1.373 ms ombudnex1-vl-
   3154.gw.unsw.edu.au (149.171.253.35) 1.627 ms 1.777 ms
4  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) 1.248 ms libcr1-po-5.gw.unsw.edu.au (149.171.255.165) 1.217 ms
5  unswbr1-te-1-9.gw.unsw.edu.au (149.171.255.101) 1.264 ms 1.265 ms 1.294 ms
6  138.44.5.0 (138.44.5.0) 1.394 ms 1.512 ms 1.488 ms
7  et-1-3-0.pe1.sxt.bkvl.nsw.aarnet.net.au (113.197.15.149) 2.116 ms 2.342 ms 2.375 ms
8  et-0-0-0.pe1.a.hnl.aarnet.net.au (113.197.15.99) 95.297 ms 95.402 ms 95.309 ms
9  et-2-1-0.bdr1.a.sea.aarnet.net.au (113.197.15.201) 146.574 ms 146.494 ms 146.455 ms
10 cenichpr-1-is-jmb-778.snvaca.pacificwave.net (207.231.245.129) 163.058 ms 163.101 ms
    163.084 ms
11 hpr-lax-hpr3--svl-hpr3-100ge.cenic.net (137.164.25.73) 170.900 ms 170.757 ms 170.802 ms
12 * * *
13 bd11f1.anderson--cr00f2.csb1.ucla.net (169.232.4.4) 173.047 ms bd11f1.anderson--
   cr001.anderson.ucla.net (169.232.4.6) 171.146 ms bd11f1.anderson--cr00f2.csb1.ucla.net
   (169.232.4.4) 172.544 ms
14 cr00f1.anderson--dr00f2.csb1.ucla.net (169.232.4.55) 171.247 ms cr00f2.csb1--
   dr00f2.csb1.ucla.net (169.232.4.53) 171.234 ms 171.262 ms
15 * * *
16 * * *
17 * * *
18 * * *
19 * * *
20 * * *
21 * * *
22 * * *
23 * * *
24 * * *
25 * * *
26 * * *
27 * * *
28 * * *
29 * * *
30 * * *
```

7.

Server: 127.0.1.1

Address: 127.0.1.1#53

Non-authoritative answer:

www.youtube.comcanonical name = youtube-ui.l.google.com.

Name: youtube-ui.l.google.com

Address: 172.217.25.46

Name: youtube-ui.l.google.com

Address: 172.217.25.142

Name: youtube-ui.l.google.com

Address: 216.58.196.142

Name: youtube-ui.l.google.com

Address: 216.58.220.142

Name: youtube-ui.l.google.com

Address: 216.58.199.46

Name: youtube-ui.l.google.com

Address: 172.217.25.174

Name: youtube-ui.l.google.com

Address: 216.58.200.110

Name: youtube-ui.l.google.com

Address: 216.58.203.110

8.

Server: 127.0.1.1

Address: 127.0.1.1#53

Non-authoritative answer:

Name: www.google.com

Address: 216.58.203.100

9.

Server: 127.0.1.1

Address: 127.0.1.1#53

1.0.0.127.in-addr.arpa name = localhost.

10.

tracert to 103.10.197.13 (103.10.197.13), 30 hops max, 60 byte packets

```
1  ge2-8.r01.sin01.ne.com.sg (202.150.221.169)  0.140 ms  0.146 ms  0.157
   ms
2  10.11.34.5 (10.11.34.5)  0.347 ms  0.414 ms  0.427 ms
3  6939.sgw.equinix.com (27.111.228.81)  0.497 ms  0.510 ms  0.570 ms
4  100ge14-2.core1.hkg1.he.net (184.105.222.101)  33.645 ms  33.778 ms
   33.790 ms
5  dc.10gigabitethernet6-4.core1.hkg1.he.net (27.50.33.34)  35.589 ms
   35.669 ms  35.737 ms
6  * * *
7  * * *
8  * * *
9  * * *
10 * * *
11 * * *
12 * * *
13 * * *
14 * * *
15 * * *
16 * * *
17 * * *
18 * * *
19 * * *
20 * * *
21 * * *
22 * * *
23 * * *
24 * * *
25 * * *
26 * * *
27 * * *
28 * * *
29 * * *
30 * * *
```

11.

```
1  gigabitethernet3-3.exil.melbourne.telstra.net (203.50.77.49)  0.352 ms  0.280 ms  0.244 ms
2  bundle-ether3-100.exi-core10.melbourne.telstra.net (203.50.80.1)  1.119
   ms  1.421 ms  2.118 ms
3  bundle-ether12.chw-core10.sydney.telstra.net (203.50.11.124)  12.113 ms
   12.166 ms  12.862 ms
4  bundle-ether1.oxf-gw11.sydney.telstra.net (203.50.6.93)  13.861 ms
   11.916 ms  12.738 ms
5  bundle-ether1.sydo-core03.sydney.reach.com (203.50.13.98)  12.863 ms
   14.291 ms  13.113 ms
6  i-73.paix-core02.telstraglobal.net (202.84.247.45)  198.505 ms  199.308
   ms  200.130 ms
7  i-92.paix02.telstraglobal.net (202.84.247.41)  198.880 ms  198.310 ms
   198.379 ms
8  he-peer.paix02.pr.telstraglobal.net (134.159.61.22)  197.879 ms
   197.935 ms  198.003 ms
9  100ge7-1.core1.lax2.he.net (184.105.81.238)  166.520 ms  166.079 ms
   166.017 ms
10 100ge10-1.core1.hkg1.he.net (184.105.64.126)  227.112 ms  227.039 ms
   227.113 ms
11 dc.10gigabitethernet6-4.core1.hkg1.he.net (27.50.33.34)  371.162 ms
   228.530 ms  228.989 ms
```