

Lab 1

Exercise 1

1. 172.67.219.46 and 104.21.45.210. Multiple IPs can be used as a way to host multiple servers or for load balancing to prevent denial of service attacks.
2. Name is localhost, which is also referred to as the loopback address since the information sent to it is routed back to the local machine.

Exercise 2

1. www.unsw.edu.au – 68/68 packets received, 0% packet loss
2. www.getfittest.com.au – unknown host, wrong domain name (doesn't exist)
3. www.mit.edu – 25/25 packets received, 0% packet loss
4. www.intel.com.au – 26/26 packets received, 0% packet loss
5. www.tpg.com.au – 25/25 packets received, 0% packet loss
6. www.hola.hp – unknown host, no such DNS
7. www.amazon.com - 31/31 packets received, 0% packet loss
8. www.tsinghua.edu.cn - 29/29 packets received, 0% packet loss
9. www.kremlin.ru - 0/21 packets received, 100% packet loss, possibly blocked by firewall to prevent DoS attacks.
10. 8.8.8.8 - 29/29 packets received, 0% packet loss

Exercise 3

1. There are 22 routers between my workstation and www.columbia.edu. There are 5 routers that are part of the UNSW network. The packets cross the Pacific Ocean between routers 7, 8 and 9.

2. The paths diverge at router 6 (138.44.5.0). This router belongs to an internet service provider known as AARNet.
 - www.ucla.edu (164.67.228.152): 15 hops, 7500 miles/12070.08 km.
 - www.u-tokyo.ac.jp (210.152.243.234): 15 hops, 4908.7 miles/7899 km.
 - www.lancaster.ac.uk (148.88.65.80): 24 hops, 10569.8 miles/17010 km.

The number of hops does not seem to be proportional to the physical distance. For example, UCLA is 4000 km further away than Tokyo but still has the same number of hops, whereas Lancaster is 4000km further away than UCLA but has 9 more hops.

- 3.

Traceroute from www.speedtest.com.sg to home:

Traceroute Result:

```
traceroute to 203.219.202.7 (203.219.202.7), 30 hops max, 60 byte packets
 1  ge2-8.r01.sin01.ne.com.sg (202.150.221.169)  0.141 ms  0.165 ms  0.178 ms
 2  10.15.62.226 (10.15.62.226)  33.474 ms  33.509 ms  33.526 ms
 3  tpg2-lacp-10g.hkix.net (123.255.90.158)  149.246 ms  149.257 ms  149.261 ms
 4  203-221-3-40.tpgi.com.au (203.221.3.40)  145.141 ms  145.187 ms  145.158 ms
 5  * * *
 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  * * *
```

Traceroute Completed.

Traceroute from home to www.speedtest.com.sg

```
Tracing route to www.speedtest.com.sg [202.150.221.170]
over a maximum of 30 hops:

 1      <1 ms      <1 ms      <1 ms  192-168-1-1.tpgi.com.au [192.168.1.1]
 2       8 ms       7 ms       8 ms  cbr-trn-nor-lns1-lo.tpgi.com.au [10.20.22.41]
 3      11 ms      10 ms      11 ms  syd-gls-har-int2-be100.tpgi.com.au [203.221.3.4]
 4     119 ms     119 ms     120 ms  newmedia1-10g.hkix.net [123.255.90.188]
 5       *         *         *     Request timed out.
 6     152 ms     152 ms     152 ms  202-150-221-170.rev.ne.com.sg [202.150.221.170]

Trace complete.
```

Traceroute from www.telstra.net to home:

```
1  gigabitethernet3-3.exi2.melbourne.telstra.net (203.50.77.53)  7.659 ms  0.454 ms  0.993 ms
2  bundle-ether3-100.win-core10.melbourne.telstra.net (203.50.80.129)  2.363 ms  1.727 ms  2.119 ms
3  bundle-ether1.win-edge901.melbourne.telstra.net (203.50.11.106)  0.988 ms  0.854 ms  0.866 ms
4  aap1604794.lnk.telstra.net (165.228.52.2)  0.992 ms  0.980 ms  0.993 ms
5  nme-apt-bur-wgw1-be30.tpgi.com.au (203.219.107.205)  1.115 ms  0.980 ms  0.992 ms
6  27-32-160-194.static.tpgi.com.au (27.32.160.194)  12.110 ms
7  syd-gls-har-crt1-be-10.tpgi.com.au (202.7.171.173)  15.107 ms  15.096 ms
8  203-221-3-90.tpgi.com.au (203.221.3.90)  11.974 ms
```

Traceroute from home to www.telstra.net:

```
Tracing route to www.telstra.net [203.50.5.178]
over a maximum of 30 hops:

  1  <1 ms  <1 ms  <1 ms  192-168-1-1.tpgi.com.au [192.168.1.1]
  2   7 ms   8 ms   7 ms  cbr-trn-nor-lns1-lo.tpgi.com.au [10.20.22.41]
  3   7 ms   7 ms   7 ms  syd-gls-har-wgw1-be-100.tpgi.com.au [203.221.3.7]
  4   8 ms   9 ms   8 ms  203-219-107-194.static.tpgi.com.au [203.219.107.194]
  5  10 ms  12 ms   8 ms  Bundle-Ether84.chw-edge903.sydney.telstra.net [110.145.180.217]
  6   9 ms  10 ms   9 ms  bundle-ether17.chw-core10.sydney.telstra.net [203.50.11.176]
  7  19 ms  20 ms  20 ms  bundle-ether8.exi-core10.melbourne.telstra.net [203.50.11.125]
  8  19 ms  20 ms  19 ms  203.50.11.209
  9  20 ms  20 ms  19 ms  www.telstra.net [203.50.5.178]

Trace complete.
```

The IP addresses of www.speedtest.com.sg and www.telstra.net are 202.150.221.170 and 203.50.5.178 respectively. The reverse paths do not go through the same routers as the forward paths and they do not share any common routers or IP addresses between them. This is because the routing is asymmetric, as each router makes its own decision about the next hop where it will send packets to depending on which is the best known path for that particular packet in that instance.

Exercise 4

1. Distance from UNSW to University of Queensland = 734 km

$$T = 734 * 1000 / 3 * 10^8 = 0.0024466 \text{ s} = 2.45 \text{ ms}$$

$$\text{RTT (from ping)} = 17.3 \text{ ms}$$

$$\text{Ratio: } 7.06$$

$$\text{Distance from UNSW to University of Malaya} = 6654 \text{ km}$$

$$T = 6654 * 1000 / 3 * 10^8 = 0.02218 \text{ s} = 22.18 \text{ ms}$$

$$\text{RTT} = 99.7 \text{ ms}$$

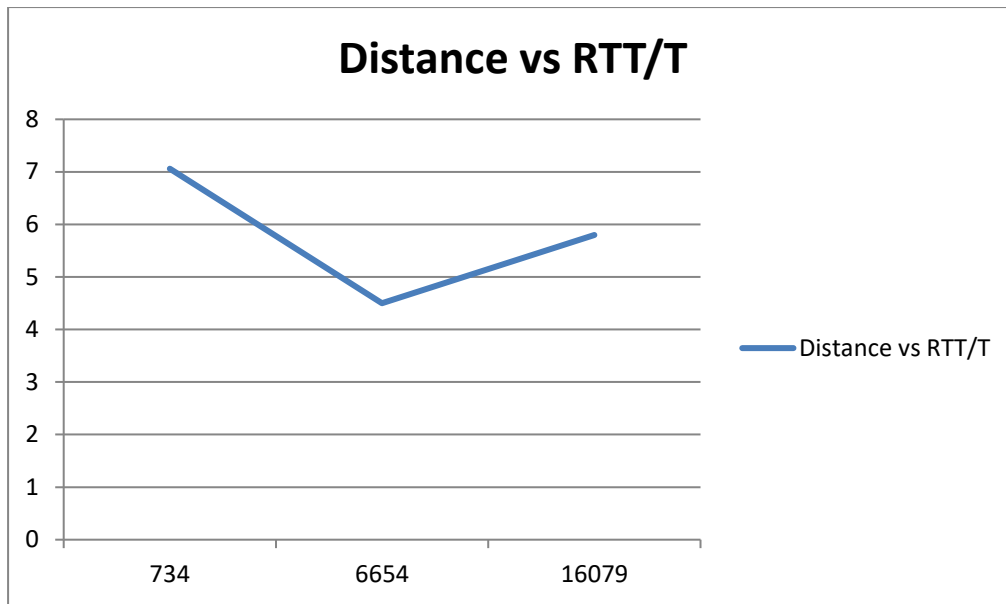
$$\text{Ratio: } 4.5$$

$$\text{Distance from UNSW to Berlin Institute of Technology} = 16079 \text{ km}$$

$$T = 16079 * 1000 / 3 * 10^8 = 0.0535966 \text{ s} = 53.6 \text{ ms}$$

$$\text{RTT} = 313 \text{ ms}$$

$$\text{Ratio: } 5.8$$



The y-axis values have to be greater than 2 since RTT measures the time for a packet to reach its destination and also return to its source. Since T is the shortest time it takes for a packet to reach its destination, then RTT has to take at least 2 times longer than T . Thus the ratio between RTT and T must be greater than 2.

2. The delay to Queensland and Berlin seems to be constant and dependent on packet size according to the scatter plot, whereas the delay to Malaysia is less consistent. This is possibly due to the use of packet switching at the University of Malaya, where resource flow is dynamically allocated to prevent potential overloads.
3. www.epfl.ch seems to be hosted somewhere in Australia given that the RTT values from ping are quite low (~ 2 ms). These RTT values would be much higher if the website was hosted in Switzerland.
4. Only transmission delay depends on packet size whereas propagation delay depends on the physical length of the link, processing delay depends on the efficiency of router in checking bit errors and queuing delays depends on the congestion level of the router.