Exercise 1: Ping test

Host	Result	Reason
CSE	**100% packet loss**	Most likely blocked by a firewall to prevent Denial of Service attacks.
Cancer Council	**100% packet loss**	Unreachable. Not the legitimate website (cancercouncil.com.au)
Compnet.epfi	123/132 received packets 6.8% packet loss	N/A reachable
Intel	74/79 received packets 6.3% packet loss	N/A reachable
Telstra	59/67 received packets 11.9% packet loss	N/A reachable
Hola.hp	**Cannot resolve, unknown host**	Unreachable. DNS could not be found.
Amazon	84/84 received packets 0% packet loss	N/A reachable.
Wkileaks	57/58 received packets 1.7% packet loss	N/A reachable.
Tsinghua University	103/106 received packets 2.8% packet loss	N/A reachable.
Kremlin	**100% packet loss**	Most likely blocked by a firewall to prevent Denial of Service attacks.
8.8.8.8	33/49 received packets 17.5% packet loss	N/A reachable.

Exercise 2: Traceroute / Network Topology

How many routers between my workstation and www.nyu.edu?

- 16 routers

How many routers along the path are part of UNSW network?

- 0 routers

Between which two routers do packets cross the Pacific Ocean?

- Between #4 and #4
- #4 = still in Australia → #5 = in United Kingdom

Which router do the paths from your machine to the three destinations diverge?

- The paths diverge at the router **198.142.139.134**

Info about this router (whois):

- This router belongs to the Optus Centre is Sydney.

Is the number of hops on each proportional with the physical distance? (geographical distance)

Geographical distance is calculated by using straight line distance from my home to the dest

- Hops to **UCLA**: 17 hops → 12,071.663 km
- Hops to **UTOKYO:** 21 hops → 7,836.810 km
- Hops to **LANCASTER:** 25 hops → 17010.123 km
- The number of hops is not proportional, as we can see that UTOKYO, with the shortest geographical distance from Sydney, Australia still takes 21 hops before arriving at the the destination, compared with UCLA with nearly TWICE the geographic distance but taking only 17 hops before arriving at the destination.
- This is likely because there is less network infrastructure around UTOKYO which limits the ability for network traffic to go through a more direct route to the location, thus needs to hop around more routers before arriving at UTOKYO.

Traceroute from servers to home machine

- Traceroute from **Speedtest.com.sg to home**: 8 hops

Traceroute Result:

```
traceroute to 110.20.162.5 (110.20.162.5), 30 hops max, 60 byte packets
 1  ge2-8.r01.sin01.ne.com.sg (202.150.221.169)  0.209 ms * *
 2  10.11.34.2 (10.11.34.2)  0.225 ms  0.289 ms  0.306 ms
 3  newmedia10ge.telstraglobal.net (210.176.138.25)  0.735 ms  0.755 ms  0.821 ms
 4  i-0-1-0-39.sydp-core03.bx.telstraglobal.net (202.84.136.30)  123.579 ms  121.312 ms  123.584 ms
 5  bundle-ether3.pad-gw10.sydney.telstra.net (203.50.13.85)  124.288 ms  124.408 ms  124.306 ms
 6  bundle-ether3.chw-core10.sydney.telstra.net (203.50.6.56)  124.316 ms  124.164 ms  124.168 ms
 7  bundle-ether1.chw-edge901.sydney.telstra.net (203.50.11.99)  122.793 ms  123.777 ms  124.491 ms
 8  opt1871911.lnk.telstra.net (139.130.40.50)  120.774 ms  120.759 ms  122.568 ms
```

From **home to Speedtest.com.sg**: 16 hops

```
o → traceroute www.Speedtest.com.sg
traceroute to www.speedtest.com.sg (202.150.221.170), 64 hops max, 52 byte packets
 1  router.asus.com (192.168.1.1)  4.079 ms  1.448 ms  1.430 ms
 2  10.108.0.1 (10.108.0.1)  9.743 ms  9.718 ms  15.645 ms
 3  * * *
 4  * * *
 5  * * *
 6  198.142.250.217 (198.142.250.217)  13.169 ms
    211.29.126.153 (211.29.126.153)  13.172 ms  17.615 ms
 7  198.142.139.118 (198.142.139.118)  11.857 ms  11.777 ms  12.020 ms
 8  198.142.139.134 (198.142.139.134)  12.172 ms  13.498 ms  15.205 ms
 9  * * *
10  * * *
11  80.81.69.149 (80.81.69.149)  14.782 ms  11.958 ms  13.186 ms
12  85.95.27.177 (85.95.27.177)  107.914 ms  107.115 ms  107.766 ms
13  ge-5-1-0.0.ejr03.sin001.flagtel.com (62.216.137.150)  115.022 ms  106.944 ms  107.751 ms
14  * * *
15  * * *
16  202-150-221-170.rev.ne.com.sg (202.150.221.170)  132.292 ms  130.005 ms  132.204 ms
```

- Traceroute from **home to Telstra.net**: 5 hops

```
 1  gigabitethernet3-3.exi1.melbourne.telstra.net (203.50.77.49)  0.259 ms  0.267 ms  0.238 ms
 2  bundle-ether3-100.exi-core10.melbourne.telstra.net (203.50.80.1)  2.614 ms  1.292 ms  2.240 ms
 3  bundle-ether12.chw-core10.sydney.telstra.net (203.50.11.124)  15.360 ms  14.284 ms  14.735 ms
 4  bundle-ether1.chw-edge901.sydney.telstra.net (203.50.11.99)  13.358 ms  13.285 ms  13.234 ms
 5  opt1871911.lnk.telstra.net (139.130.40.50)  13.610 ms  13.661 ms  13.614 ms
```

From **Telstra.net to home**: 10 hops

```
o → traceroute www.telstra.net
traceroute to www.telstra.net (203.50.5.178), 64 hops max, 52 byte packets
 1  router.asus.com (192.168.1.1)  2.144 ms  1.603 ms  1.338 ms
 2  10.108.0.1 (10.108.0.1)  10.611 ms  11.414 ms  9.932 ms
 3  * * *
 4  * * *
 5  * * *
 6  59.154.18.134 (59.154.18.134)  11.625 ms
    59.154.142.28 (59.154.142.28)  12.150 ms
    59.154.142.132 (59.154.142.132)  12.496 ms
 7  bundle-ether32.chw-edge901.sydney.telstra.net (139.130.40.49)  15.313 ms
    bundle-ether16.ken-edge901.sydney.telstra.net (139.130.28.253)  14.860 ms  12.200 ms
 8  bundle-ether13.ken-core10.sydney.telstra.net (203.50.11.94)  15.452 ms  12.674 ms
    bundle-ether13.chw-core10.sydney.telstra.net (203.50.11.98)  16.321 ms
 9  bundle-ether8.exi-core10.melbourne.telstra.net (203.50.11.125)  25.211 ms
    bundle-ether12.win-core10.melbourne.telstra.net (203.50.11.123)  24.454 ms
    bundle-ether8.exi-core10.melbourne.telstra.net (203.50.11.125)  28.827 ms
10  gigabitethernet5-0.exi-service2.melbourne.telstra.net (203.50.80.132)  25.327 ms  31.855 ms  29.874 ms
```

- From the output we can see that the reverse path **does NOT go through the same routers as the forward path** and also for some reason takes **twice as many hops to go from home → dest** as opposed to dest → home.
- This is likely because routes are determined based on each router. Each one would have its own set of routing rules so that path forward is not necessarily the same path home. They are determined by things such as neighbouring networks, default routing, administrative distance and metrics. Usually your ISP would route outbound traffic through filters to warn you if you do any “illegal” things such as pirating movies.

Exercise 3: Ping / Network Performance

Analysing the dependency of packet size and delay

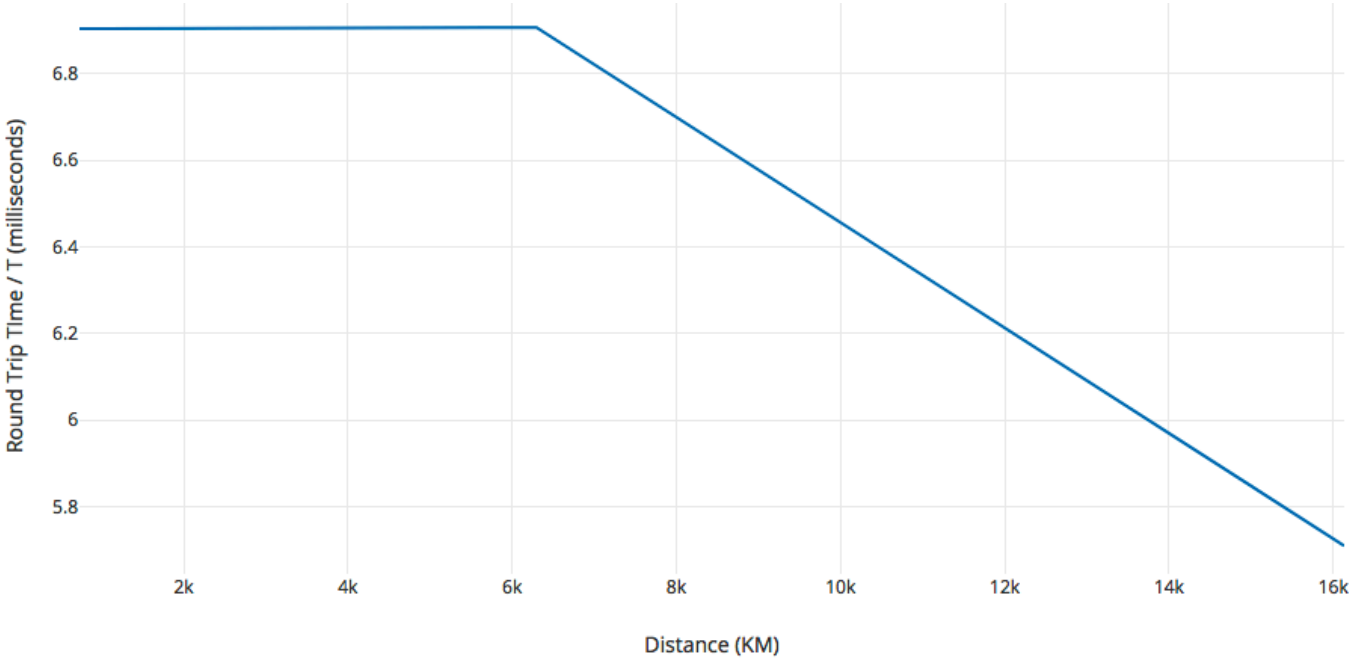
Assuming propagation speed is the speed of light = **~(3 * 10^8) metres per second**

- Therefore, speed of light = **~(3 * 10^8 / 1000) km per second**
- Therefore, speed of light = **~300,000 km per second**

Approximate physical distance from UNSW (straight line distance in KM)	Shortest Time (T) to reach destination from UNSW (seconds / milliseconds)
National University of Singapore: 6,297.62 km	T = ~0.021 seconds / 21ms
Technical University of Berlin: 16,133.87 km	T = ~0.053 seconds / 53ms
University of Queensland: 731.78 km	T = ~0.0024 seconds / 2.4ms

Round Trip Time / T Calculations:

- Queensland: 16.570km / 2.4ms = **6.904**
- Singapore: 145.049km / 21ms = **6.907**
- Berlin: 302.668km / 53ms = **5.710**



Why are the y-axis values greater than 2?

- The Round Trip Time is counting the time it takes for a packet to travel from the source to the destination and receive a response (back again to the source). Whereas T is the shortest time is takes to reach the destination, so RTT would at least be twice as big as T. Therefore, for Y-axis value would be greater than 2.

Is the delay to the destinations constant or does it vary over time + why?

- Delay to the destinations seems to be constant over time, except for Singapore. Also, there seems to be bursts of delays at some intervals.
- This is because of the use of Packet Switching which leverages statistical multiplexing. Resource flow is dynamically allocated and shared, so no overloading occurs.

Which destinations does the delay depend on the size of the ping packets?

- For Singapore and Queensland, the delay seems to depend on the size of the ping packets. For Singapore, the larger-sized ping packets have a much larger delay than smaller packets and for Queensland, some packet sizes have a larger delay and some smaller.
- However, for Berlin every packet size seems to have similar delay.

Transmission, Propagation, Processing and Queuing: Which of these delays depend on the packet size and which do not?

- **Transmission delay** depends on packet size, as it is the amount of time taken to transmit a whole pack of a certain size. It is calculated by L / R, where L = size of the whole packet and R = the link bandwidth
- **Propagation, Processing and Queueing** do NOT depend on the packet size.
    - Propagation relies on length of the physical link, divided by the propagation speed
    - Processing just checks for errors and processes the packet header
    - Queuing is just the time taken for the packet to wait at the output link for transmission