Department of Computer Science
Computer Networks
Due: Sunday 6th September 23.59

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TA Name: Hannes
Time Taken: 8 hours
Estimated Time: 10 hours

This is an individual assignment and should be submitted as a pdf using Canvas.

For those who like to dabble in the dark arts, the latex version is also available. You may submit in any legible form you wish.

Marks are awarded for question difficulty. While there is typically a relationship between difficulty and length of answer, it may not be a strong one. Always justify your answer if necessary, especially with open ended questions such as pricing, or design.

Optional: Please include a rough estimate of how long it took you do the assignment so that we can calibrate the work being assigned for the course. (The estimated time is provided purely as a guideline.)

Question:	1	2	3	Total
Points:	11	7	12	30
Score:				

Introduction

Network Transport Times

1 . . . . . *11 points*

(a) (2 points) traceroute and ping are command line tools to show the network path to another host.

Perform a traceroute to each of the following hosts. For each host, give at least one intermediate countries the network packets are going through. (Identifying paths depends on the network providers naming convention for their switches. Network providers often use Airport City codes for this, so the following site may be helpful `https://www.world-airport-codes.com/`.

1. mel1.speedtest.telstra.net
2. 103.242.70.4

traceroute mel1.speedtest.telstra.net
Iceland - UK - USA - Australia - Haiti - Australia - UK

traceroute 103.242.70.4
Iceland - UK - NY - CAL - CAL(LA) - New Zealand - Australia.

(b) (2 points) What does a "* * *" line in the traceroute response mean?

Timeout error.

(c) (2 points) Using the ping command, what is the round trip time (RTT) to the following hosts?

1. mel1.speedtest.telstra.net
2. per1.speedtest.telstra.net

ping mel1.speedtest.telstra.net
27 packets transmitted, 27 received, 0% packet loss, time 27368ms
avg = 354.881 ms

ping per1.speedtest.telstra.net
78 packets transmitted, 78 received, 0% packet loss, time 79050ms
avg = 387.579 ms

(d) (2 points) Both the hosts are in Australia, mel1 is in Melbourne, perl1 is in Perth. If the speed of light in a vacuum is 300,000,000 m/s and the core index of refraction of fiber-optic cable in the Australian backbone is 1.50, approximately how far is Perth from Melbourne?

From mel1, Melbourne, and perl1, Perth, is 0.015 s in delay. Speed in an optic cable is 300,000,000 m/s / 1.50 or 200,000,000 m/s. So the distance between is 3,000,000 m or 3,000 km.

(e) (3 points) CA Technologies provides a site which allows you to ping a publicly accessible Internet host from different hosts worldwide in order to measure local response time for your users.

`https://asm.ca.com/en/ping.php`

Use this site to ping:

- www.ru.is
- www.mit.edu

By examining the difference in ping response times for www.ru.is, name the country this host is actually located in?

In what countries does MIT appear to be located?

What service is MIT using to do this?

www.ru.is: The server is located in Ireland

www.mit.edu: There seems to be a server in many different countries, like India, Australia, Germany, and more. MIT must be using Content Delivery Network (CDN) to achieve this.

Network Throughput

2 . . . . . *7 points*

(a) (2 points) You need to transfer a geophysical dataset of 200TB stored on disk in Iceland to the Norwegian Metrology Office. How long will it take to transfer this dataset to Norway assuming a 1Gbps connection, and 20% protocol overhead?

1Gbps or 1/8GBps.
200,000GB/1/8GBs = 1,600,000s
= 444h, with 20% overhead
= 533h

(b) (2 points) Ref: `https://en.wikipedia.org/wiki/Linear_Tape-Open`

An industry standard tape (circa 2018) can hold 12TB of data on a single cartridge. Assuming a best case scenario of 3 hours ground transport time to Keflavik airport and 1 hour from Oslo to destination company, with a scheduled flight time also of 3 hours. How much data do you need before it is quicker to send the data by tape than transfer it over the network? (Ignore time to read and write the tape.)

12,000 GB per 7h. 0.125 GBps = 450 GBh.
450 GB/h / 1.2 * 7h = 2,625 GB.
= 2,625+ GB

(c) (2 points) Tannenbaum in Computer Networks wisely advises never to overlook the speed of sending data by existing transport networks - planes in this case. However, his example overlooks the time taken to create the tapes in the first place.

Assuming that the maximum writing and reading speed for a tape is 900(MB/s), how long does it actually take to transfer the data to Norway including the time to read and write the tapes, and that you only have one tape reader/writer in each city?

7h + (2*200.000 GB / 0.9GB/s = 123.4679h) = 130.4679h

(d) (1 point) What is the new break even amount for sending data by planes?

450 GB/h / 1.2 * 130.46h = 48921 GB.
= 48,921+ GB.

Network Engineering

3 ..... *12 points*

An ISP is statistically multiplexing its customers over 50Gb links. You have been asked to calculate how many customers it can afford to assign to each link, and maintain a reasonable level of service to each one.

Nominally, each customer is being sold a 1Gb link.

(a) (1 point) If each customer is to be guaranteed access to 1Gb at any time, how many customers can the ISP provision per 50Gb link.

50 customers.

(b) (2 points) Assume that the 50Gb link costs the ISP 5,000,000 ISK/month, and the ISP needs to make 25% profit to cover all overheads. What is the smallest number of customers that the ISP can provision for each 10Gb link, and still meets its profit targets, if the ISP charges each customer 10,000ISK for their Internet service?

ISP needs to make 50,000,000 ISK/month per 50 Gb * 1.25/10,000 ISK/month per customer.
= 625 customers per 50 Gb.
= 125 customers per 10 Gb.

(c) (1 point) What is the maximum speed each customer will be able to download data at, assuming all the customers provisioned in (b) are maximising their network connection?

10 Gb/125
= 0.08Gb
= 80 Mb.

(d) (2 points) How much should the company charge a customer who wants a guaranteed 10 GB link at all times?

5,000,000 ISK/month per 50 Gb * 1.25 / 5 Gb*8
= 10,000,000 ISK/month

(e) (4 points) The ISP decides that on average each customer will use their link 20% of the time, evenly distributed over the day. Assuming this is correct, how many customers can the ISP now provision and still maintain the illusion that they have access to 1Gb each?

Can guarantee 50 customers 1Gb,
but with 20% usage 250 customers can think they have 1Gb.

(f) (2 points) If the ISP has a mixture of business and household customers, how should it assign the different types of customer to its links in order to improve performance?

Best to assign businesses with household customers because I would assume the business uses much traffic in the day which is a contrast to the household at that time, but in the evening the household uses much more internet traffic than businesses.

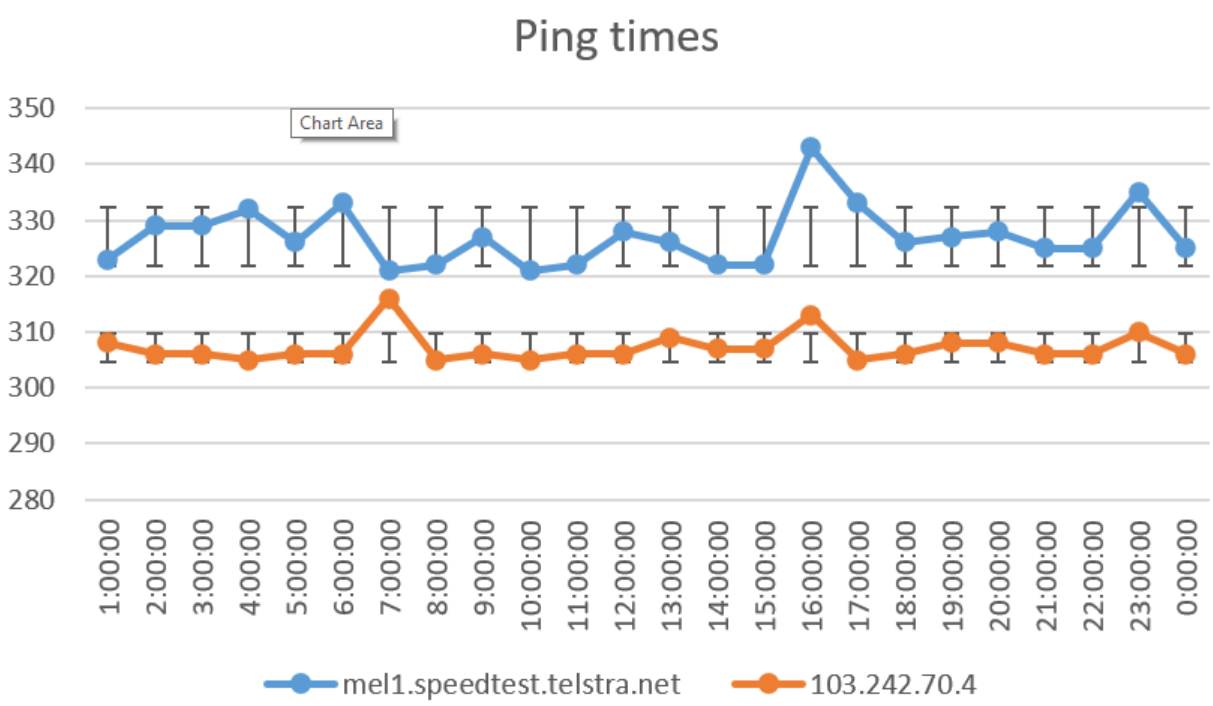
Bonus Question: 2 Bonus Marks

Referring back to question 1, and the time taken for a packet to travel to and across Australia. Using traceroute create a table of round trip times to the two hosts in question 1, and to and from one of the London switches performed at least four different times of the day (it does not have to be the same day), separated by at least 2 hours from each other. That is you are capturing the time from Iceland to London, and from London to Australia for the same route.

Include your measurements in a table. With reference to these measurements:

What is the fastest and slowest time of day to send traffic to Australia?

Where does it seem the congestion is occurring that may slow down the traffic?


Ping times
Chart Area
350
340
330
320
310
300
290
280
1:00:00
2:00:00
3:00:00
4:00:00
5:00:00
6:00:00
7:00:00
8:00:00
9:00:00
10:00:00
11:00:00
12:00:00
13:00:00
14:00:00
15:00:00
16:00:00
17:00:00
18:00:00
19:00:00
20:00:00
21:00:00
22:00:00
23:00:00
0:00:00
mel1.speedtest.telstra.net
103.242.70.4