CMSC3180: Data Communication and Networking
Assignment 1 Due in class on Wednesday 09/11

Policies:

1. Discussions on these questions are welcomed and encouraged. However, you should NOT ask any other person to write solution for you or copy solutions from any other person directly. You should write the names of the persons from whom you received help and cite the references used if any.
2. The total score for this assignment is 30. Late turn in will cause a 10% deduction on your grade for each late day.
3. Either turn in hard-copy in class or submit e-copy to D2L dropbox

Question 1. (10 points)

How long does it take a packet of length 1440 bytes to propagate over a link of distance 3000 km, propagation speed $2x10^8$ m/s, and transmission rate 2.5 Mbps (**Note: bps=bit per second)**?
More generally, how long does it take a packet of length L to propagate over a link of distance d, propagation speed s, and transmission rate R bps?
Does this delay depend on packet length? Does this delay depend on transmission rate?

Q1 Calculations:

L = 1440 bytes = 11520 bits
D = 3000km → convert to m
S = 2x10^8 ms
R = 2.5 Mbps = 2.5E+6 bps

Transmission Delay:

$$D_{trans} = \frac{L}{R} = \frac{11520\ bits}{2.5E6\ bits/sec} = 0.004608\ \text{sec} = 4.6\ \text{ms}$$

Propagation Delay:

$$D_{prop} = \frac{d}{s} = \frac{3000km * 10\text{^}3}{2E8\ ms} = 0.015 = 15ms$$

Conclusion:

Propagation Delay does not depend on either packet length or transmission rate. By implementing both the distance a propagate travels over a link between routers and the speed at which it is delivered, we can find the propagation delay ($D_{prop} = \frac{d}{s}$). After converting all units into a corresponding base, we can then find the resulting data in *ms*. Question 1 Propagation Delay = 15ms

Question 2. (10 points)

Suppose Host A wants to send a large file to Host B. The path from Host A to Host B has three links, of rate R_1=600 kbps, R_2=1.8 Mbps, and R_3=1 Mbps.

a. Assuming no other traffic in the network, what is the throughput for the file transfer?
b. Suppose the file is 7.2 million bytes. Dividing the file size by the throughput, roughly how long will it take to transfer the file to Host B?
c. Repeat (a) and (b), but now with R_2 reduced to 300 kbps.

Part A.

Since the bottleneck link is the constraining factor of end-end throughput for file transfer, the smallest link would determine the throughput without traffic. Hence, R_1 = 600 kbps would be the throughput.

Part B.

Calculations:
7.2 million bytes = 5.76E7 bits
600 kbps = 600000 Mbps

5.76E7 bits/600 kbps = 96 sec

Conclusion:
It would take roughly 96 seconds for the file to be transferred to Host B.

Part C.

After adjusting R_2 to be 300 kbps, it would then be the bottleneck link that constrains the system. It can therefore be viewed as the throughput for file transfer.

Refactored Calculations:
7.2 million bytes = 5.76E7 bits

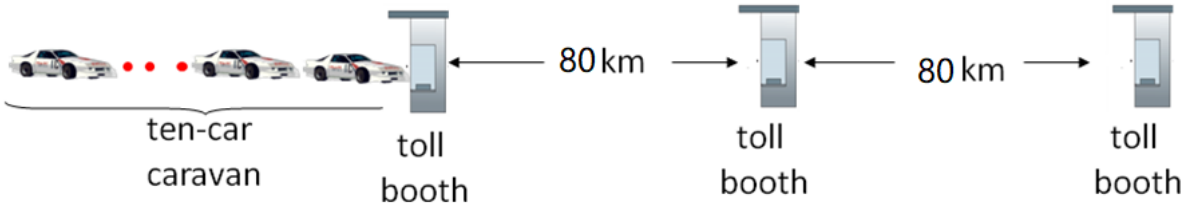
5.76E7 bits/300 kbps = $\frac{5.76E7 \text{ bits}}{300E3} = 192\ sec$

Conclusion:

The two throughput values show us a direct relationship between link size and throughput. When a link is larger in size, it allows bits to be sent from sender to receiver at a faster rate. However, when the link is smaller in size, the sending rate is substantially slower.

Question 3. (10 points)

Consider the car-caravan analogy we discussed in the class. The cars propagate at 120km/hr. A tollbooth services a car at a rate of one car every 8 seconds.



Answer the following with brief explanation:

a. When these ten cars line up in front of the first toll booth, how long it takes for them to finishing just after the third toll booth shown in the figure above (**Note: ten cars will line up in front of a toll booth before any car goes through the toll booth)**?
b. Repeat (a), now assuming there are eight cars in the caravan instead of ten.

Part A.

Calculations:

Cars = 10
160 total distance/ 120km/hr = 4/3 = 1.33 = 60 +19.8 = 79.8min
Total service time = 10cars * 8sec * 3booths =240 sec = 4min
Total time = 4min + 79.8min = 83.8 min

Conclusion:

This problem requires multiple elements: total packets, rate of propagation, service rate, and distance traveled. We can use the factors to calculate the total time required to complete the toll booth system. It will take the 10-car caravan 83.8 minutes to complete the system.

Part B.

Calculations:

Cars = 8
Total distance = 160km
Speed = 120km/hr
Service Time = 8cars * 8sec = 64sec
Booths = 3
Total service time = 3booths * 64sec = 192sec = 3.2 min
Propagation Delay = d/s = 160km/120km/hr = 1.33 hr = 79.8min
Total time = 3.2min + 79.8min = 83min

Conclusion:

When we substitute 8 cars in the toll booth problem, we see a similar result of approximately 83 minutes. This show that since the service rate is fixed, the input does not greatly affect the overall time.