CptS 455 Homework 1
Due Friday, Sept. 4, 11:59:59PM
Turn in using the Project turn-in link on the Course Home page www.eecs.wsu.edu/~hauser/cs455
Answers should be typed. If you need to add hand drawings do so. Please copy the text of each question onto your answer page preceding your answer.

Notet that the problems at the back of each chapter are organized into Review Questions with numbers that start with an R and Problems whose numbers start with a P. Please observe the difference when working on assignments.

As a general rule, the Review problems should be part of your study of each chapter. I suggest looking at them when the chapter is assigned, after you've read the chapter, and again as part of your exam study.

Hint: some of these questions have *very short* answers – 2 or 3 words. Others don't.

1. What is the propagation time over a link of length 3,000km if the propagation speed is 2*10^8 m/s? (the notation 10^8 means 10 to the 8th power)
2. How does the length of a transmitted packet affect *propagation* time?
3. How does the transmission rate affect *propagation* time?
4. What is the transmission time for a packet of length 1500 B on a link with data rate 10Mb/s? Note the conventions: B stands for byte (8 bits); b stands for bit (1 bit); M stands for decimal Mega (10^6)
5. How does the length of a link affect the *transmission* time of packets?
6. How does the propagation speed of a link affect the *transmission* time of packets?
7. Draw a diagram and use it to show that the notion of the *width (measured in metres)* of a bit on a link makes physical sense. Try to explain in terms that would make sense to a 5 grader.
8. Give a formula for the width *w* of a bit on a link in terms of the data rate *R* and the propagation speed *s*.
9. Give a formula for how many bits of width *w* will be “in-flight” at the same time on a link of length *d?*
10. Refer back to question 1 and write the general formula for the propagation time in terms of the propagation speed *s* and length of a link *d*. Call this quantity *t*.
11. Combine your answers to problems 8, 9, and 10 to give a physical interpretation of the quantity R*t – also known as the bandwidth-delay product.
12. (Combining problems 1 and 4): What is the total delay associated with sending a 1500 B packet on a 3,000km link with a propagation speed of 2*10^8 m/s and a transmission rate of 10Mb/s? (Ignore queueing and processing delays)
13. Now suppose instead of a single 3,000km link there are three 1,000km links connected by *store-and-forward* routers. Assuming the propagation speed and transmission rate are the same as before what is the total delay for a 1500 B packet? The picture looks like this (S is the source, D is the destination and R1 and R2 are the two routers.)
    S → R1 → R2 → D
14. Under the conditions of problem 13 what is the total delay (from the time the first bit is sent to the time that the last bit is received) for 1000 packets?
15. Now suppose a second source S2 sends to R1 over a separate link having the same speed as the S → R1 link. The packets from S2 are also destined for D. How will the delay change relative to question 14? Why? What assumption do you have to make to ensure that no packets are lost?