CSE/EE 461
Assignment 1
Due Friday, October 10, 1997

Your solutions must contain the derivation of your answers.

1. The speed of light is approximately 3×10^8 meters per second. Geosynchronous satellite communication is popular where satellites are at a distance of approximately 36,000 kilometers.
   (a) What is the approximate shortest possible delay that data can have in being transmitted from one point to another on earth through a geosynchronous satellite?
   (b) Suppose that data can be sent through a geosynchronous satellite link at a rate of 1,000,000 bits per second. What is the minimum time it will take for a message of 100,000 bits to be sent from one site and received at another remote site on earth?
   (c) Suppose that long messages are sent in packets of 100,000 bits. To send a long message a sequence of packets are sent, but each packet must be acknowledged by the receiver with a 1,000 bit packet before the next one can be sent. What is the utilization of the satellite link in using this way to send long messages?
   (d) Would a stop-and-wait protocol be appropriate for geosynchronous communication? Justify your answer.
2. There is a local company, Teledesic, that is planning to put approximately 1,000 low orbit satellites rotating around the earth at about a height of 750 km. At any one moment each point on earth would be within a relatively short distance to some satellite. This could potentially decrease the delay in transmitting through satellites.
   (a) What is the approximate maximum delay to send a bit from a point A on earth to a satellite that is directly above some point on earth that is no more than 1500 km from point A?
   (b) What is the approximate maximum delay to send a bit from Seattle to London (10,000 km) using low orbit satellites? Assume that once a bit reaches one satellite it can be sent to any other at the speed of light.

(c) What applications would be more appropriate for low orbit satellites than for geosynchronous satellites and vice versa? You can assume that low orbit satellite transmission and geosynchronous satellite transmission run at about the same bandwidth and the cost is about the same. Please explain why your applications are in one list but not the other. Examples of applications are video-on-demand, web browsing, telephone calls, cable TV, teleconferencing, and so on.

3. Consider a communication link between A and B. Suppose that the probability that a packet sent from A to B is corrupted with probability $p > 0$. A corrupted packet will be resent by A.

   (a) Give an expression in p for the expected number of times a packet is sent by A before being successfully received by B.

   (b) What is the maximum expected utilization as a function of p that can be achieved in the communication between A and B?

   Here is a little guidance on this problem. To compute the expected number of packets sent you need to know the probability p_i that exactly i packets are sent. For example $p_1 = 1 - p$ and $p_2 = (1 - p)p$. The expected number of packets is $\sum_{i=1}^{\infty} ip_i$. You should be able to simplify this infinite sum to be a very simple formula.