EE450 Fall 2009 Homework 1 (solution)

Problem 4 (10 points, 6 points part a and 4 points part b)

Tollbooths are 75 km apart, and the cars propagate at 100km/hr. A tollbooth services a car at a rate of one car every 12 seconds.

a) There are ten cars. It takes 120 seconds, or 2 minutes, for the first tollbooth to service the 10 cars. Each of these cars has a propagation delay of 45 minutes (travel 75 km) before arriving at the second tollbooth. Thus, all the cars are lined up before the second tollbooth after 47 minutes. The whole process repeats itself for traveling between the second and third tollbooths. It also takes 2 minutes for the third tollbooth to service the 10 cars. Thus the total delay is 96 minutes.

b) Delay between tollbooths is 8*12 seconds plus 45 minutes, i.e., 46 minutes and 36 seconds. The total delay is twice this amount plus 8*12 seconds, i.e., 94 minutes and 48 seconds.

Problem 5 (28 points, 4 points each)

a) $d_{prop} = m/s$ seconds.

b) $d_{trans} = L/R$ seconds.

c) $d_{end-to-end} = (m/s + L/R)$ seconds.

d) The bit is just leaving Host A.

e) The first bit is in the link and has not reached Host B.

f) The first bit has reached Host B.

g) Want

$$m = \frac{L}{R}s = \frac{120}{56\times10^3}\left(2.5\times10^8\right) = 536\,\text{km}.$$

Problem 6 (10 points)

Consider the first bit in a packet. Before this bit can be transmitted, all of the bits in the packet must be generated. This requires

$$\frac{56\cdot8}{64\times10^3}\,\text{sec}=7\text{msec}.$$

The time required to transmit the packet is

$$\frac{56\cdot8}{2\times10^6}\,\text{sec}=224\mu\,\text{sec}.$$

Propagation delay = 10 msec.

The delay until decoding is

$$7\text{msec} + 224\mu\,\text{sec} + 10\text{msec} = 17.224\text{msec}$$

A similar analysis shows that all bits experience a delay of 17.224 msec.

Problem 11 (10 points)

The arriving packet must first wait for the link to transmit 6,750 bytes or 54,000 bits. Since these bits are transmitted at 2 Mbps, the queuing delay is 27 msec. Generally, the queuing delay is (nL + (L - x))/R.

Problem 24 (10 points, 2 points each)

a) 160,000 bits
b) 160,000 bits
c) The bandwidth-delay product of a link is the maximum number of bits that can be in the link.
d) the width of a bit = length of link / bandwidth-delay product, so 1 bit is 125 meters long, which is longer than a football field
e) *s/R*

Problem 26 (12 points, 4 points each)

a) 80,000,000 bits
b) 800,000 bits, this is because that the maximum number of bits that will be in the link at any given time = min(bandwidth delay product, packet size) = 800,000 bits.
c) .25 meters

Problem 27 (8 points, 4 points each)

a) $t_{trans} + t_{prop}$ = 400 msec + 80 msec = 480 msec
b) 20 * ($t_{trans} + 2\ t_{prop}$) = 20*(20 msec +2* 80 msec) = 3.6 sec

Problem 28 (12 points, 4 points each)

Recall geostationary satellite is 36,000 kilometers away from earth surface.
a) 150 msec
b) 1,500,000 bits
c) 600,000,000 bits