Solutions HW 8

EE 450

Dr. Walker

R5.2)

Although each link guarantees that an IP datagram sent over the link will be received at the other end of the link without errors, it is not guaranteed that IP datagrams will arrive at the ultimate destination in the proper order. With IP, datagrams in the same TCP connection can take different routes in the network, and therefore arrive out of order. TCP is still needed to provide the receiving end of the application the byte stream in the correct order. Also, IP can lose packets due to routing loops or equipment failures.

R5.6)

After the 5th collision, the adapter chooses from {0, 1, 2,…, 31}. The probability that it chooses 4 is 1/32. It waits 204.8 microseconds.

P5.3)

To compute the Internet checksum, we add up the values at 16-bit quantities:

```
  01001100  01101001
+ 01101110  01101011
------------------------------
  10111010  11010100
+ 00100000  01001100
------------------------------
  11011011  00100000
+ 01100001  01111001
-----------------------------
  00111100  10011010  (overflow, then wrap around)
+ 01100101  01110010
------------------------------
```

10100010 00001100

The one's complement of the sum is 01011101 11110011

P5.5)

If we divide 10011 into 1010101010 0000, we get 1011011100, with a remainder of R=0100. Note that, G=10011 is CRC-4-ITU standard.

P5.7)

a) Without loss of generality, suppose ith bit is flipped, where 0<= i <= d+r-1 and assume that the least significant bit is 0th bit.
   A single bit error means that the received data is K=D*2r XOR R + 2i. It is clear that if we divide K by G, then the reminder is not zero. In general, if G contains at least two 1's, then a single bit error can always be detected.
b) The key insight here is that G can be divided by 11 (binary number), but any number of odd-number of 1's cannot be divided by 11. Thus, a sequence (not necessarily contiguous) of odd-number bit errors cannot be divided by 11, thus it cannot be divided by G.

P5.13)

The length of a polling round is

$$N(\frac{Q}{R} + d_{poll})$$

The number of bits transmitted in a polling round is NQ. The maximum throughput therefore is

$$\frac{NQ}{N\left(\frac{Q}{R} + d_{poll}\right)} = \frac{R}{\left(1 + \frac{d_{poll}R}{Q}\right)}$$

P5.18)

At $t = 0$ A transmits. At $t = 576$, A would finish transmitting. In the worst case, B begins transmitting at time t=324, which is the time right before the first bit of A's frame arrives at B. At time t=324+325=649 B's first bit arrives at A. Because 649> 576, A finishes transmitting before it detects that B has transmitted. So A incorrectly thinks that its frame was successfully transmitted without a collision.

P5.20)

a) Let Y be a random variable denoting the number of slots until a success:

$P(Y = m) = \beta(1-\beta)^{m-1}$,

where β is the probability of a success.

This is a geometric distribution, which has mean $1/\beta$. The number of consecutive wasted slots is $X = Y - 1$ that

$$x = E[X] = E[Y] - 1 = \frac{1-\beta}{\beta}$$

$$\beta = Np(1-p)^{N-1}$$

$$x = \frac{1 - Np(1-p)^{N-1}}{Np(1-p)^{N-1}}$$

$$\text{efficiency} = \frac{k}{k+x} = \frac{k}{k + \frac{1-Np(1-p)^{N-1}}{Np(1-p)^{N-1}}}$$

b) Maximizing efficiency is equivalent to minimizing x, which is equivalent to maximizing β. We know from the text that β is maximized at $p = \frac{1}{N}$.

c)

$$\text{efficiency} = \frac{k}{k + \frac{1-(1-\frac{1}{N})^{N-1}}{(1-\frac{1}{N})^{N-1}}}$$

$$\lim_{N\to\infty} \text{efficiency} = \frac{k}{k + \frac{1-1/e}{1/e}} = \frac{k}{k+e-1}$$

d) And we have: $\frac{k}{k+e-1}$ approaches 1 as $k \to \infty$.