Chapter 6 Problems

6.7 The inclusion of a parity bit extends the message length. There are more bits that can be in error since the parity bit is now included. The parity bit may be in error when there are no errors in the corresponding data bits. Therefore, the inclusion of a parity bit with each character would change the probability of receiving a correct message.

6.8 The receiver won't detect the error, as a parity check bit only detects inversion of an odd number of bits.

6.9 Any arithmetic scheme will work if applied in exactly the same way to the forward and reverse process. The modulo 2 scheme is easy to implement in circuitry. It also yields a remainder one bit smaller than binary arithmetic.

6.10 **a.** We have:

Pr [single bit in error] = 10^{-3}

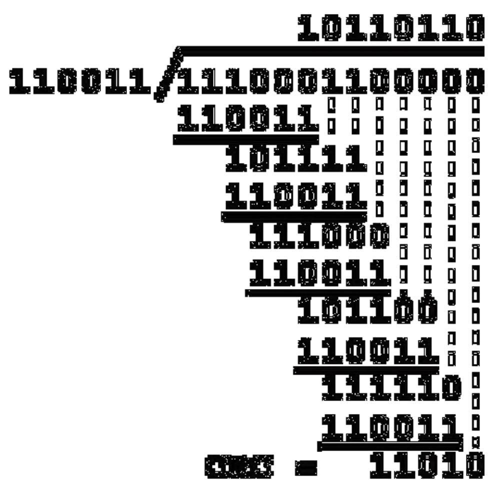
Pr [single bit not in error] = $1 - 10^{-3} = 0.999$

Pr [8 bits not in error] = $(1 - 10^{-3})^8 = (0.999)^8 = 0.992$

Pr [at least one error in frame] = $1 - (1 - 10^{-3})^8 = 0.008$

b. Pr [at least one error in frame] = $1 - (1 - 10^{-3})^{10} = 1 - (0.999)^{10} = 0.01$

6.13



Chapter 7 Problems

7.1 a. Because only one frame can be sent at a time, and transmission must stop until an acknowledgment is received, there is little effect in increasing the size of the message if the frame size remains the same. All that this would affect is connect and disconnect time.

b. Increasing the number of frames would decrease frame size (number of bits/frame). This would lower line efficiency, because the propagation time is unchanged but more acknowledgments would be needed.

c. For a given message size, increasing the frame size decreases the number of frames. This is the reverse of (b).

7.3 Let L be the number of bits in a frame. Then, using Equation 7.5 of Appendix 7A:

$$a = \frac{\text{Propagation Delay}}{\text{Transmission Time}} = \frac{20 \times 10^{-3}}{L/\left(4 \times 10^{3}\right)} = \frac{80}{L}$$

Using Equation 7.4 of Appendix 7A:

$$U = \frac{1}{1+2a} = \frac{1}{1+\left(160/L\right)} \geq 0.5$$

$$L \geq 160$$

Therefore, an efficiency of at least 50% requires a frame size of at least 160 bits.

7.4 $a = \dfrac{\text{Propagation Delay}}{L/R} = \dfrac{270 \times 10^{-3}}{10^{3}/10^{6}} = 270$

a. U = 1 / (1 + 2a) = 1 / 541 = 0.002

b. Using Equation 7.6: U = W / (1 + 2a) = 7 / 541 = 0.013

c. U = 127 / 541 = 0.23

d. U = 255 / 541 = 0.47

7.5 A → B: Propagation time = $4000 \times 5\ \mu\text{sec} = 20$ msec

Transmission time per frame $= \dfrac{1000}{100 \times 10^3} = 10$ msec

B → C: Propagation time = $1000 \times 5\ \mu\text{sec} = 5$ msec

Transmission time per frame $= x = 1000/R$

R = data rate between B and C (unknown)

A can transmit three frames to B and then must wait for the acknowledgment of the first frame before transmitting additional frames. The first frame takes 10 msec to transmit; the last bit of the first frame arrives at B 20 msec after it was transmitted, and therefore 30 msec after the frame transmission began. It will take an additional 20 msec for B's acknowledgment to return to A. Thus, A can transmit 3 frames in 50 msec.

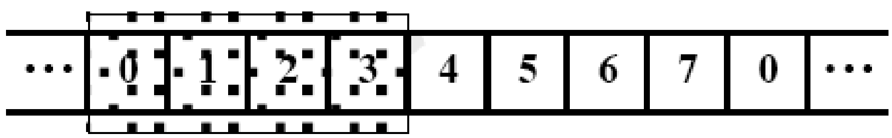
B can transmit one frame to C at a time. It takes $5 + x$ msec for the frame to be received at C and an additional 5 msec for C's acknowledgment to return to A. Thus, B can transmit one frame every $10 + x$ msec, or 3 frames every $30 + 3x$ msec. Thus:

$30 + 3x = 50$

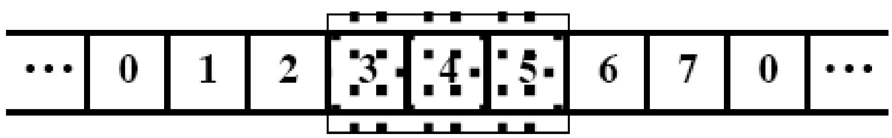
$x = 6.66$ msec

$R = 1000/x = 150$ kbps

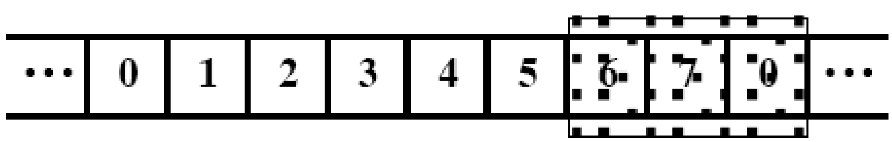
7.10 a.



b.



c.



7.13 Let $t_1 =$ time to transmit a single frame

$$t_1 = \frac{1024 \text{ bits}}{10^6 \text{ bps}} = 1.024 \text{ msec}$$

The transmitting station can send 7 frames without an acknowledgment. From the beginning of the transmission of the first frame, the time to receive the acknowledgment of that frame is:

$$t_2 = 270 + t_1 + 270 = 541.024 \text{ msec}$$

During the time t_2, 7 frames are sent.

$$\text{Data per frame} = 1024 - 48 = 976$$
$$\text{Throughput} = \frac{7 \times 976 \text{ bits}}{541.024 \times 10^{-3} \text{ sec}} = 12.6 \text{ kbps}$$