Problem 7.3

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

$$a = \frac{delay_{\Pr opagation}}{time_{Transmission}} = \frac{20 \times 10^{-3}}{\frac{L}{4 \times 10^{3}}} = \frac{80}{L}$$

Using Equation 7.4 of Appendix 7A:

$$U = \frac{1}{1+2a} = \frac{1}{1+\frac{160}{L}} \geq 0.5$$

$$L \geq 160$$

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

Problem 7.4

$$a = \frac{Delay_{\Pr opagation}}{\frac{L}{R}} = \frac{270 \times 10^{-3}}{\frac{10^{3}}{10^{6}}}$$

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

Problem 7.6

Round trip propagation delay of the link = $2 \times L \times t$
Time to transmit a frame = B/R
To reach 100% utilization, the transmitter should be able to transmit frames continuously during a round trip propagation time. Thus, the total number of frames transmitted without an ACK is:

$$N = \left\lceil \frac{2 \times L \times t}{\frac{B}{R}} + 1 \right\rceil$$ where $\lceil x \rceil$ is the smallest integer greater than or equal to X

This number can be accommodated by an M-bit sequence number with:

$$M = \lceil \log_2 (N) \rceil$$

Problem 7.9

Using the formulas given below

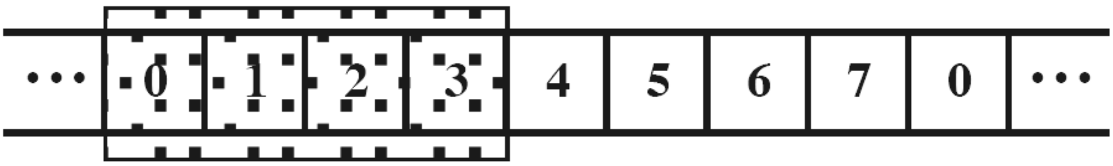
a	0.1	1.	10	100
S&W	(1 – P)/1.2	(1 – P)/3	(1 – P)/21	(1 – P)/201
GBN (7)	(1–P)/(1+0.2P)	(1–P)/(1+2P)	7(1–P)/21(1+6P)	7(1 – P)/201(1+6P)
GBN (127)	(1–P)/(1+0.2P)	(1–P)/(1+2P)	(1 – P)/(1+20P)	127(1–P)/201(1+126P)
SREJ (7)	1 – P	1 – P	7(1 – P)/21	7(1 – P)/201
SREJ (127)	1 – P	1 – P	1 – P	127(1 – P)/201

For a given value of 'a', the utilization values change very little as a function of P over a reasonable range (say 10^{-3} to 10^{-12}). We have the following approximate values for $P = 10^{-6}$:

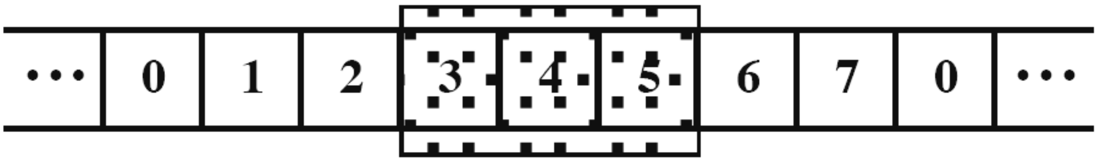
a	0.1	1.0	10	100
Stop-and-wait	0.83	0.33	0.05	0.005
GBN (7)	1.0	1.0	0.33	0.035
GBN (127)	1.0	1.0	1.0	0.63
SREJ (7)	1.0	1.0	0.33	0.035
SREJ (127)	1.0	1.0	1.0	0.63

Problem 7.10

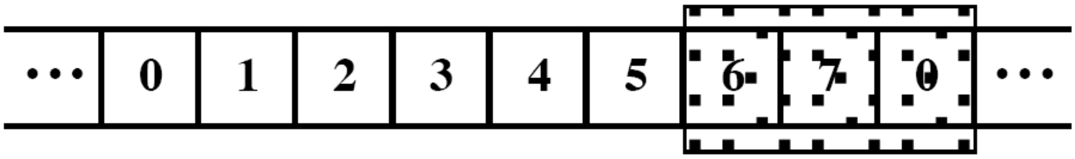
a.



b.



c.



Problem 7.12

From the standard: "A SREJ frame shall not be transmitted if an earlier REJ exception condition has not been cleared (To do so would request retransmission of a data frame that would be retransmitted by the REJ operation.)" In other words, since the REJ requires the station receiving the REJ to retransmit the rejected frame and all subsequent frames, it is redundant to perform a SREJ on a frame that is already scheduled for retransmission.

Also from the standard: "Likewise, a REJ frame shall not be transmitted if one or more earlier SREJ exception conditions have not been cleared." The REJ frame indicates the acceptance of all frames prior to the frame rejected by the REJ frame. This would contradict the intent of the SREJ frame or frames.

Problem 7.13

Let t_1 = time to transmit a single frame

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

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:

$t_2 = 270 + t_1 + 270 = 541.024$ msec

During the time t_2, 7 frames are sent.

Data per frame = 1024 – 48 = 976

$$\text{Throughput} = \frac{7 \times 976 bits}{541.024 \times 10^{-3}} = 12.6 \text{ kbps}$$

Problem 7.20 The selective-reject approach would burden the server with the task of managing and maintaining large amounts of information about what has and has not been successfully transmitted to the clients; the go-back-N approach would be less of a burden on the server.