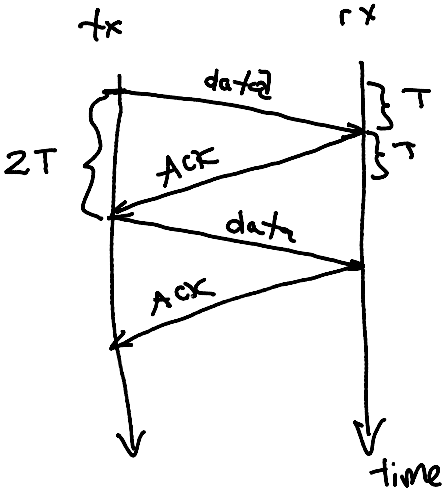
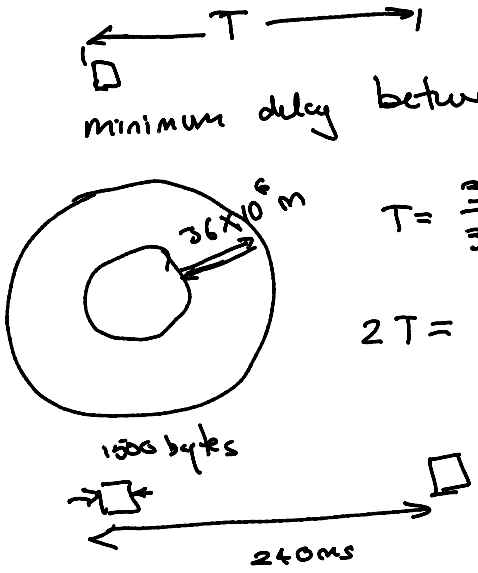
ARQ and Flow Control

Exercise 1: Assuming the one-way propagation delay, T, is much longer than the frame transmission time, what is the minimum delay between transmitted frames if no ACKs are lost? Geostationary satellites are located about 36,000 km above the equator. What is the minimum value of T? If a frame contains a maximum of 1500 bytes, what is maximum data rate for such a link if it uses stop-and-wait ARQ?





$$T = \frac{36 \times 10^6}{3 \times 10^8 \text{ m/s}} = 12 \times 10^{-2} = 120 \text{ ms}.$$

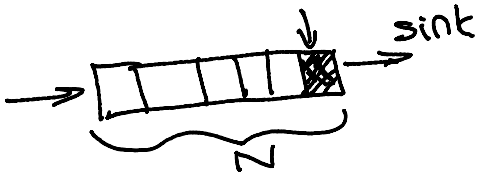
$$2T = 240 \text{ ms}.$$

$$\text{data rate} = \frac{1500 \times 8 \text{ bits}}{240 \times 10^{-3}}$$

$$= \frac{12000}{240 \times 10^{-3}} = \frac{120 \times 10^2}{240 \times 10^{-3}}$$

$$= 0.5 \times 10^5 = \underline{\underline{50 \text{ k bps}}}.$$

Exercise 2: Create a table summarizing the three different types of ARQ. Include: throughput, transmitter memory, receiver memory and relative complexity.



	throughput		tx	rx
	low latency	high delay	memory	memory
stop & wait	H	L	1	0
go-back N	M	M	N	0
selective repeat	H	H	N	N

Exercise 3: Assume a transmitter transmits 1000 data packets per second and has to retransmit an average of 5 packets when using go-back-N ARQ and only one packet using Selective-Repeat ARQ. If 10% of the data frames are lost, what is the throughput using go-back-N ARQ? Using Selective ARQ? Ignore delays and other overhead.

1000 frames/second

100 frames/second lost

→ go-back N 5 x 100 = 500 frames/second need to retransmit

sel. repeat: 1 x 100 = 100 frames/" " "

ignoring retransmissions:

1000 − 500 = 500 frames/second throughput for go-back-N

1000 − 100 = 900 " " " sel. repeat.

Exercise 4: Which of the above flow control methods can be used on unidirectional data links? Which are limited to frame-oriented protocols?