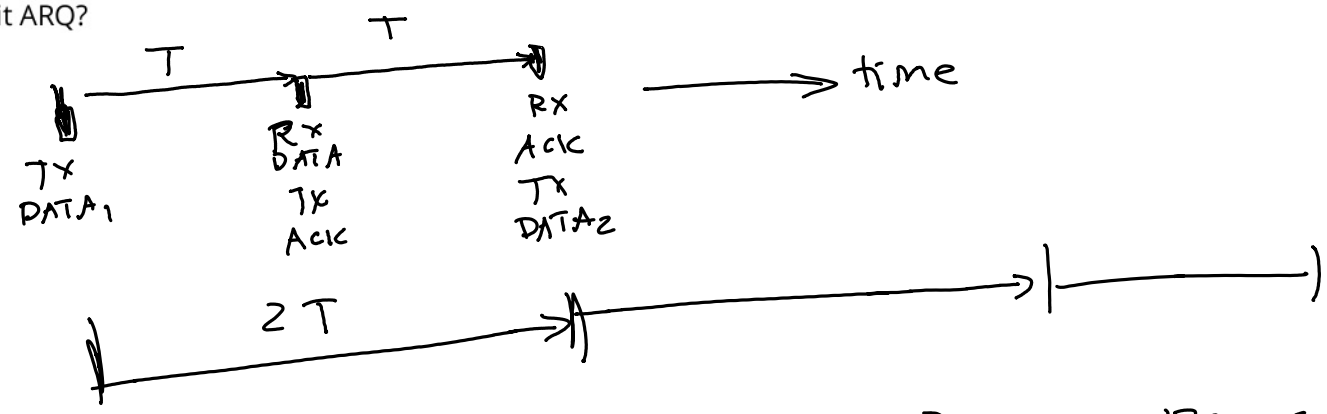
ARQ and Flow Control

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?

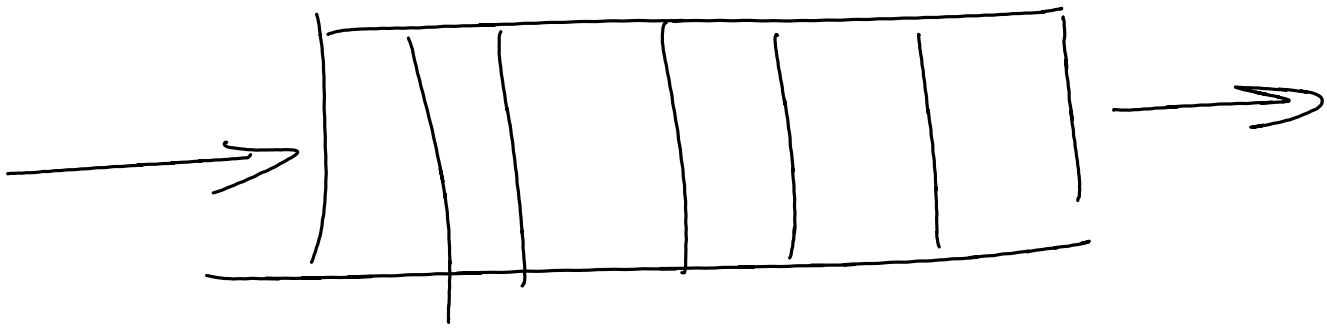


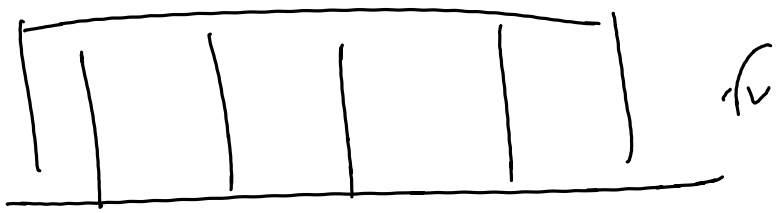
$$T = \frac{36000 \text{ km}}{0.3 \text{ km}/\mu\text{s}.} = 120{,}000\ \mu\text{s}. = 120 \text{ ms}.$$

$$\frac{1580 \text{ bytes} \times 8 \text{ bits/byte}}{2 \times 120 \text{ ms}.} = \frac{12{,}000 \text{ bits}}{0.24 \text{ s}} \approx 48 \text{ kb/s}.$$

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

	S & wait	sel. repeat	go back N
throughput (with long delay)	Low	High.	High Low (many errors).
transmit memory	1	N	N
receiver memory	0	N	0
complexity	Low	High	Medium





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.

go-back N: $5 \times 10\% \cdot 1000$ every second.

$= 500$ (roughly) are retransmitted.

500 are not.

throughput $\approx \frac{500}{1000} \cdot 1000 = 500$ /s

selective repeat: $1 \times 10\% \cdot 1000$ every second

$= 100$ (roughly) are retransmissions

900 are not

throughput $\approx \frac{900}{1000} \cdot 100 = 900$/s.

(ignoring errors in retransmissions).

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

type	if unidirectional?	only for frames
hardware	Y	N
software	N	N
ACK/ARQ	N	Y