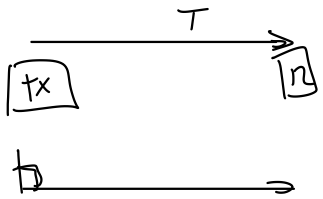
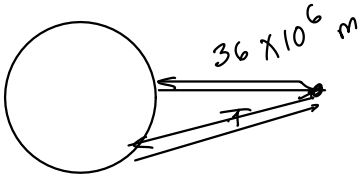
ARQ



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?

Time between frames is 2T.



$$T = 2 \cdot \frac{36 \times 10^6 \text{ m}}{3 \times 10^8 \text{ m/s}} = 240 \text{ ms}.$$

$2T = 480$ ms $RTT = 4T \approx 1$ s.

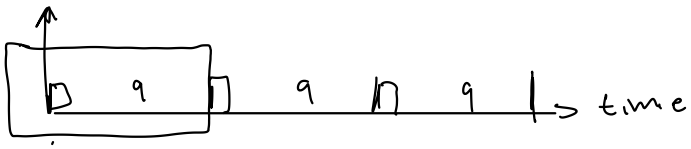
$$1500 \text{ bytes} = \frac{12000 \text{ bit}}{4 \cdot 240 \text{ ms}} \approx 12 \text{ kb/s}$$

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

	throughput	tx buffer	rx buffer	complexity
stop & wait	high if delay is small low for delays > packet duration	1	0 (1)	low
selective repeat	high	N	N	high
go-back N	high	N	1	medium

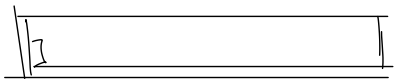
N = # packets transmitted in 2T (two-way delay)

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.



w/ selective repeat: $\frac{10 \text{ received}}{\underbrace{9}_{\text{received}} + \underbrace{1}_{\text{error}} + \underbrace{1}_{\text{retransmission}}} = \frac{10}{11} = 0.9$

go-back N (5): $\frac{10}{9 + 1 + 5} = \frac{10}{15} = 0.66$

if low FER:  $\frac{1000}{1000 + 1 + 5} =$