ARQ and Flow Control

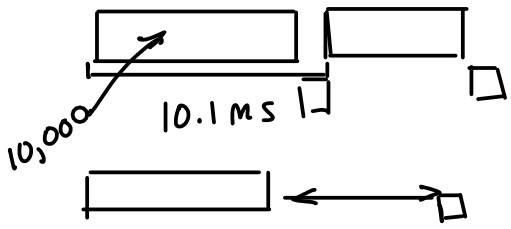
Exercise 1: Create a table summarizing the three different types of ARQ. Include: throughput, transmitter memory, receiver memory and relative complexity.

	Throughput	tx mem.	rx mem.	complexity
STOP & WAIT	low delay → high long delay → low	1	1	LOW
Go back N	low error → high high error rate → low	N	1	MED.
Sel. Repeat	high	N	N	HIGH

Exercise 2: A data communication system operates at 1 Mb/s and uses 10000-bit data frames and 100-bit ACK frames. What are the frame durations? What is the throughput if there is no channel delay and no errors? If the round-trip channel delay is a 0.5s (typical for satellite links)? If go-back-N ARQ is used, assuming the transmitter can store all unacknowledged frames?

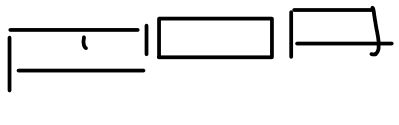
$$\frac{10{,}000\ b.}{1\,Mb/s} = \frac{10^4}{10^6} = 10^{-2} = 10\,ms.$$

$$\frac{100}{1 \times 10^6} = 10^{-4} = 0.1\,ms$$



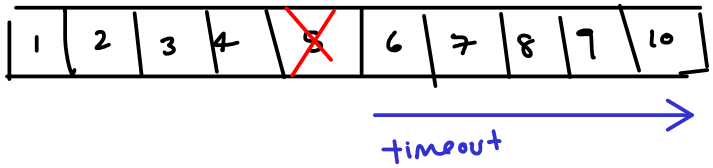
$$\text{throughput} = \frac{10{,}000}{10.1\ ms.} \approx 1\,Mb/s$$

$$\frac{10{,}000}{500 + 10 + 0.1} \approx 20\,kb/s$$



$$\frac{10{,}000}{10} = 1\,Mb/s$$

Exercise 3: Assume a transmitter has an ARQ timeout that is 5 packet durations and fails to get an ACK for every 10th frame (e.g. due to periodic noise bursts). Ignoring ACK delay and overhead, what is the throughput using go-back-N ARQ? Using Selective ARQ?



go-back N: transmit 1 ... 10 timeout 5 6 7 8 9 10 ....

$$\text{throughput} = \frac{10 \text{ frames}}{16 \text{ frame transmissions}} \approx \frac{2}{3}$$

selective repeat

1 .... 10, 5, 11, 12 ...

$$\text{throughput} = \frac{10}{11} \approx 90\%$$

Exercise 4: Which of the above flow control methods can be used with frame-oriented protocols? On unidirectional links?

	require frame-oriented	unidirectional
h/w	N	Y
s/w	N	N
Ack-based	Y (Ack frames).	N