Lecture 14 - ARQ and Flow Control

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

	stop & wait	go back N	selective repeat
throughput	slowest	medium	highest
tx memory	1	M	M
rx memory	0	0	M
complexity	simplest	medium	most complex

1 ~~2~~ 3 4

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 200 unacknowledged frames?

$$\frac{10^4 \text{ bits}}{10^6 \text{ bits/s}} = 10^{-2} = 10 \text{ ms} \qquad \frac{.10^2}{10^6} = 10^{-4} = 0.1 \text{ ms}$$
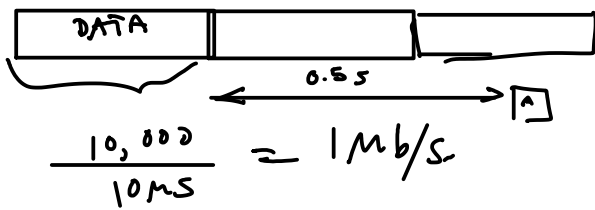

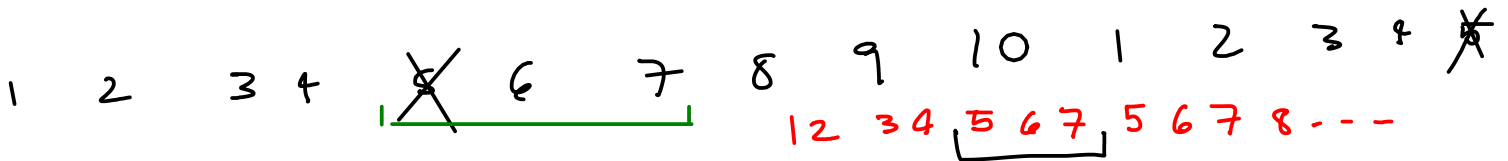$$\frac{10,000}{10 + 0.1 \times 10^{-3}} \approx 1 \text{ Mb/s}$$

$$\approx \frac{10^4}{0.5} = 20 \text{ kb/s}$$

$$200 \text{ frames} \quad \times \text{ 10ms} = 2s$$

DATA

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

0.5 s

Exercise 3: A communication system loses every 10th frame (e.g. due to periodic noise bursts). Ignoring ACK overhead, what is the throughput using go-back-N ARQ? Using Selective ARQ?

1   2   3   4   5̶   6   7   8   9   10   1   2   3   4   5̶

12 34 ｜5 6 7｜ 5 6 7 8 - - -

w/ sele ofm ARQ

$$\frac{transmit\ 10\ frames}{in\ \ 11\ frame\ durations} \approx 90\%$$

if there are always ∧ 3 unacknowledged frames then each retransmission requires repeating all 3 (or 4) frames

$$\frac{transmit\ 10\ frames}{in\ \ 13\ frame\ duration} = 75\%$$

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

	hardware	software	delayed Ack
frame	?	?	✓
unidirectional links	?	NO	NO