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.

	throughput w/ large delay no errors	tx memory	rx memory	complexity
stop & wait	L	1	1	L
go-back N	H	N	1	M
selective repeat	H	N	N	H

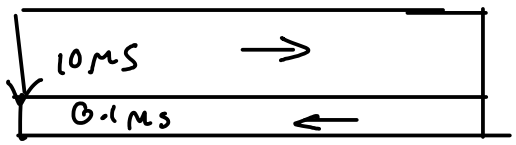
Exercise 2: A data communication system operates at 1 Mb/s and uses 10000-bit data frames and 100-bit ACK frames. What are the frame durations? What is the throughput if there is no channel delay and no errors? If the round-trip channel delay is a 0.5s (typical for satellite links)? If go-back-N ARQ is used, assuming the transmitter can store 200 unacknowledged frames?

DATA:

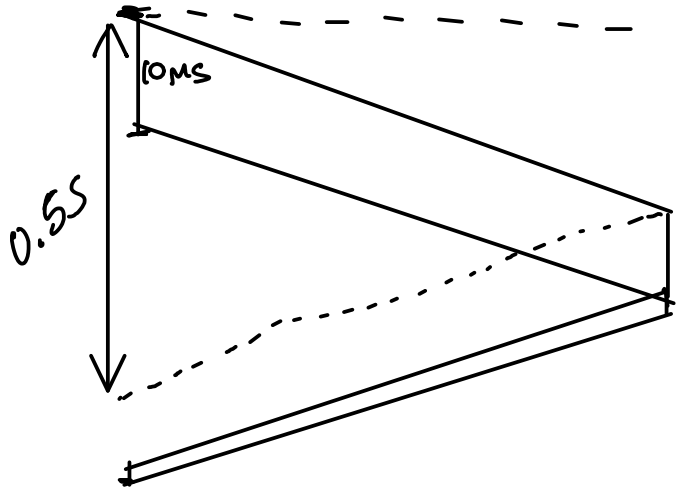
$$\frac{10^4}{10^6} = 10^{-2} = 10\text{ms}$$

ACK:

$$\frac{10^2}{10^6} = 1 \times 10^{-4} = 0.1\text{ms}$$



no-delay throughput $= \frac{10^4}{10.1 \times 10^{-3}} \approx 1\text{Mb/s}$



with 0.5 s delays

$$= \frac{10^4}{0.5 + 10 \times 10^{-3} + 0.1 \times 10^{-3}}$$

$$\approx 20\text{ kb/s}$$

big difference!

w/ go-back N (& no errors):

if can transmit for $200 \times 10\text{ms} = 2\text{s}$ before stopping for an ACK, we will receive the ACK before need to stop transmitting & throughput will be $\simeq 1\text{Mb/s}$.

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?

Answer depends on delay

If no delay, same throughput ($\frac{10 \text{ received}}{11 \text{ transmissions}} \simeq 91\%$)

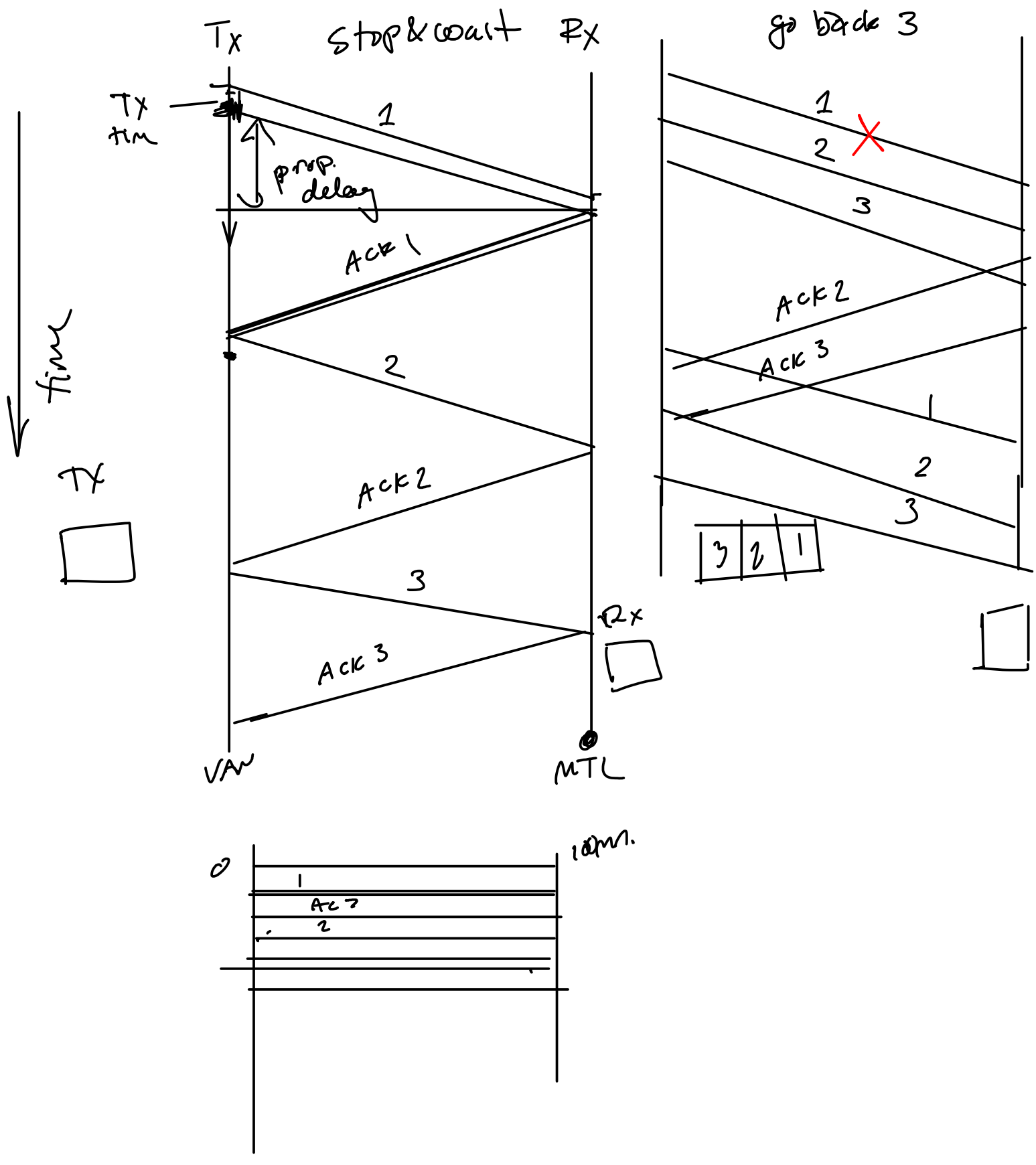
If have to repeat N frames due to delay then throughput is $\frac{10 \text{ received}}{10+1+N}$

e.g. $N=5$ throughput $= \frac{10}{16} \simeq 63\%$ for go-back-N

but still $\frac{10}{11} = 91\%$ for selective repeat.

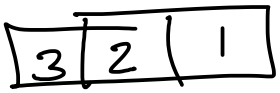
Exercise 4: Which of the above flow control methods can be used with frame-oriented protocols? On unidirectional links?

- frame oriented protocols can delay ACKs to do flow control (can also use other methods).
- unidirectional links cannot use software flow control (or ACK packets), only h/w f/c.

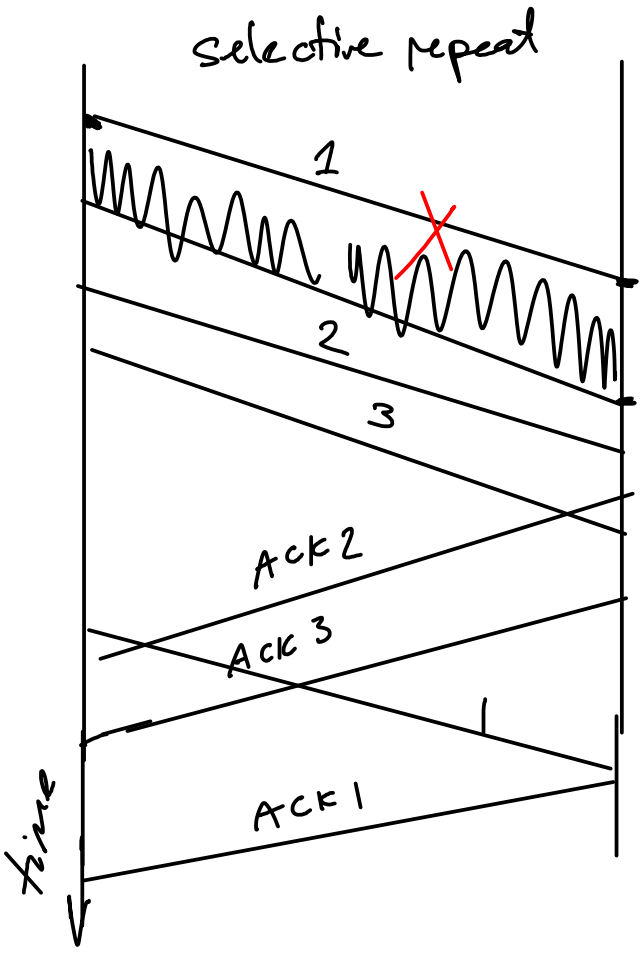

Tx
Stop & wait
Rx
go back 3
TX tim
prop. delay
1
ACK 1
2
ACK 2
3
ACK 3
time
TX
RX
VAN
MTL
1
2
3
ACK 2
ACK 3
1
2
3
3 2 1

1
Ack
2

Tx buffer



selective repeat



Rx buffer