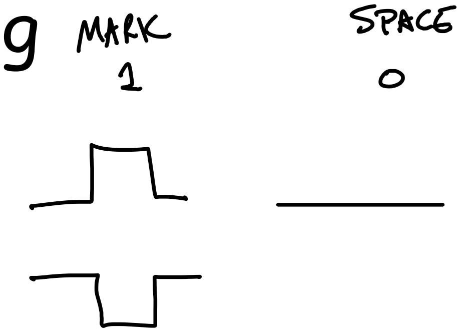
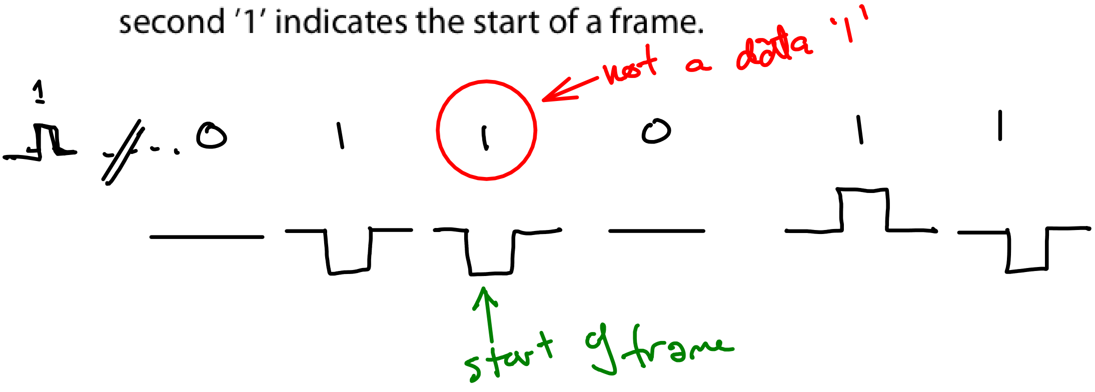
Lecture 9 - Framing



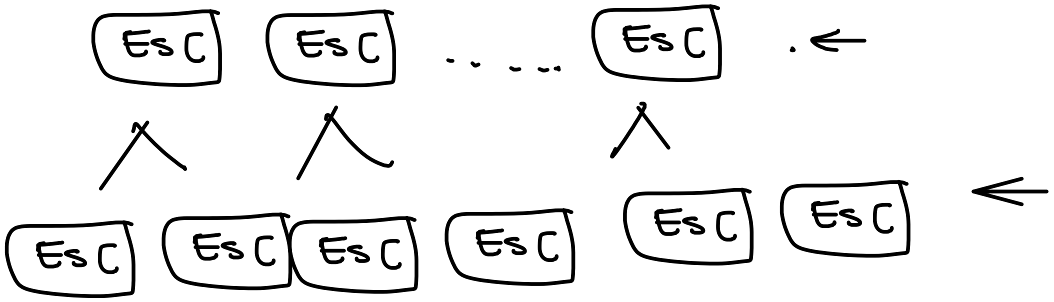
Exercise 1: Draw the waveform for an AMI-RZ encoded sequence of bits '011011' assuming the previous mark was transmitted as a positive pulse. Draw the waveform assuming the second '1' indicates the start of a frame.



Exercise 2: Preambles such as this allow multiple transmission formats to be used in a backwards-compatible way. What might be some disadvantages of using such a preamble? *Hint: to be decoded by old ("legacy") devices the preamble must be transmitted at the lowest possible data rate. This can be 100 times slower than the fastest devices.*

— preambles add overhead

Exercise 3: By how much does the use of escape characters slow down a link transmitting a continuous stream of escape characters?



throughput is ½ of original data.

(slowed by factor of 2)

Exercise 4: What sequence of bytes would be sent to transmit a PPP-encapsulated frame containing the bytes 0xff 0x03 0x7d 0x1b 0x7e?

0x7e = flag
0x7d = escape char

$$\underbrace{0x7e}_{flag}\quad \underbrace{0xff \quad 0x03}_{data}\quad \underbrace{0x7d}_{esc}\quad \underbrace{0x7d \quad 0x1b}_{data}\quad \underbrace{0x7d}_{esc}\quad \underbrace{0x7e}_{data.}\quad \underbrace{0x7e}_{flag}$$

Exercise 5: You receive the sequence of bits 10001101 and are told that bit stuffing was used to limit runs of 0 to three or fewer. What was the original data sequence?

0 0 0 ↗ 1

0 0 0 1

1 0 1

1 0 0 1

1 0 0 0 1

1 0 0 0 0 1

1

Stuffed.

0 1 2 3 0 0 1 0

1 0 0 0 1 1 0 1

1 0 0 0 1 0 1 ← actual data

Exercise 6: Write out the complete sequence of 1's and 0's required to transmit the 12 bits 0110 1111 1100. Include the start and end flag sequences and any necessary bit stuffing.

0 1 2 0 1 2 3 4 5 1 0 0

0 1 1 0 1 1 1 1 1 ∧ 1 0 0

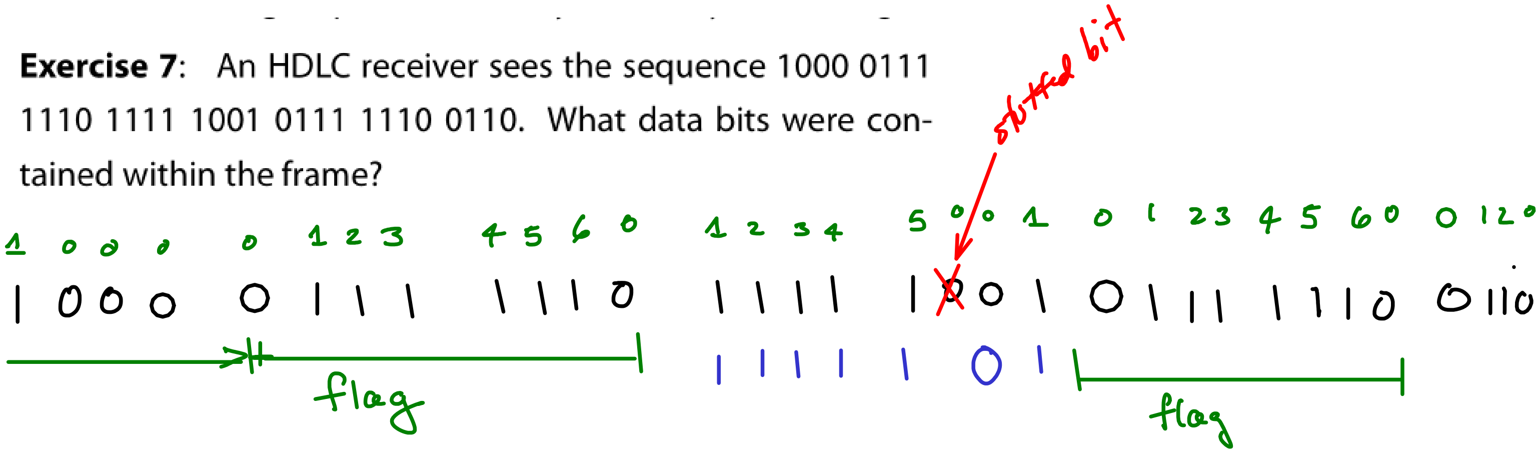
Stuffed bit

flag

flag

0 111 1110 0 11 0 1 1 1 1 1 0 1 0 0 0111 1110

Exercise 7: An HDLC receiver sees the sequence 1000 0111 1110 1111 1001 0111 1110 0110. What data bits were contained within the frame?



Exercise 8: A physical layer transmits 3 bits per symbol. A frame of 128 bytes is being transmitted. How many padding bits will have to be added to the frame?

$$128 \times 8 = \frac{1024 \text{ bits}}{3 \text{ bits/symbol}} = 341\tfrac{1}{3} \text{ symbols}$$

∴ need to send 342 symbols → $342 \times 3 = 1026$ bits

∴ need $1026 - 1024 = 2$ padding bits