Computer Networks

Framing (§3.1.2)

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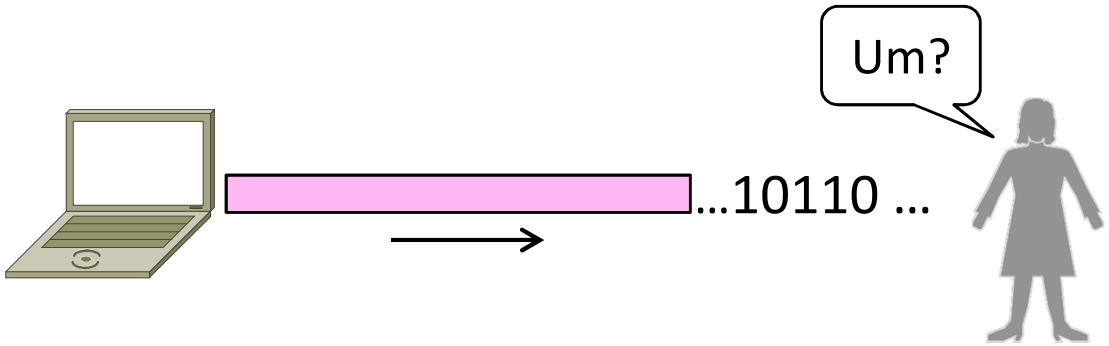
Topic

- The Physical layer gives us a stream of bits. How do we interpret it as a sequence of frames?



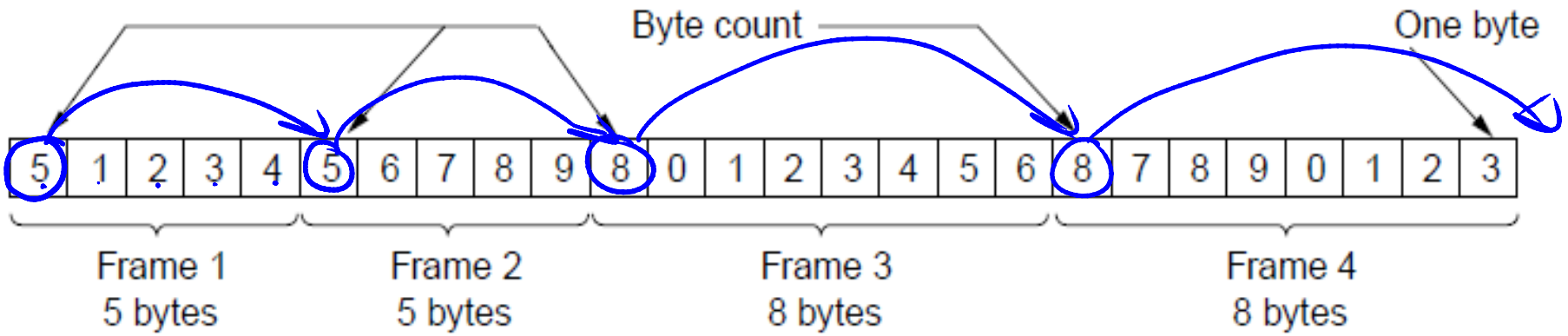
Framing Methods

- We'll look at:
  - Byte count (motivation)»
  - Byte stuffing »
  - Bit stuffing »
- In practice, the physical layer often helps to identify frame boundaries
  - E.g., Ethernet, 802.11

Byte Count

- First try:
  - Let's start each frame with a length field!
  - It's simple, and hopefully good enough …

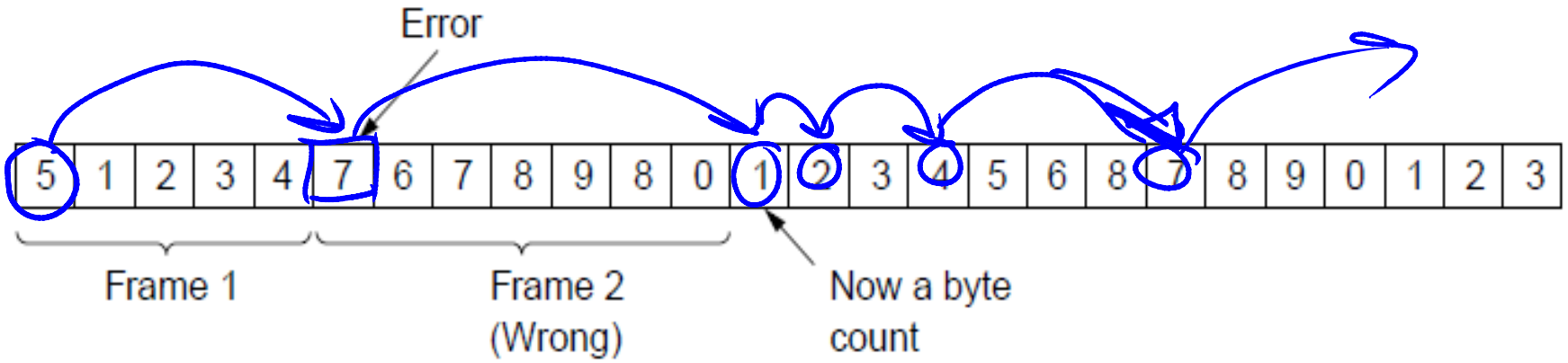
Byte Count (2)



- How well do you think it works?

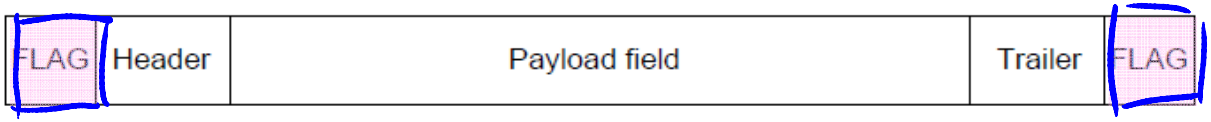
Byte Count (3)

- Difficult to re-synchronize after framing error
  - Want a way to scan for a start of frame



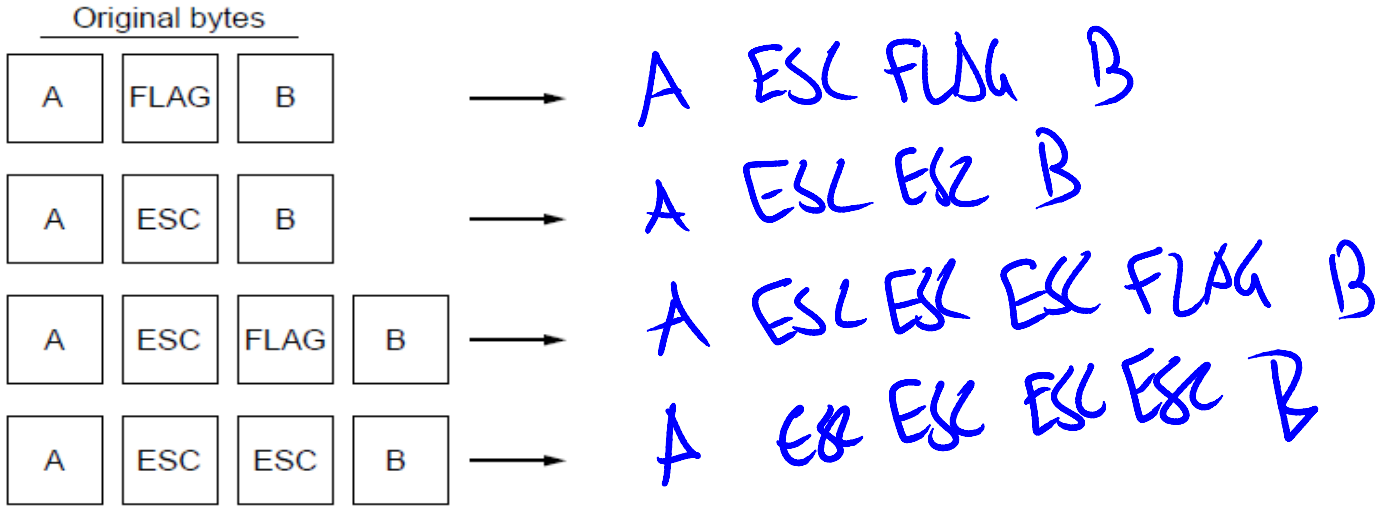
Byte Stuffing

- Better idea:
  - Have a special flag byte value that means start/end of frame
  - Replace (“stuff”) the flag inside the frame with an escape code
  - Complication: have to escape the escape code too!



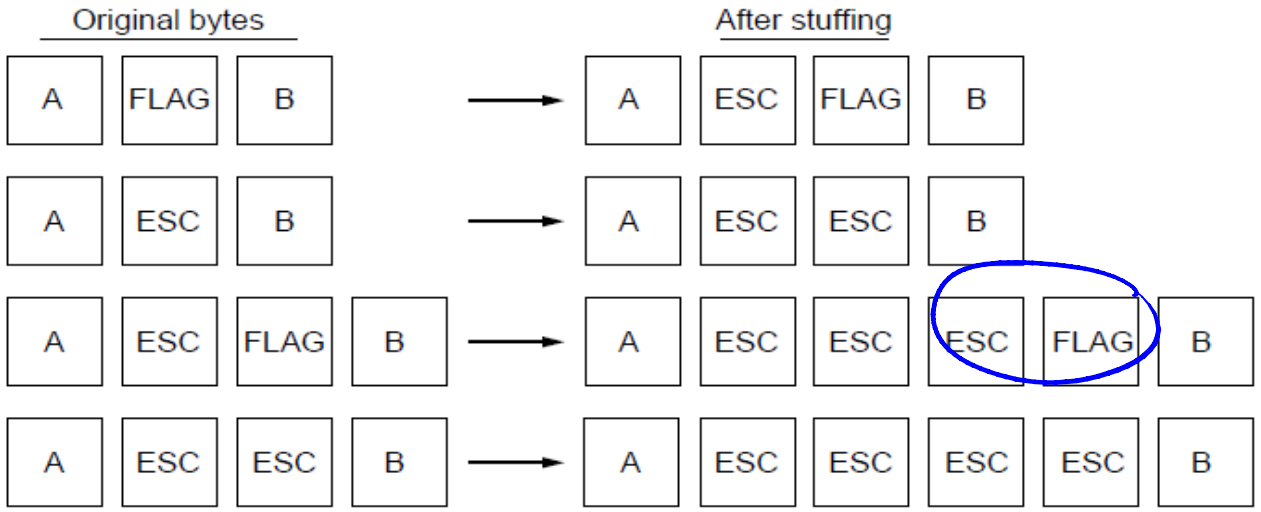
Byte Stuffing (2)

- Rules:
  - Replace each FLAG in data with ESC FLAG
  - Replace each ESC in data with ESC ESC



Byte Stuffing (3)

- Now any unescaped FLAG is the start/end of a frame

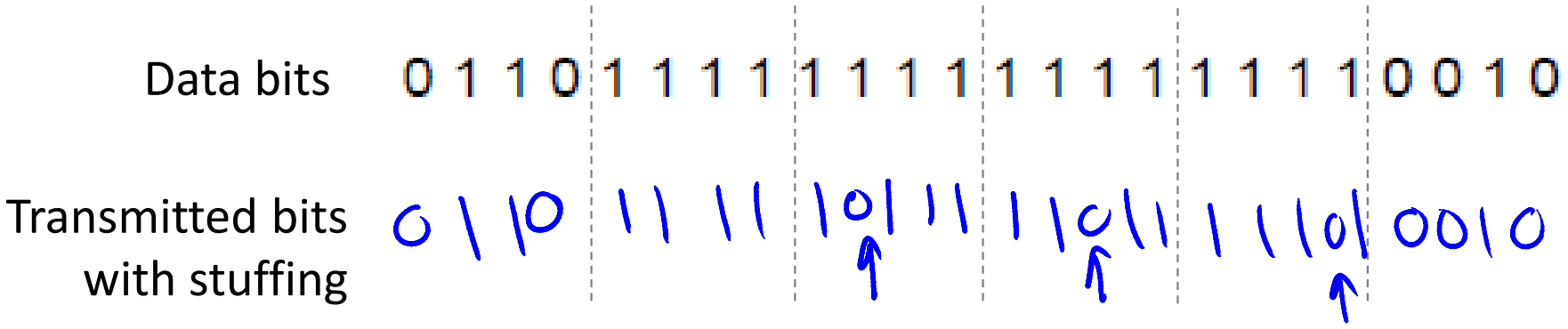


Bit Stuffing

- Can stuff at the bit level too
  - Call a flag six consecutive 1s
  - On transmit, after five 1s in the data, insert a 0
  - On receive, a 0 after five 1s is deleted

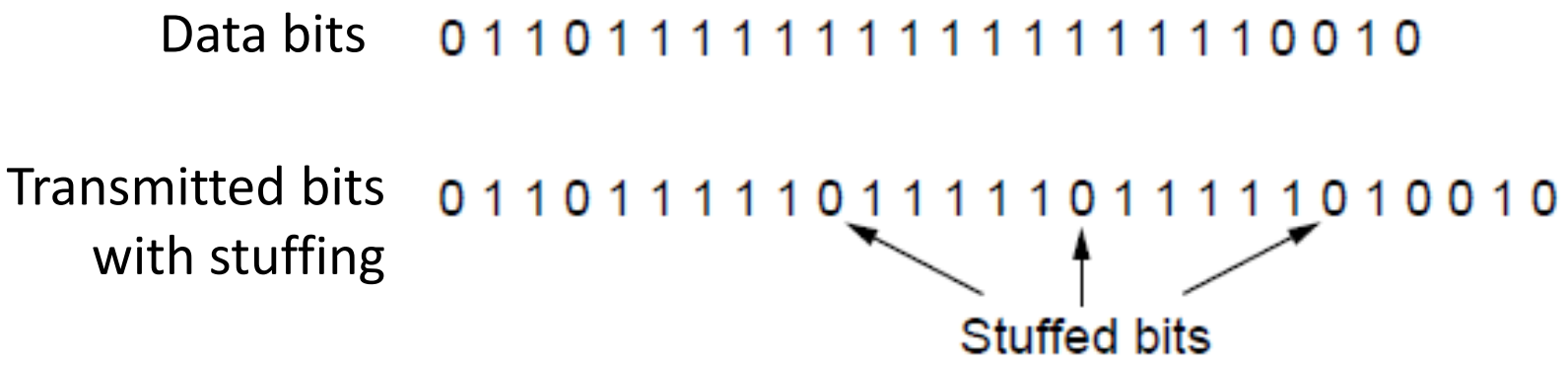
Bit Stuffing (2)

- Example:



Bit Stuffing (3)

- So how does it compare with byte stuffing?

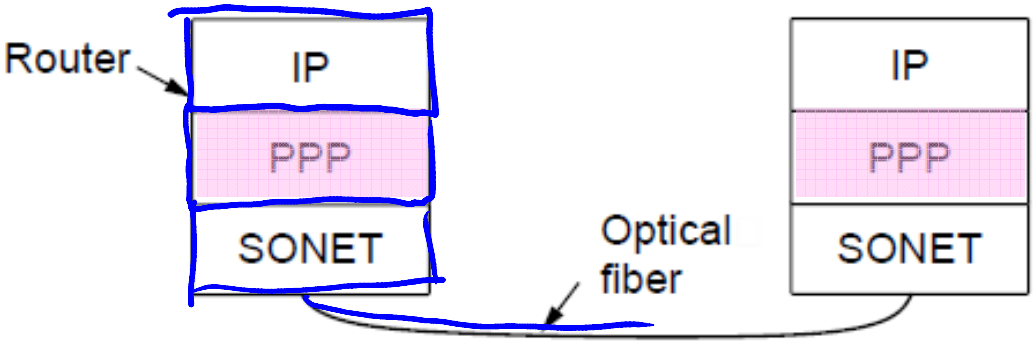


Link Example: PPP over SONET

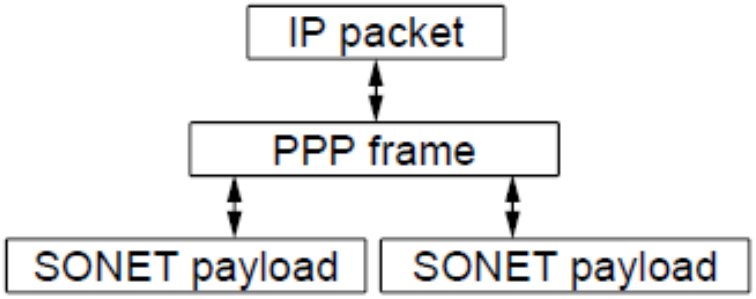
- PPP is Point-to-Point Protocol
- Widely used for link framing
  - E.g., it is used to frame IP packets that are sent over SONET optical links

Link Example: PPP over SONET (2)

- Think of SONET as a bit stream, and PPP as the framing that carries an IP packet over the link



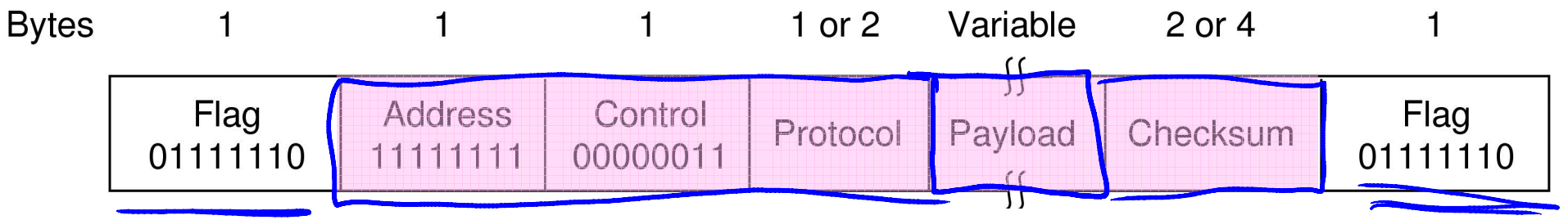
Protocol stacks



PPP frames may be split over SONET payloads

Link Example: PPP over SONET (3)

- Framing uses byte stuffing
  - FLAG is 0x7E and ESC is 0x7D



Link Example: PPP over SONET (4)

- Byte stuffing method:
  - To stuff (unstuff) a byte, add (remove) ESC (0x7D), and XOR byte with 0x20 ~ toggle 5th bit
  - Removes FLAG from the contents of the frame

0x7E → 0x7D5E

0x7D → 0x7D5D

END