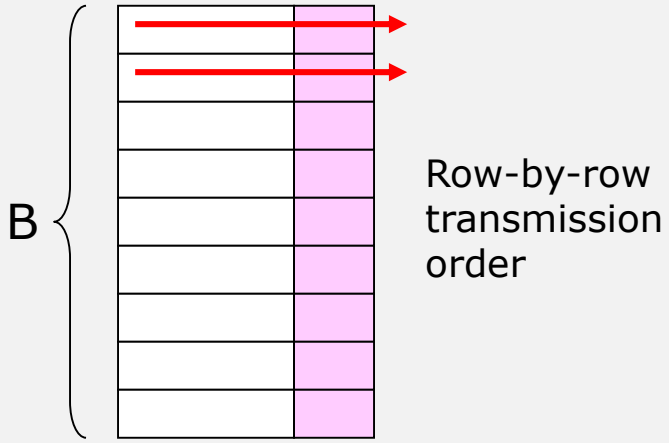
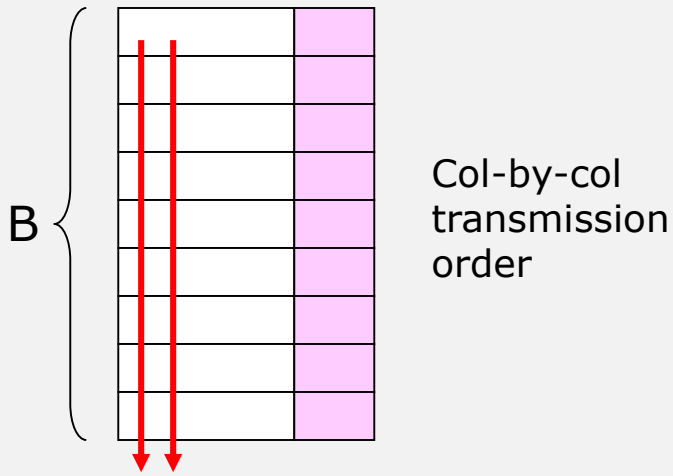
Burst Error Correction

Burst Errors

Correcting errors in a single bit or a few bits is nice, but in many situations errors come in bursts many bits long (e.g. damage to storage media, burst of interference on wireless channel, etc.).



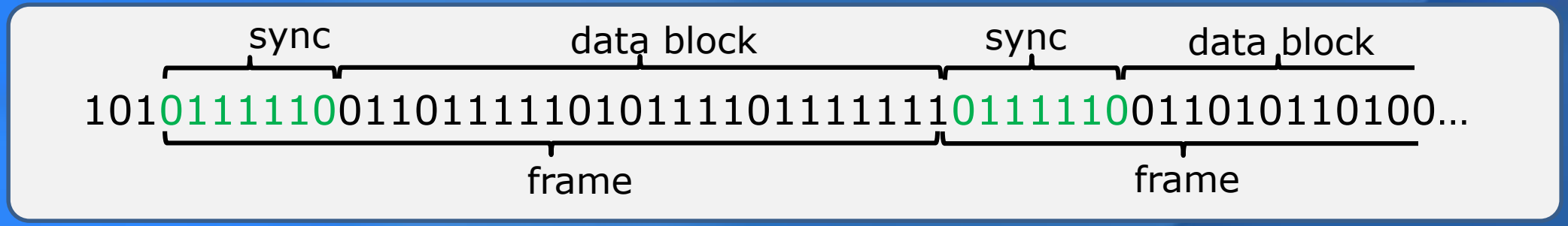


Problem: Bits from a particular codeword are transmitted sequentially, so a B-bit burst produces multi-bit errors.

Solution: **interleave bits** from B different codewords. Now a B-bit burst produces 1-bit errors in B different codewords.

Framing

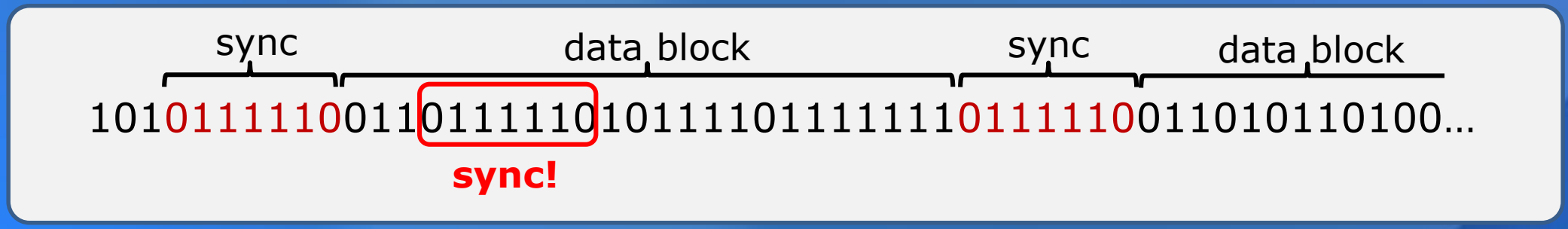
- Looking at a received bit stream, how do we know where a block of interleaved codewords begins?
- Possible solutions
  - Physical indication, e.g.
    - beginning of disk sector
    - separate control channel
  - Frame sync sequence
    - a unique bit pattern placed to mark start of a block (like start bit)
    - example sync sequence: 0111110 (5 1's framed by 0's)



- However, there is something that we need to take care of before adding the sync sequence.

Bit Stuffing: Motivation

- **Bit pattern used for the sync sequence cannot appear elsewhere in frame, otherwise our search for the start of the frame will get confused.**



- **To deal with this, we preprocess the data block by bit stuffing, to make sure the sync sequence does not appear.**

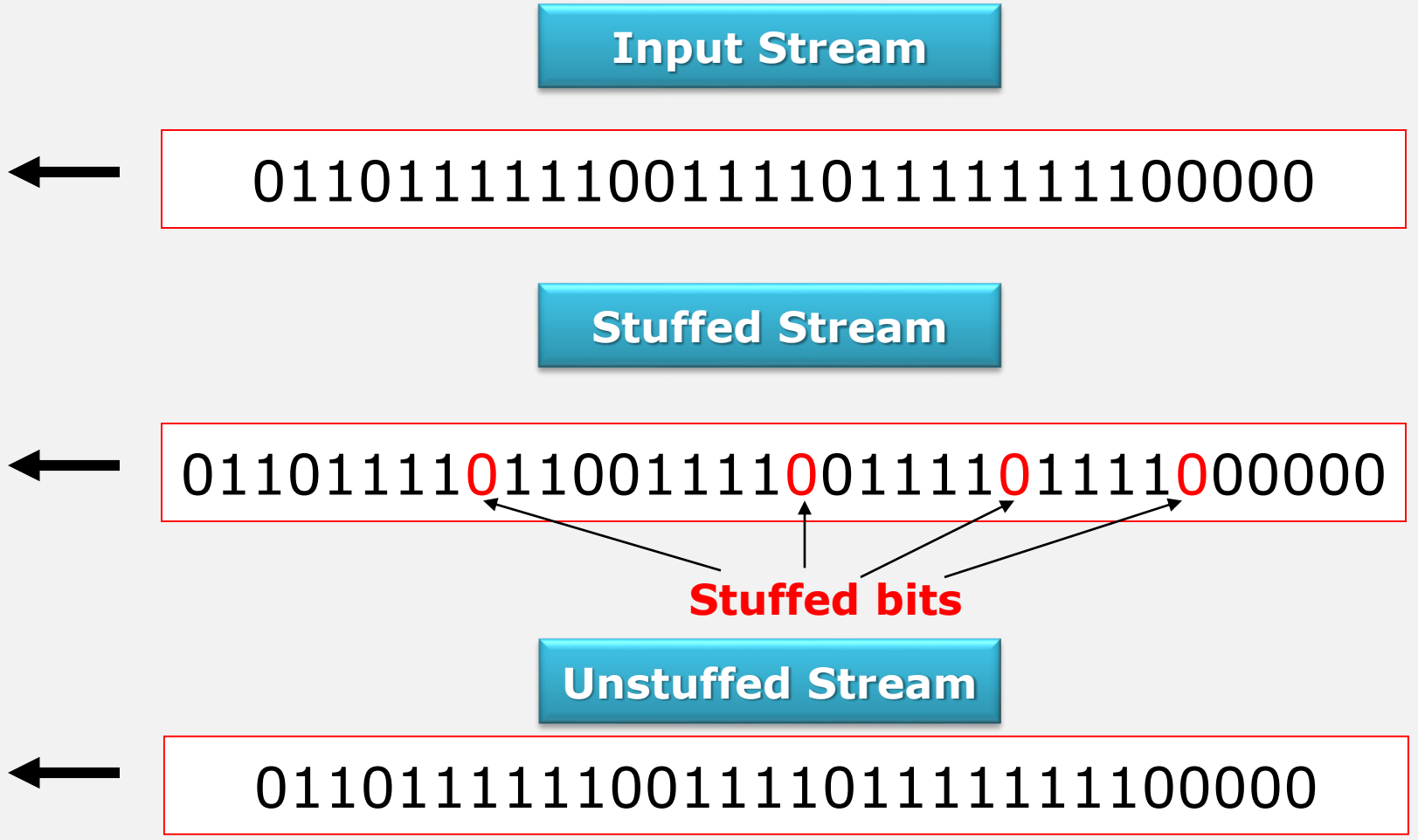
Bit Stuffing

- If the sync sequence is [0111110], one way to guarantee the sync sequence never appears in the data block is to make sure there are never five 1's in a row.

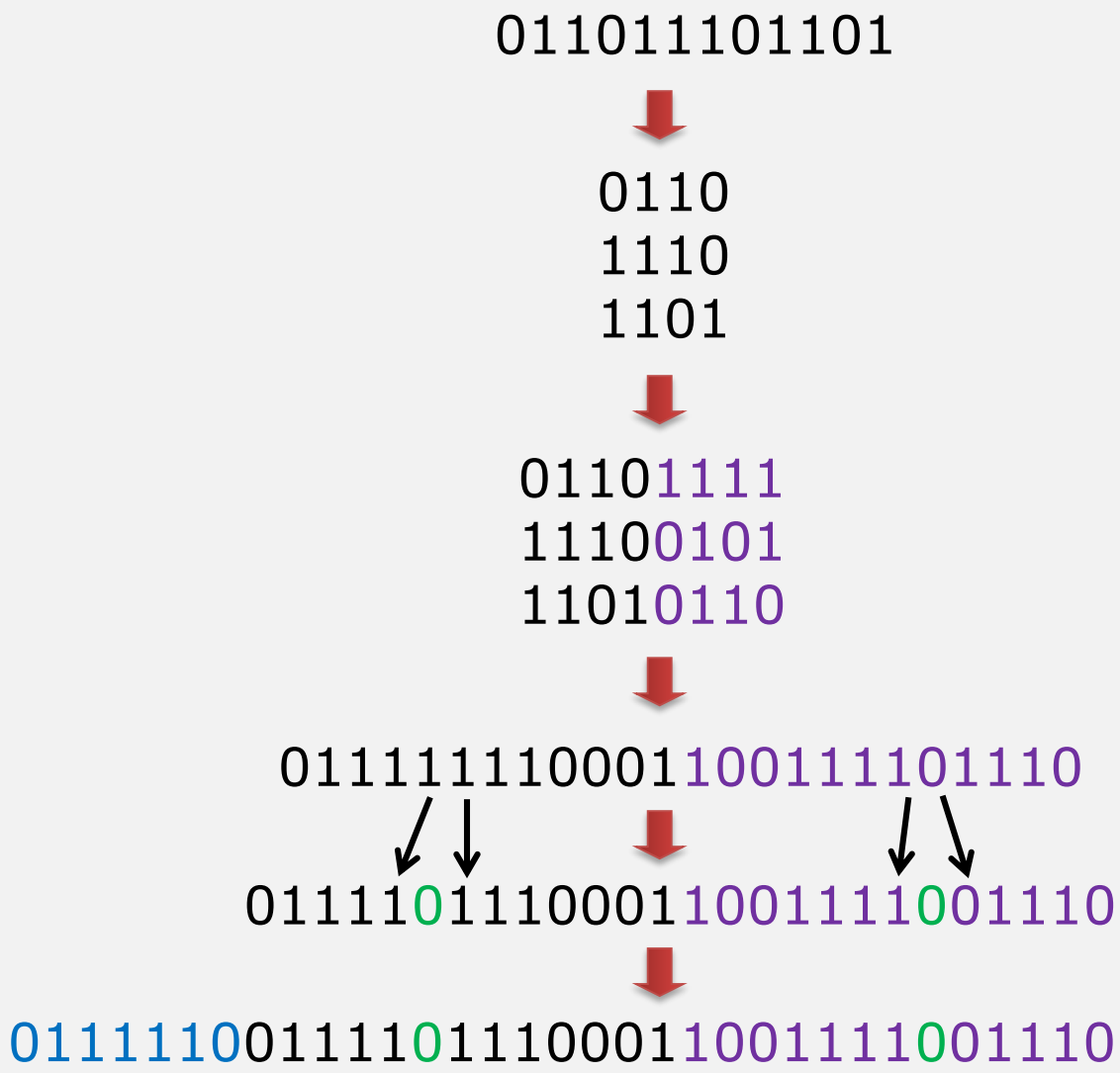
- Bit stuffing
  - Scan through the data block
  - Whenever the sender finds *four* consecutive 1's, it stuffs (adds) a 0 bit into the outgoing stream.
  - The 0 is always stuffed whether or not the next bit is 1.

- Unstuffing
  - When the receiver sees *four* consecutive 1's, it unstuffs (removes) the next bit (which will be a 0).

Bit Stuffing Example



Example: Channel Coding



Take an input message

Break the message into k-bit blocks (k = 4)

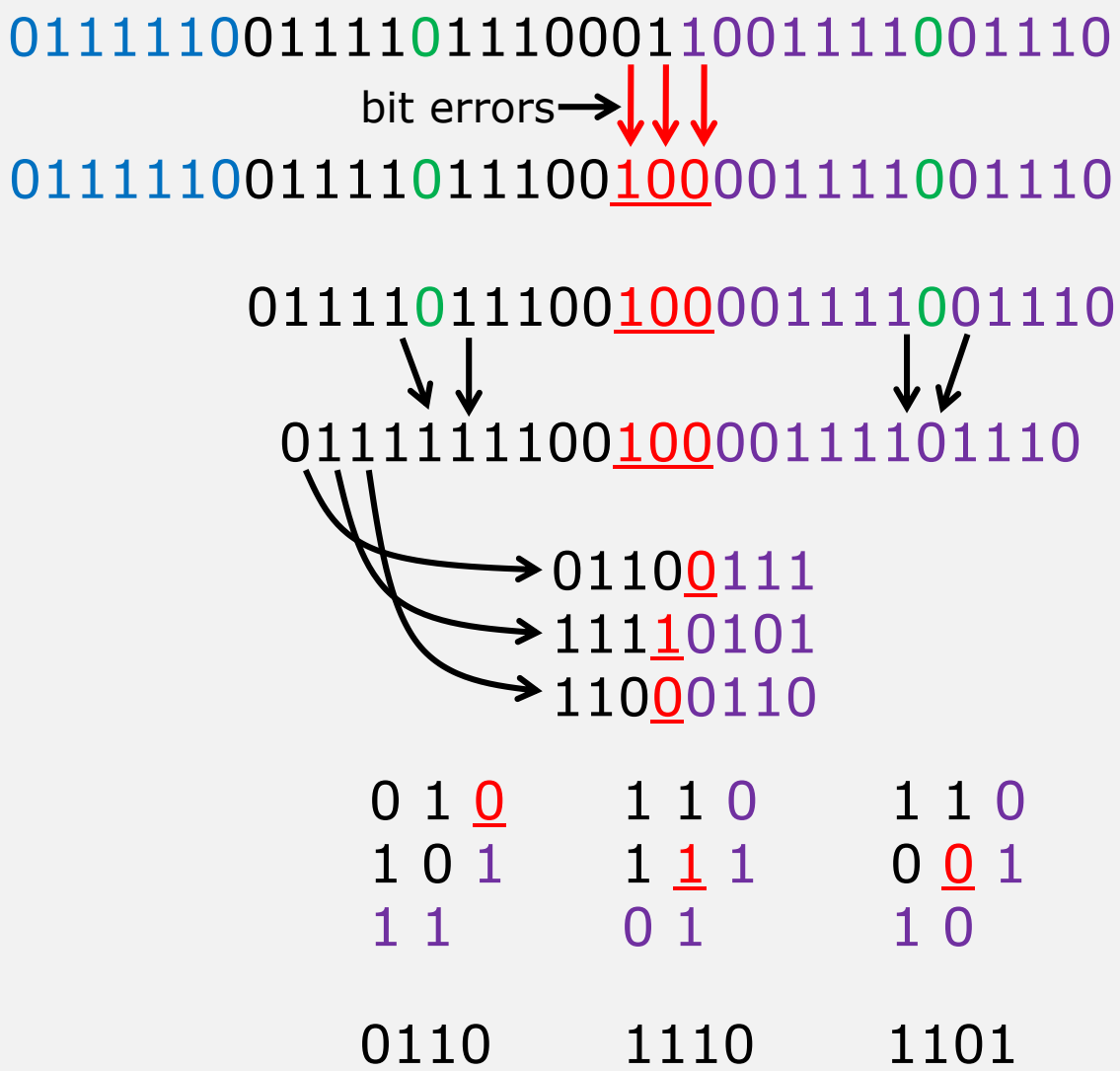
Add (n-k) parity bits to form n-bit codewords (n = 8)

Interleave bits from B codewords (B = 3)

Bit-stuff

Add sync pattern ([0111110])

Example: Error Correction



Sent bit stream

Received bit stream (with errors)

Search for and remove sync pattern

Destuff the frame

De-interleave to form B n-bit codewords (B=3, n=8)

Perform error correction

Extract the k=4 corrected message bits