



Chapter 6

Digital Data Communications
Techniques



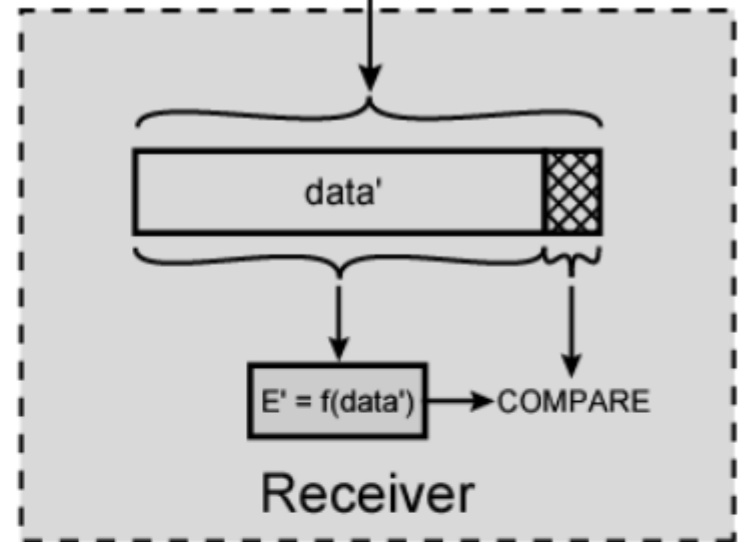
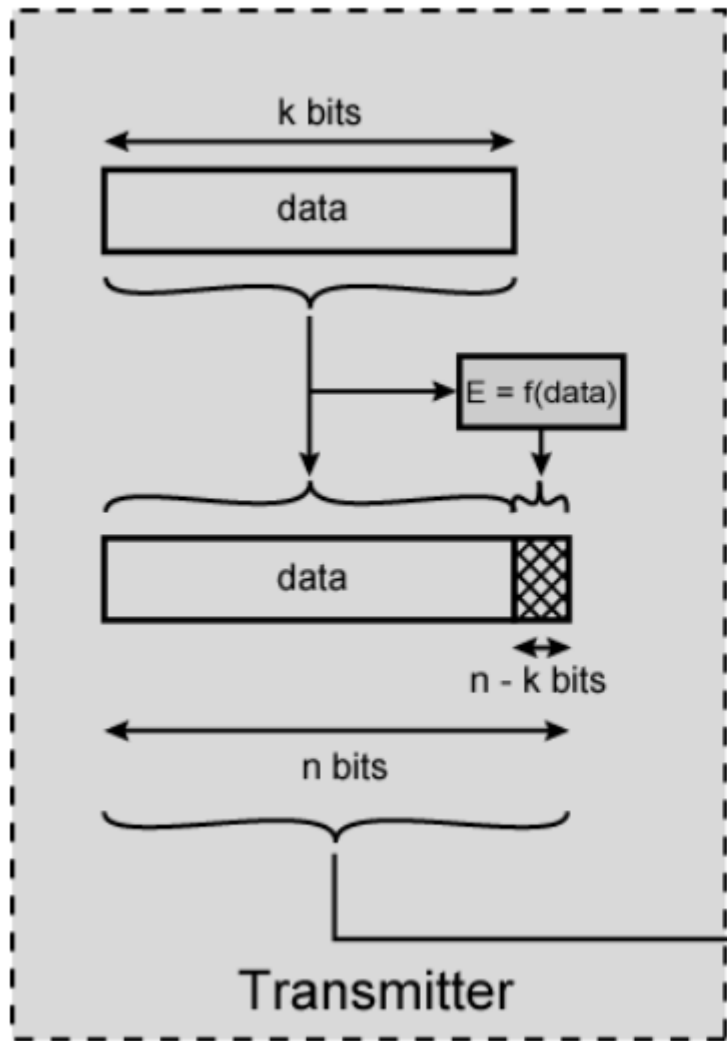
Reading Materials

- **Data and Computer Communications,**
William Stallings
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Types of Error

- An error occurs when a bit is altered between transmission and reception
- Single bit errors
 - One bit altered
 - Adjacent bits not affected
 - White noise
- Burst errors
 - Length B
 - Contiguous sequence of B bits in which first last and any number of intermediate bits in error
 - Impulse noise
 - Fading in wireless
 - Effect is greater at higher data rates

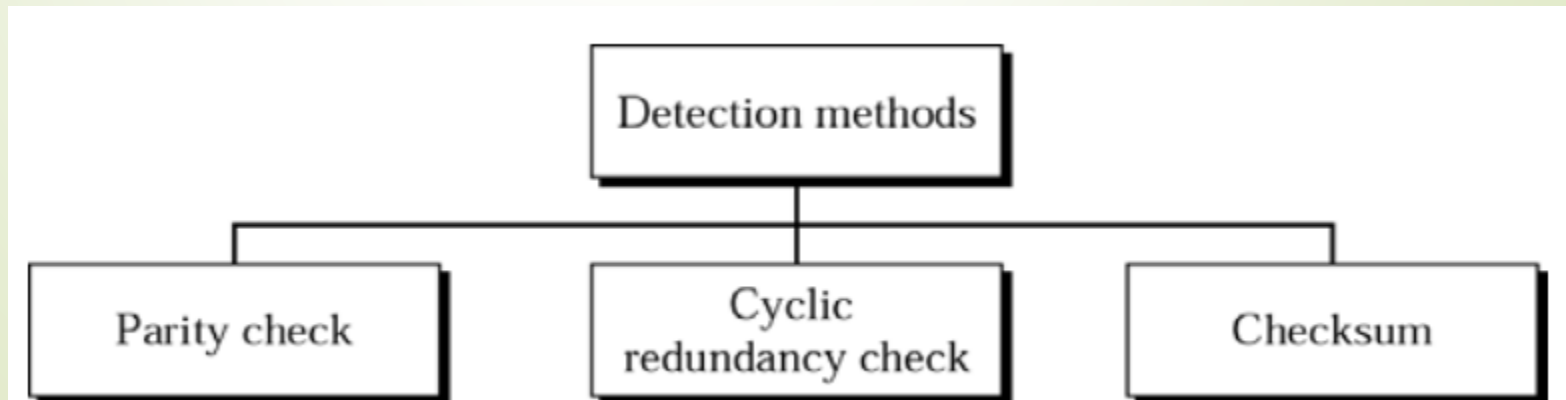
Error Detection Process



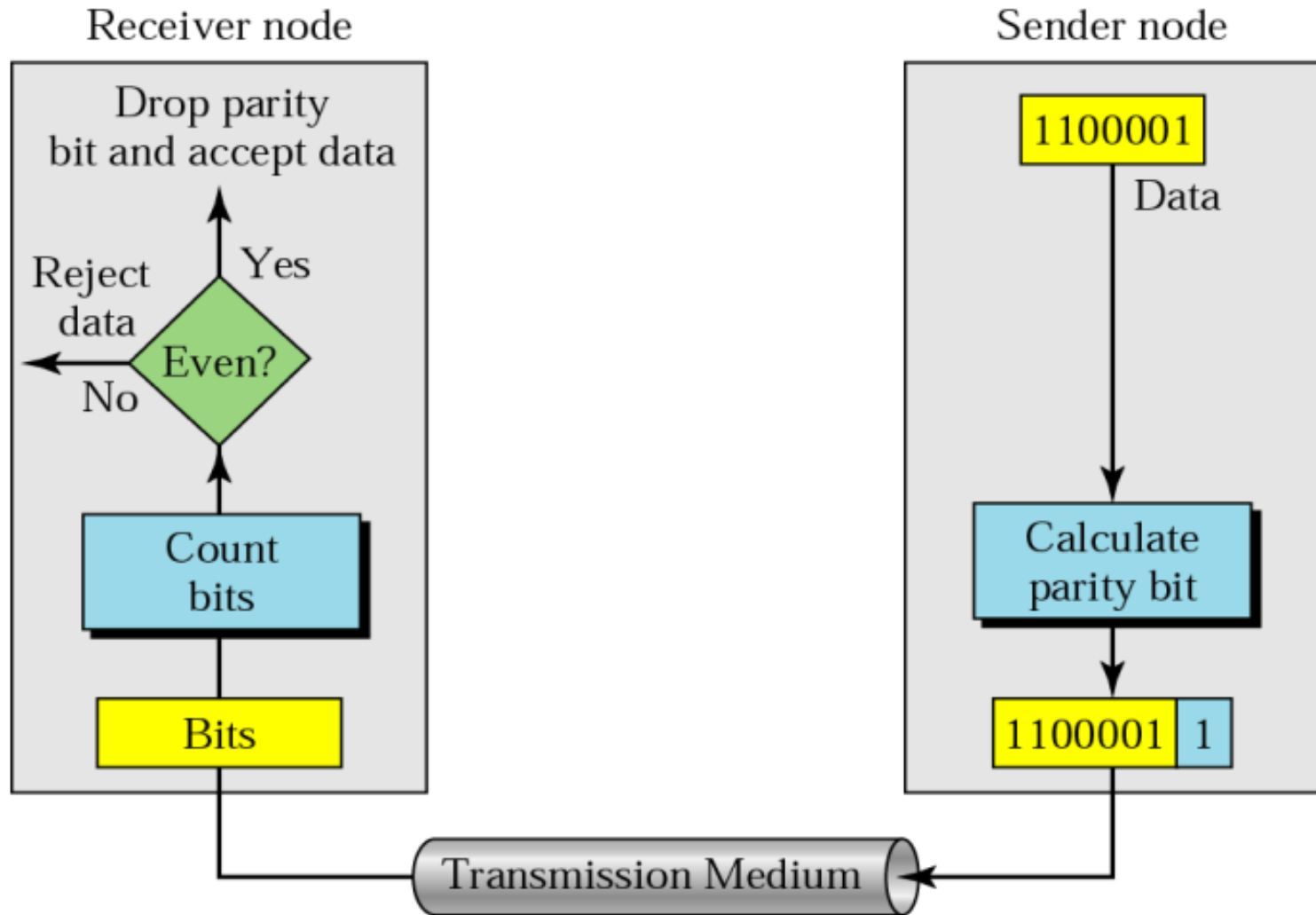
E, E' = error-detecting codes
 f = error-detecting code function

Error Detection

- Additional bits added by transmitter for error detection code
- Parity
 - Value of parity bit is such that character has even (even parity) or odd (odd parity) number of ones
 - Even number of bit errors goes undetected
- Checksum

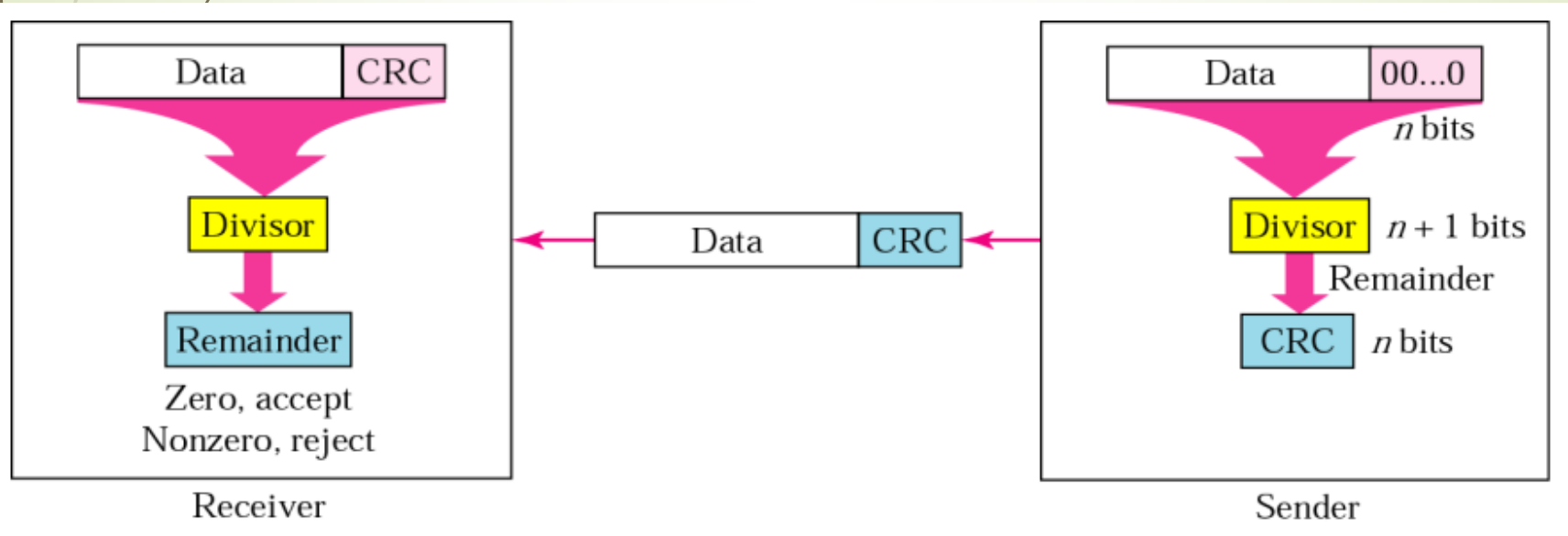


Even Parity Check

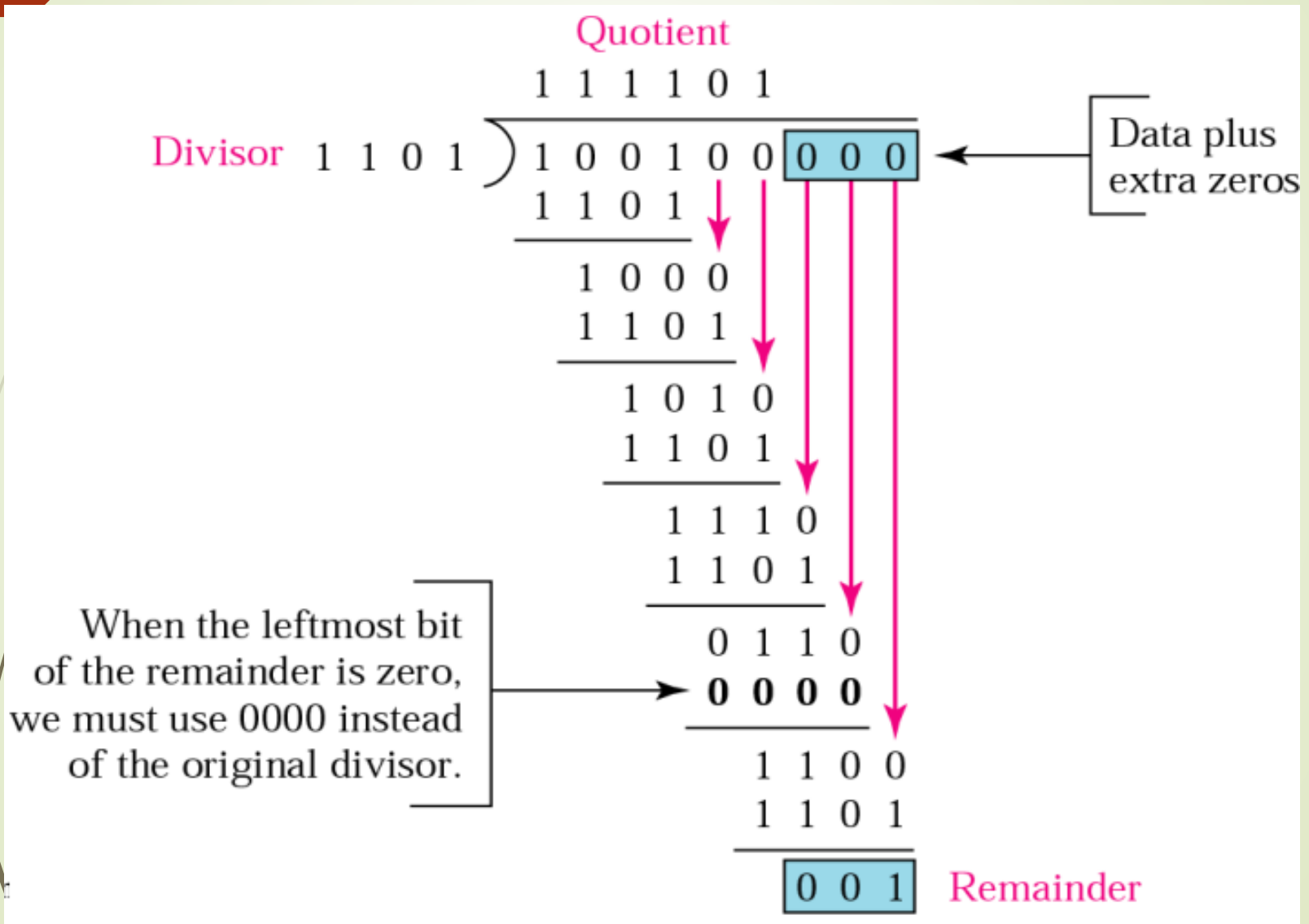


Cyclic Redundancy Check

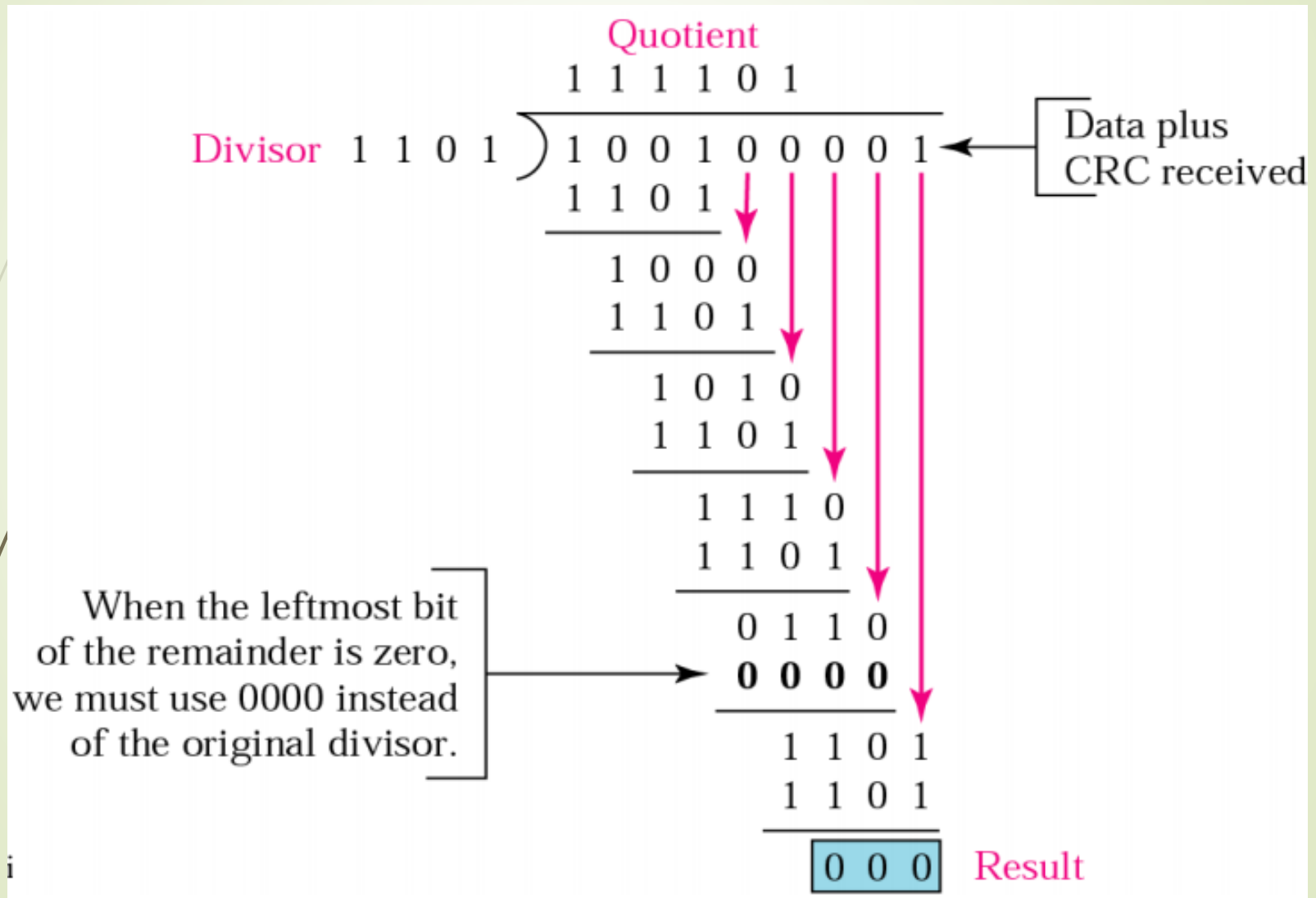
- For a block of k bits transmitter generates n bit sequence
- Transmit $k+n$ bits which is exactly divisible by some number
- Receiver divides frame by that number
 - If no remainder, assume no error



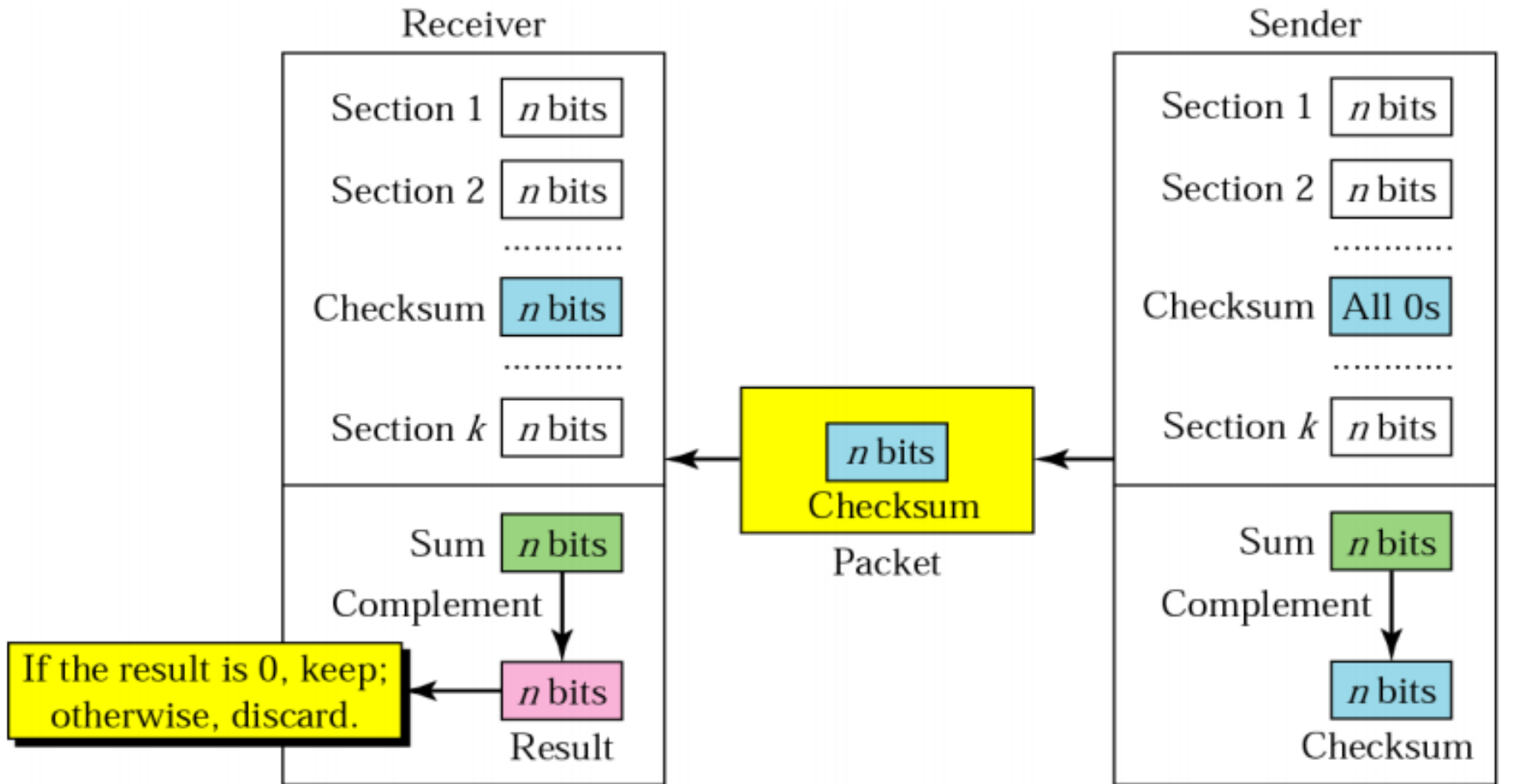
Binary Division in CRC Generator



Binary Division in CRC Checker



Checksum



Checksum (cont'd)

Suppose the following block of 16 bits is to be sent using a checksum of 8 bits.

10101001 00111001

The numbers are added using one's complement

	10101001
	00111001

Sum	11100010
Checksum	00011101

The pattern sent is 10101001 00111001 **00011101**

Checksum (cont'd)

Now suppose the receiver receives the pattern sent in Example 7 and there is no error.

10101001 00111001 00011101

When the receiver adds the three sections, it will get all 1s, which after complementing, is all 0s and shows that there is no error.

	10101001
	00111001
	00011101
Sum	11111111

Complement **00000000** means that the pattern is OK.

Checksum (cont'd)

Now suppose there is a burst error of length 5 that affects 4 bits.

10101111 11111001 00011101

When the receiver adds the three sections, it gets

10101111

11111001


00011101

Partial Sum **1** 11000101

Carry **1**

Sum 11000110

Complement **00111001** the pattern is corrupted.



Human being is a collection of energy, intelligence, effort and time. With time they either increase or decrease.





Courtesy

- Professor Jiying Zhao, University of Ottawa
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