CSE 306

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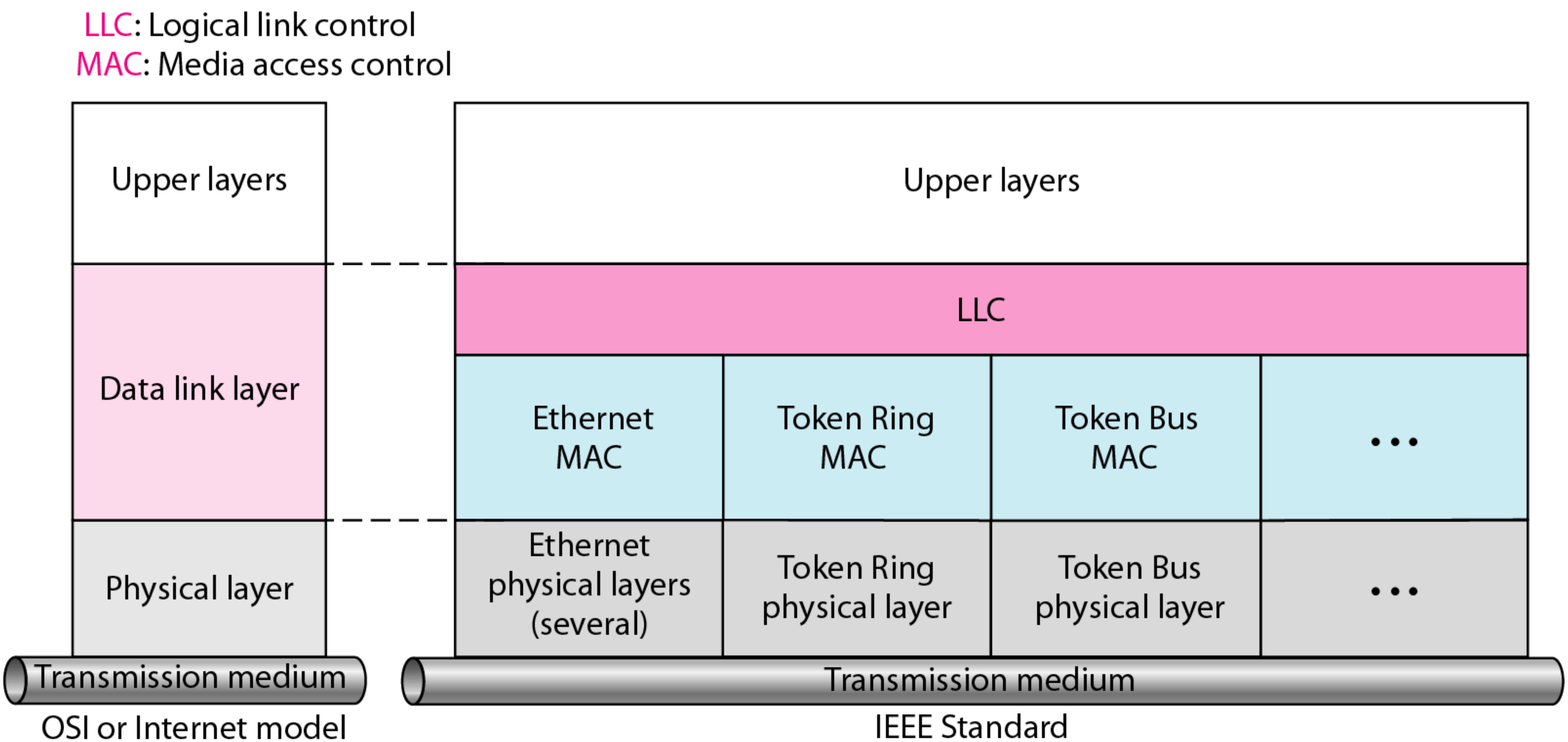
IEEE standard for LANs



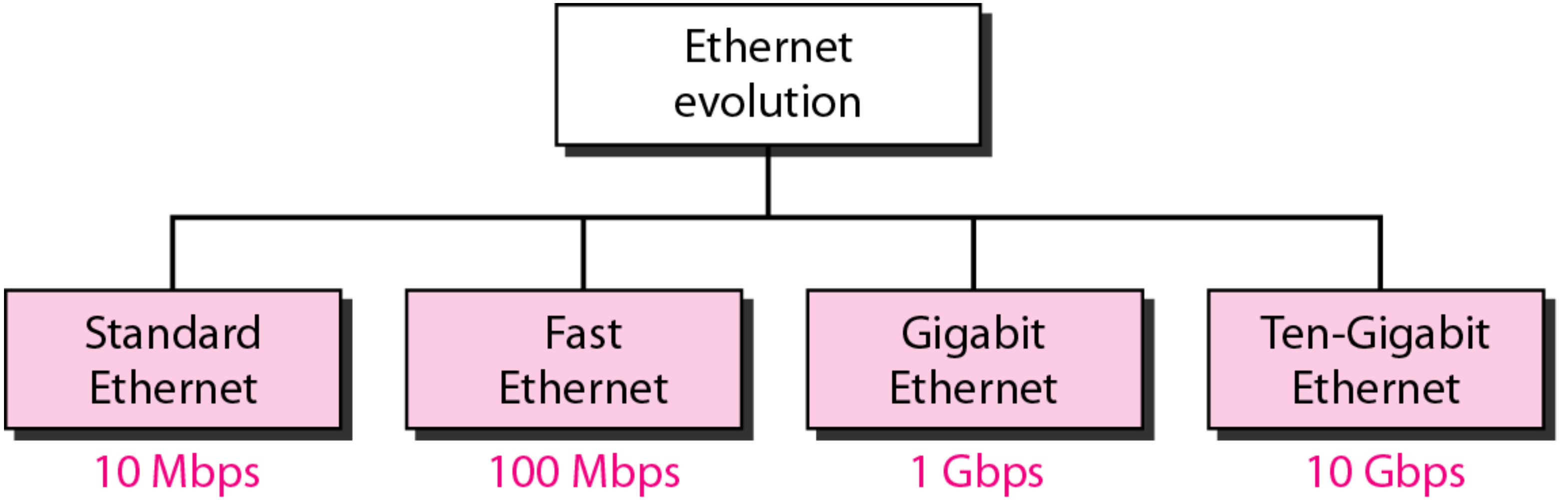
STANDARD ETHERNET

The original Ethernet was created in 1976 at Xerox's Palo Alto Research Center (PARC). Since then, it has gone through four generations. We briefly discuss the Standard (or traditional) Ethernet in this section.

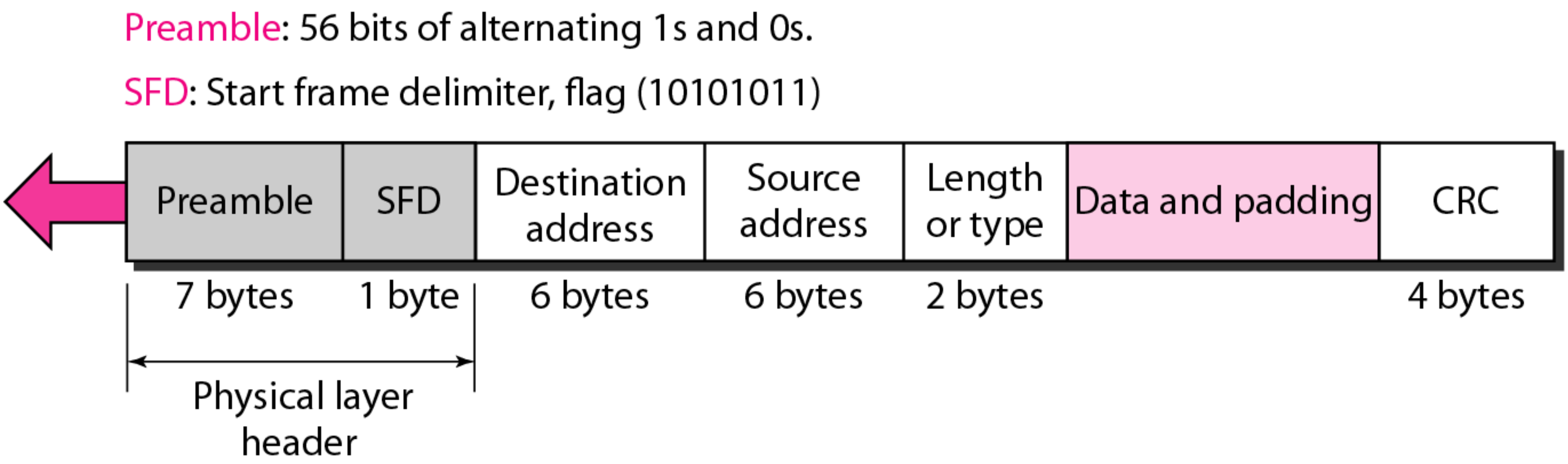
Topics discussed in this section:

MAC Sublayer
Physical Layer

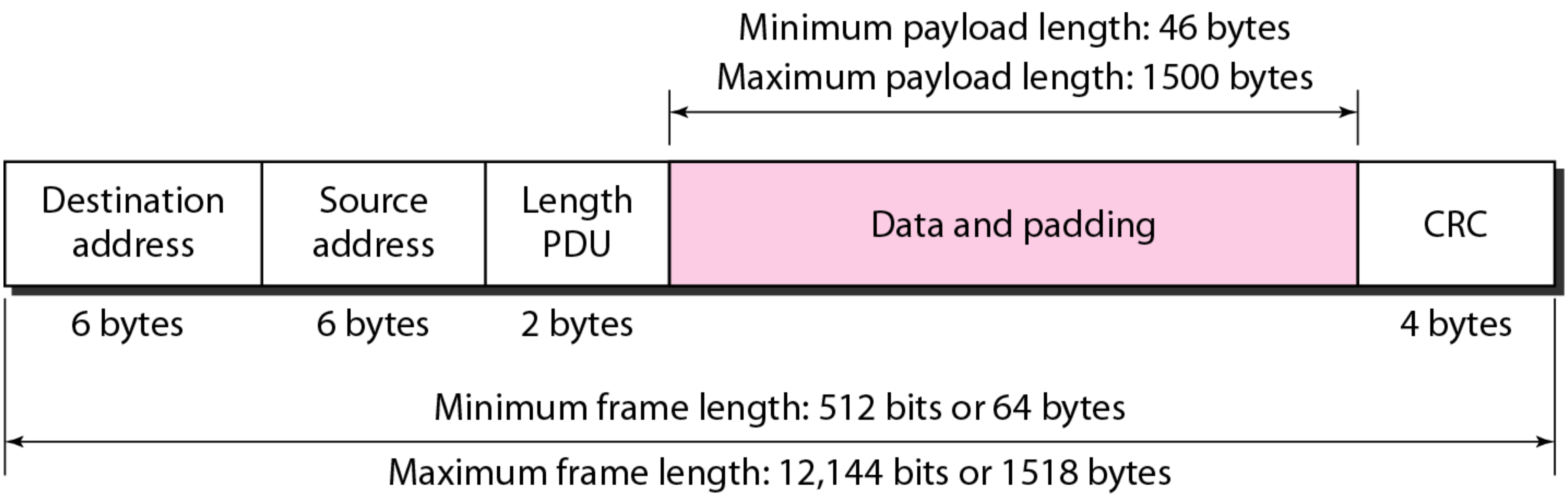
Ethernet evolution through four generations



802.3 MAC frame



Minimum and maximum lengths



Note

Frame length:

Minimum: 64 bytes (512 bits)

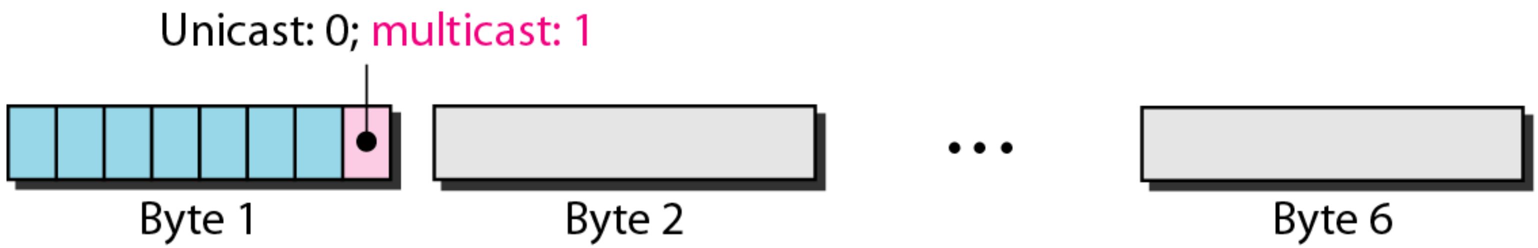
Maximum: 1518 bytes (12,144 bits)

Example of an Ethernet address in hexadecimal notation

06 : 01 : 02 : 01 : 2C : 4B

6 bytes = 12 hex digits = 48 bits

Unicast and multicast addresses



Note

The least significant bit of the first byte defines the type of address.
If the bit is 0, the address is unicast; otherwise, it is multicast.

POLL 1

- In a MAC address, the address is broadcast if in the first byte

a) LSB is 1

b) MSB is 1

c) LSB is 0

d) MSB is 0

Note

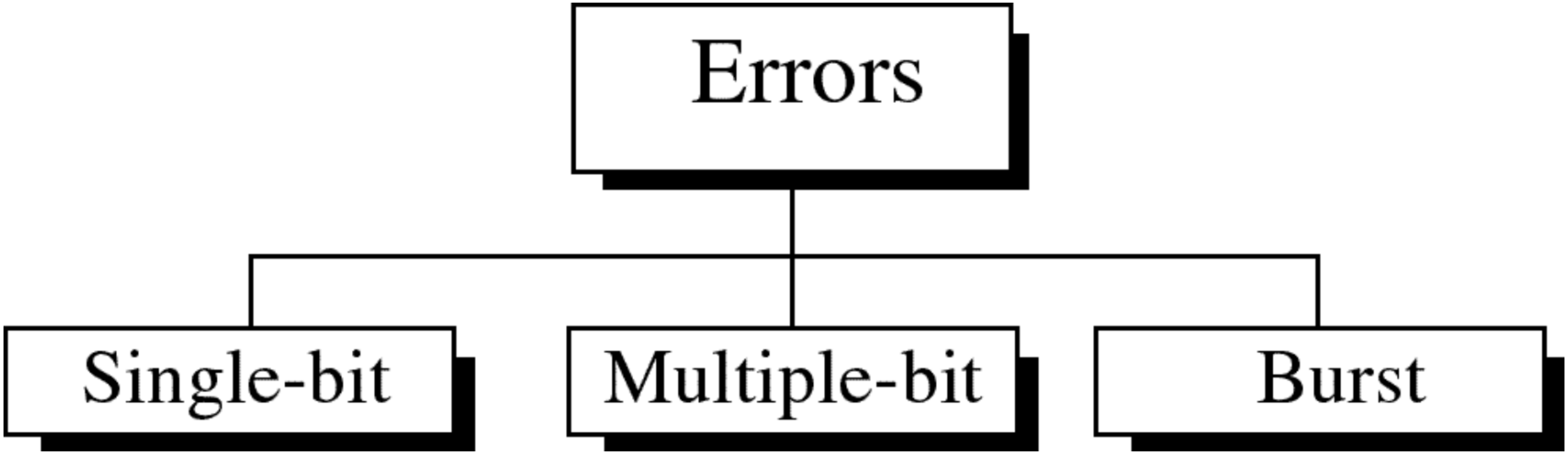
The broadcast destination address is a special case of the multicast address in which all bits are 1s.

ERROR CONTROL

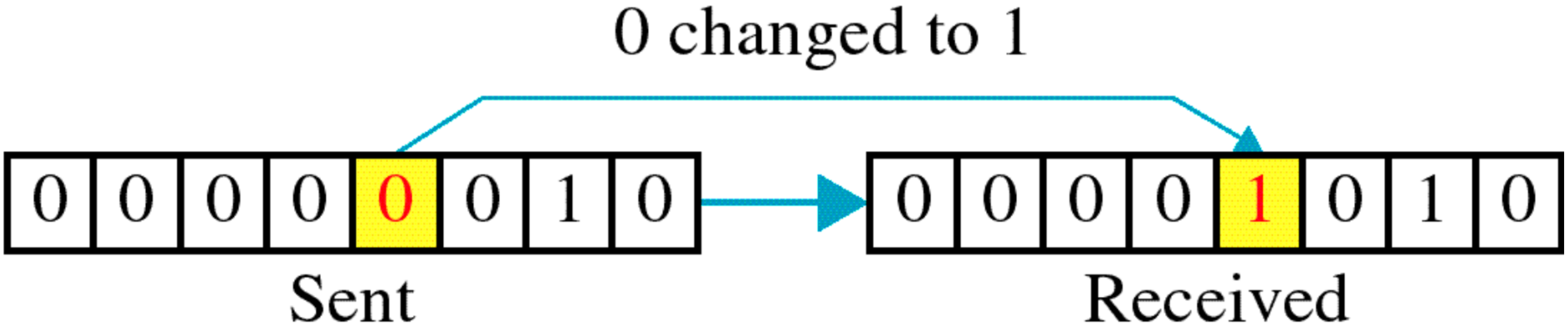
Basic concepts

- Networks must be able to transfer data from one device to another with complete accuracy.
- Data can be corrupted during transmission.
- For reliable communication, errors must be detected and corrected.
- **Error detection and correction** are implemented either at the **data link layer** or the **transport layer** of the OSI model.

Types of Errors

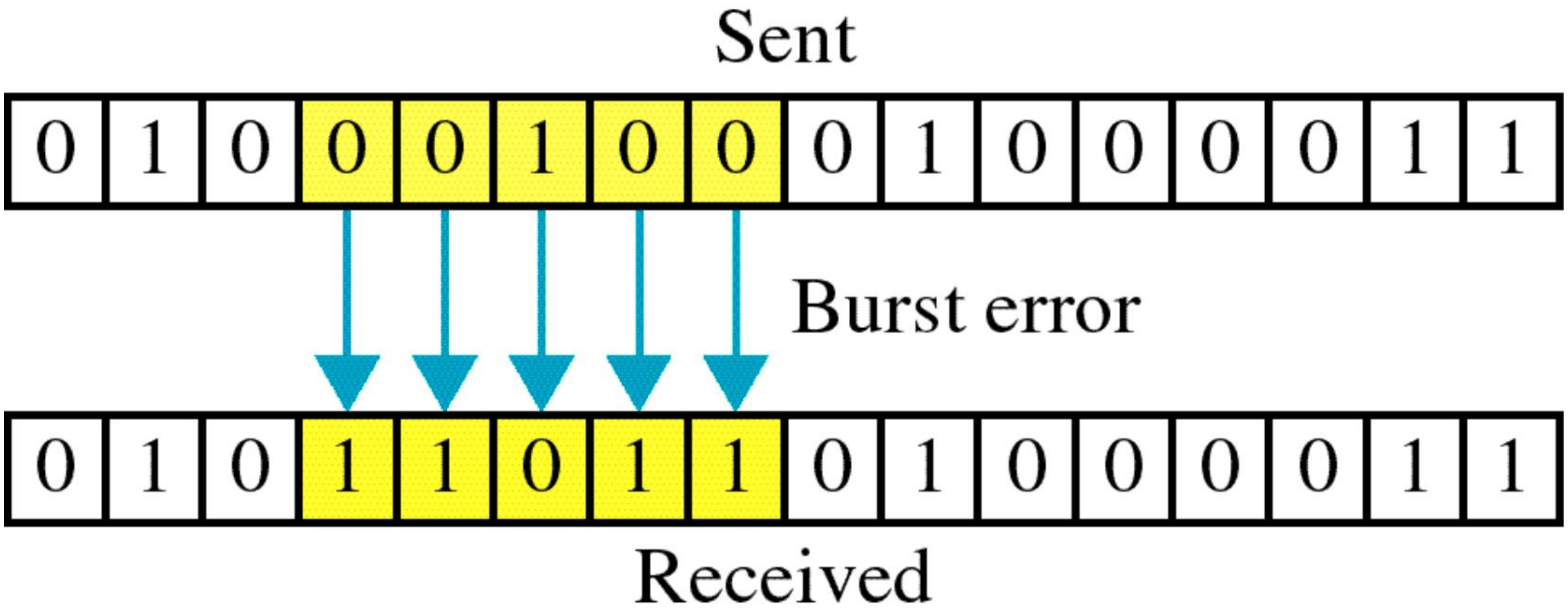


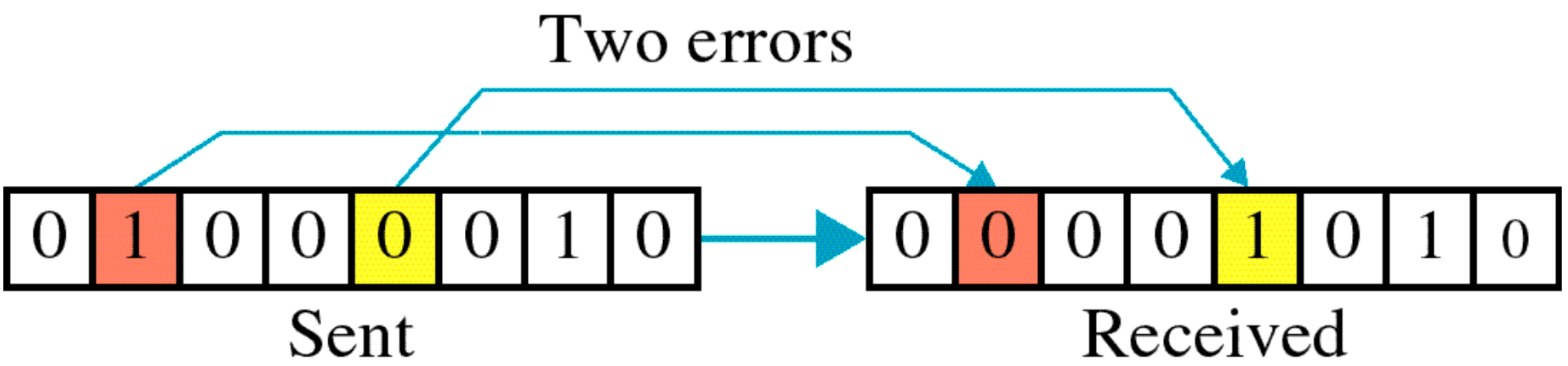
Single-bit error



Single bit errors are the **least likely** type of errors in serial data transmission because the noise must have a very short duration which is very rare. However this kind of errors can happen in parallel transmission.

Burst error


Sent
0 1 0 0 0 1 0 0 0 1 0 0 0 0 1 1
Burst error
0 1 0 1 1 0 1 1 0 1 0 0 0 0 1 1
Received


Two errors
0 1 0 0 0 0 1 0
Sent
0 0 0 0 1 0 1 0
Received

The term **burst error** means that two or more bits in the data unit have changed from 1 to 0 or from 0 to 1.

Burst errors does not necessarily **mean that the errors occur in consecutive bits**, the length of the burst is measured from the first corrupted bit to the last corrupted bit. Some bits in between may not have been corrupted.

- **Burst error is most likely to happen in serial transmission** since the duration of noise is normally longer than the duration of a bit.
- The number of bits affected depends on the data rate and duration of noise.

POLL 2

- Which is not an example of Error

a) Single bit

b) Double bit

c) Burst

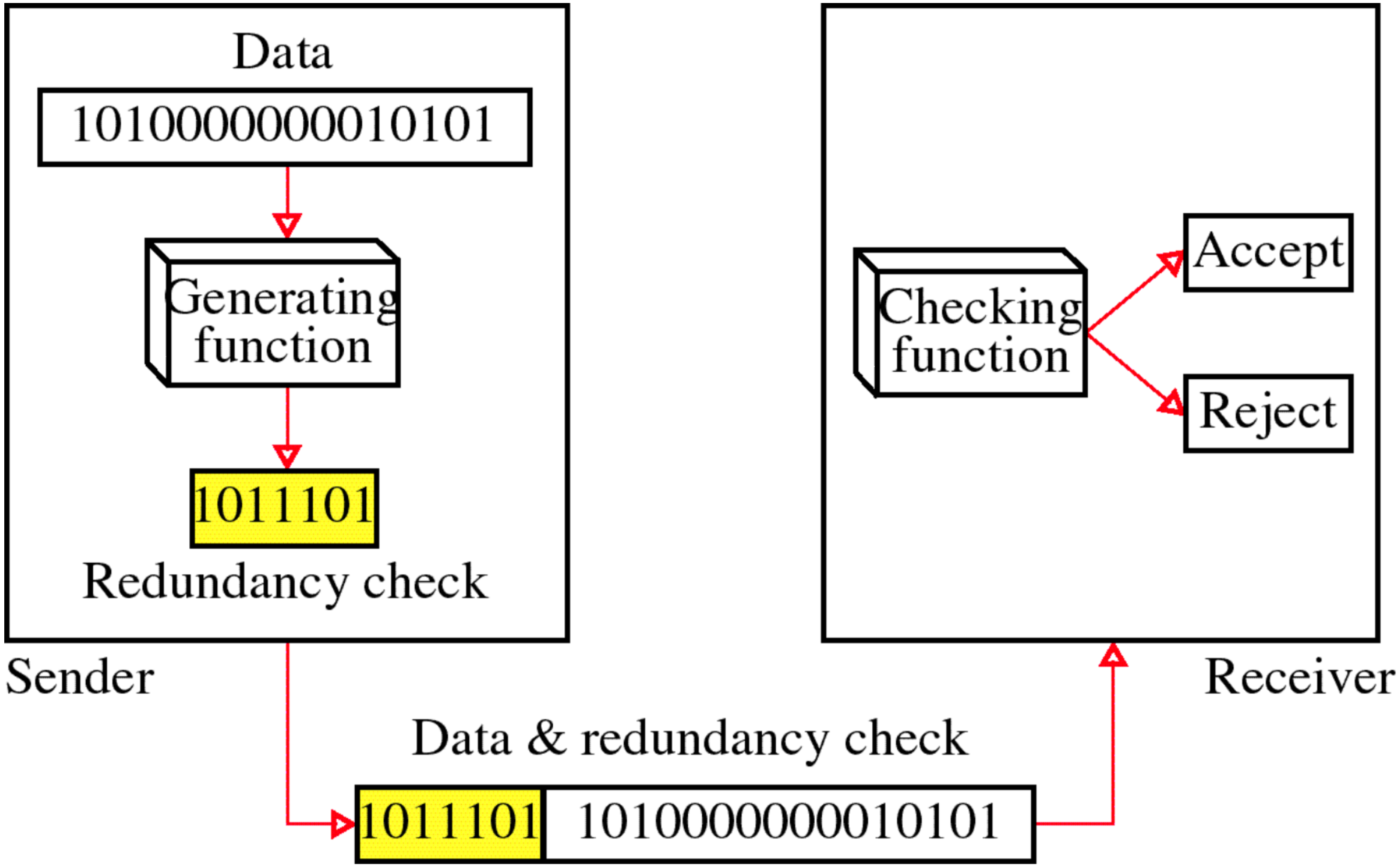
d) rust

Error detection

Error detection means to decide whether the received data is correct or not without having a copy of the original message.

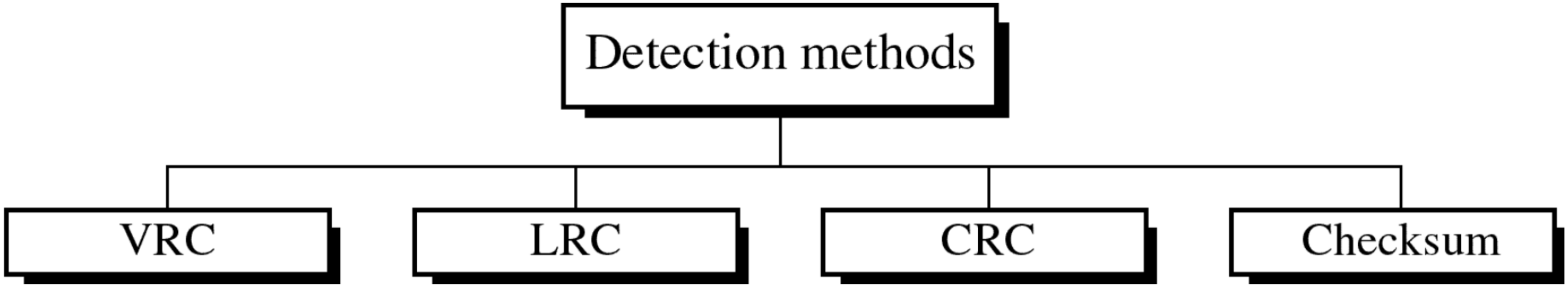
Error detection **uses the concept of redundancy**, **which means** adding extra bits for detecting errors at the destination.

Redundancy



Data
1010000000010101
Generating function
1011101
Redundancy check
Sender
Checking function
Accept
Reject
Receiver
Data & redundancy check
1011101
1010000000010101

Four types of redundancy checks are used in data communications



POLL 3

- Which of the following is not an example of redundancy check

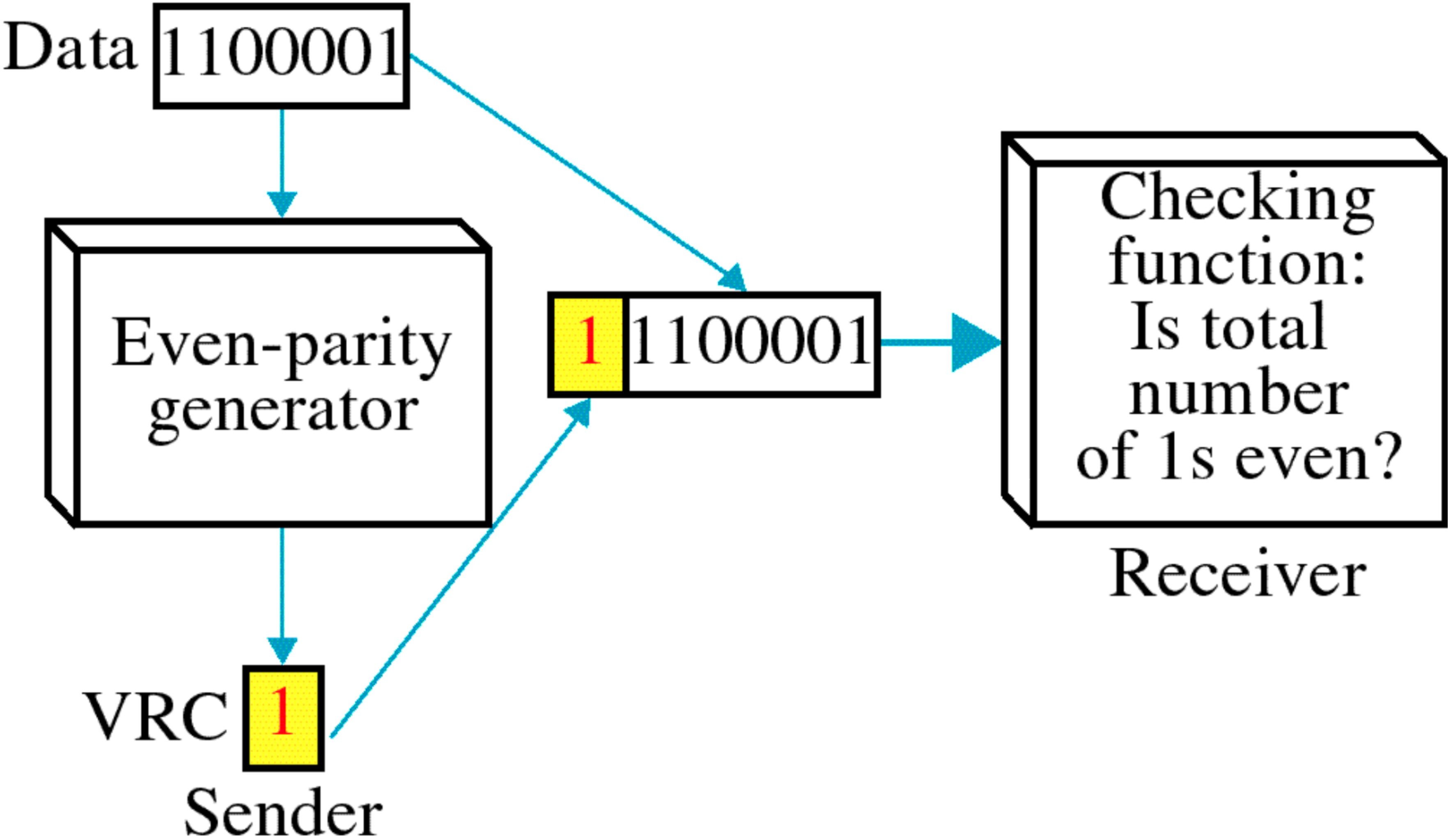
a) CRC

b) VRC

c) LRC

d) NRC

Vertical Redundancy Check VRC



Example

Suppose the sender wants to send the word *world*. In ASCII the five characters are coded as

1110111	**1101111**	**1110010**	**1101100**	**1100100**
w	o	r	l	d

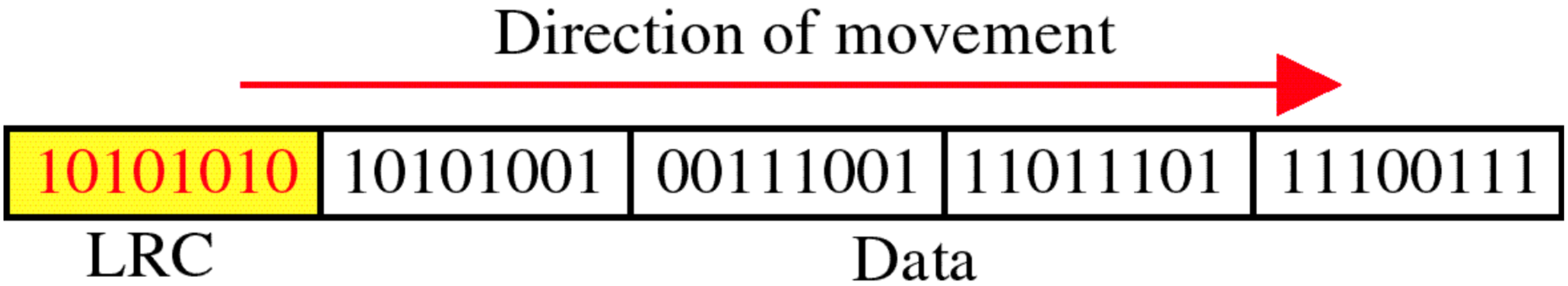
The following shows the actual bits sent

1110111<u>0</u> 1101111<u>0</u> 1110010<u>0</u> 1101100<u>0</u> 1100100<u>1</u>

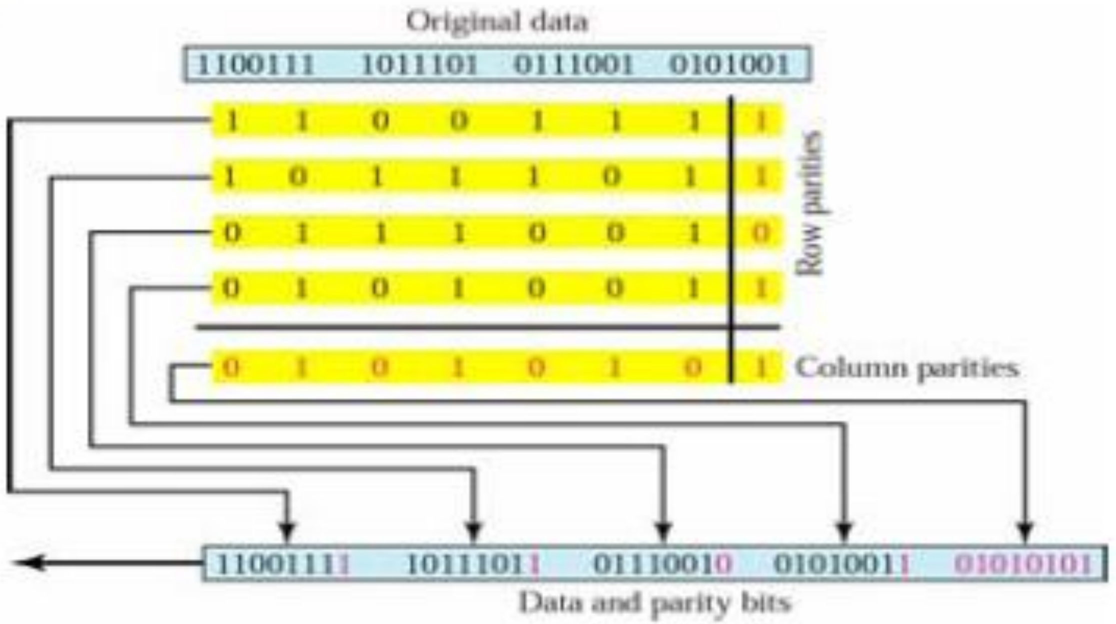
Performance

➔It can detect burst errors only if the total number of errors is odd.

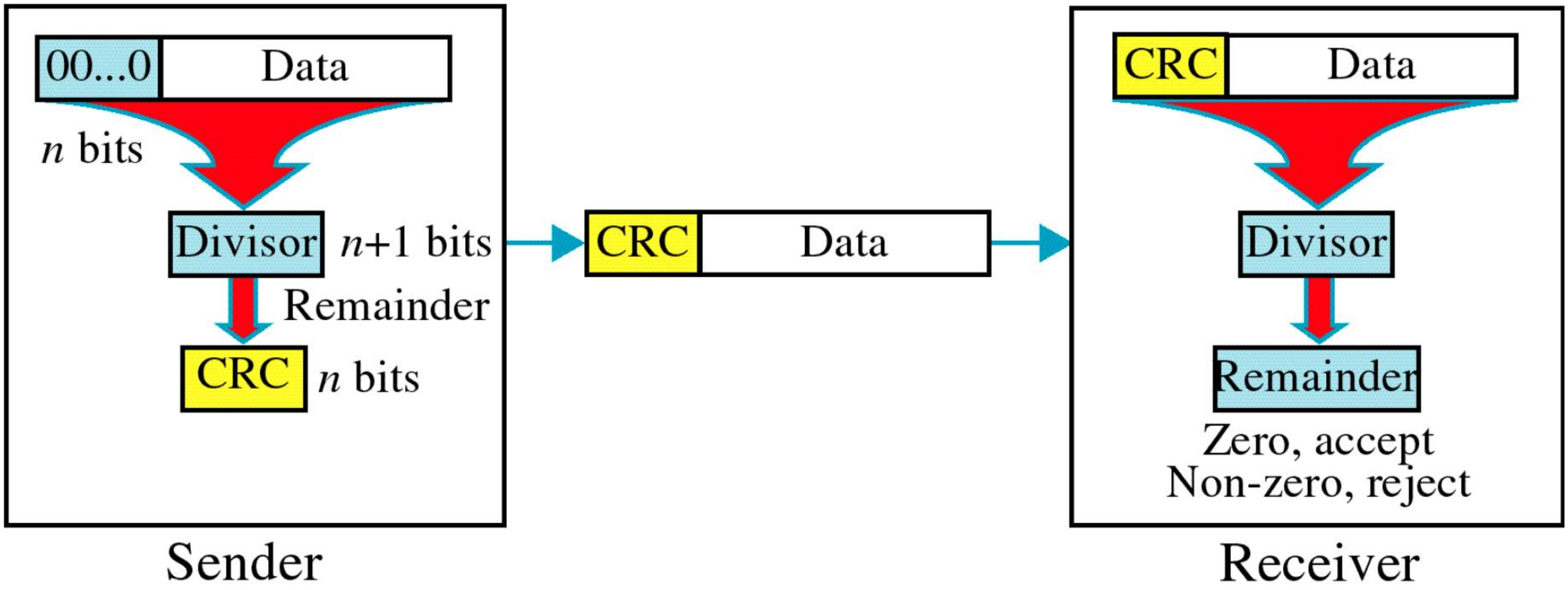
Longitudinal Redundancy Check LRC



Two-dimensional parity (LRC + VRC)



Cyclic Redundancy Check CRC

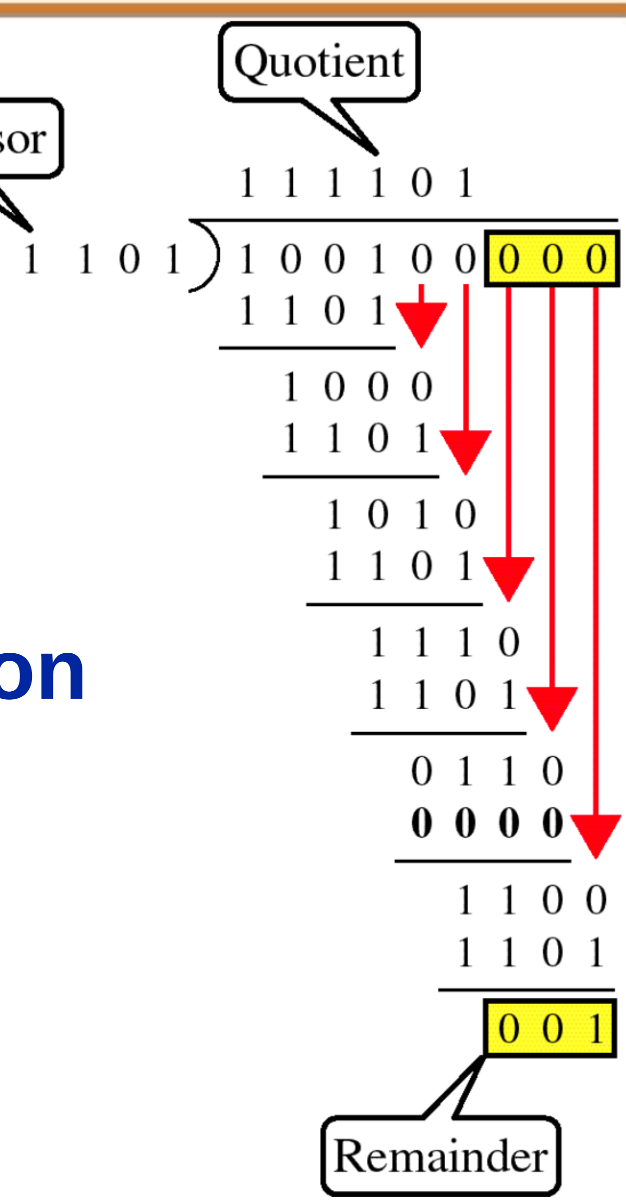


Cyclic Redundancy Check

- Given a k-bit frame or message, the transmitter generates an n-bit sequence, known as a *frame check sequence (FCS)*, so that the resulting frame, consisting of (k+n) bits, is exactly divisible by some predetermined number.

- The receiver then divides the incoming frame by the same number and, if there is no remainder, assumes that there was no error.

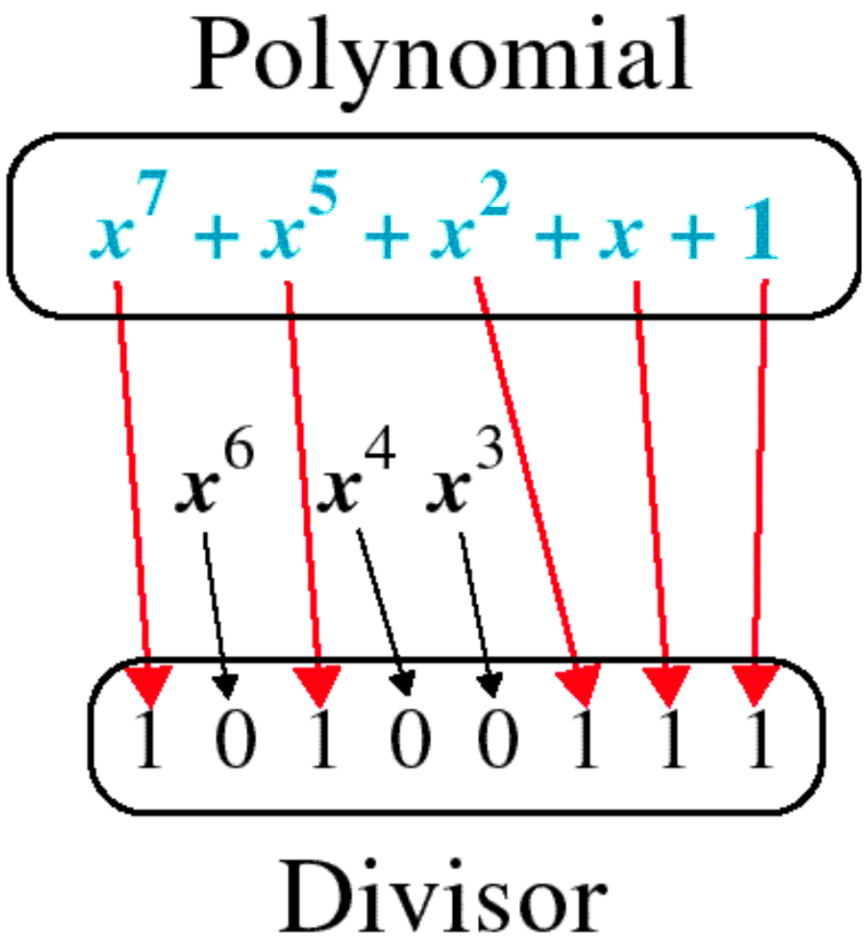
Binary Division



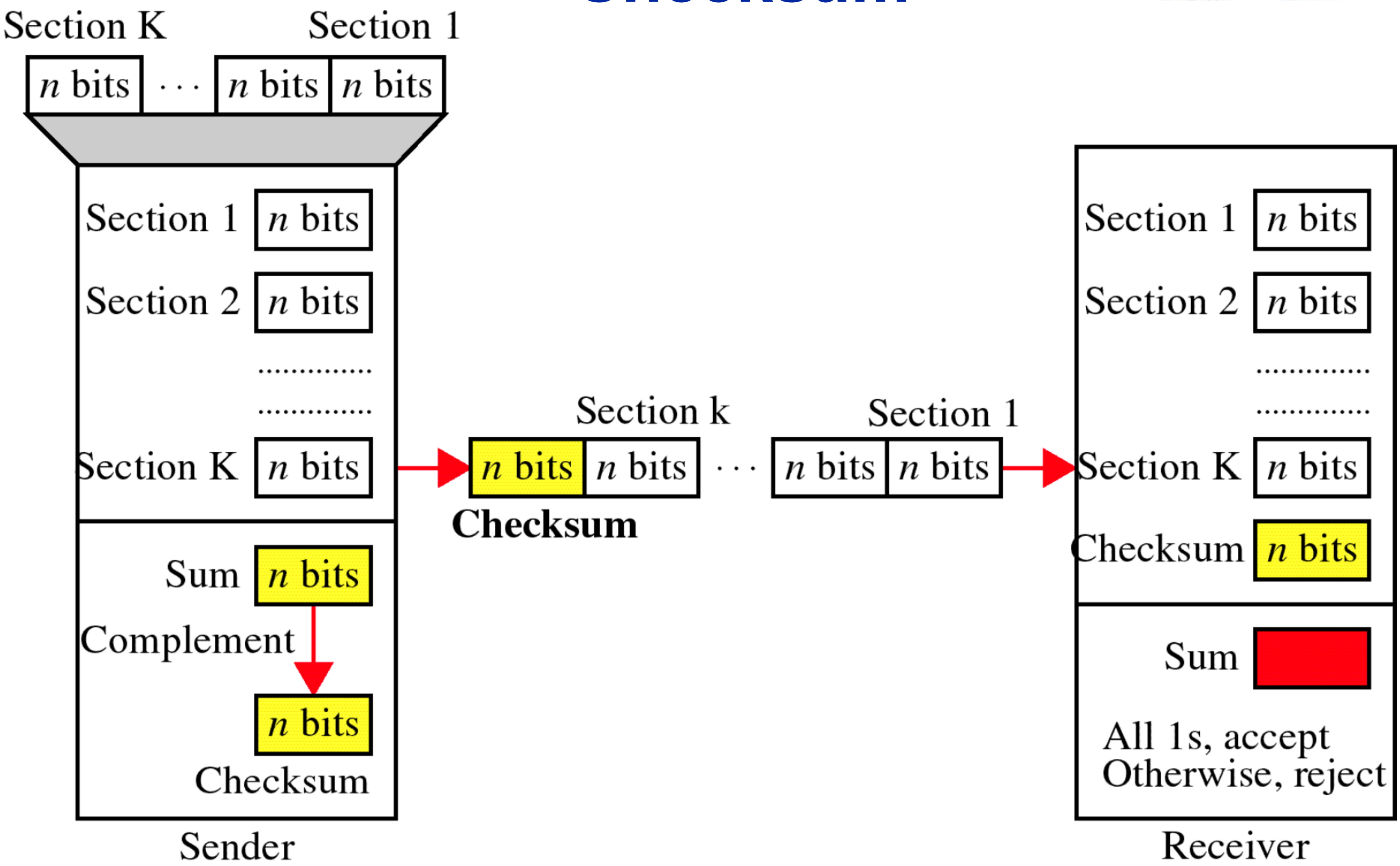
Polynomial

$$\boxed{x^7 + x^5 + x^2 + x + 1}$$

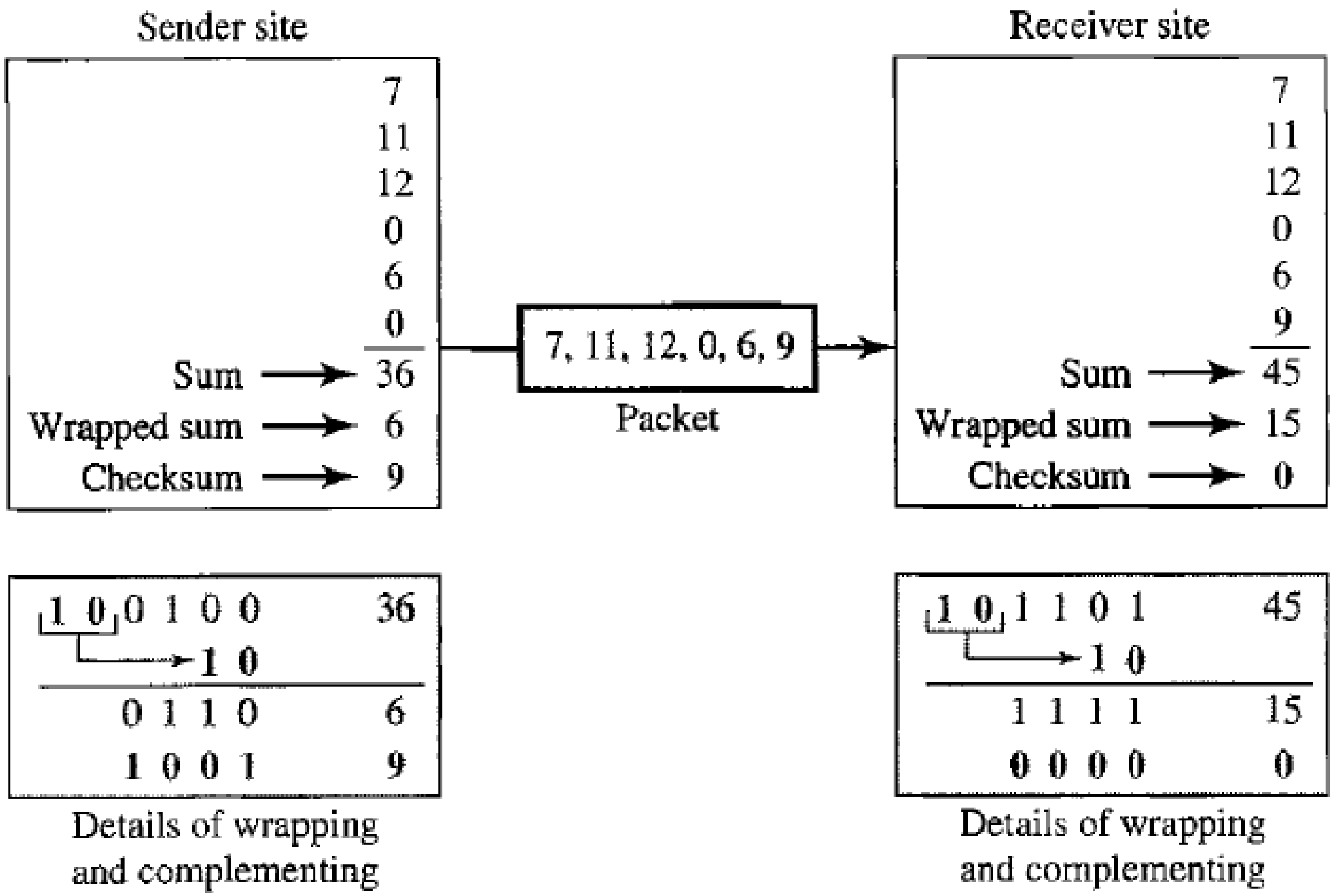
Polynomial and Divisor



Checksum



Section K
Section 1
n bits
n bits
n bits
Section 1
n bits
Section 2
n bits
Section K
n bits
Sum
n bits
Complement
n bits
Checksum
Sender
Section k
Section 1
n bits
n bits
n bits
n bits
Checksum
Section 1
n bits
Section 2
n bits
Section K
n bits
Checksum
n bits
Sum
All 1s, accept
Otherwise, reject
Receiver


Sender site
7
11
12
0
6
0
Sum
36
Wrapped sum
6
Checksum
9
7, 11, 12, 0, 6, 9
Packet
Receiver site
7
11
12
0
6
9
Sum
45
Wrapped sum
15
Checksum
0
1 0 0 1 0 0
36
1 0
0 1 1 0
6
1 0 0 1
9
Details of wrapping and complementing
1 0 1 1 0 1
45
1 0
1 1 1 1
15
0 0 0 0
0
Details of wrapping and complementing

Error Correction

It can be handled in two ways:

1) receiver can have the sender retransmit the entire data unit.
2) The receiver can use an error-correcting code, which automatically corrects certain errors.

Single-bit error correction

To correct an error, the receiver reverses the value of the altered bit. To do so, it must know which bit is in error.

Number of redundancy bits needed

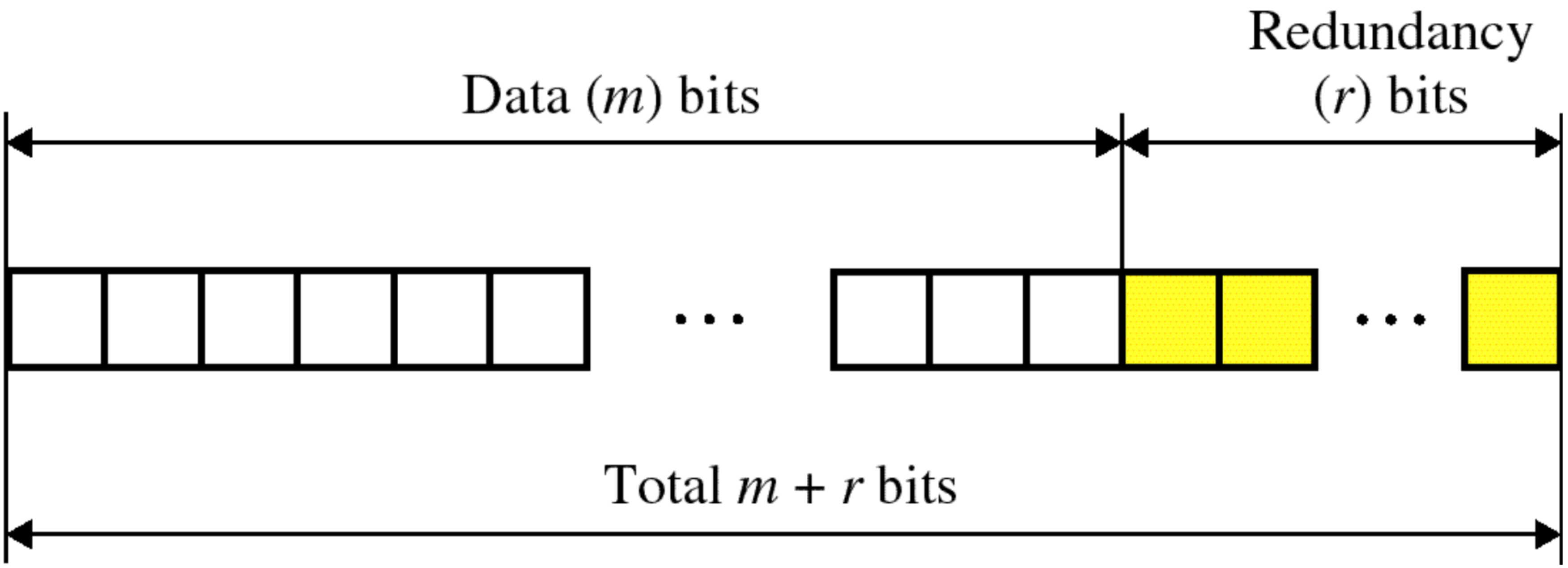
- Let data bits = *m*
- Redundancy bits = *r*

$\therefore$ Total message sent = $m+r$

The value of r must satisfy the following relation:

$$2^r \geq m+r+1$$

Error Correction



POLL 3

- Is Hamming code

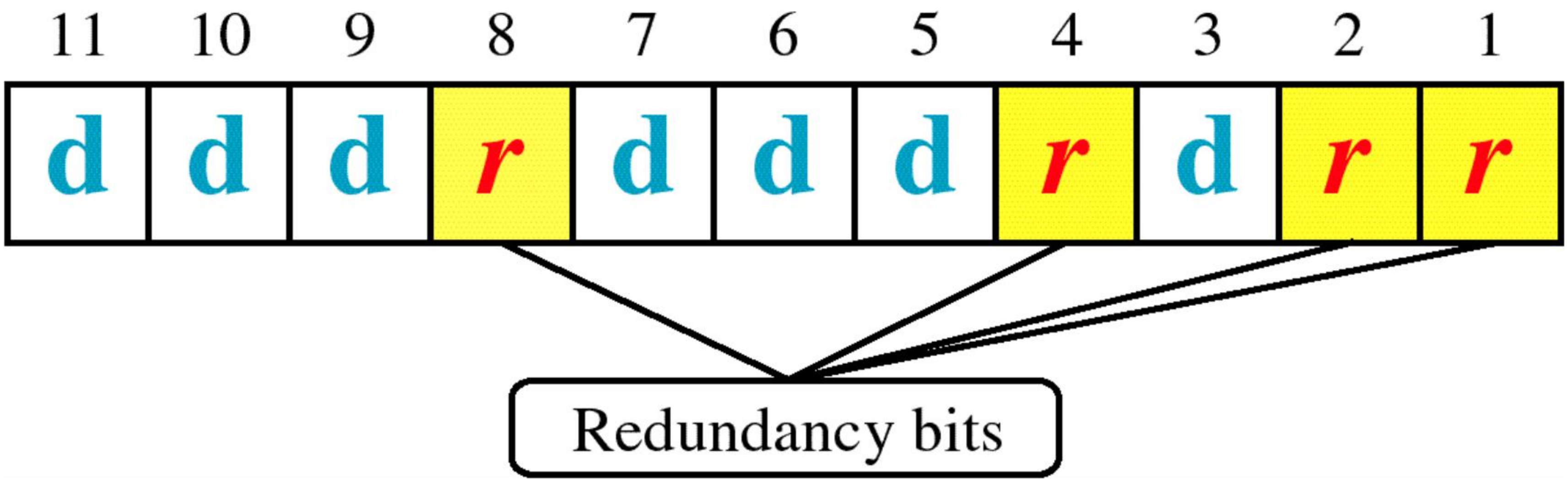
a) Error detection Only

b) Error Correction Only

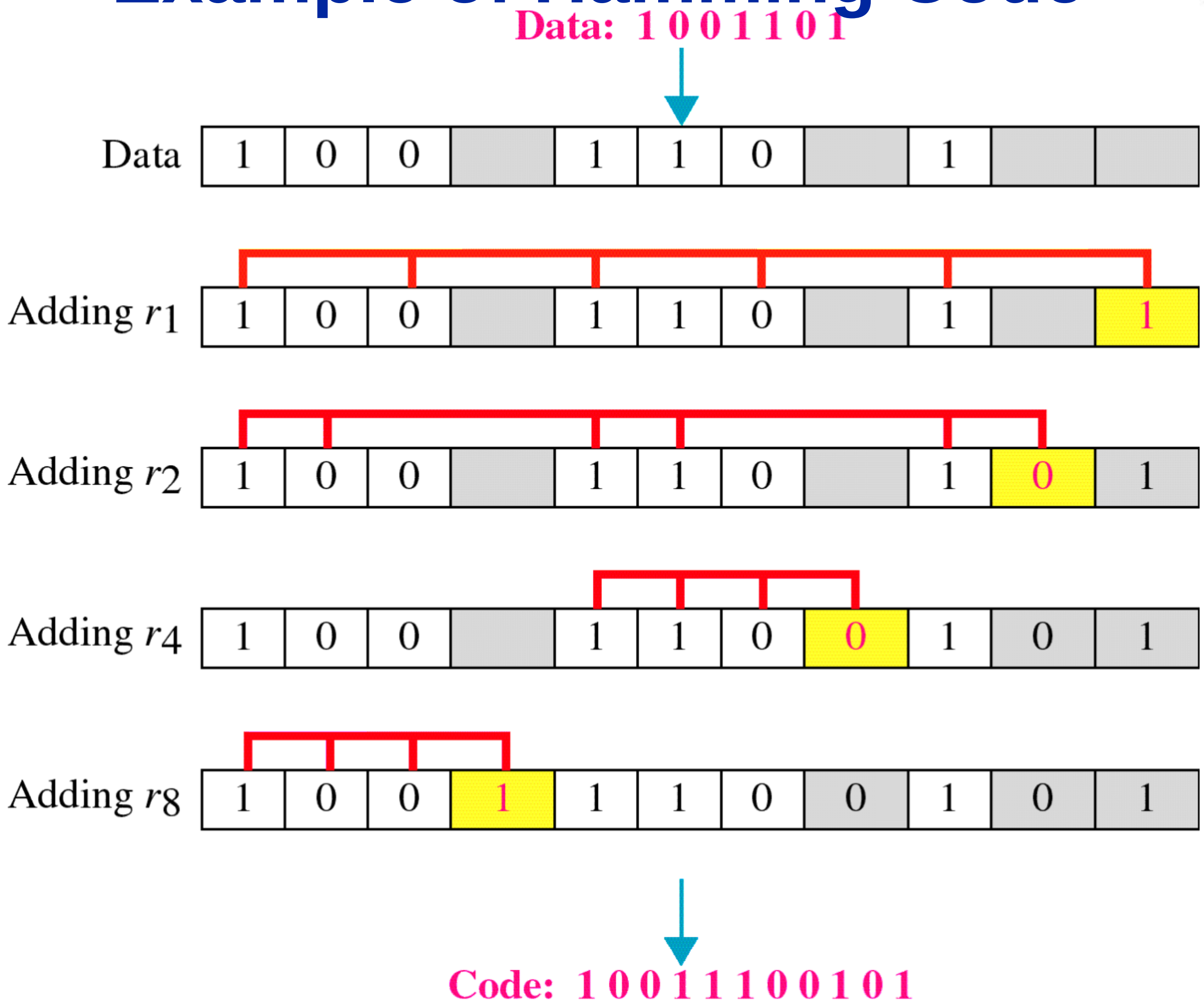
c) Both A and B

d) None of the above

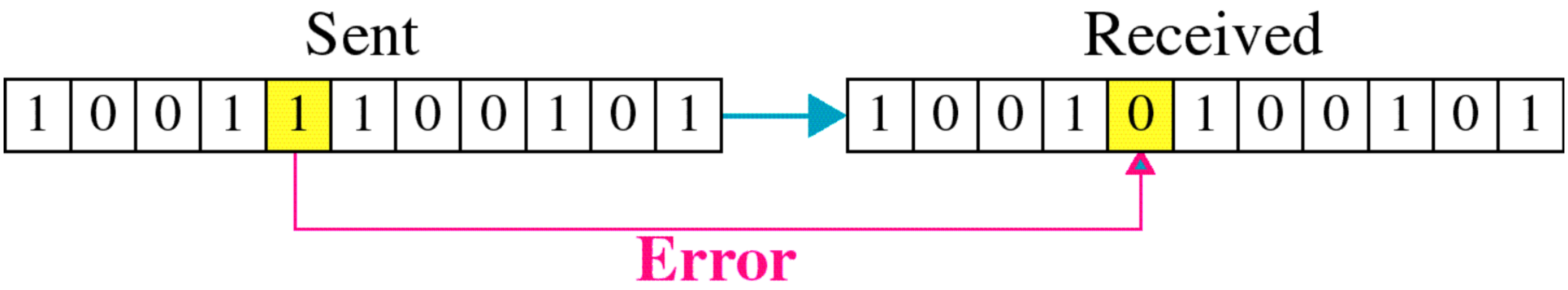
Hamming Code



Example of Hamming Code



Single-bit error



Error Detection