Error Detection and Correction
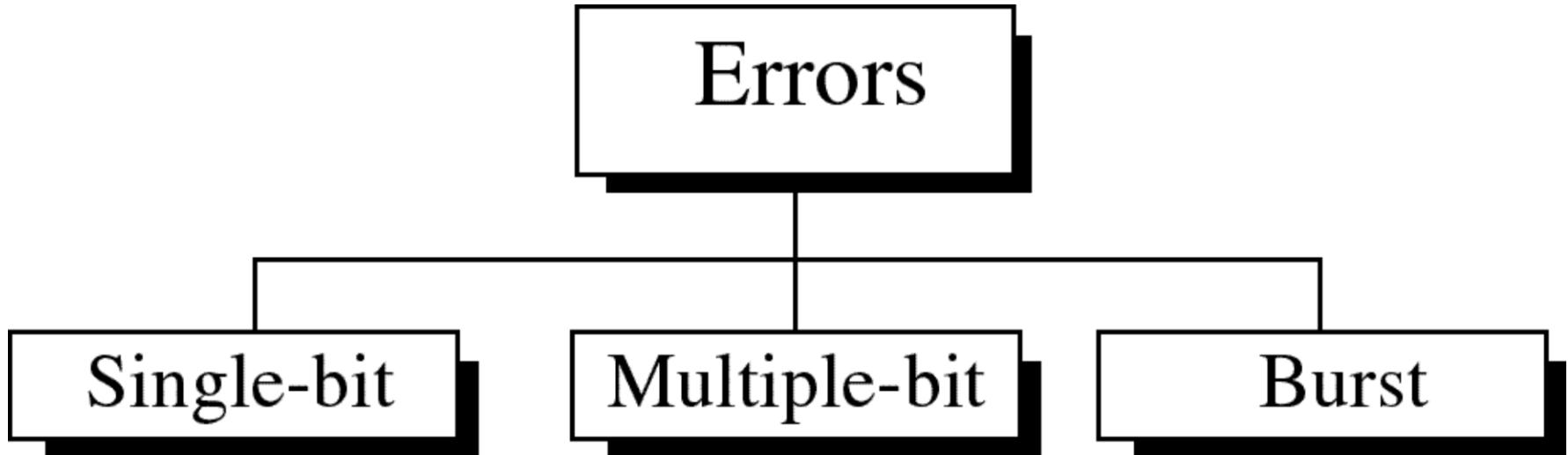
By

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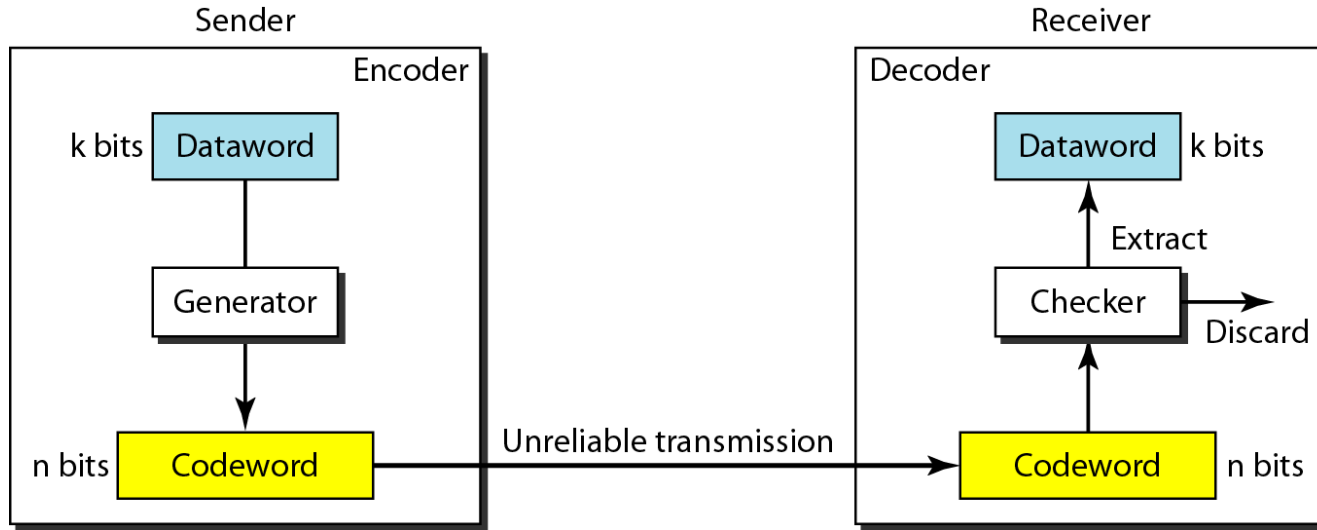
Department of Computer Science

Government Arts and Science College, Avinashi - 641654
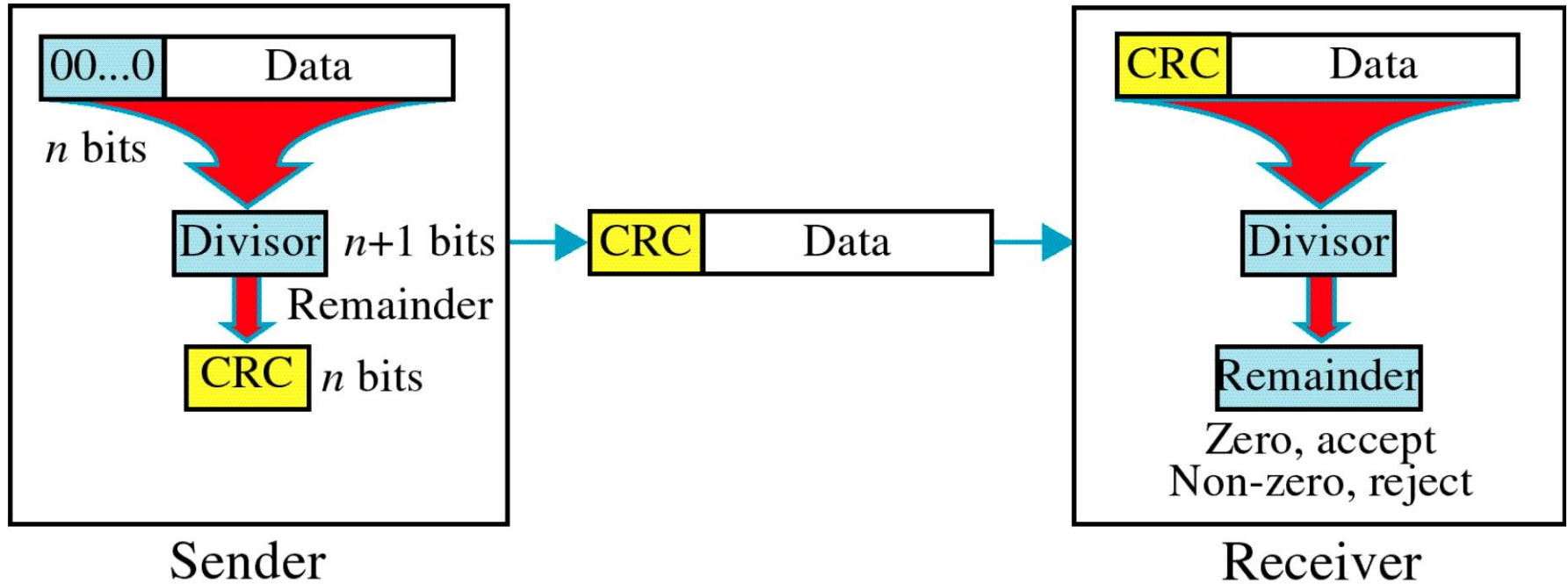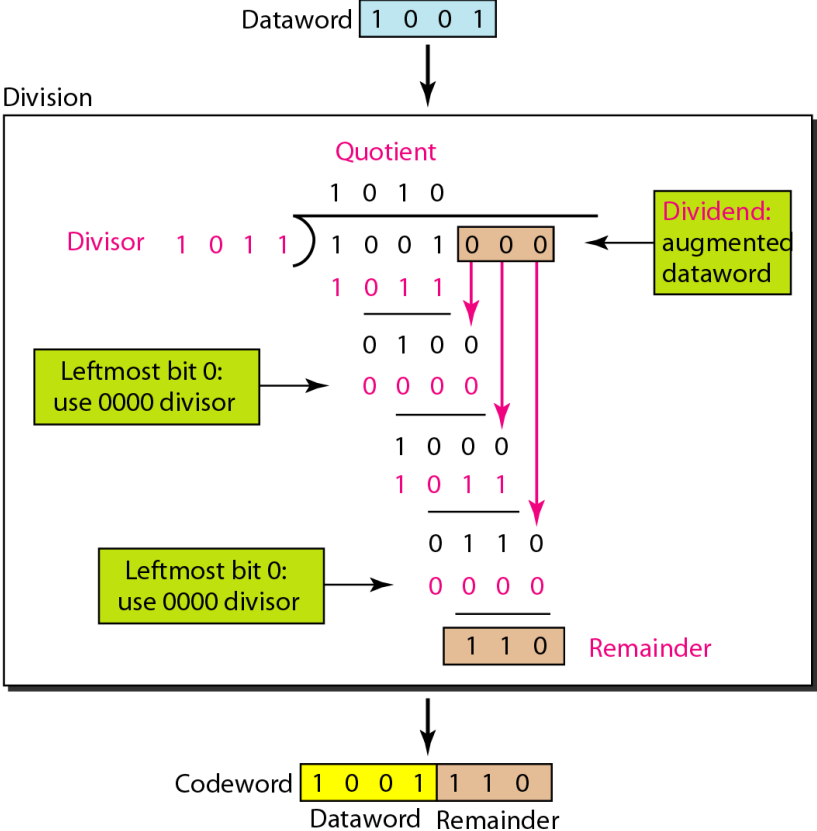
Types of Errors

Error Detection

✓ To detect or correct errors, we need to send extra (redundant) bits with data
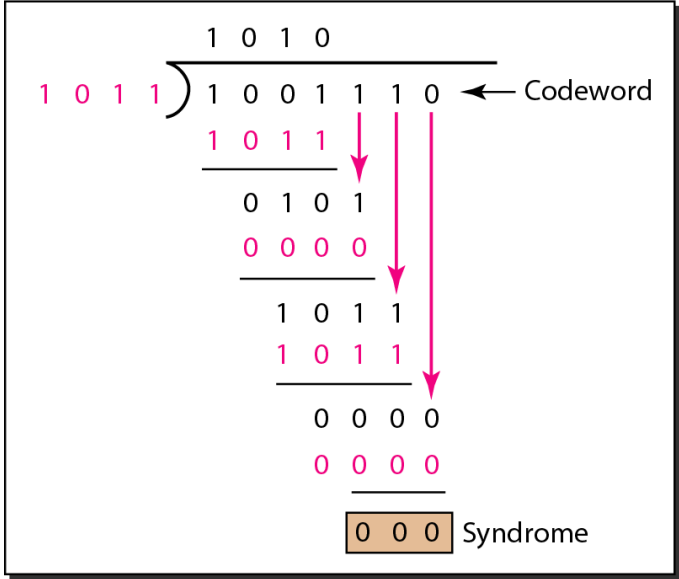
Error Detection - CRC

Sender

Receiver

CRC Error Detection

CRC Error Detection
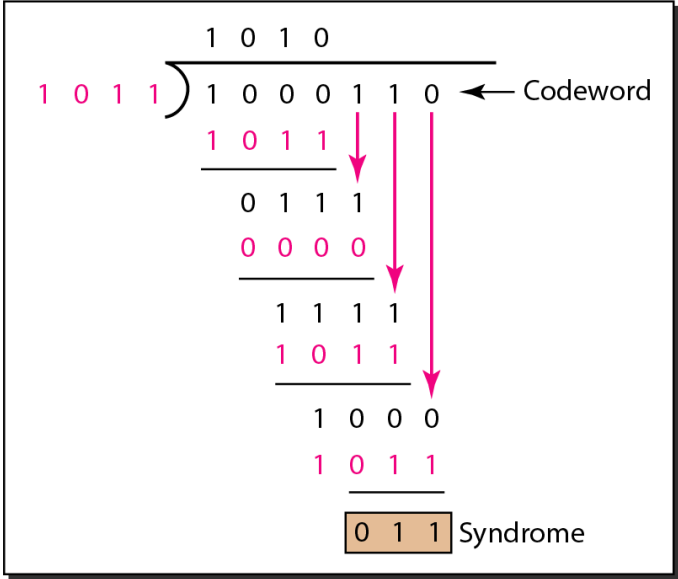
CRC Encoder/Decoder
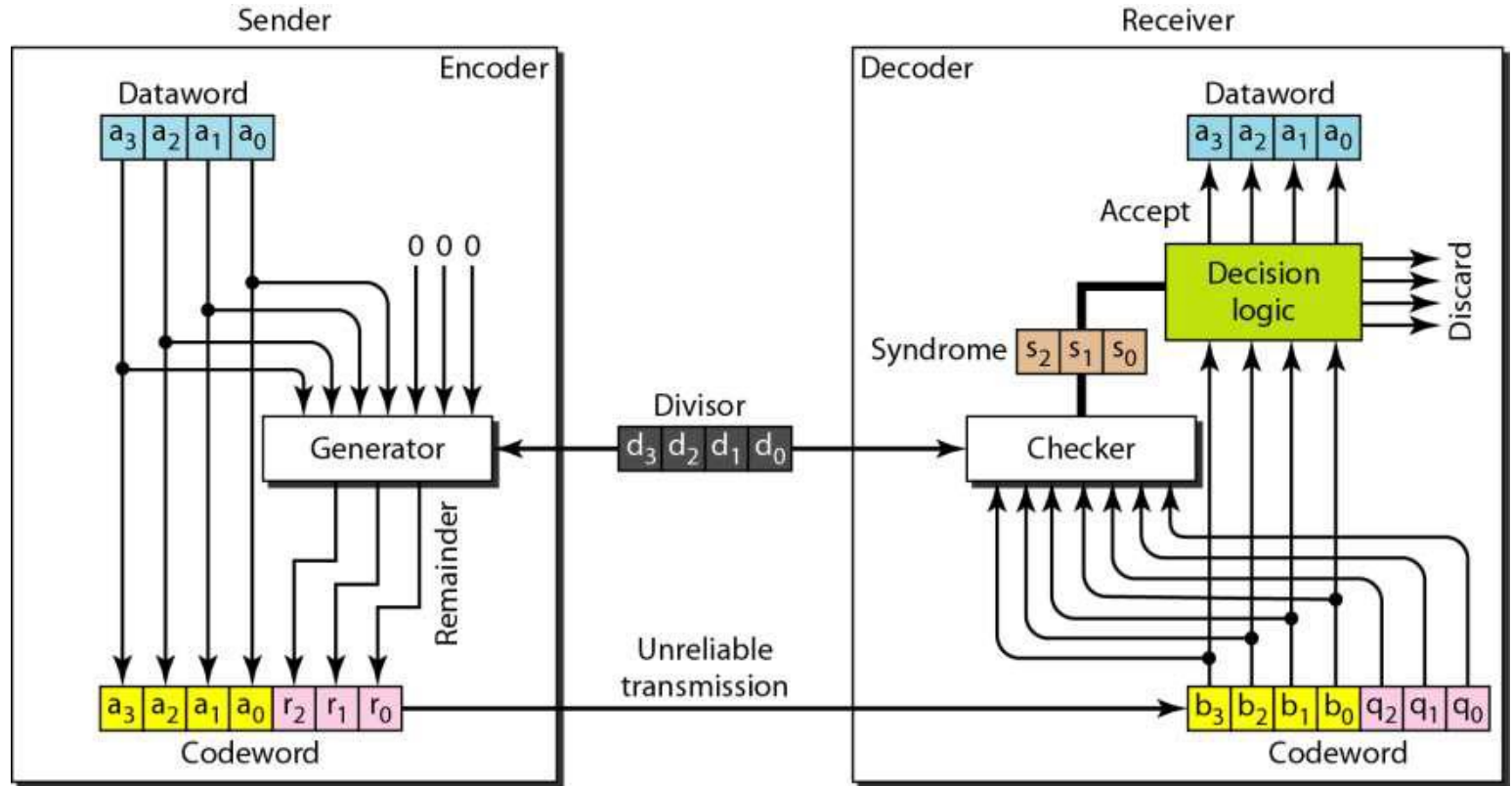
CRC Error Detection – Polynomial and Divisor

- ✓ The divisor is represented as algebraic polynomial
- ✓ Polynomial formatting is useful for the following two reasons
  - ✓ It is short
  - ✓ It can be used to prove the concept mathematically
- ✓ Polynomial selection
  - ✓ Polynomial should not be divisible by x
    - ✓ Guaranties that all burst errors affecting odd no of bits are detected
  - ✓ Polynomial should be divisible by (x+1)
    - ✓ Guaranties that all burst errors of length equal to Degree(polynomial) are detected

Polynomial

$$x^7 + x^5 + x^2 + x + 1$$

$$x^6 \quad x^4 \quad x^3$$

$$1 \quad 0 \quad 1 \quad 0 \quad 0 \quad 1 \quad 1 \quad 1$$
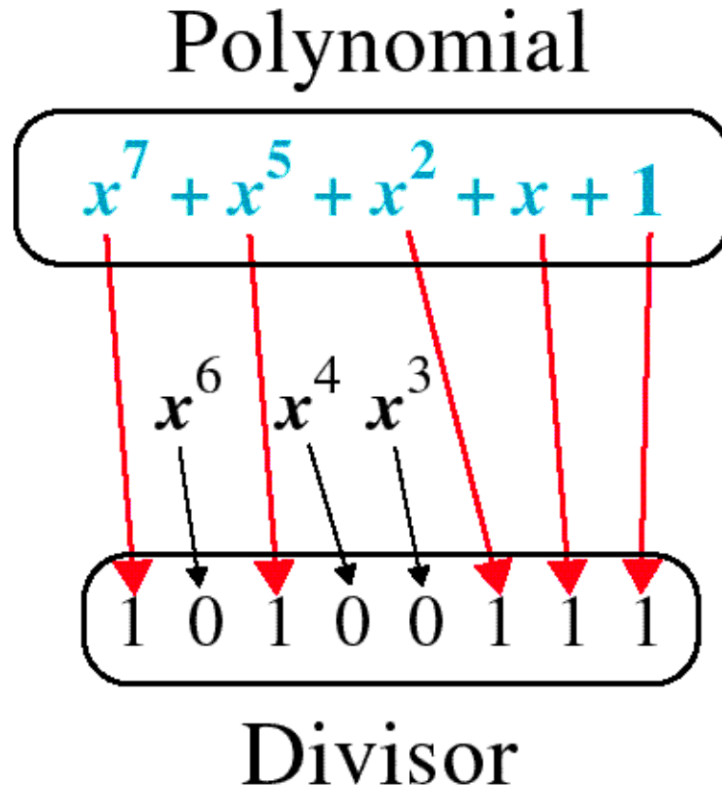
Divisor

CRC Error Detection – Polynomial and Divisor

Example:

- ✓ We can not choose x (binary 10) or $x^2 + x$ (binary 110) as polynomials

- ✓ We can choose x + 1 (binary 11) as polynomial
  Because it is not divisible by x but it is divisible by x + 1

- ✓ We can choose $x^2 + 1$ (binary 101) as polynomial
  Because it is divisible by x + 1

CRC Error Detection – Performance

If the divisor is chosen according to the rules

✓ CRC can detect all burst errors that affect an odd no of bits

✓ CRC can detect all burst errors of length <= the Degree (Polynomial)

✓ CRC can detect very high probability burst errors of length > the Degree (Polynomial)

CRC Error Detection – Standard Polynomials

CRC-12

$$x^{12} + x^{11} + x^3 + x + 1$$

CRC-16

$$x^{16} + x^{15} + x^2 + 1$$

CRC-ITU

$$x^{16} + x^{12} + x^5 + 1$$

CRC-32

$$x^{32} + x^{26} + x^{23} + x^{22} + x^{16} + x^{12} + x^{11} + x^{10} + x^8 + x^7 + x^5 + x^4 + x^2 + x + 1$$

CRC Error Detection

Name	Polynomial	Application
CRC-8	$x^8 + x^2 + x + 1$	ATM header
CRC-10	$x^{10} + x^9 + x^5 + x^4 + x^2 + 1$	ATM AAL
CRC-16	$x^{16} + x^{12} + x^5 + 1$	HDLC
CRC-32	$x^{32} + x^{26} + x^{23} + x^{22} + x^{16} + x^{12} + x^{11} + x^{10} + x^8 + x^7 + x^5 + x^4 + x^2 + x + 1$	LANs

References

- ✓ Book: Data communication and Networking
  Fourth edition
  By : BEHROUZ A FOROUZAN

- ✓ various relevant websites

Thank You