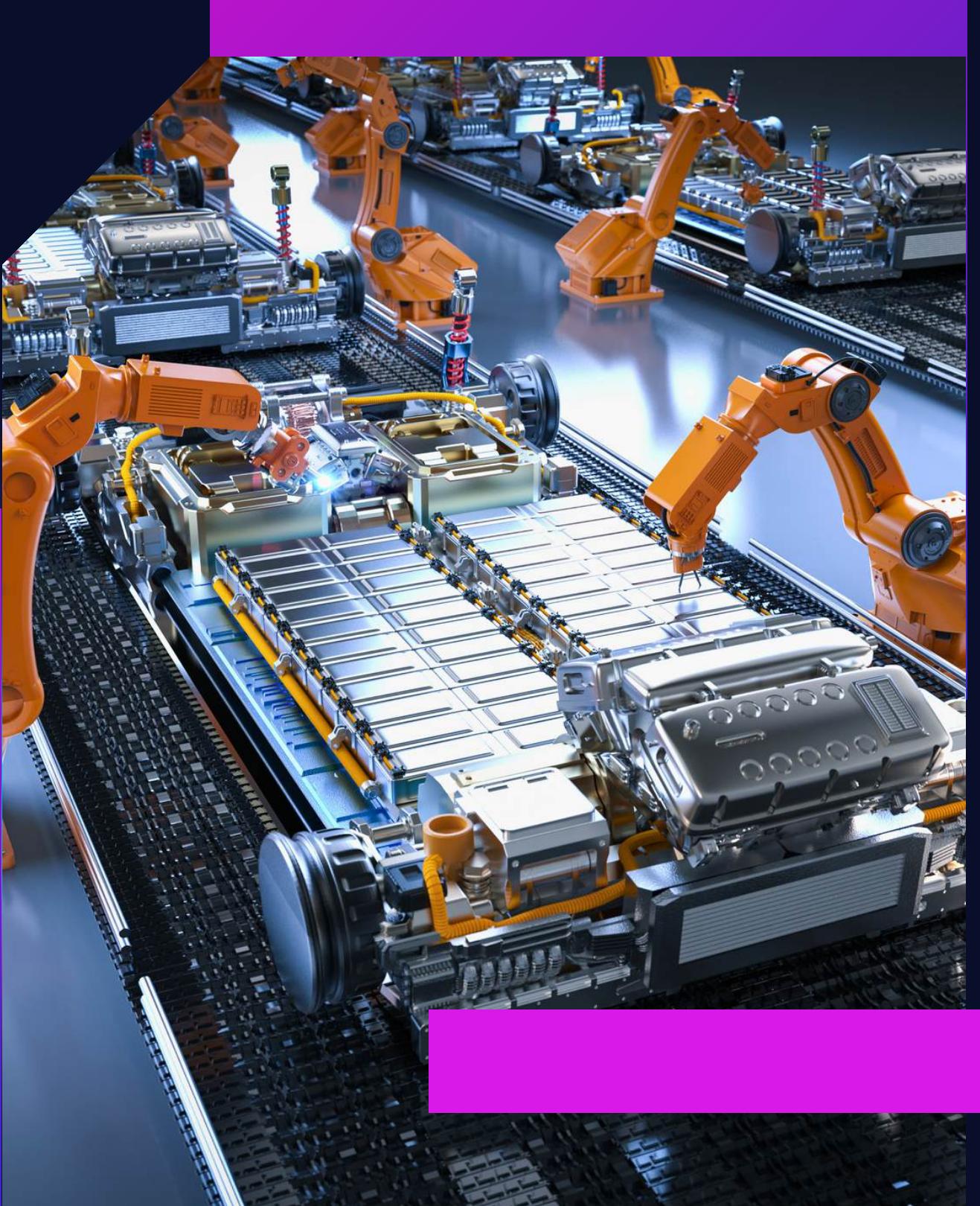




Group 1



The application of error correction codes in wireless communication



Presenter's: Pham Nguyen Cao Trieu

Presenter's: Truong Quang Hung

Date: 27 November, 2024



ECCs in Wireless Communication

Ensure reliable data transmission by detecting and correcting errors through techniques like:

Reed Solomon

22207123

Phạm Nguyên Cao Triều

22207113

Trương Quang Hưng

22207121

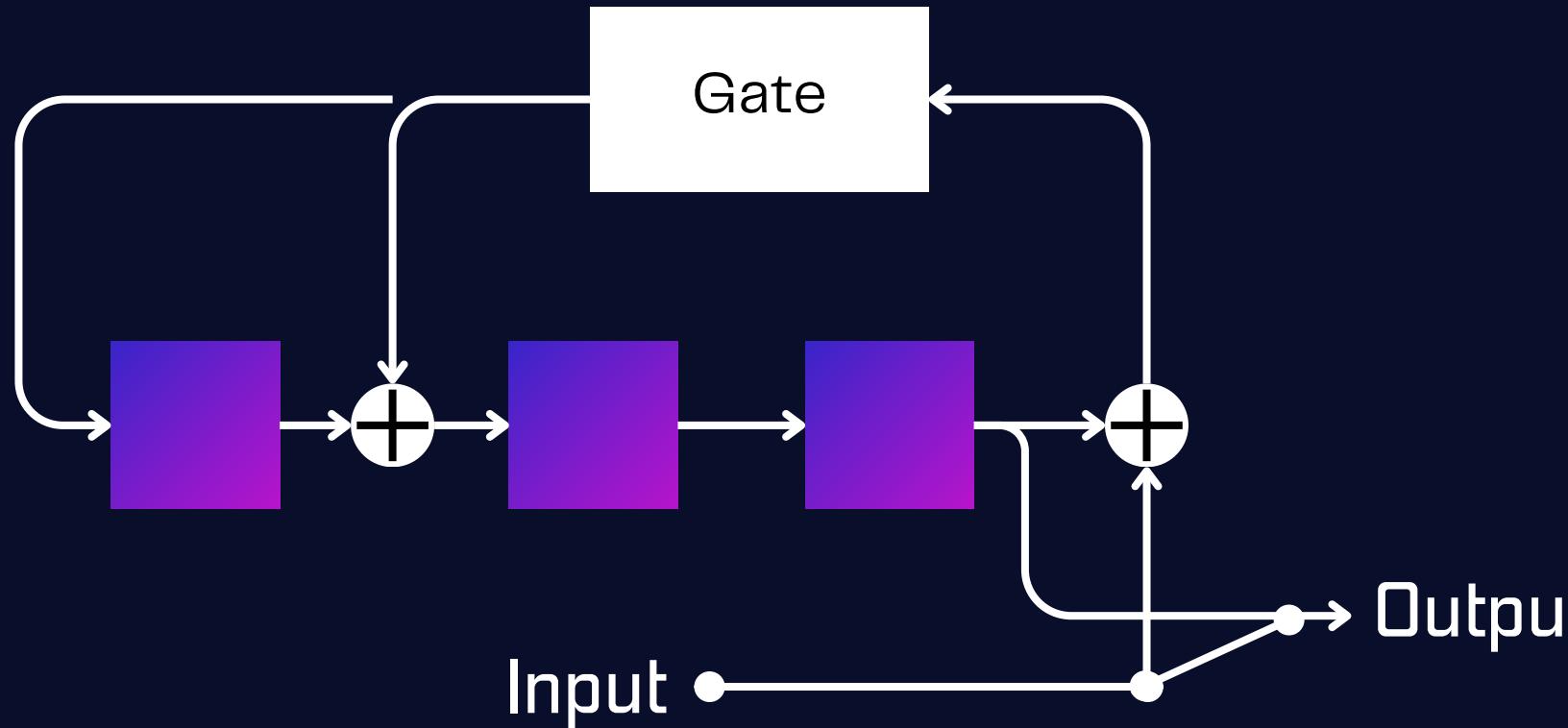
Nguyễn Anh Thiện

22207094

Huỳnh Phạm Minh Tú

Techniques used in digital communication systems to detect and correct errors during data transmission, ensuring accurate data transfer without requiring retransmission.

Cyclic block codes



SYSTEMATIC ENCODING ALGORITHM

01. Multiply the message polynomial $m(X)$ by X
02. Divide the result of step 1 by the generator polynomial $g(X)$. Let $p(X)$ be the remainder
03. Add $p(X)$ to $X \cdot m(X)$ to form the code word $U(X)$

1. Find the codeword for the message $\mathbf{m} = (1011)$.

$$n = 7, \quad k = 4, \quad n - k = 3$$

$$\mathbf{m} = (1011) \Rightarrow \mathbf{m}(X) = 1 + X^2 + X^3$$

$$\rightarrow X^{n-k} \mathbf{m}(X) = X^3 \mathbf{m}(X) = X^3(1 + X^2 + X^3) = X^3 + X^5 + X^6.$$

\rightarrow Divide $X^{n-k} \mathbf{m}(X)$ by $\mathbf{g}(X)$:

$$X^3 + X^5 + X^6 = \underbrace{(1 + X + X^2 + X^3)}_{\text{quotient } \mathbf{q}(X)} \underbrace{(1 + X + X^3)}_{\text{generator } \mathbf{g}(X)} + \underbrace{1}_{\text{remainder } \mathbf{p}(X)}$$

\rightarrow Form the codeword polynomial:

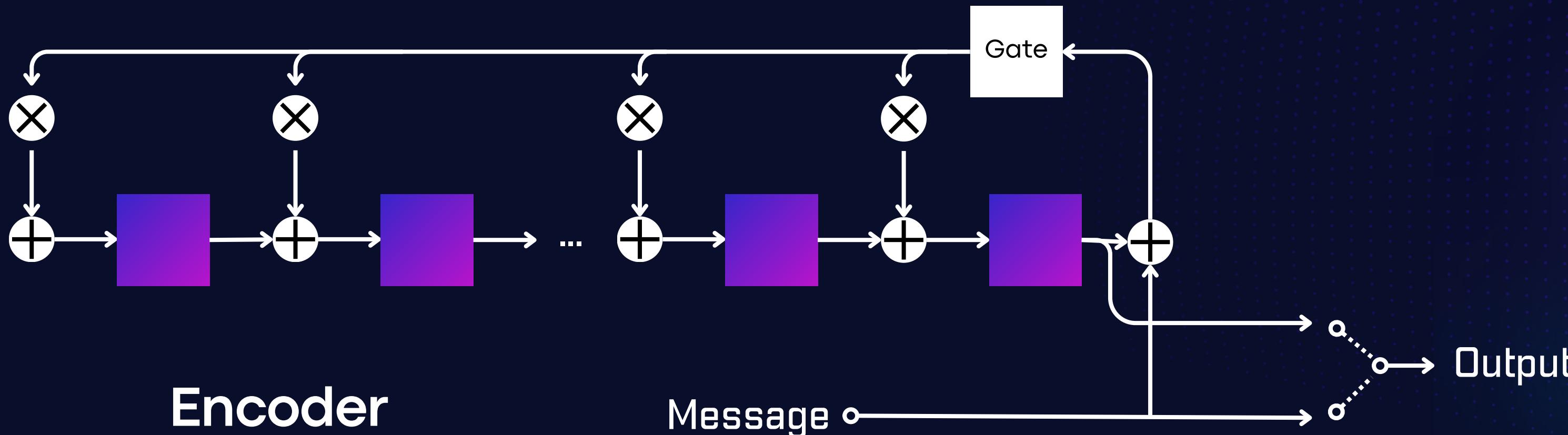
$$\mathbf{U}(X) = \mathbf{p}(X) + X^3 \mathbf{m}(X) = 1 + X^3 + X^5 + X^6$$

$$\mathbf{U} = (\underbrace{1 \ 0 \ 0}_{\text{parity bits}} \ \underbrace{1 \ 0 \ 1 \ 1}_{\text{message bits}})$$

Reed Solomon

01. Turn on the gate to shift the message
02. Turn off the gate to break the connection
03. Shift the parity check digits out and send

SYSTEMATIC ENCODING ALGORITHM



Let the input message be : $m = (m_0, m_1, m_2, \dots, m_{k-1})$ (as we know $n-k=2t$)

Then $m(X) = m_0 + m_1X + m_2X^2 + \dots + m_{k-1}X^{k-1}$

If we multiply $m(X)$ by X^{2t} , we can get as following:

$$X^{2t}m(X) = m_0X^{2t} + m_1X^{2t+1} + m_2X^{2t+2} + \dots + m_{k-1}X^{n-1}$$

In order to find the parity check digits, the polynomial $X^{2t}m(X)$ is divided by $g(X)$ to obtain the remainder $b(X)$ as follows:

$$X^{2t}m(X) = a(X)g(X) + b(X)$$

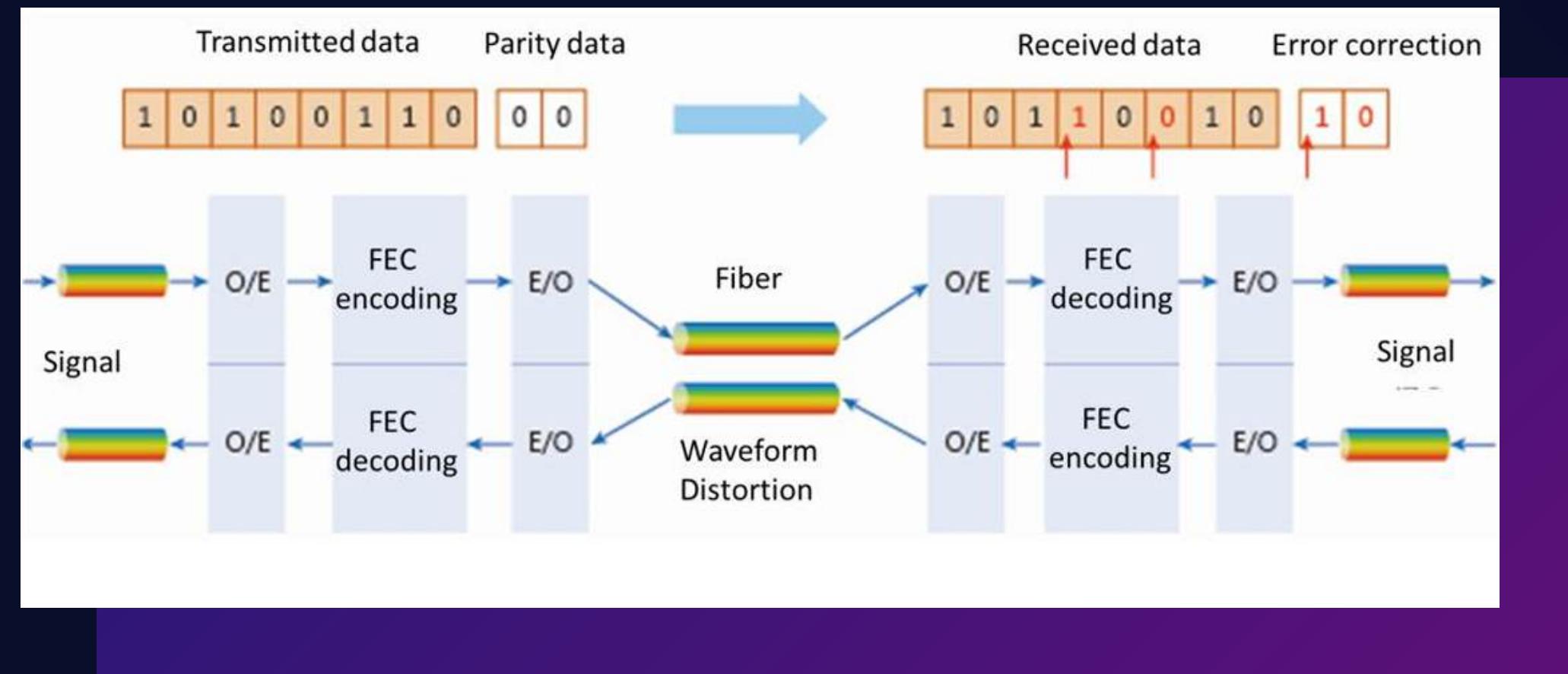
In the equation, $a(x)$ is the quotient, and $b(X)$ is the remainder of the division.

Therefore the remainder $b(X)$ can be written as: $b(X) = X^{2t}m(X) \bmod g(X)$

Then the resulting codeword polynomial $U(X) = b(X) + X^{n-k} m(X)$

Reed Solomon

- Characteristic -



Based on Galois Field algebra to
process large data blocks

STRUCTURE

Encoding by adding redundant
bits to the original data

PRINCIPLE



SCAN QR



Presenter's: TRƯỜNG QUANG HƯNG

SCAN QR



Presenter's: TRƯỜNG QUANG HƯNG

CODE

```
import os  
os.system('pip install qrcode[pil]')  
os.system('pip install pillow')  
os.system('pip install pyzbar')  
from PIL import Image  
from pyzbar.pyzbar import decode
```

```
def read_qr_code(filename):  
    try:  
        img = Image.open(filename)  
        result = decode(img)  
  
        if result:  
            for obj in result:  
                print("Dữ liệu giải mã:", obj.data.decode("utf-8"))  
        else:  
            print("Không thể giải mã QR code.")  
    except Exception as e:  
        print(f'Lỗi khi đọc QR code: {e}')
```



Cài đặt thư viện quét và sửa lỗi QR



1. Quét QR code từ file ảnh

CODE

```
def damage_qr_code_with_color(filename="hinh_goc.jpg", damaged_filename="hinh_loi.png"):
    try:
        img = Image.open(filename).convert("RGB") # Chuyển sang chế độ RGB để hỗ trợ màu
        pixels = img.load()

        width, height = img.size
        box_size = 125
        start_x = width // 5 - box_size // 2
        start_y = height // 2 - box_size // 2
        end_x = start_x + box_size
        end_y = start_y + box_size

        for x in range(start_x, end_x):
            for y in range(start_y, end_y):
                pixels[x, y] = (255, 255, 255) # Lỗi màu trắng
        img.save(damaged_filename)
        print(f"QR code bị lỗi với màu được lưu tại: {damaged_filename}")

    except Exception as e:
        print(f"Lỗi khi làm hỏng QR code: {e}")
```



2. Làm hỏng QR code



Chỉnh phần QR lỗi



Làm hỏng vùng chính giữa bảng
cách đổi pixel thành màu trắng

CODE

```
if __name__ == "__main__":
    original_file = "hinh_goc.jpg" # Ảnh gốc
    damaged_file = "hinh_loi.png" # Ảnh lỗi

    # Quét QR code gốc
    print("\nĐọc QR code gốc:")
    read_qr_code(original_file)

    # Làm hỏng QR code
    print("\nĐang làm hỏng QR code...")
    damage_qr_code_with_color(original_file, damaged_file)

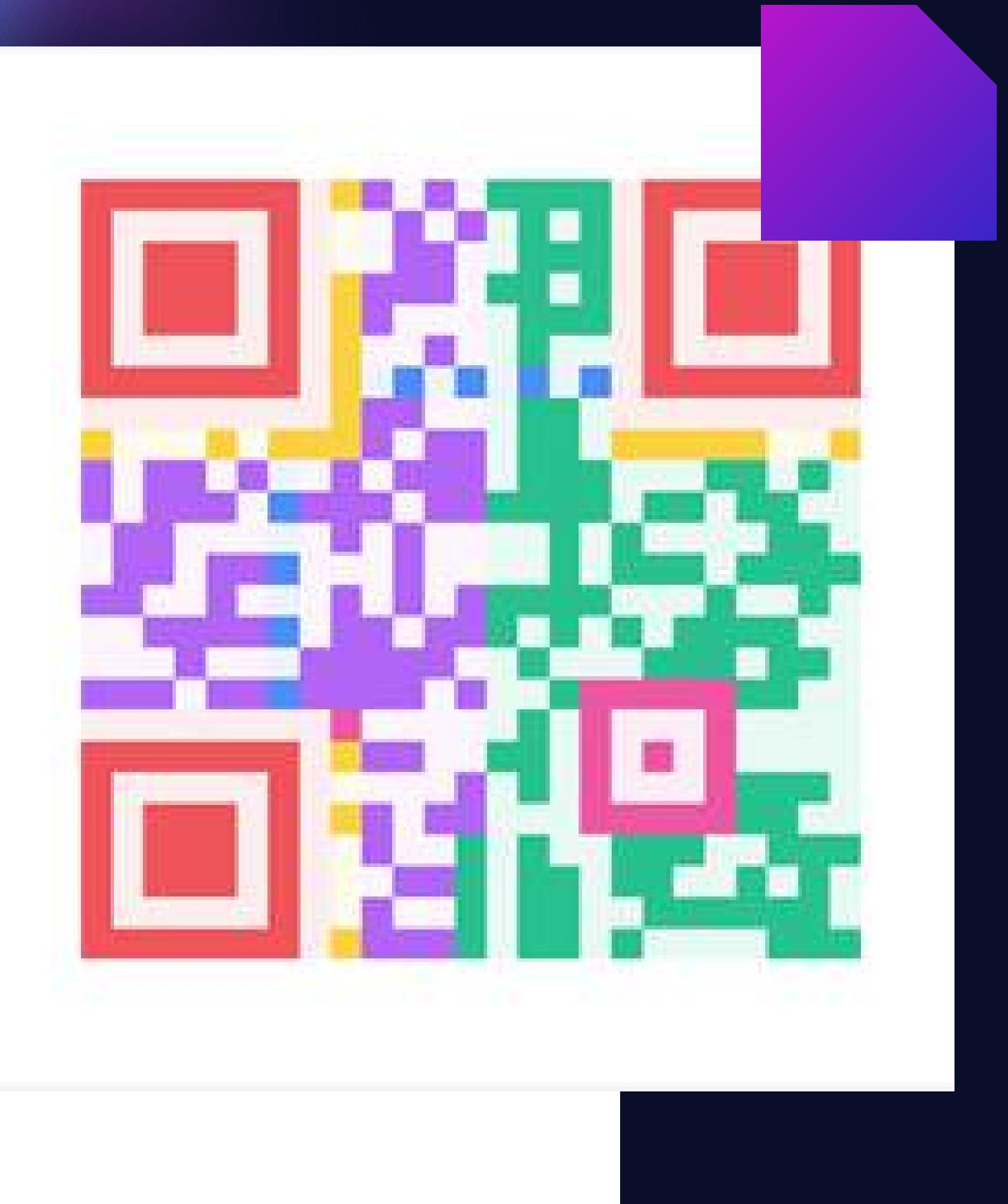
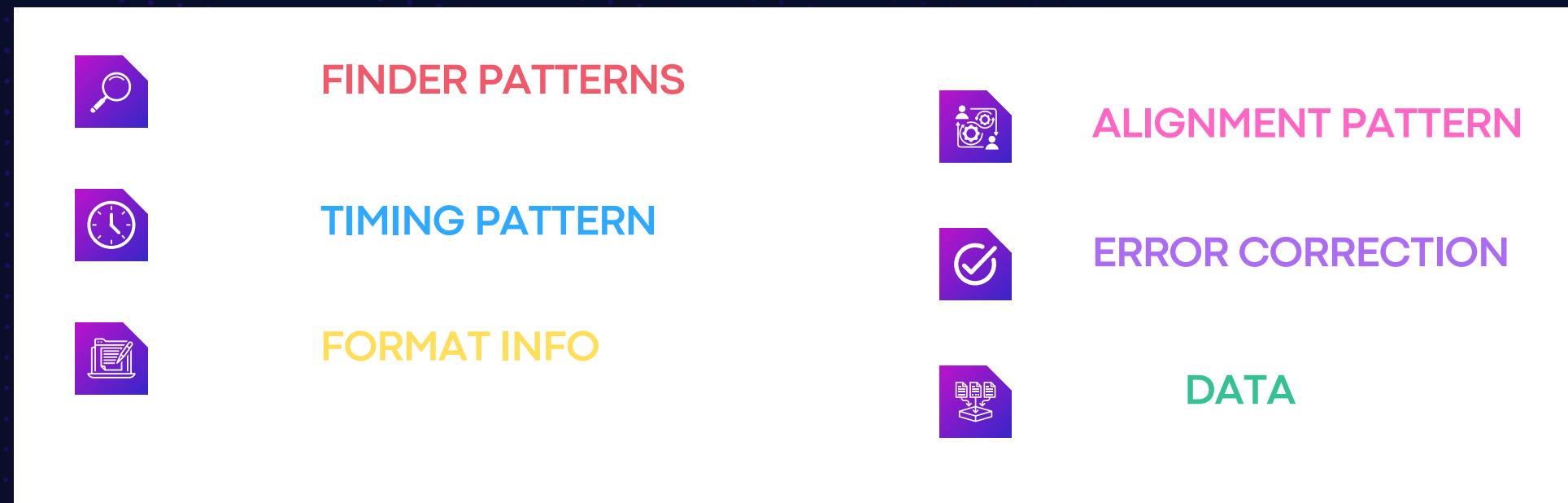
    # Quét QR code bị lỗi
    print("\nĐọc QR code bị lỗi:")
    read_qr_code(damaged_file)
```



3. Chương trình chính

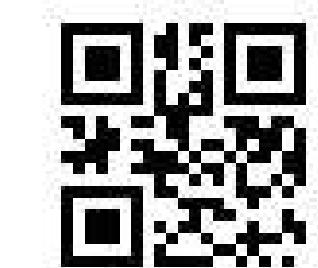
THE STRUCTURE OF A QR CODE

A two-dimensional barcode with a specific design that can store a large amount of information in a small space

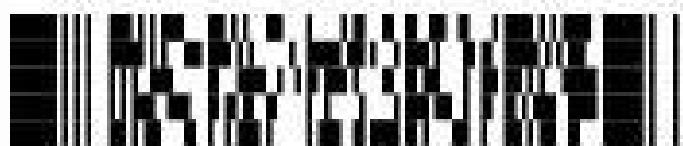


THE STRUCTURE OF A QR CODE

All types of barcodes
commonly use Reed-Solomon
error correction coding



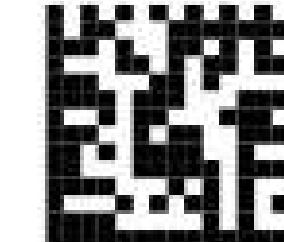
VS



QR Code

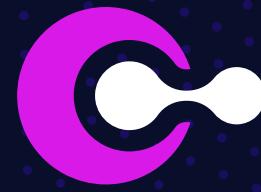
PDF417

VS



Data Matrix Code





GROUP 1



THANK
YOU!



Presenter's: Pham Nguyen Cao Trieu

Presenter's: Truong Quang Hung

Date: 27 November, 2024

