The implementation of Hamming decoder on Spartan 3
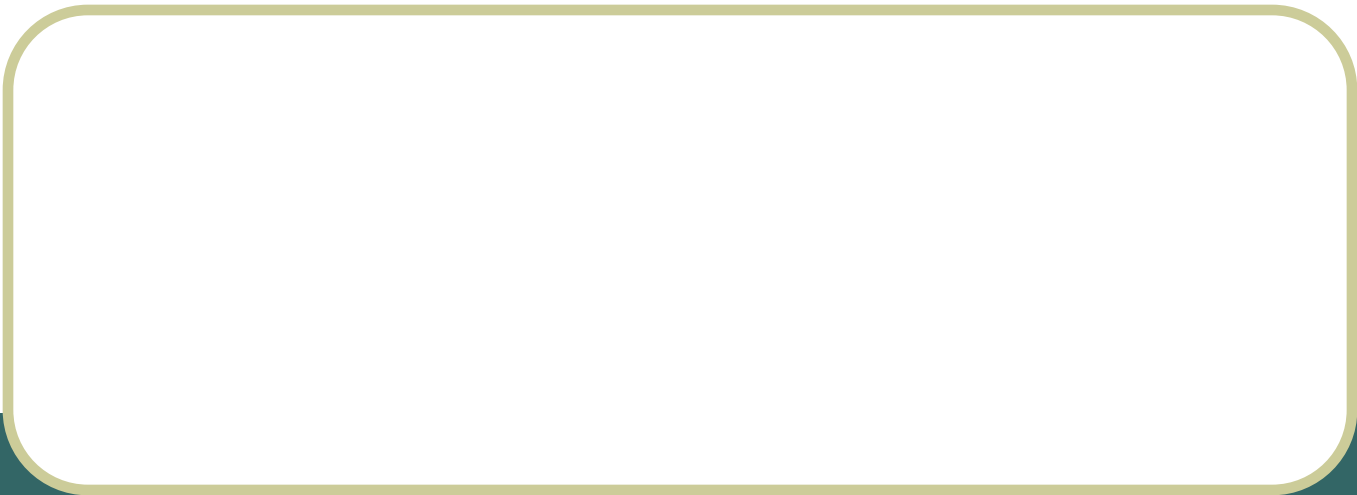
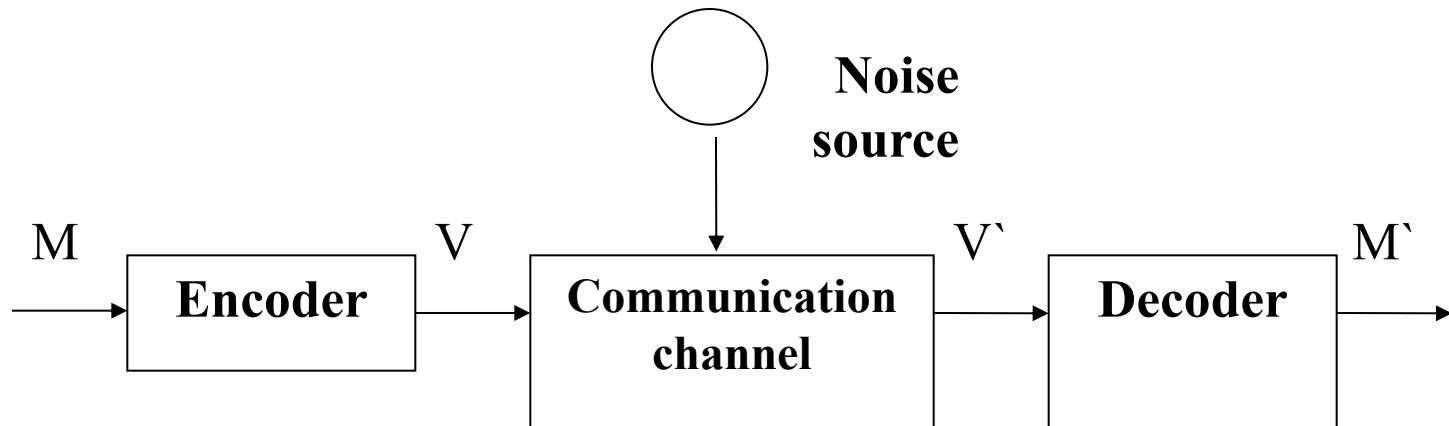# The goal of paper:

- a reliable and efficient solution for detecting and correcting errors in communication channels;

- an implementation method of Hamming decoder onto a reconfigurable platform

Linear code Hamming – basic elements

The general scheme for a transmission system

M – the message generated by the source of information
V – the codeword
V` - the codeword resulted from the output of transmission channel
M` - the message received by the user

Designing of the Hamming linear decoder (7, 4)

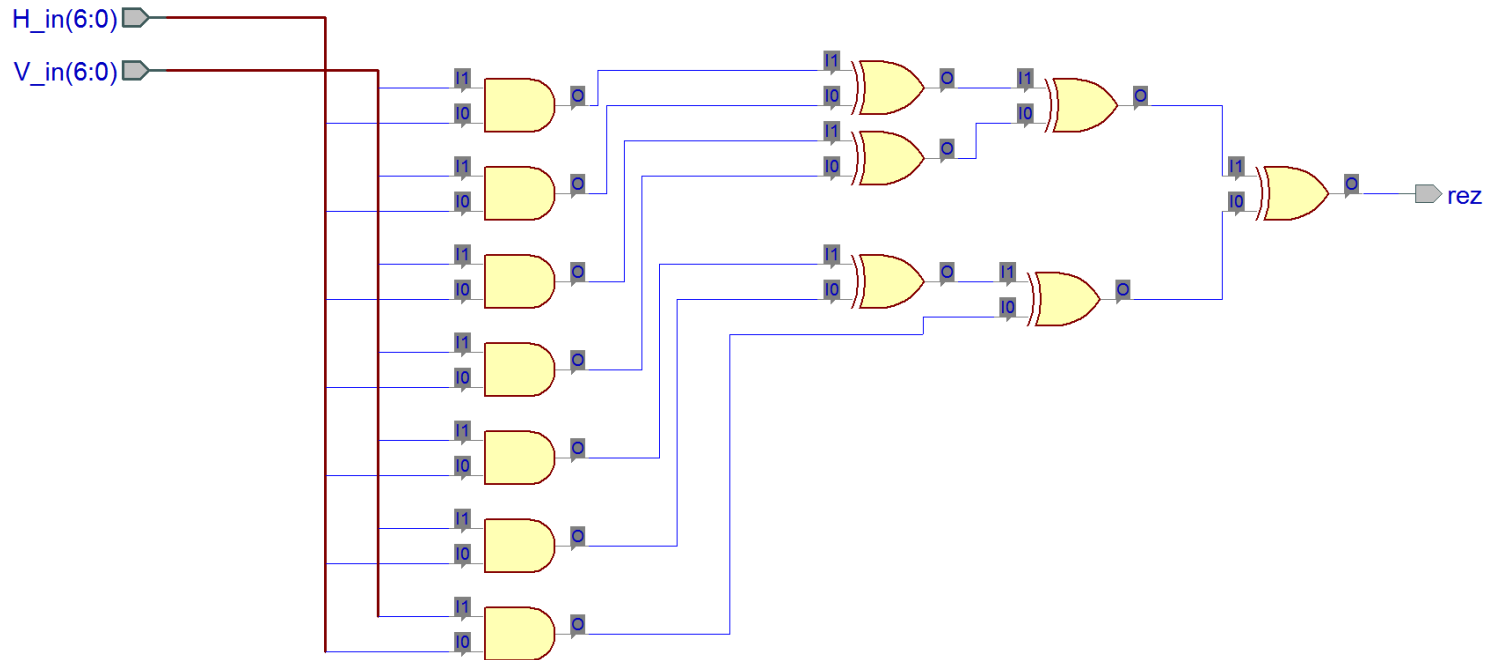➤ the message (M) is presented as a vector with length 4

➤ after the coding operation, to these information symbols 3 more control symbols are added

➤ the codeword: $V = [c_1 c_2 i_3 c_4 i_5 i_6 i_7]$

➤ the control matrix that is involved in coding process :

$$H = \begin{bmatrix} 0 & 0 & 0 & 1 & 1 & 1 & 1 \\ 0 & 1 & 1 & 0 & 0 & 1 & 1 \\ 1 & 0 & 1 & 0 & 1 & 0 & 1 \end{bmatrix}$$

Decoder structure
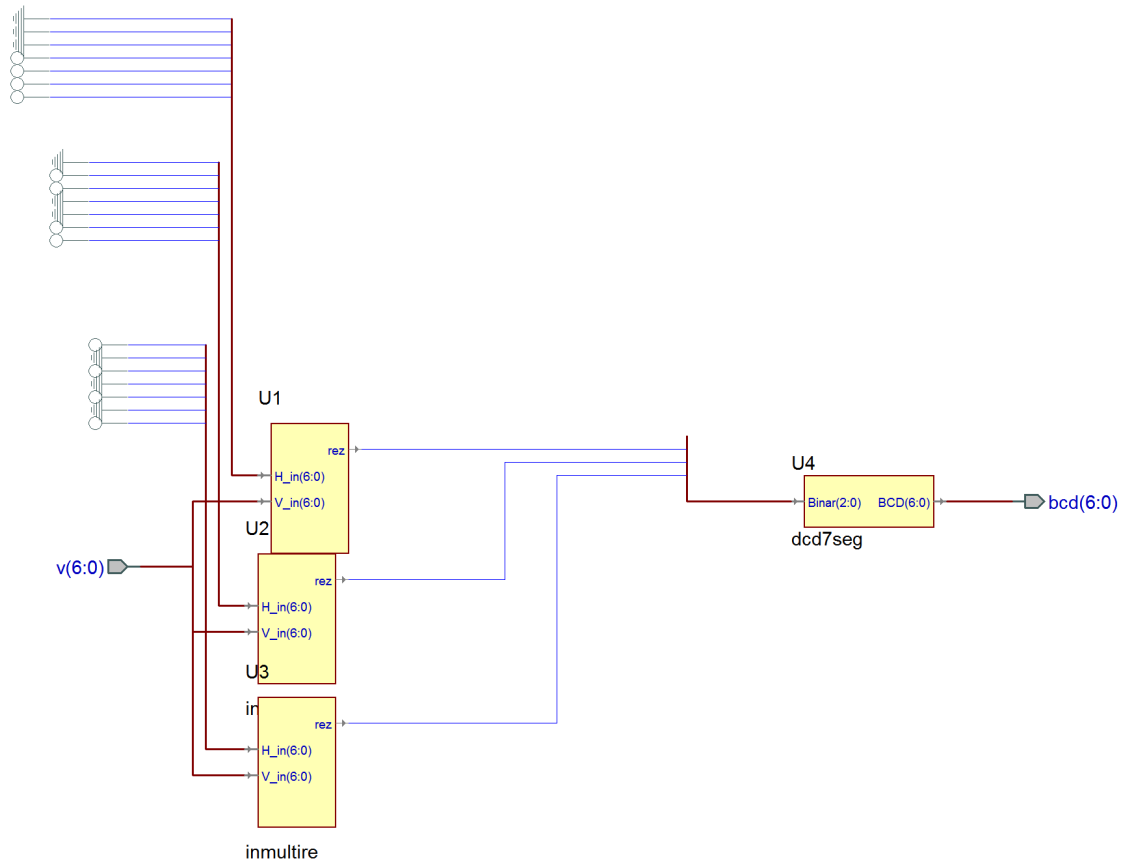
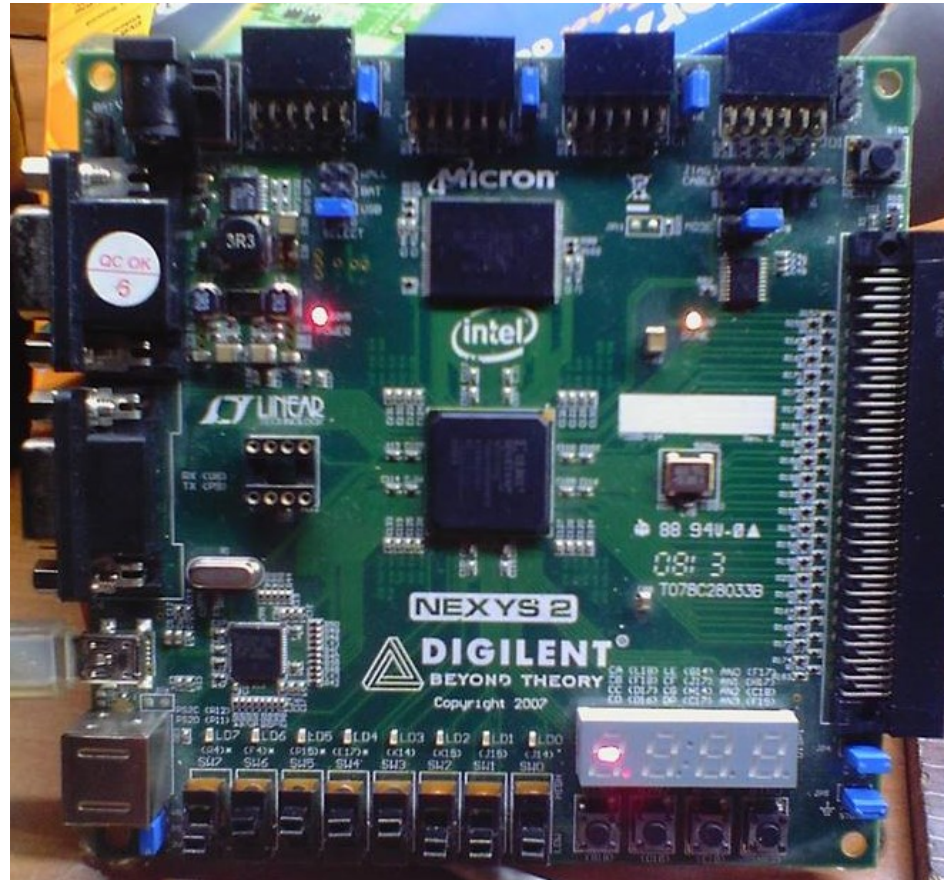# Multiplying operator implementation

The prototipe validation

•We suppose an output of transmission channel has received the following sequence: $V'=[0111100]$

• The decoder operation :

$$H \cdot (V')^T = \begin{bmatrix} 0 & 0 & 0 & 1 & 1 & 1 & 1 \\ 0 & 1 & 1 & 0 & 0 & 1 & 1 \\ 1 & 0 & 1 & 0 & 1 & 0 & 1 \end{bmatrix} \cdot \begin{bmatrix} 0 \\ 1 \\ 1 \\ 1 \\ 1 \\ 0 \\ 0 \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \\ 0 \end{bmatrix}$$

•The place of error : $p = 2^0 \cdot 0 + 2^1 \cdot 0 + 2^2 \cdot 0 = 0$

Without transmission error (WTF)

The prototipe validation

• We suppose an output of transmission channel has received the following sequence: $V' = [0111101]$
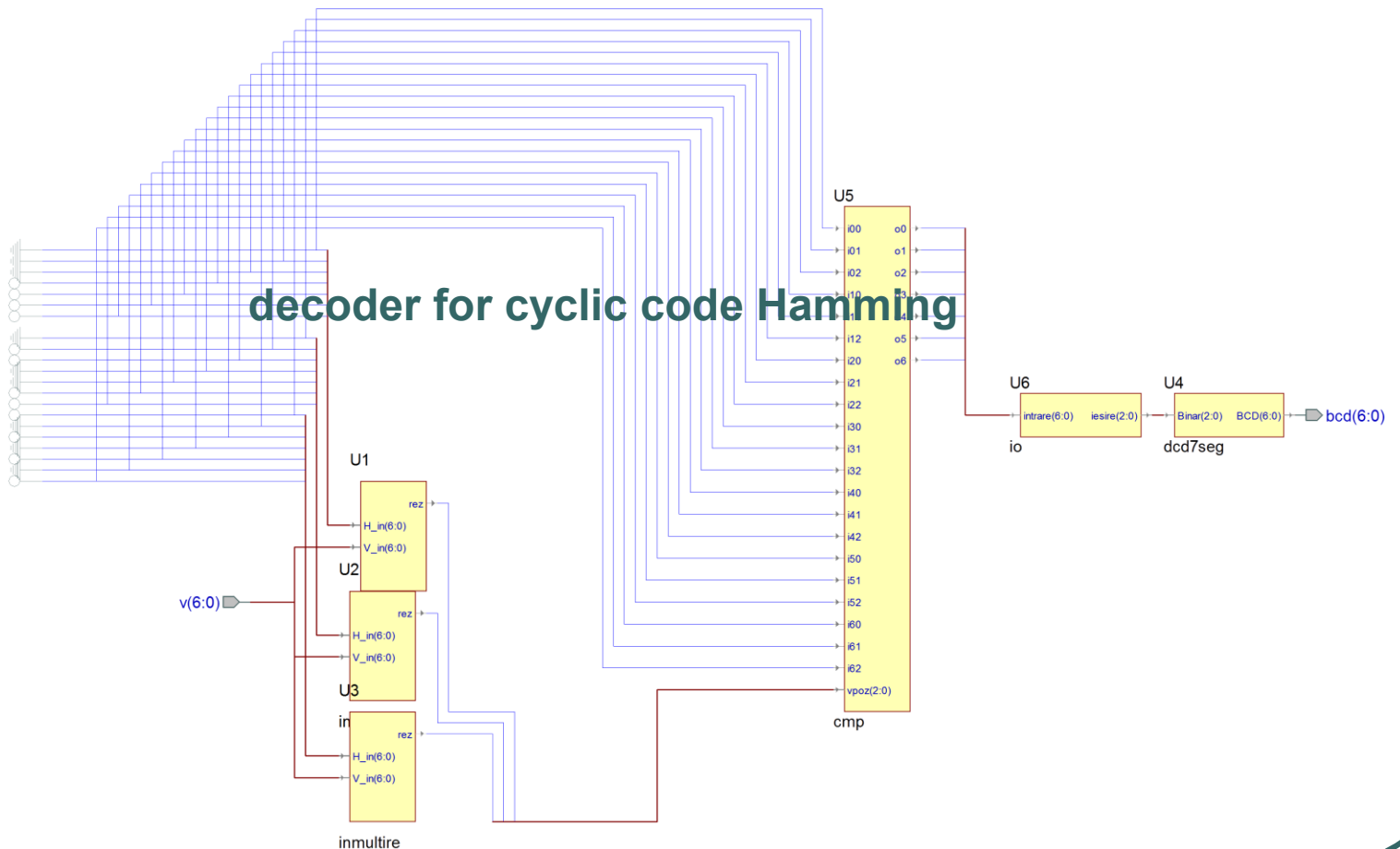
• The decoder operation :

$$H \cdot (V')^T = \begin{bmatrix} 0 & 0 & 0 & 1 & 1 & 1 & 1 \\ 0 & 1 & 1 & 0 & 0 & 1 & 1 \\ 1 & 0 & 1 & 0 & 1 & 0 & 1 \end{bmatrix} \cdot \begin{bmatrix} 0 \\ 1 \\ 1 \\ 1 \\ 1 \\ 0 \\ 1 \end{bmatrix} = \begin{bmatrix} 1 \\ 1 \\ 1 \end{bmatrix}$$

• The place of error : $p = 2^0 \cdot 1 + 2^1 \cdot 1 + 2^2 \cdot 1 = 7$

The general structure of decoder for cyclic code Hamming

decoder for cyclic code Hamming

Conclusions

- **Our solution allows the recognition of one wrong symbol from a code sequence ;**

- **We tested this platform for linear and cyclic Hamming codes and we can demonstrate that the implementation of the Nexys2 board is possible for any code used for detecting and correcting errors in communication channels ;**

- **This allows us to further develop algorithms, with higher detection and correction capacity.**