Abstract

The project here presents the essence of error free transfer of message between two nodes.To make the communication error free, Error Control and Coding (ECC) is used, which is achieved by using encoder and decoder pair(codec). Thus the work here is to concentrate on channel encoding and decoding techniques.Errors caused in the channel are because of AWGN (Additive White Gaussian Noise), multipath fading, interference and so on. So, to measure the errors BER(Bit Error Rate)is used, which is dependent on SNR(Signal to Noise Ratio). In first phase of the project channel coding techniques are tested for their performance with respect to BER, by simulinting their models in Simulink and BERTool. And in next phase channel coding techniques are simulated in Xilinx and ModelSim, by preparing the verilog codes nad these codes are made to run on FPGA.

Introduction

Communication

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- Transfer of Data in a medium

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Communication

- Transfer of Data in a medium
- Transmission Channel

Introduction

Communication

- Transfer of Data in a medium
- Transmission Channel
- Data Corruption

Introduction

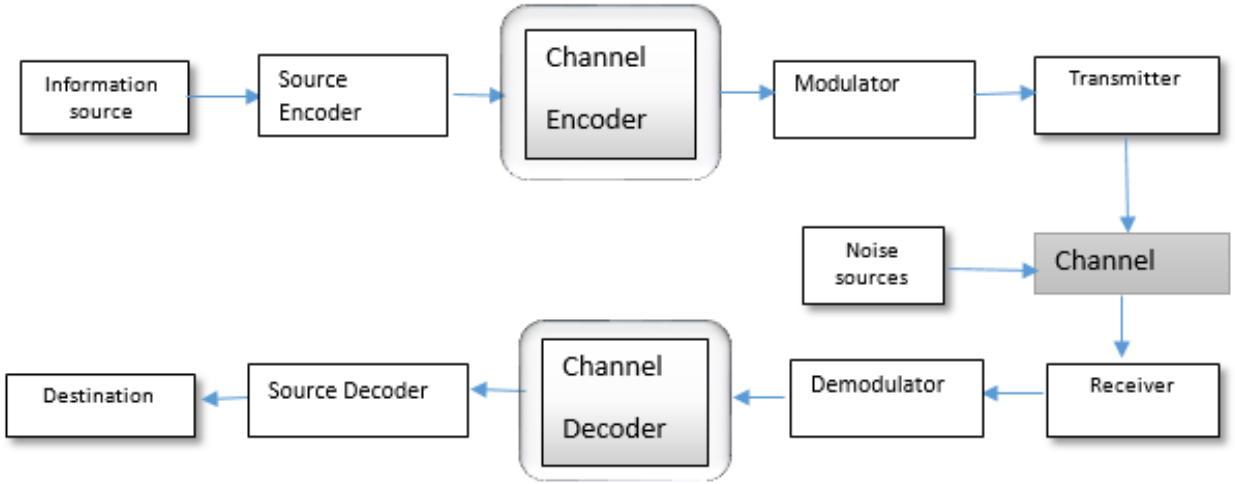

Figure: Block Diagram of Communication System

Introduction

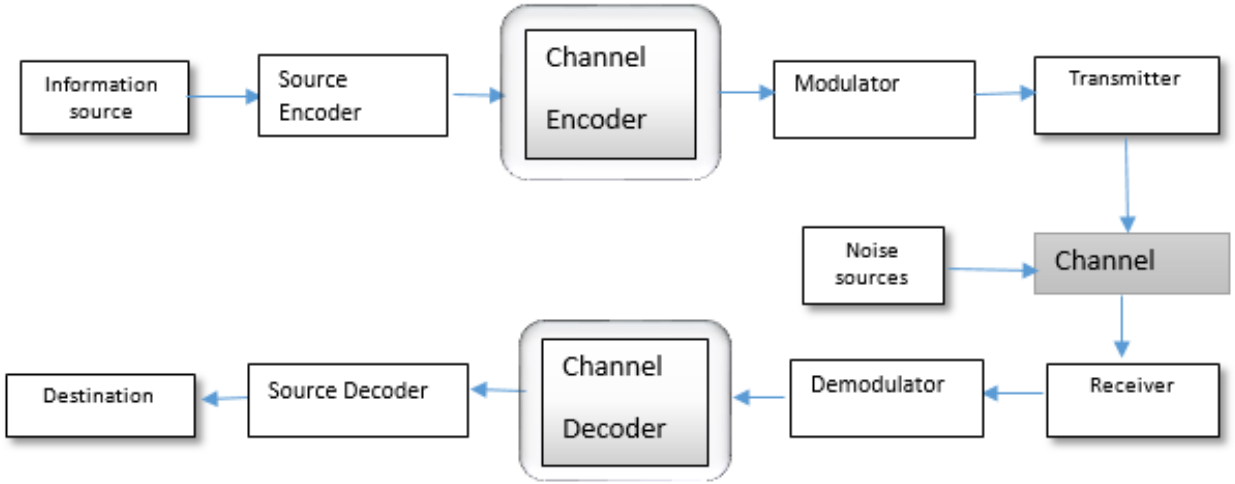

Figure: Block Diagram of Communication System

- Channel Encoder Decoder Pair

Introduction

Channel Coding

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Channel Coding

- Inevitable Existence of Errors on any given Communication Channel

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Channel Coding

- Inevitable Existence of Errors on any given Communication Channel
- Channel Noises

Error Control and Coding

Error Control and Coding

- Detection and Correction of Codes

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- Detection and Correction of Codes
- To Achieve Reliable Communication

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- To Achieve Reliable Communication
- Types of Error Correction Mechanisms

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  - Reverse Error Correction

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  - Block Codes
  - Convolutional codes

Error Control & Coding

Hamming Codes

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- First Class of Linear Block Codes

Error Control & Coding

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- FEC Achieved by Using Parity Bit Mechanism

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- Multiple Bit Error Detection

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- Table Driven Decoding

Error control & Control

Hamming Codes

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- (n,k)Hamming Code

Error control & Control

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- Code length:n=$2^m - 1$
- No. of information symbols:k=$2^m - m - 1$
- m>=3 : Hamming Distance=n-k

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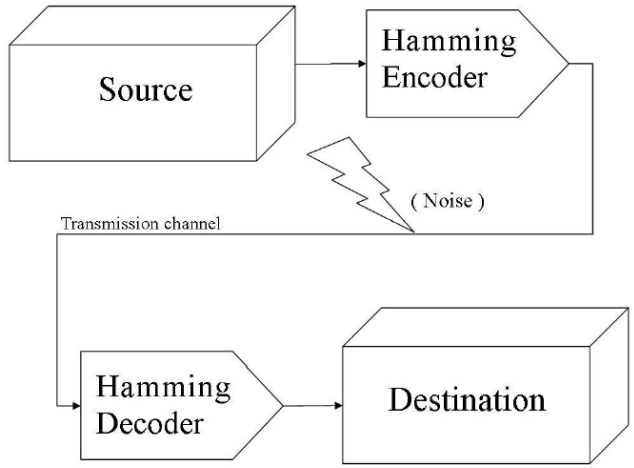

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Convolutional Codes

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Convolutional Codes

- Non Linear Block Codes

Error Control & Coding

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- Contains Memory

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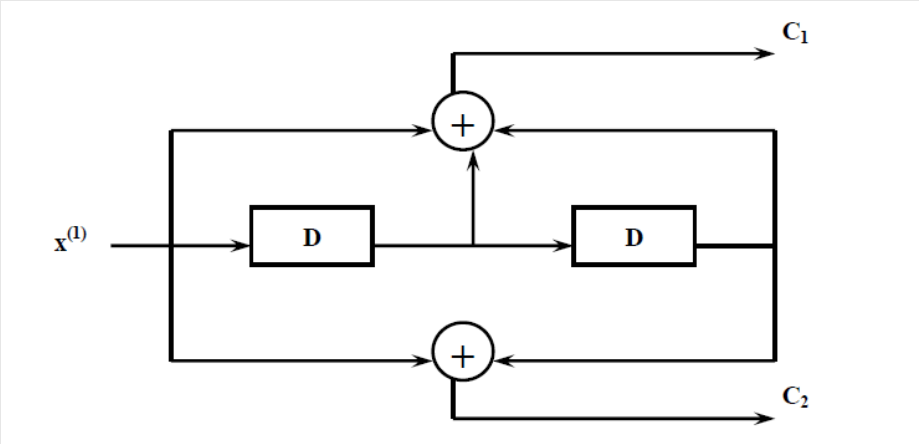

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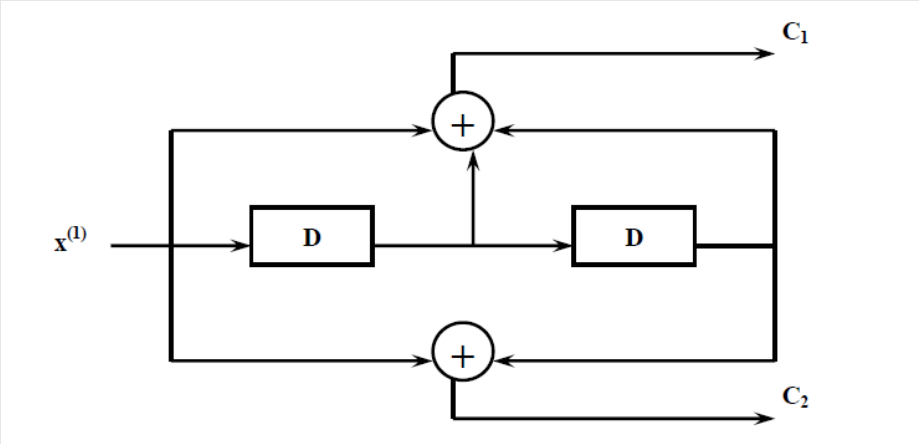
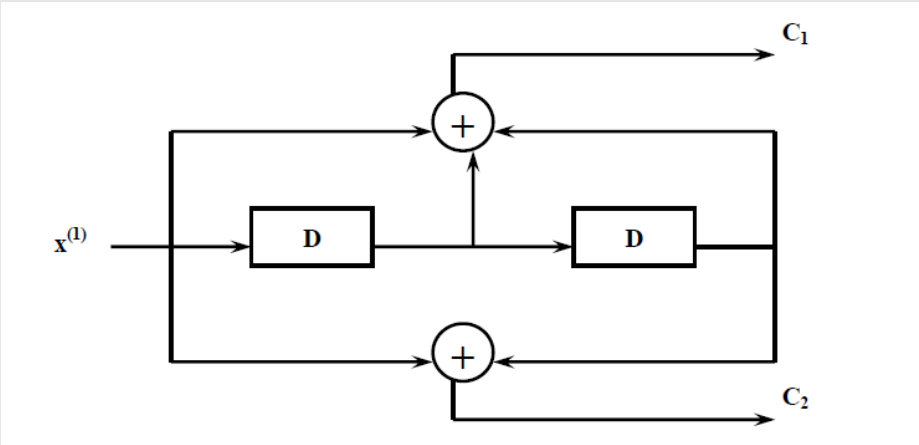
Convolutional Codes



- (n,k,m)Convolutional Codes

Error Control & Coding

Convolutional Codes



- (n,k,m)Convolutional Codes
- no of input bits k
- no of encoded bits n
- memory order m
- code rate= k/n

Viterbi Decoding

Error Control & Coding

Viterbi Decoding

- Maximum Likelihood Decoding Algorithm

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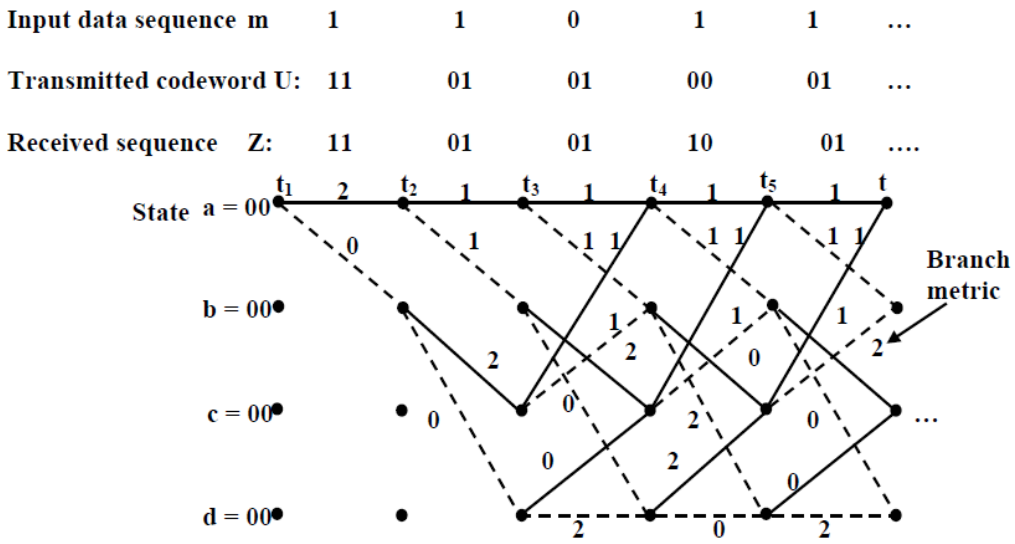
  - Path Metric and Branch Metric
  - Bit Metrics



Tools Used

Tools Used

- **Software Tools**
  - MATLAB

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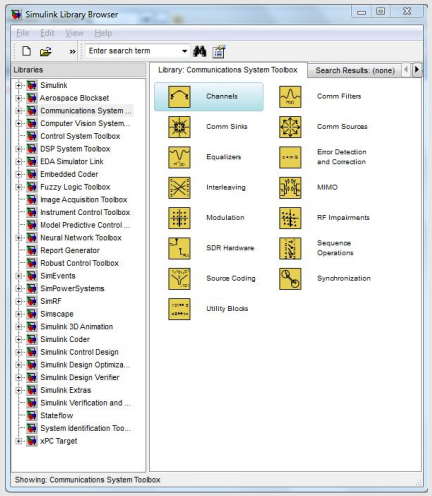
- **Hardware Tools**
  - FPGA

Software Tools Used

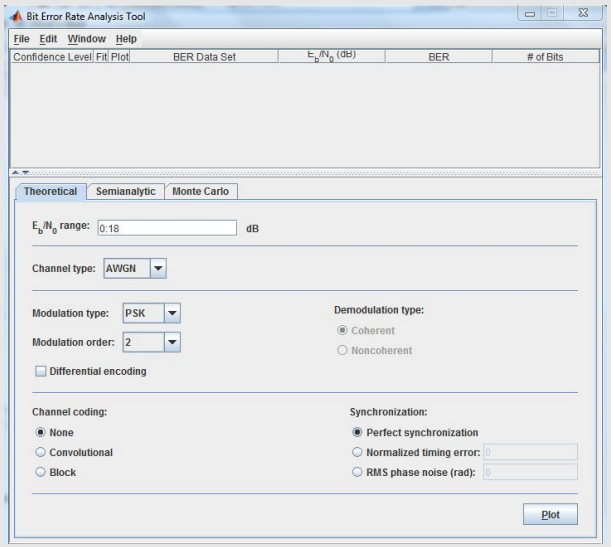
Simulink



- Graphical Programming Environment
- Libraries of Functional Blocks
- Model Analysis Tools
- Generating Code(C,C++,HDL)

Software Tools Used

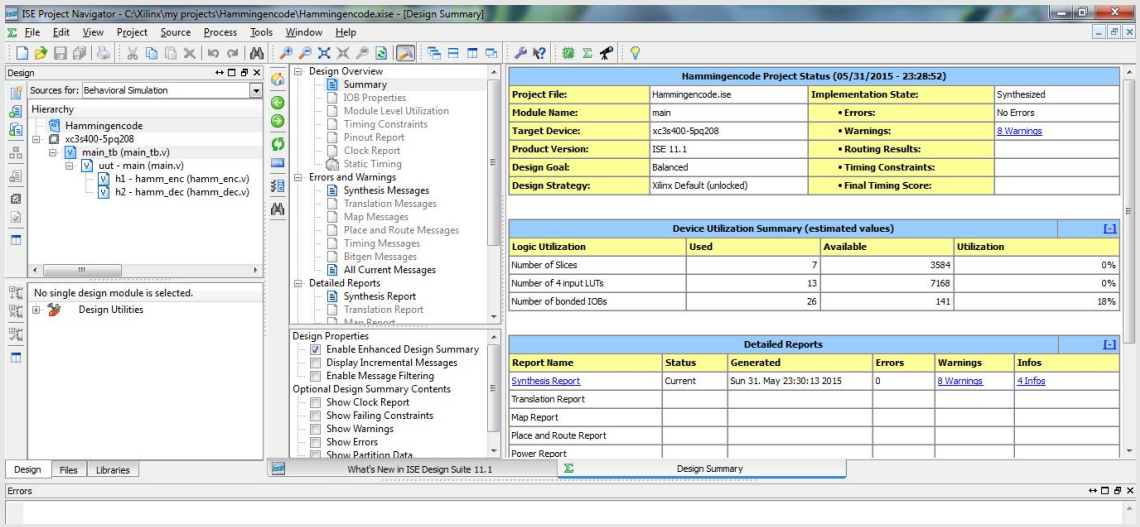
BER Tool



- Bit Error Rate Analysis
- Theoretical Simulation
- Monte-Carlo Simulations

Software Tools Used

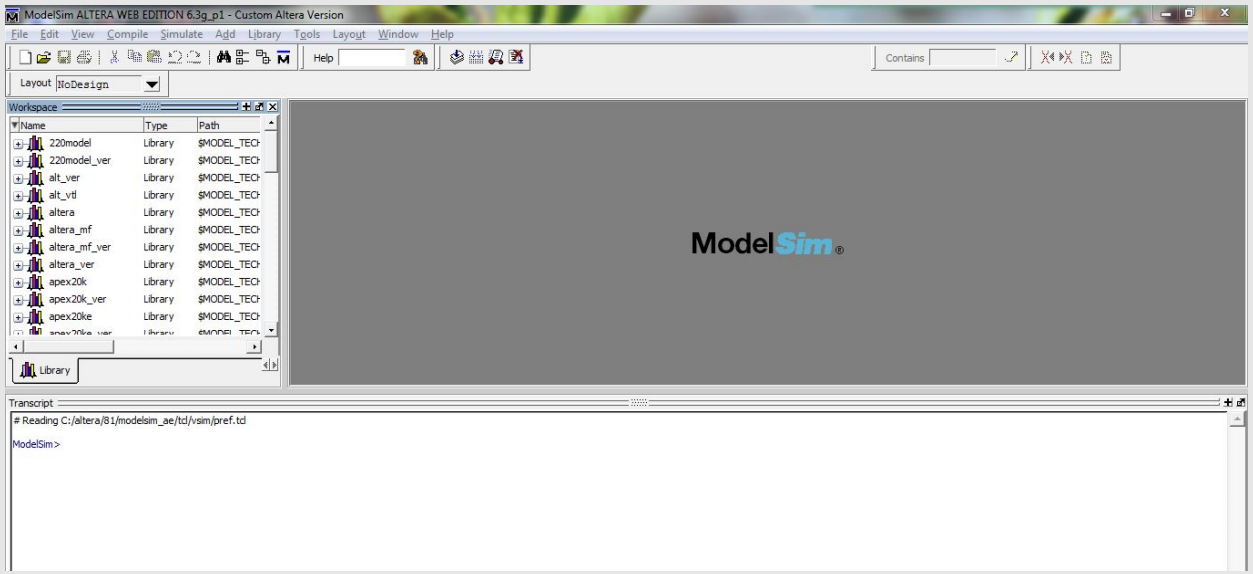
XILINX



- HDL Design Analysis and Synthesis
- Integration With ModelSim
- Behavioural Verification
- FPGA Synthesis

Software Tools Used

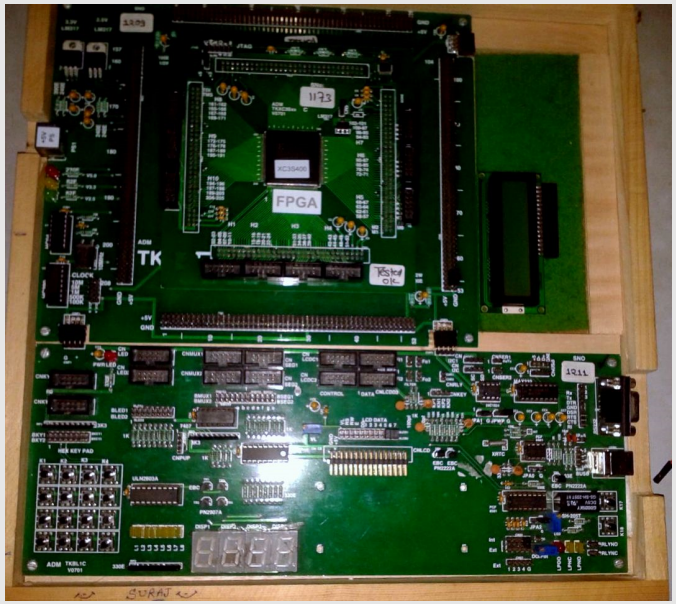
ModelSim



- Implements Verilog and System Verilog Languages
- Test Bench Development

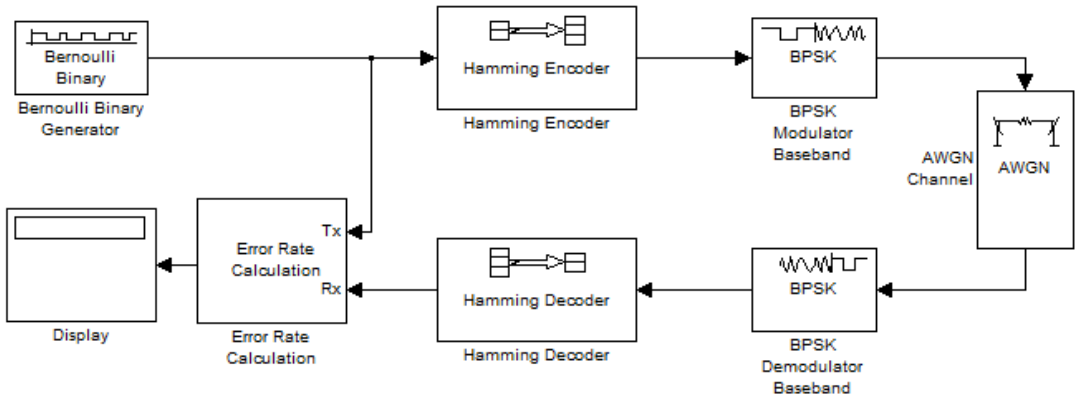
Hardware Tools Used

FPGA



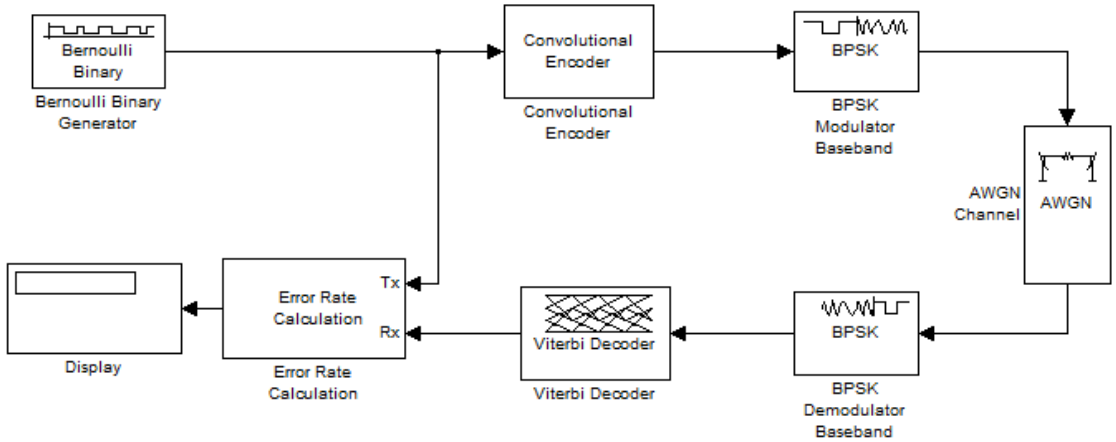
- Contains an array of programmable logic blocks.
- Netlist can be generated.
- It has a serial interface called JTAG.

Implementation of Hamming Codes



- Hamming code:(7,4)
- Modulation: BPSK
- Channel:AWGN

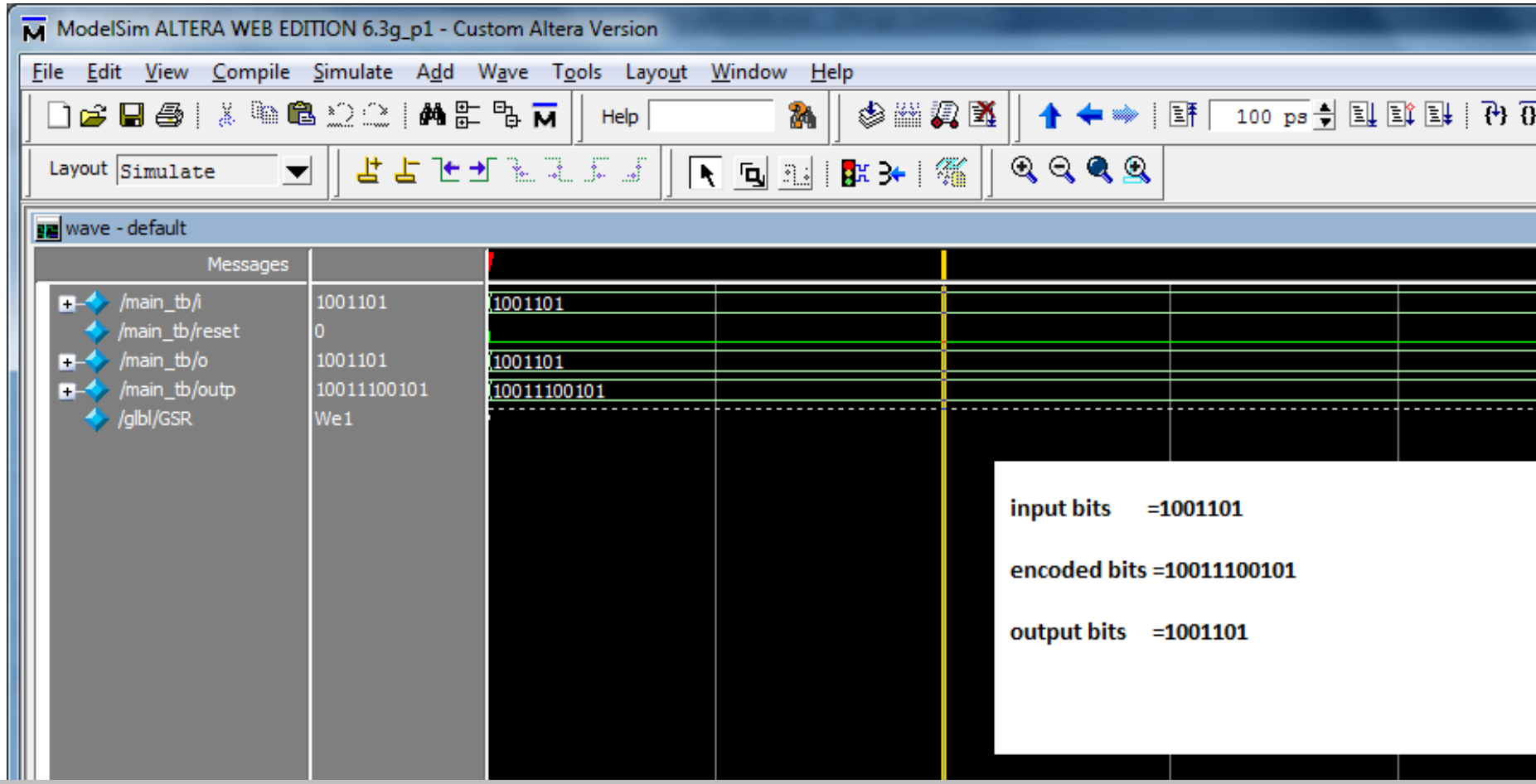
Implementation of Convolutional Codes



- Convolution code :(7,[171 133],171)
- Modulation: BPSK
- Channel:AWGN

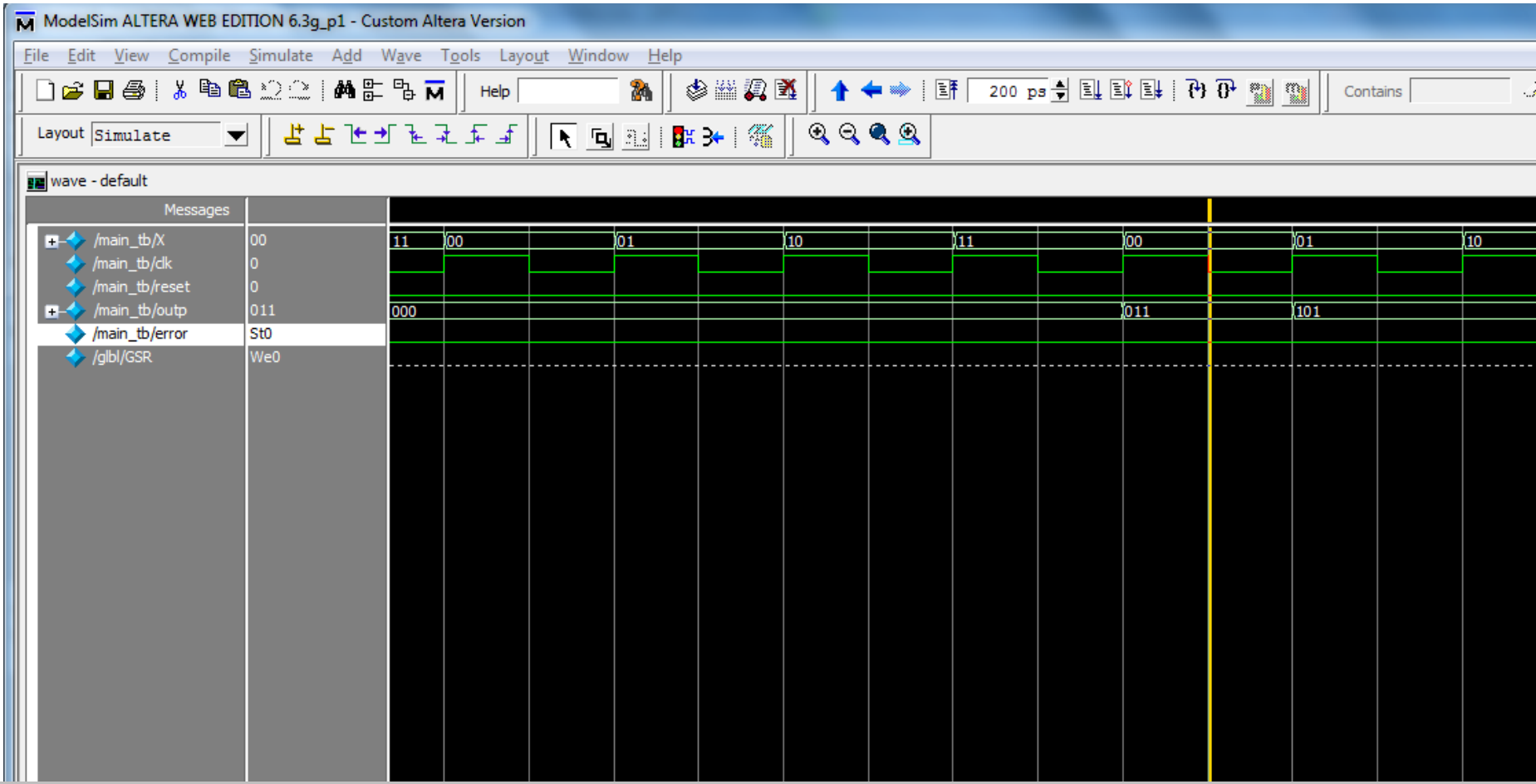
Results and Discussions

Simulation Results of Hamming Codes



Results and Discussions

Simulation Results of Convolutional Codes



Results and Discussions

Comparative Analysis of BER for Hamming and Convolutional Codes

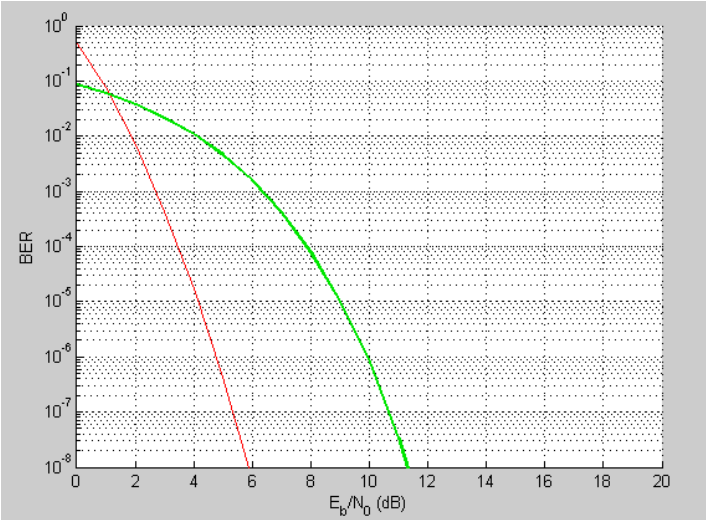


Figure: where, Green-Hamming and Red-Convolution

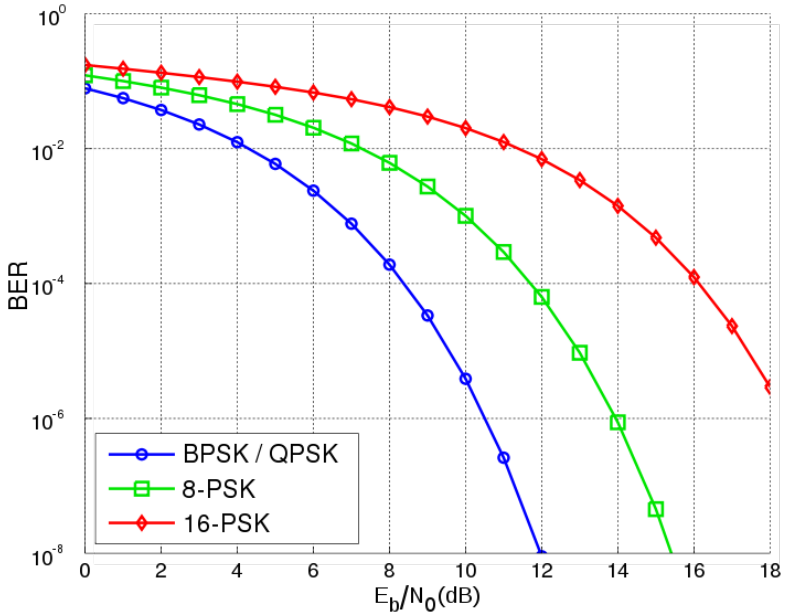
Eb/No	Hamming	Convolutional
1	0.149	0.195
2	0.115	0.125
3	0.093	0.035
4	0.064	0.009
5	0.043	0
6	0.030	0
7	0.020	0
8	0.010	0
9	0.006	0
10	0.002	0

Figure: BER values of Hamming and Convolutional Coding

- X-axis:Eb/N0, Y-axis:BER
- Modulation:BPSK, Channel Model: AWGN

Results and Discussions

BER Comparison for Modulation Techniques



- In a limited bandwidth channel, BER increases with the bit rate.
- BER of BPSK and QPSK are almost same.
- BPSK is chosen for the simplicity in circuit.

Conclusion

- BER and SNR Inversely Proportional
- The Simulation Results Show Convolutional Codes Perform Better Than Hamming Codes
- BER is Dependent on Modulation Techniques

Future Scope

- The Work Can be Further Extended on Rayleigh and Ricean Channel Models
- Constructing Adaptive Channel Encoder and Decoders
- SDR - Software Defined Radio

References


Prakash C.Gupta. *"Data Communications"*, Prentice-Hall of India pvt. ltd.,New Delhi,2002.


Shu Lin / Daniel J. Costello,Jr. *"Error Control Coding:Fundamentals and Applications"*,Prentice-Hall, Inc. Englewood Cliffs,New Jersey 07632,1983.


Simon Haykin. *"Communication Systems"*,John Wiley and Sons,Inc. New York,2000.


Jayshree S. Nandaniya,Nilesh B. Kalani,Dr.G.R.Kulkarni. *"Comparative Analysis of Different Channel Coding Techniques"*,IRACST International Journal of Computer Networks and Wireless Communications (IJCNWC), vol.4,No.2,April 2014.


Himanshu Saraswat, Govind Sharma Sudhir Kumar Mishra and Vishwajeet. *"Performance Evaluation and Comparative Analysis of Various Concatenated Error Correcting Codes Using BPSK Modulation for AWGN Channel"*,International Journal of Electronics and Communication Engineering. ISSN 0974-2166 Volume 5, Number 3 (2012), pp. 235-244,International Research Publication House.