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DESIGN AND IMPLEMENTATION OF POLAR ENCODER FOR 5G COMMUNICATION

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ABSTRACT

Polar codes are the first class of error-correcting codes that achieve the symmetric capacity of any memoryless channels. Arikan introduced a new method called Channel Polarization. In this project we Design and Implement encoding process of polar codes adopted by the 5G standard. The purpose of this work is to provide with a straightforward, self-contained guide to the understanding hardware implementation of 5G-compliant encoding of polar codes. This project involved developing the encoder using a reliability sequence, sending the output to the BPSK modulator and passing through the AWGN channel. The result of these efforts is an elaborate framework that applies novel coding techniques to provide a solid channel code for NR requirement.

INTRODUCTION

Digital communication technologies are incorporated into our daily life in many ways, for example, cell phones, television etc. The typical structure of a digital communication system. A source is one of the communication system's primary components. A source encoder compresses data. A channel encoder adds redundancy. A communication channel is a channel which may introduce errors to the transmitted message. A channel decoder eliminates the errors caused by the noisy channel. C. Shannon initially discussed this structure. Only the core blocks—specifically, the channel coding block seen is important for our discussion. The function of a channel encoder is to protect the transmitted message prone to interference, noise, and distortion.

This architecture aim to improve the performance of the polar code by modifying the existing architecture.

This architecture is the parallel polar encoder, which involves splitting the code into multiple sub-codes and processing them in parallel. This architecture can reduce the encoding latency and increase the throughput.

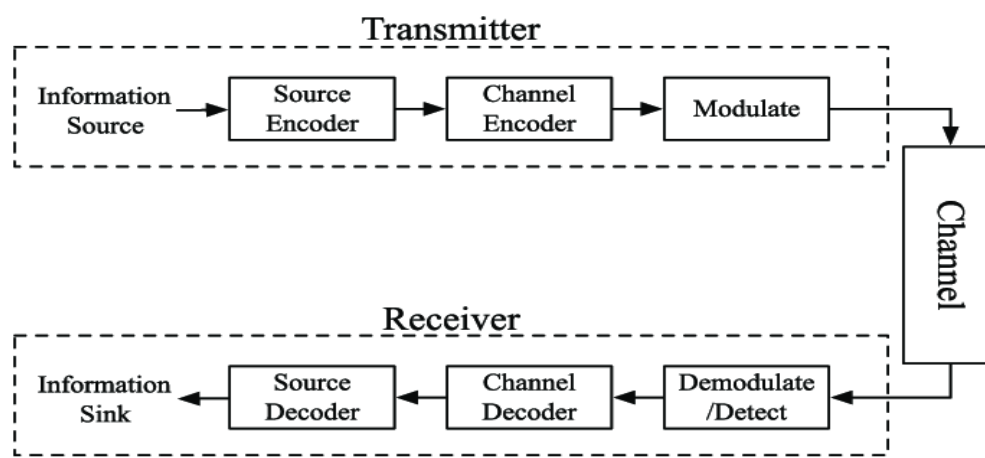


Figure.1 shows the typical structure of a digital communication system.

LITERATURE SURVEY

Polar Codes: Begin with seminal papers on polar codes, such as the original work by Erdal Arıkan. Understanding the fundamentals of polar codes, their construction, encoding, and decoding algorithms is crucial. Look for papers that discuss the theoretical aspects of polar codes.

5G Communication: Review literature on the requirements and challenges of 5G communication systems. Understand the key features of 5G networks that make polar codes an attractive choice for error correction.

Polar Encoding Techniques: Explore different techniques for polar encoding, including successive cancellation (SC) decoding, belief propagation (BP), list decoding, and their variations. Look for studies that compare the performance and complexity of these techniques.

Implementation Approaches: Investigate research on efficient hardware and software implementations of polar encoders tailored for 5G communication systems. This includes FPGA, ASIC, and software-based implementations optimized for low latency and high throughput.

PROPOSED METHODOLOGY

This architecture aim to improve the performance of the polar code by modifying the existing architecture.

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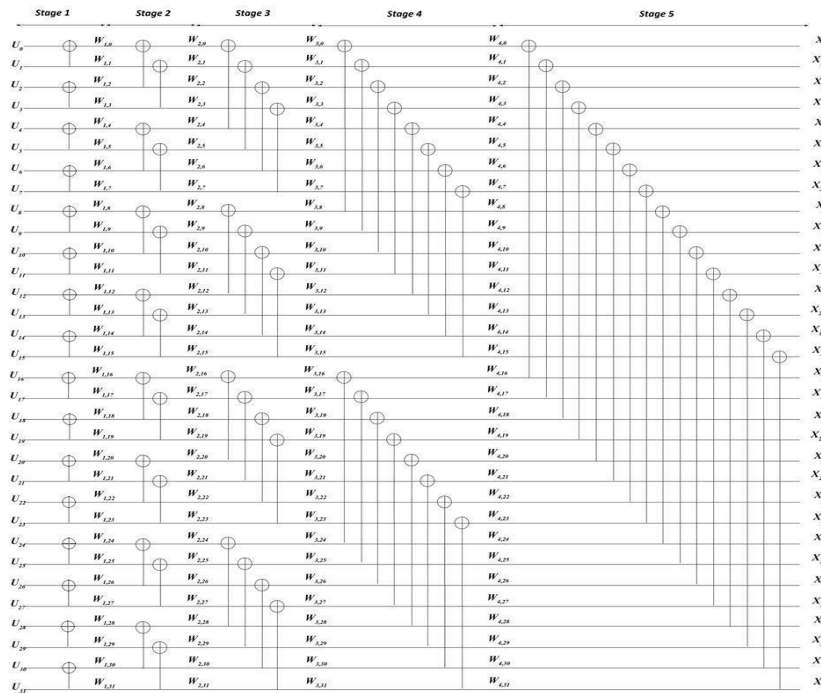


Figure.2 Polar Encoding Mechanism for 32-bit

SIMULATION & SYNTHESIS RESULTS

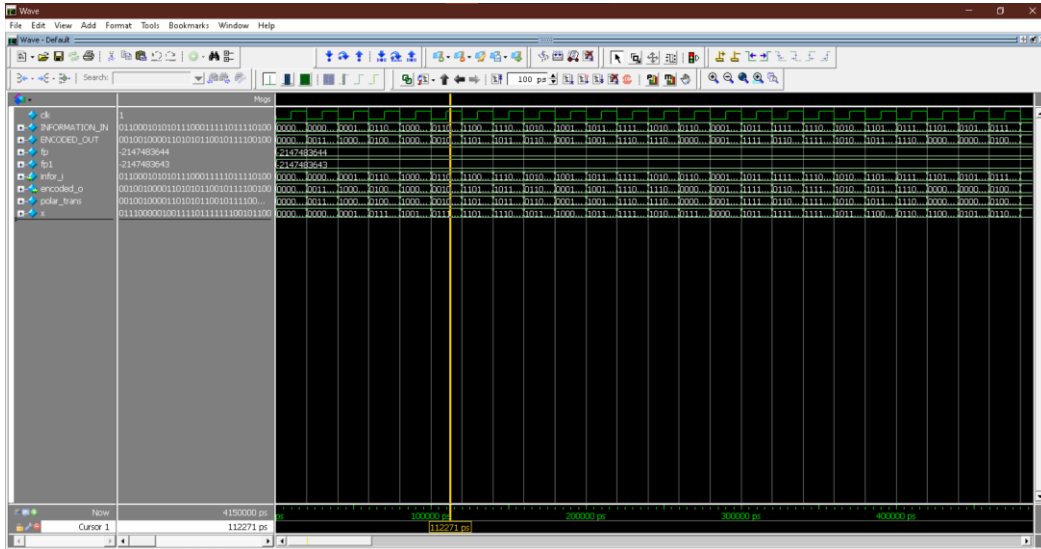


Figure.3 Simulation Result of Polar Encoder (32-bit)

The above results shows the waveform of encoded output for different inputs. In the Simulation result shown, infor_i is the message signal (i.e.0101111001011011) and the encoded_o is the encoded output (i.e.11010111111010110100111010001101).

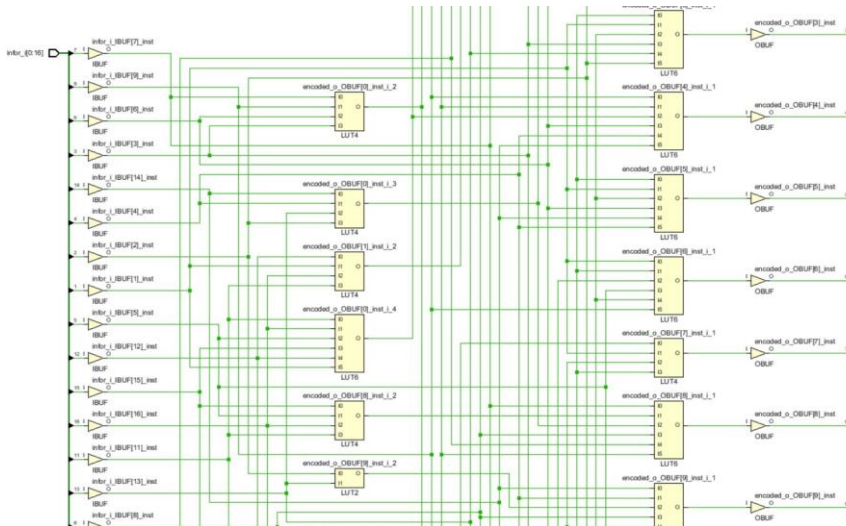


Figure.4 Technology Schematic of Polar Encoder Closeup(32-bit)

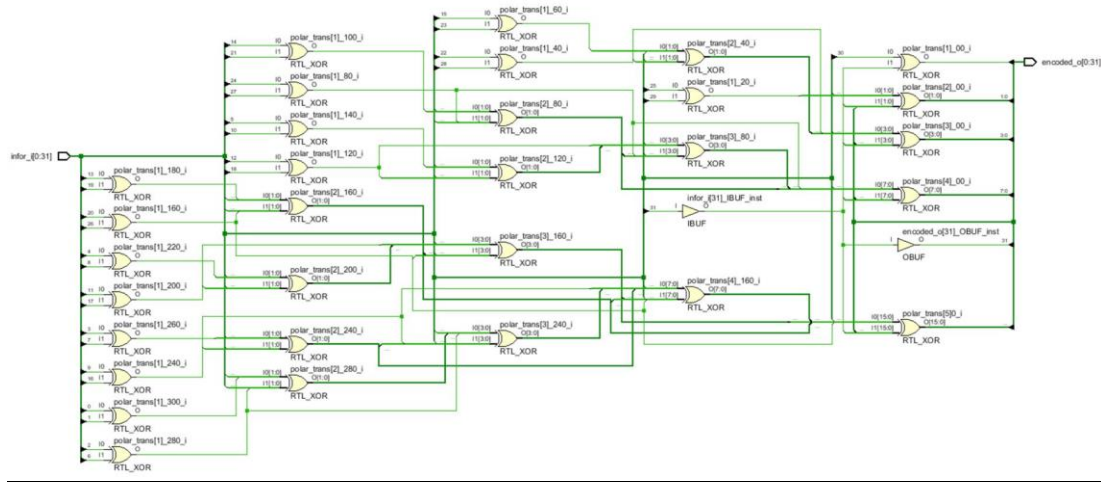


Figure.5 Schematic Diagram of Polar Encoder(32-bit)

Area Report

Site Type	Used	Fixed	Available	Util%
Slice LUTs*	29	0	303600	< 0.01
LUT as Logic	29	0	303600	< 0.01
LUT as Memory	0	0	130800	0.00
Slice Registers	0	0	607200	0.00
Register as Flip Flop	0	0	607200	0.00
Register as Latch	0	0	607200	0.00
F7 Muxes	0	0	151800	0.00
F8 Muxes	0	0	75900	0.00

Ref Name	Used	Functional Category
OBUF	32	IO
IBUF	17	IO
LUT4	14	LUT
LUT6	13	LUT
LUT2	5	LUT
LUT5	3	LUT
LUT3	1	LUT

CONCLUSION

In this work, we have detailed the polar code encoding process within the 5th generation wireless systems standard, providing the reader with a user-friendly description to understand, implement and simulate 5G-compliant polar code encoding. This encoding chain showcases the successful efforts to meet the various requirements on the code for the eMBB control channel: low description complexity and low encoding complexity, while covering a wide range of code lengths and code rates.

FUTURE SCOPE

Low-latency communication: The design of Polar Codes in 5G NR has already shown excellent potential for low-latency communication. Further research can explore ways to

optimize the Polar Code design for even lower latency in applications such as autonomous vehicles, remote surgery, and other time-critical systems.

High-speed communication: With the ever-increasing demand for high-speed data transfer, the design of Polar Codes can be further optimized to support higher data rates. This can include exploring new code rates, code lengths, and construction methods that can support even higher data rates.

Resource-constrained communication: Polar Codes can be designed to work efficiently with resource-constrained communication systems such as the Internet of Things (IoT) and Machine-to-Machine (M2M) communication. This can include designing codes that can handle higher levels of noise and interference while utilizing minimal computational resources.

Beyond 5G communication: The design of Polar Codes can play a crucial role in future communication systems beyond 5G, such as 6G and beyond. Research in this area can explore the potential for using Polar Codes as a channel coding scheme for emerging wireless communication technologies.

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