Overview of Performance of Coding Techniques in Mobile WiMAX Based System

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***Abstract*— In this paper, we present the review of the convolution coding (CC) and convolutional product code (CPC) based on mobile WiMAX system. In coding techniques the number of symbols in the source encoded message is increased in a controlled manner in order to facilitate two basic objectives at the receiver one is Error detection and other is Error correction. The amount of error detection and correction required and its effectiveness depends on the signal to noise ratio (SNR). The WiMAX technology based on standard 802-16 wireless MAN is configured in the same way as a traditional cellular network with base stations using point to multipoint architecture to drive a service over a radius up to several kilometers. The range and the Non Line of Sight (NLOS) ability of WiMAX make the system very attractive for users, but there will be slightly higher BER at low SNR. Coding is a technique where redundancy is added to original bit sequence to increase the reliability of the communication. This paper reviews the code used in mobile WIMAX. A detailed description of the coding techniques in WIMAX system is studied.**

Keywords: WiMAX, CPC, IEEE 802.16

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I. INTRODUCTION

WiMAX is introduced by the Institute of Electrical and Electronic Engineers (IEEE) which is designated by 802.16 to provide worldwide interoperability for microwave access. There are fixed (802.16d) and mobile (802.16e) WiMAX. The majority of aspects which make WiMAX technology different from others that can be applied to the same scenario reside in its physical layer. This technology offers a high speed, secure, sophisticate, last mile broadband service, ensuring a flexible and cheap solution to certain rural access zones [1]-[7]. In a fixed wireless communication, WiMAX can replace the telephone company's copper wire networks, the cable TV's coaxial cable infrastructure. In comparison with Wi-Fi and Cellular technology, Wi-Fi provides a high data rate, but only on a short range of distances and with a slow movement of the user. And Cellular offers larger ranges and vehicular mobility, but it provides lower data rates, and requires high investments for its deployment [4]. WiMAX tries to balance this situation. WiMAX fills the gap between Wi-Fi and Cellular, thus providing vehicular mobility, and high service areas and data rates. WiMAX is a standards based technology for wireless MANs conforming to parameters which enable interoperability [1][2]. WiMAX developments have been rapidly moving forward.

The objective of this paper is to done literature review and to provide a critical review of the performance of the different coding techniques using mobile WiMAX. WIMAX transmit data with low bit error rate in the noisy environment for that we apply Forward Error Correction method with different coding techniques. This method is useful to reduce the bit error rate (BER) and increase the efficiency. The paper is organized as follows. In Section I, we give an introduction to the WiMAX system. Section II, the Literature is reviewed. Section III, describes the critical evaluation based on the literature review, we conclude in Section IV, which will summarize the work done in the paper followed by the future work..

II. LITERATURE REVIEW

The purpose of this literature review is to study the literature of both coding techniques and WiMAX/802.16e.

A. WiMAX/802.16e

The WiMAX technology, based on the IEEE 802.16 Air Interface Standard is rapidly proving itself as a technology that will play a key role in fixed broadband wireless metropolitan area networks In December, 2005 the IEEE ratified the 802.16e amendment [9] to the 802.16 standard. Mobile WiMAX is a broadband wireless solution that enables convergence of mobile and fixed broadband networks through a common wide area broadband radio access technology and flexible network architecture. The Mobile WiMAX Air Interface adopts Orthogonal Frequency Division Multiple Access (OFDMA) for improved multi-path performance in non-line-of-sight environments.

B. CONVOLUTION CODE (CC)

In the Mobile Wi-Max OFDMA part, the CC is the only mandatory coding scheme. Its computations depend not only on the current set of input symbols but on some of the previous input symbols. A trellis description is used for convolution encoding which gives relation how each possible input to the encoder influences the output in shift register. It uses the Viterbi algorithm for decoding. In communication, a convolution code [12] is a type of error-correcting code in which

- each m-bit information symbol (each m-bit string) to be encoded is transformed into an n-bit symbol, where m/n is the code rate (n ≥ m) and
- the transformation is a function of the last k information symbols, where k is the constraint length of the code.
- There are three parameters which define the convolotional code[11]:

(a) Rate: Ratio of the number of input bits to the number of output bits. In this example, rate is 1/2 which means there are two output bits for each input bit.

(b) Constraint length: The number of delay elements in the convolutional coding. In this example, with $K = 3$ there are two delaying elements.

c) Generator polynomial: Wiring of the input sequence with the delay elements to form the output. In this example, generator polynomial is $[7,5]_8 = [111,101]_2$. The output from the $7_8 = 111_2$ arm uses the XOR of the current input, previous input and the previous to previous input. The output from the $5_8 = 101_2$ uses the XOR of the current input and the previous to previous input.

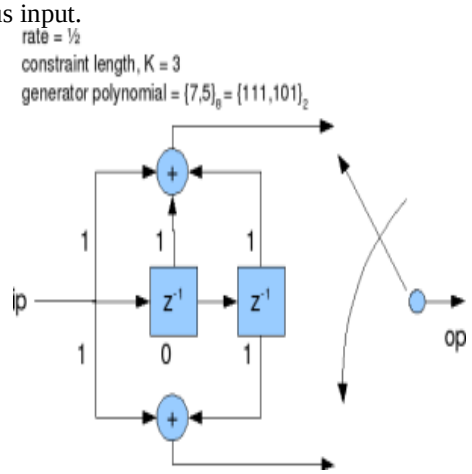

Figure 1: Convolutional code with Rate 1/2, K=3, Generator Polynomial [7, 5] octal

C. CONVOLUTIONAL ENCODER

The channel coding scheme, IEEE 802-16, as shown in fig 2 is based on binary non-recursive Convolutional Coding (CC) [4].

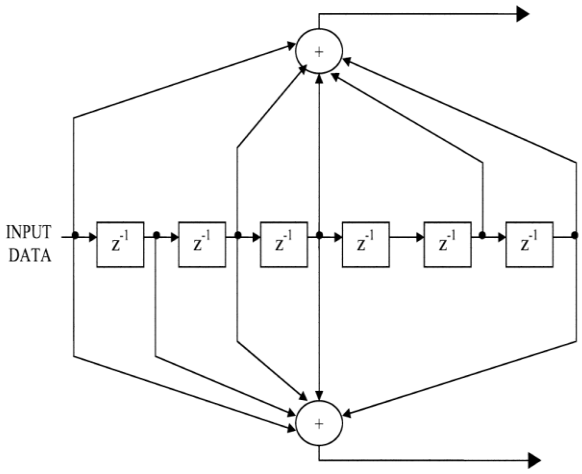

Fig: 2 Convolutional Encoder

The convolutional encoder uses a constituent encoder with constraint length 7, code rate 1/2 and generator polynomials (133,171) octal. Tail biting is used to initialize the encoder by padding each FEC block with 6 zeros.

D. CONVOLUTION PRODUCT CODE (CPC) METHOD

CPC is a new coding method, in which the information bits are placed into two dimensions (2D) Matrix. The rows and the columns are encoded separately by using recursive systematic convolutional encoders. Each row of the matrix is encoded using a convolutional code the same recursive systematic convolutional code is used to encode each row. Once all rows have been encoded, the matrix is sent, if desired, to an interleaver. Our original data matrix dimensions are (nxk), and the encoded data matrix dimensions will be (Znxk). The coded rows matrix is then recoded column by column using the same or different recursive systematic convolutional encoder. CPC uses a recursive systematic convolutional code with rate 1/2 and generator polynomials (1, 5/7) octal to encode each row and column. Hence, the overall code rate is 1/4. The coding by CPC will be done in 2 stages. First each column will be independently coded, and then each row of the resulting matrix will be coded by the same generator polynomials.

Therefore the following step are done [13]

(1) Dividing the overall matrix produced from CPC into three matrices. Each one has a size (nx4) or (nx6) according to the

type of QAM .The reason for using three matrices only is to have a number of message bits equals to bits used in the turbo code method, as a comparison between it and CPC is done.
(2) Applying symbol mapping for each one independently (16QAM or 64QAM).
(3) Inserting the pilot and DC subcarriers for each matrix.
(4) Performing the IFFT independently resulting in three OFDMA symbols.
(5) Applying (cyclic prefix) CP for each symbol.
(6) Sending each symbol independently.

III. CRITICAL EVALUATION

In this section the evaluation of review is done critically. Table 1 contains the tabular format of a summarized review of the literature. What are the problem for performance of coding techniques and WiMAX? & what are the solutions for these problems. Every author has its own view. The limitations found in the reviewed papers are also mentioned in this table. An analysis of the data communication on the WiMAX has been conducted. Main focus is on the error detection and correction during data transmission in noisy behavior.

TABLE I. SUMMARIZED TABLE OF THE LITERATURE REVIEW

Author	Summary	Problems/ Challenges	Solutions	Limitations
Prabhakar Telagarapu, G.B.S.R.Naidu, K.Chiranjeevi	Performance evaluation of physical layer of WiMAX by using Reed-Solomon coding and convolution coding scheme, cyclic prefix and interleaving for different modulation technique with respect to bit-error rate and SNR ratio.	When data is transmitted over a noisy channel than some information are loss and burst error.	The effect of error occur during transmission is reduced by adding redundancy to the data prior to transmission.	Low data rate, limited bandwidth.
Eng. Ahmed Ebian, Dr. Mona Shokair, Prof. Kamal Awadalla	A comparison between the performance of WiMAX using convolutional code and Convolutional Product Code (CPC) is made on the basis of BER.	Different behaviour of the WiMAX system with different coding techniques.	Using different number of sub carrier with different coding techniques.	Bit error rate.
Shraddha Bansal, Raksha Upadhyay	Mobile WiMAX, its physical layer is simulated using Matlab and bit error rate (BER) performance is observed. Performance improvement is achieved using forward error correction codes (FEC) for this convolution code (CC) and LDPC are used.	At small bit rate the behaviour of the system is not appropriate with convolution code.	LDPC perform better than CC in low SNR environment due to its inherent property. WiMAX Performance is improved in presence of FEC.	Not suitable for fading channel.

IV. CONCLUSION

Error detection and correction techniques are essential for reliable communication over a noisy channel. Error detection and correction technique are essential for reliable communication over a noisy channel. The effect of error occur during transmission is reduced by adding redundancy to the data prior to transmission. The redundancy is used to enable decoder in the receiver to detect and correct errors. CPC code is efficient code to correct the errors by using this codes in WiMAX we can reduce the bit-error in noisy environment and useful to provide the efficient data to the subscriber. In this paper, CPC coding and convolution coding method have been discussed. The CPC coding method leads to reduce BER as compare to convolution coding method.

V. FUTURE SCOPE

After studying different coding technique performance and mobile WiMAX and their performance, we came to an end that performance of coding techniques for provided error free communication but still not correct. A lot of error detection and correction techniques should be provided, so future work is needed in this area to error free communication. Further scope of this paper is that performance analysis of WiMAX MC-CDMA based system using CPC coding and convolution coding method. Which may gives better result as compare to WiMAX OFDMA based system using CPC coding and convolution coding method.

VI. REFERENCES

[1 L. Nuaymi, *"WiMAX: Technology for Broadband Wireless Access,"* John Wiley & Sons, 2007.

[2] WiMAX Forum, "*Mobile WiMAX - Part I: A Technical Overview and Performance Evaluation,"* White paper, August 2006.

[3] IEEE 802.162004," *IEEE Standard for Local and Metropolitan Area Networks Part 16: Air Interface for Fixed Broadband Wireless Access Systems",* 1 October 2004.

[4] WiMAX Forum, "*Mobile WiMAX - Part I: A Technical Overview and Performance Evaluation,*" white paper, August 2006.

[5] Y. Xiao, "WiMAX-Mobile Fi: Advanced research andtechnology, "Auerbach publications, and 2008.

[6] Changlong Xu,"Soft Decoding Algorithm for RS-CC Concatenated Codes in Wimax System", Vehicular Technology Conference, 2007.

[7] Jeffrey G Andrews, Arunabha Ghosh, and Rias Muhamed, "*Fundamentals of WiMAX "*

[8] "*Air Interface for Fixed Broadband Wireless Access Systems,"* IEEE STD 802.16 – 2004, October, 2004.

[9] "Air Interface for Fixed and Mobile Broadband Wireless Access Systems," IEEE P802.16e/D12, Feb, 2005.

[10] Eng. Ahmed Ebian, Mona Shokair and Kamal Awadalla, "Performance Evaluation of WiMAX System Using Convolutional Product Code (CPC)."

[11] Prabhakar Telagarapu, Prabhakar Telagarapu, K.Chiranjeevi," Analysis of Coding Techniques in WiMAX" *International Journal of Computer Applications Volume 22– No.3, May 2011*.

[12] http://en.wikipedia.org/wiki/Convolutional_code.

[13] http://www.dsplog.com/2009/01/04/convolutional-code.

[14] http://www.waset.org/journals/waset/v51/v51-33.pdf