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Performance Evaluation Of WIMAX MC-CDMA system using LDPC Coding

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Abstract— IEEE 802.16, is Worldwide Interoperability for Microwave Access (WiMAX). It is a wireless broadband standard which promised high bandwidth over Long-range transmission. The standard specifies the air interface, including the medium access control (MAC) and physical (PHY) layers of broadband wireless access (BWA). Worldwide Interoperability for Microwave Access (WiMAX) provides specifications for both Line of sight (LOS) communication in the range of 10-66GHz (802.16c) and Non-LOS communication in the range of 2-11GHz (802.16a & 802.16d)[1]. The WiMAX technology play a key role in fixed broadband wireless metropolitan area networks. The major drawback of WIMAX system is high BER and as BER increases , signal to noise ratio decreases. It means, the less the BER result is the higher the SNR and the better communication quality .Hence in order to fill the gap there is great necessity to optimize the BER so that performance of WIMAX is increased. In this paper, the performance of WiMAX PHY layer using MC-CDMA as a transmission technique with LDPC coding mechanisms is investigated over different modulation technique. These codes can be used for various code rates. The proposed work will focus on development and implementation of WIMAX MC - CDMA system using LDPC coding techniques .BER performance is observed for these codes under different conditions. BER versus E_b/N_o curves shows comparison between the modulation technique for different coding mechanism. The results show that the proposed scheme achieves significantly higher BER performance as compared to existing schemes.

Index Terms**—WiMAX, MC-CDMA, LDPC, BER**

I. INTRODUCTION

WiMAX(Worldwide Interoperability for Microwave Access)has gaining the attention of the no of wireless companies. This new wireless technology provides both high data rates and long range coverage. With the approval of the new mobile WiMAX standard (IEEE802.16e-2005) at the beginning of the year 2006, this technology has become even more exciting[2].

Unlike WiFi, which was designed for indoor applications and local area networks (LAN), WiMAX is used for outdoor applications and Metropolitan area networks (MAN). It has been believe that WiMAX will compete with city-wide WiFi and 3G cellular networks, making it even more attractive[2].

In this paper physical layer transmission technique used for WiMAX is MC- CDMA. MC-CDMA has advantages of both OFDM and CDMA. The combining of two techniques has advantage in lowering the symbol rate in each sub-carrier compared to OFDM so that longer symbol duration makes it easier to synchronize. The MC-CDMA not only mitigates the Inter-Symbol Interference (ISI) but also exploits the multipath [3]. The serial input data stream is converted into parallel streams and are spread using CDMA spreading sequences in the frequency domain. This ensures frequency non-selective fading in the subcarriers [4].

MC-CDMA uses number of narrowband orthogonal subcarriers with symbol duration longer than the delay spread. And due to this all the subcarriers to be affected by the same
deep fades of the channel at the same time thereby improving performance [4]. Multi-Carrier Code Division Multiple Access (MC-CDMA) is a spectrally efficient multiplexing method where each individual data symbol is transmitted over multiple sub-carriers of an Orthogonal Frequency Division Multiplexing (OFDM) signal . Through the use of orthogonal spreading codes, multiple data symbols share common subcarriers and their signals remain separable at the receiver[5].

This paper analyses the performance of WiMAX in terms of the BER as a function of E_b/N_o

The rest of the paper is organized as follows. Section II presents an overview about WiMAX physical layer. Section III will present the simulation model. Section IV simulate WiMAX system using Matlab. The paper will be concluded in section V.

II. WIMAX PHYSICAL LAYER

WiMAX uses radio microwave technology to provide wireless internet service to computers and other devices for example PDA’s, cell phones etc. It works like cellular network technology. The theoretical range of WiMAX is up to 30 miles and achieves data rates up to 75 Mbps [6].

WiMAX operates in similar manner as Wi-Fi but with two differences as compared to Wi-Fi. These differences are

- Data rate
- Data range

WIMAX 802.16 physical layer considers two types of transmission techniques OFDM and OFDMA. Both of these techniques have frequency band below 11 GHz and use TDD and FDD as its duplexing technology .OFDM physical layer is implemented differently in Fixed and Mobile versions of WIMAX. Fixed WIMAX uses 256 – FFT based OFDM physical layer where as the Mobile WIMAX uses a scalable OFDMA (SOFDMA) based physical layer and the FFT sizes in this case can vary from 128 bits up to 2048 bits [7].

Features of WiMAX physical layer:-

- Flexible Channel Bandwidth
- Adaptive Modulation and Coding
- Forward Error Correction Control Mechanism
- Adaptive Antenna System

To implement MC-CDMA system, spreading process is done before OFDM block in the OFDM system and dispreading process after OFDM block in the receiver. In simulation, the Hadamard code is used in spreading process. In MATLAB, the function Hadamard (L) gives Hadamard matrix of size *L*, where *L* can be the number of users.

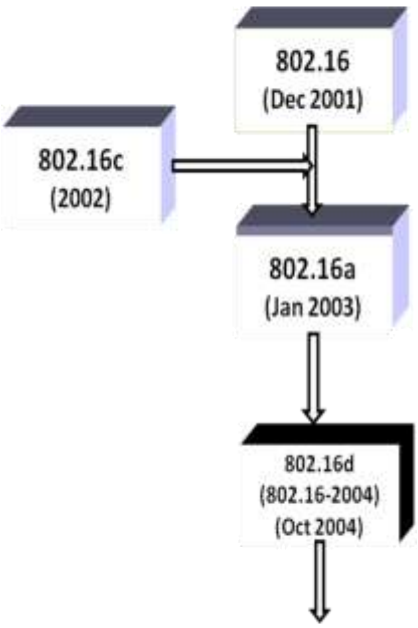

Fig 1. 802.16 Standards History [8]

III. SIMULATION MODEL

Low density parity check (LDPC) codes are one of the best error correcting and are known to approach the Shannon limit. LDPC codes add redundancy to the uncoded input data to make it more immune to channel impairments [9]. Low-density parity-check (LDPC) codes are a linear block codes. Its parity-check matrix contains only a few 1's in comparison to the amount of 0's. Some of the advantages of LDPC code are:-a)They allow a higher code rate and also a lower error floor rate,b)LDPC decoding is linear with the block length, c)A single LDPC code can be universally good over a collection of channel. The graphical representation for a typical (8, 4) LPDC encoding is shown Fig 2 .

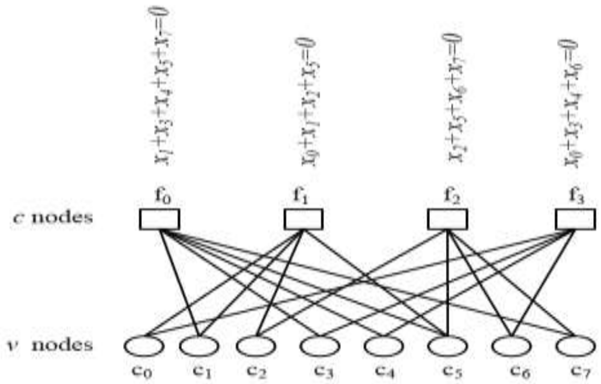

Fig 2. Graphical representation of a (8, 4) LDPC code [9]

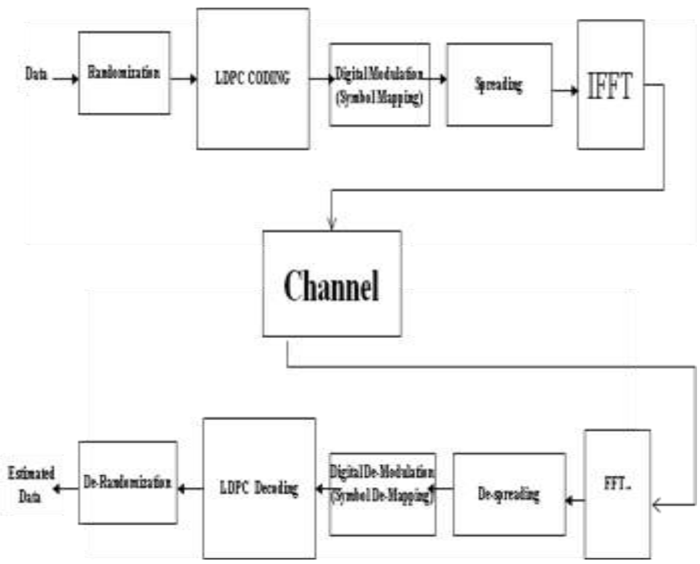

Fig 3. Simulation model

Fig 3. Shows the simulation model . In this at first, random bits are generated, and then, coded by a concatenated LDPC and Convolutional encoder. After mapping the bits to symbols, serial-to-parallel conversion is carried out to form OFDM symbols. Pilots, a zero DC carrier, and guard carriers are added.

In our simulation, MC-CDMA system is simulated in WiMAX by applying Walsh Hadamard spreading codes in the frequency domain. Hadamard code is orthogonal and easy to generate. MC-CDMA transmits a data symbol of a user simultaneously on various sub-channels. These sub-channels are multiplied by the chips of the user-specific spreading code. MC-CDMA offers a flexibility, allowing adjustable receiver complexities.

In MATLAB, the function Hadamard(L) gives Hadamard matrix of size *L*, where *L* can be the number of users.In this simulation, values of *L* are used with 2. At receiver, the opposite operations of the transmitter is performed, that is, cyclic prefix removal, FFT, despreading, extraction of data subcarriers and pilots subcarriers. The received bits are compared to the transmitted bits, and BER is calculated for different E_b/N_o.

IV. SIMULATION PARAMETER AND RESULTS

In this section, the simulation results obtained are discussed to evaluate the performance. The parameters are listed in Table I. In this paper physical layer Simulation of WiMAX is obtained in terms of BER Vs $\mathbf{E_b/N_o}$ curve. The plots are presented for QPSK, 16-QAM according to the IEEE 802.16 standard.

TABLE I

PARAMETER	VALUE
BW	5MHz
CYCLIC PREFIX	1/4
SPREADING CODE	WALSH HADAMARD
SPREADING FACTOR	2
DIGITAL MODULATION	QPSK,16QAM

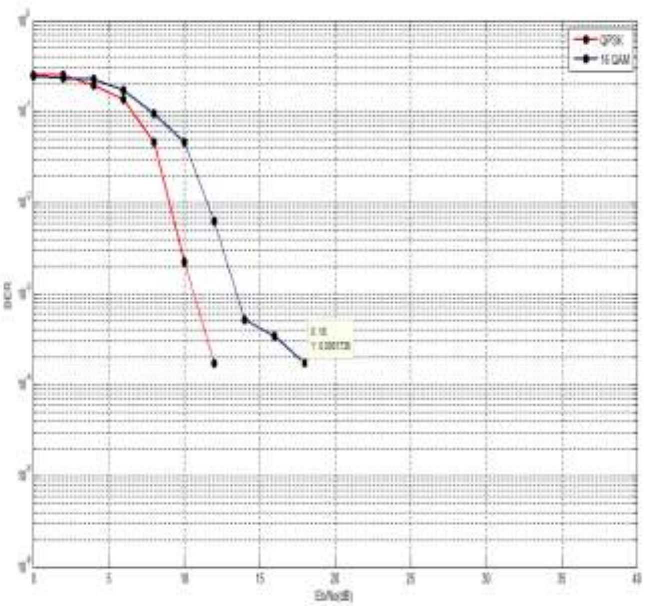

Fig. 4 Simulation Result of QPSK and 16 QAM ,LDPC r=½, SF=2

Observation

Fig 4 show the BER performance using the proposed WiMAX MC-CDMA system using LDPC coding when QPSK modulation and 16 QAM is employed, N=256 and SF =2. Hence from the simulation result, observation table is given below

TABLE II

MODULATION	CODE RATE	E_b/N_o (dB)	BER
QPSK	½	12	.0001736
16 QAM	½	18	.0001736

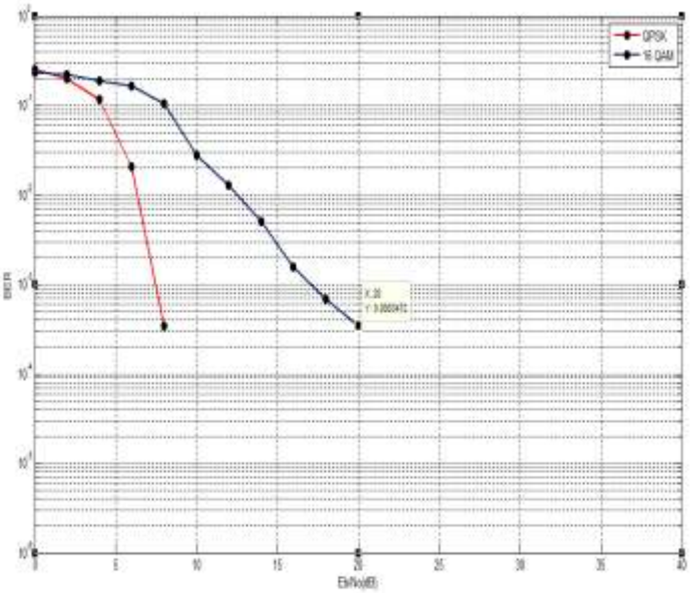

Fig. 5 Simulation Result of QPSK and 16 QAM, LDPC r =¾, SF=2

Observation

Fig 5 show the BER performance using the proposed WiMAX MC-CDMA system using LDPC coding when QPSK and 16 QAM modulation is employed, N=256 and SF =2. Hence from the simulation result, observation table is given below

TABLE III

MODULATIO N	CODE RATE	E_b/N_o (dB)	BER
QPSK	¾	8	.0003472
16 QAM	¾	20	.0003472

IV a. Comparison with existing work

This section used to show the proposed work with existing work. We are using two modulation technique QPSK and 16 QAM of code rate ½ and ¾ respectively From.the results obtained, these output show that BER of LDPC coding is less than RS coding for same no of parameter.

TABLE IV

YEAR OF PAPER	N	Code rate	Modulation Technique	Coding	BER
2010[15]	256	½	QPSK	RS	.003646
		¾	16 QAM	RS	.0006896
PROPOSED	256	½	QPSK	LDPC	.0001736
		¾	16 QAM	LDPC	.0005208

V . CONCLUSION

The major drawback of WIMAX system is high BER and as BER increases , signal to noise ratio decreases. This paper will focus on development and implementation of WIMAX MC - CDMA system using LDPC coding techniques. We have investigated parameters: Bit Error Rate (BER), E_b/N_o (dB) for various modulation and coding schemes and every modulation scheme has its own value for the error function. That is why each modulation scheme performs in different manner due to the presence of background noise. For instance, the higher modulation scheme (16-QAM) is not robust but it carries higher data rate. On the contrary, the lower modulation scheme (QPSK) is more robust but carries lower data rate. Based on conclusion made in Table IV, we can conclude that LDPC coding achieve less BER as compare to RS coding for same modulation technique. Hence from the simulation results we conclude that E_b/N_o of 16 QAM r=¾ is higher than QPSK r =¾ for same value of BER and for same value for spreading factor. Similarly E_b/N_o of 16 QAM r=½ is higher than QPSK r =½ for same value of BER and for same value for spreading factor. For QPSK-½, QPSK-¾ decrease the code rate the BER performance improves and the best result comes for rate ½.

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