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# PERFORMANCE EVALUATION OF A WIMAX SYSTEM USING CODING TECHNIQUE

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**ABSTRACT:**

This paper provide a wireless digital communications system, also known as IEEE 802.16, that is intended for wireless "metropolitan area networks" .WIMAX can provide broadband wireless access (BWA) up to 30 miles for fixed stations, and 3 - 10 miles for mobile stations. The name "WiMAX" was created by the WiMAX Forum. The forum describes WiMAX as "a standards-based technology enabling the delivery of last mile wireless broadband access as an alternative to cable and DSL"[1]. 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 This paper presents simulation of WiMAX using OFDM technique using coding technique . BER versus Eb/No curves are used for comparing the results.

**KEYWORDS**

WIMAX, OFDM, RS CODE.

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# I INTRODUCTION

Broadband wireless is a technology that provide high-speed connection over the air. It uses radio waves to transmit and receive data directly to and from the users. Technologies such as 3G, Wi-Fi, WiMAX and UWB work together to meet unique customer requirements.

WiMAX is short for Worldwide Interoperability for Microwave Access, and it also known as the IEEE name 802.16. WiMAX systems are used to deliver broadband access services to customers. WiMAX was formed in April 2001, in anticipation of the publication of the original 10-66 GHz IEEE 802.16 specifications. WiMAX is to 802.16 as the Wi-Fi Alliance is to 802.11.

WiMAX is designed to operate in both, licensed frequency band of 10-66 GHZ and unlicensed frequency band of 2-11GHZ. If line of sight (LOS) operation is desired, then frequencies greater than 10 GHZ will be utilized. However, for communications that require non-line of sight (NLOS), frequency bands below the 10 GHZ are utilized. Regardless of the frequency bands used, Time Division Duplexing (TDD) and Frequency Division Duplexing (FDD) are both supported [2].

The bandwidth and range of WiMAX make it suitable for the applications like providing portable mobile broadband connectivity across cities and countries, providing a wireless alternative to cable and digital subscriber line (DSL) for "last mile" broadband access, providing data telecommunications (VoIP) and IPTV services (triple play),providing a source of Internet connectivity as part of a business continuity plan[2].

WiMAX supports a number of signal-processing techniques to improve overall system capacity. These techniques include adaptive modulation and coding, multiuser diversity WiMAX is similar to the wireless standard known as Wi-Fi, but on a much larger scale and at faster speeds.

The paper is organized as follows. In Section I, we give an introduction to the WiMAX system. In Section II we give an explanation of WiMAX standard. In Section III we give a brief introduction of coding technique . Section IV illustarate the simulated WiMAX OFDM using different modulation technique. It gives a brief explanation of the transmitter, the channel and the receiver blocks. In Section V, the results are obtained and In Section VI we concludes this paper.

## II WIMAX STANDARDS

In 2001, the WiMAX forum introduced the first fixed Standard 802.16 with line of sight requirement using a single carrier frequency with 10-66GHz spectrum support. This basic standard provides theoretical rates of up to 134Mbps. In January 2003, 802.16a standard was approved with a non line of site support of 2-11 GHz frequency, where the first orthogonal frequency division Multiplexing (OFDM) and the mesh mode were added to WiMAX.[3]

The 802.16 b&c were amendment to the 802.16a and all of them were theoretical standards which later were grouped in the 2004 WiMAX standard 802.16d. The 802.16d known as the first fixed working standard of WiMAX supports data rates of up to 70Mbps, uses 256 point fast Fourier transform for Orthogonal Frequency Division Multiplexing (OFDM) and 2048 points transform OFDMA (OFD Multiple Access)

In 2005 the mobile WiMAX IEEE 802.16e was introduced with the following improvement over previous standards: It supports mobility by Introducing a Mobile Stations (MS) instead of SS. MS in this standard can stay connected during movement from one BS coverage area to another BS coverage area through efficient handover procedures between Base stations[3].

• It uses Scalable OFDMA (SOFDMA) technology to enhance spectrum efficiency and reduce cost in wide and narrow band channels. It obtains this scalability by allowing different FFT point values for each channel width to resulting in a constant carrier spacing[3].

• It adapts to the Advance antenna technology supporting the Multiple In Multiple Out MIMO technology and uses hybrid automatic repeat-request (HARQ) to enhance reliability

• Introduces Turbo Coding and Low-Density Parity Check (LDPC)

• It uses the downlink sub-channelization, allowing administrators to trade coverage for capacity or vice versa[3]

WiMAX standards with details of frequency band, applications, modulation techniques etc are given in Table1 [4].

**Table1.** WiMAX Standards

| | 802.16a | 802.16d-2004 | 802.16e-2005 |
|---|---|---|---|
| Status | Completed December 2001 | Completed June 2004 | Completed December 2005 |
| Application | Fixed LOS | Fixed NLOS | Fixed and mobile NLOS |
| Frequency band | 10GHz-66 GHz | 2GHz-11GHz | 2GHz-11GHz for fixed and 2GHz to 6 GHz for Mobile |
| Modulation | QPSK, 16QAM, 64 QAM | QPSK, 16QAM, 64 QAM | QPSK, 16QAM, 64 QAM |
| Gross data rate | 32 Mbps-134.4 Mbps | 1 Mbps-75 Mbps | 1 Mbps-75 Mbps |
| Multi-plexing | Burst TDM/ TDMA | Burst TDM/ TDMA/ OFDMA | Burst TDM/ TDMA/ OFDMA |
| Duplexing | TDD and FDD | TDD and FDD | TDD and FDD |
| WiMAX implement-tation | None | 256-OFDM | Scalable OFDM |
| Trans-mission scheme | Single carrier only | Single carrier only, 256 OFDM, 2048 OFDMA | Single carrier only, 256 OFDM, SODFM with 128,512, 1024,2048 multicarrier |
| Channel bandwidth | 20MHz, 25MHZ, 28 MHz | 1.75 MHz, 3.5 MHz, 7 MHz, 14 MHz, 1.25 MHz, 5 MHz, 10 MHz, 15 MHz, 8.75 MHz | 1.75 MHz, 3.5 MHz, 7 MHz, 14 MHz, 1.25 MHz, 5 MHz, 10 MHz, 15 MHz, 8.75 MHz |

III Channel coding

Channel coding is an inherent part of any multi-carrier system. By using channel state information (CSI) in a maximum likelihood type FEC decoding process a high diversity and, hence, high coding gain can be achieved, especially in fading channels [6] .

Therefore, it is crucial to choose the encoder in such a way that it enables the exploitation of soft information for decoding. Furthermore, flexibility on the coding scheme to derive different code rates (e.g. for unequal error protection) from the same mother code is always preferred. This flexibility may allow one to adapt the transmission scheme to different transmission conditions.

Compared to a single code, the main advantage of concatenated coding schemes is to obtain much higher coding gains at low BERs with reduced complexity. For concatenated coding, usually as the outer code a shortened Reed Solomon code and as the inner code punctured convolutional codes are used .

Coding techniques is used for providing reliable information through the transmission channel to the user. 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. It is used to reduce the level of noise and interferences in electronic medium. The amount of error detection and correction required and its effectiveness depends on the signal to noise ratio (SNR). In digital communication, coding techniques is a broadly used term mostly referring to the forward error correction code.

The advantage of forward error correction is that a back-channel is not required, or that retransmission of data can often be avoided, at the cost of higher bandwidth requirements on average[7].

Reed Solomon coding and Convolution coding are the two powerful error correction and detection methods to reduce the noise,

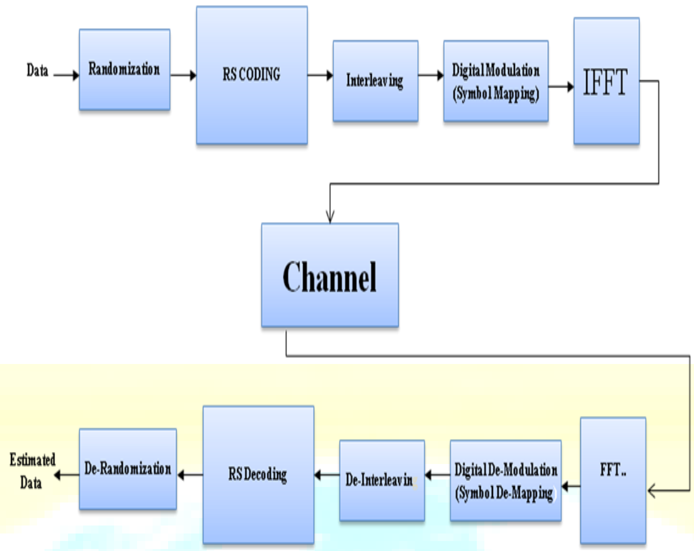


Fig. 1. WiMAX OFDM based Simulation Block Diagram.

## IV. SYSTEM BLOCK DIAGRAM

A. The Transmitter

Fig. 1 above shows the block diagram for the simulated WiMAX system used in this paper. At first, random bits are generated, and then, coded by a concatenated RS and Convolutional encoder. After coding, an interleaver is implemented to avoid long runs of low reliable bits at the decoder input. The interleaved bits are mapped adaptively to a symbol alphabet . The coding, interleaving, and symbol mapping are the same as the ones defined in the WiMAX IEEE 802.16 specification [5]. In our simulation, we have simulated OFDM system in WiMAX .We chose a cyclic prefix length of 1/4 of the total OFDM symbol length for fixed WiMAX .Rician channel is used for transmission of data.

B. The Receiver

At the receiver, we first perform the inverse operations of the transmitter, that is, cyclic prefix removal, FFT, extraction of data subcarriers and pilots subcarriers. The received bits are compared to the transmitted bits, and BER is calculated for different Eb/No.

## PARAMETER SPECIFICATION

MATLAB is a mathematical computing environment which is very effective to calculate and simulate the technical problems. This tool has the capability to perform many different tasks by its different tools in particular cases like matrix manipulation, plotting of functions and data, implementation of algorithms, creation of user interfaces and interfacing with other languages (C, C++, and FORTRAN).

**Table 2 Simulation Parameter.**

| PARAMETER | VALUE |
|---|---|
| BW(FFT) | 5MHz(256) |
| CYCLIC PREFIX | 1/4 |
| DIGITAL MODULATION | QPSK,16QAM,64 QAM |
| Sampling Factor, | 144/125 |
| Sampling Time | 0.1736 $\mu s$ |

## V. SIMULATION RESULTS

In this section we will discuss the results obtained from the WiMAX platform by employing RS codes..

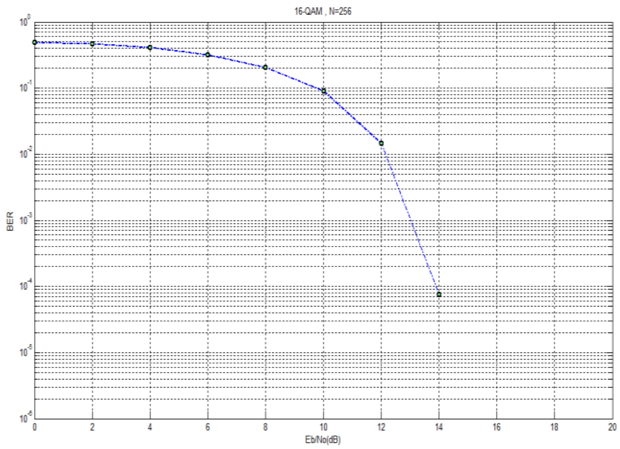


Fig.2. BER versus Eb/No for 16 QAM with RS CODE for r =1/2.

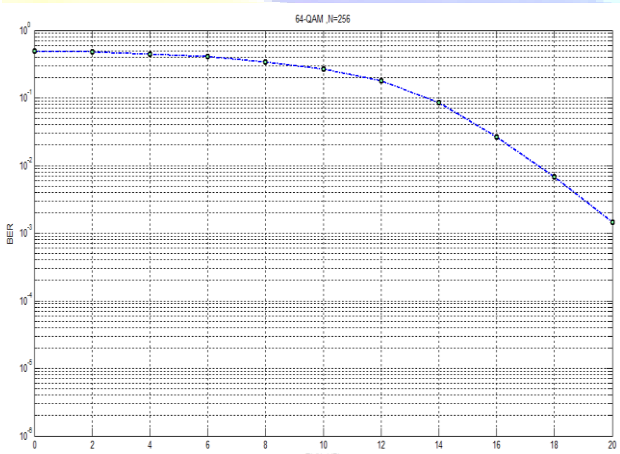


Fig.3. BER versus Eb/No for 64 QAM with RS CODE for r =2/3.

## VI. CONCLUSIONS

In this paper, we present the BER analysis of the RS codes in WiMAX using modulation technique. In case of bandwidth utilization, the 64-QAM (or 256-QAM when used) modulation requires higher bandwidth and gives an excellent data rates as compared to others .At Eb/No =20 dB,BER =.001451

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