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Performance Analysis of Error Correction Code for Mobile OFDM System Using Channel Modelling

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Abstract: - Spectral efficiency is one of the important parameter in order to achieve higher performance in mobile communication environment using modulation and Coding technique. In mobile communication applications higher capacity and data rates is the basic requirement for the reliable communication Forward error correction coding such as convolutional coding (CC) is applied to improve the BER and spectral efficiency of a OFDM system. In this paper, we present the performance of OFDM system with different modulation techniques (16-PSK and 16-QAM) by using forward error correcting codes (convolution code and Reed Solomon code). We performed simulation for RS-CC codes. Here the outer code is RS code and the inner code is CC. The information bits go into the RS encoder and the output of RS encoder is the input of the CC encoder. Performance analyzed using Matlab simulator.

Keywords:-**Convolution coding (CC) codes, Orthogonal Frequency Division Multiplexing (OFDM), Reed Solomon (RS) codes.**

I. INTRODUCTION

From last few decades wireless communications industry is gaining momentum in both fixed and mobile applications. The continued increase in demand for all types of wireless services such as voice, data, and multimedia is demanding the need for higher capacity and data rates not only in fixed but also in mobile applications. 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. The amount of error detection and correction required and its effectiveness depends on the signal to noise ratio (SNR). WiMAX is a wireless technology that provides high throughput broadband connection over long distances based on IEEE.802.16 wireless MAN air interface standard [1]-[5]. WIMAX is a wireless internet service that is capable of covering a wide geographical area by serving hundreds of users at a very low cost. It particularizes a metropolitan area networking protocol that not only provides a wireless alternative for cable, Digital Subscriber Line (DSL) and T1 level services for last mile broadband access but also provides a backhaul for 802.11 hotspots and due to its higher data rates. The IEEE WiMAX standard [2] covers a large range of wireless transmission applications. Compared to WiFi, it can support higher throughput above 100Mbps over larger distances, even with higher mobility involved. The upcoming IEEE WiMAX 802.16e standard also referred to as Wireless MAN [4], is the next step toward very high throughput wireless backbone architectures, supporting up to 500Mbps. Orthogonal frequency division multiplexing (OFDM) is a very attractive multi carrier modulation technique and is being implemented to achieve high bit data rate transmission. This technique is well suited to overcome adverse effects in hostile transmission environment. This technique provides a reliable reception of signals. OFDM is a special form of spectrally efficient MCM technique, which employs densely spaced orthogonal sub carriers and overlapping spectrums. The use of Cyclic Prefix (CP) in OFDM symbol can reduce the effect of ISI even more, but it also introduces a loss in SNR and data rate. The two major drawbacks which hamper the performance of OFDM systems are poor bit error rate (BER) in fading environments and high Peak to average power ratio (PAPR). The transmit signals in an OFDM system might produce high peak values in the time domain since many sub carrier components are added via an IFFT operation. Therefore, OFDM systems are known to have a high PAPR compared with single-carrier systems. The rest of paper is organized as follows: Section II introduces a description for the OFDM simulation model. Detail description of convolutional coding (CC) is presented in Section III. Simulation results are presented in Section IV, and finally conclusions are reflected in Section V.

II. OFDM SYSTEM MODEL

In Fig. 1 shows the OFDM Transmitter and Receiver system, the effect of this is seen as the required bandwidth is greatly reduced by removing guard band and allowing subcarrier to overlap. It is still possible to recover the individual subcarrier despite their overlapping spectrum provided that the orthogonality is maintained. The orthogonality is achieved by performing Fast Fourier Transform (FFT) on the input stream. Because of the combination of multiple low data rate subcarriers, OFDM provides a composite high data rate with long symbol duration. Depending on the channel coherence time this reduces or completely eliminates the risk of Inter-symbol Interference (ISI), which is a common phenomenon in multipath channel environment with short symbol duration.

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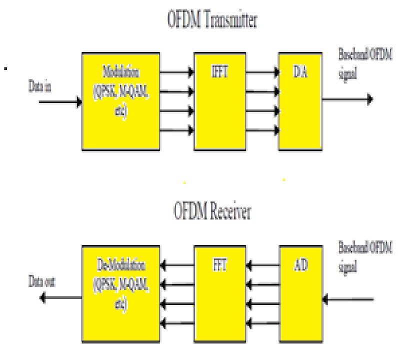

Fig: 1 Basic OFDM Transmitter and Receiver

Orthogonal Frequency Division Multiplexing (OFDM) is a modulation technique that employs N_s separate subcarriers to transmit data instead of one main carrier. Input data is grouped into a block of N bits, where

$$N=N_s.\ m_n \qquad (1)$$

mn is the number of bits used to represent a symbol for each subcarrier. In order to maintain orthogonality between the subcarriers they are required to be spaced apart by an integer multiple of the subcarrier symbol rate, Rs. The subcarrier symbol rate is related to the overall coded bit rate Rc of the entire system by

$$R_s = R_c/N \qquad (2)$$

The effect of fading on BER of OFDM system can be compensated by using channel coding which results in to a coded-OFDM system. The Turbo codes and RS codes with convolution codes are used for channel coding. The symbol mapping schemes used is 16-PSK, 16-QAM. The IFFT/FFT length used is 256. The zero padding is done for confirming the IFFT/FFT size and cyclic prefix is 25% of the IFFT/FFT size, thus making the total size of OFDM frame to 320 symbols.

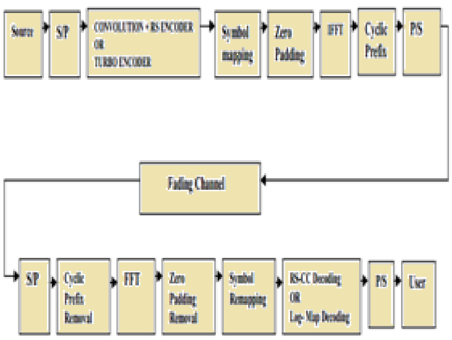

Fig: 2 Coded-OFDM based System

III. FORWARD ERROR CORRECTION CODE

Forward error correction (FEC) is a digital signal processing technique used to enhance data reliability. It does this by introducing redundant data, called error correcting code, prior to data transmission or storage. FEC provides the receiver with the ability to correct errors without a reverse channel to request the retransmission of data. Forward Error Correction (FEC) codes can detect and correct a limited number of errors without retransmitting the data stream. There are two different types of FEC techniques, namely block codes i.e. Reed-Solomon code and Convolutional codes [9]. The Viterbi algorithm is a method for decoding convolutional codes. It has been counted as one of good decoding scheme up to date. This algorithm, however, is vulnerable to burst error which means a series of consecutive errors [10]. Since most physical channels make burst errors, it can be a serious problem.

A. Reed Solomon (RS) Coding

The RS code is one of linear block code [9]. It is vulnerable to the random errors but strong to burst errors. Hence, it has good performance in fading channel which have more burst errors. Reed Solomon codes are Maximum Distance Separable (MDS) codes, which mean they achieve the maximum possible, minimum distance (d_{min}) for the forward error correction codes (FEC) with the specified parameters. The Reed-Solomon (R-S) codes [9] are particularly useful for burst-error correction that is, they are effective for channels that have memory. Also, they can be used efficiently on channels where the set of input symbols is large. An interesting feature of the R-S code is that as many as two information symbols can be added to an R-S code of length n without reducing its minimum distance. This extended R-S code has length n + 2 and the same number of parity check symbols as the original code. Reed-Solomon codes are used to correct errors in many systems such as storage devices, (including tape, Compact Disk, DVD, barcodes, etc), Wireless or mobile communications (including cellular telephones, microwave links, etc), Satellite communications, Digital television / DVB, High-speed modems such as ADSL, xDSL. Reed-Solomon codes have found important applications in space communication and consumer electronics. The R-S decoded symbol-error probability, PE, in terms of the channel symbol-error probability, P_E, can be written as

$$P_E \approx \frac{1}{2^m-1}\sum_{j=t+1}^{2^m-1} j\binom{2^m-1}{j} p^j(1-p)^{2^m-1-j} \qquad (3)$$

where t is the symbol-error correcting capability of the code, and the symbols are made up of m bits each.

B. Convolutional Encoder

Convolution codes offer an approach to error control coding substantially different from that of block codes. Convolutional codes are used extensively in numerous applications in order to achieve reliable data transfer, including digital video, radio, mobile communication, and satellite communication [9]. Convolutional coding is

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done by combining the fixed number of input bits. The input bits are stored in fixed length shift register and they are combined with the help of mod-2 adders. An input sequence and contents of shift registers perform modulo-two addition after information sequence is sent to shift registers, so that an output sequence is obtained. This operation is equivalent to binary convolution and hence it is called convolutional coding [11][12]. The ratio R=k/n is called the code rate for a convolutional code where k is the number of parallel input bits and n is the number of parallel decoded output bits, m is the symbolized number of shift registers. Shift registers store the state information of convolutional encoder, and constraint length (K) relates the number of bits upon which the output depends.

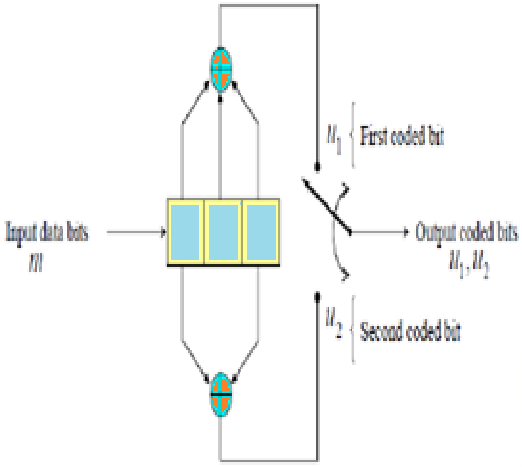

Fig. 3: Convolutional encoder with rate ½, k=1, n=2, K= 4, m= 3.

A convolutional code can become very complicated with various code rates and constraint lengths. A simple convolutional code with ½ code rate is shown in fig.3. Here m represent the current message bit and m1,m2 represent the previous two successive message bits stored which represent the state of shift register. This is a rate (k/n) = 1/2, with constraint length K=3 convolutional encoder. Here k is the number of input information bits and n is the number of parallel output encoded bits at one time interval.

IV. SIMULATION RESULTS

In this section, the simulation results are shown and discussed. In the following sections, first we analysis of Coded OFDM using convolutional Code with 16-PSK and 16-QAM modulation technique is explained. In our study we have done all the simulations to achieve a desired Bit Error Probability. For analysis, we considered the AWGN channel, Rayleigh and Rician fading channel models. Bit error rate (BER) and signal to noise ratio are the parameter that are used for the analysis of OFDM using convolutional Code. Then we performed simulation for RS-CC codes. Here the outer code is RS code and the inner code is CC. The information bits go into the RS encoder and the output of RS encoder is the input of the CC encoder. We have developed the simulator in Matlab. Each block of the transmitter, receiver and channel is written in separate m-file. The main procedure call each of the block in the manner a communication system works. The main procedure also contains initialization parameters, input data and delivers results. The parameters that can be set at the time of initialization are the CP length, modulation and coding rate, range of SNR values.

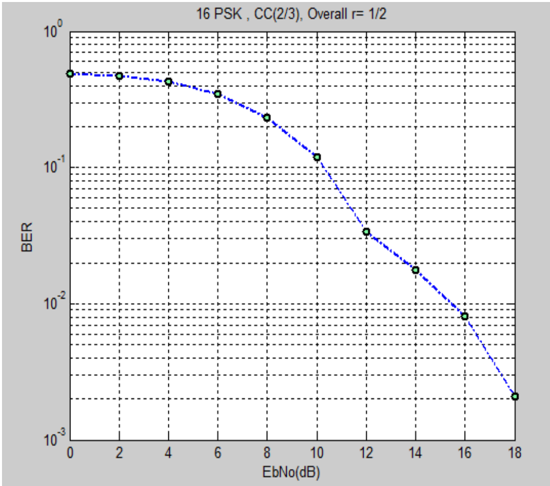

Fig. 4. Bit error rate vs signal to noise ratio for 16 PSK using Convolutional Coding with rate (1/2)

Fig. 4 shows the Bit error rate vs signal to noise ratio for 16-PSK using Convolution Coding with rate (1/2). Fig:5 shows the Constellation diagram for 16-PSK using Convolution Coding with rate (1/2). Convolution coding with a ½ rate and a constraint length of 7, a 16-PSK signal can be transmitted with less power. This can increases data rate for the same transmitter power and antenna size. However, it also increases of bandwidth by a factor of 2. Fig. 6 shows the Constellation diagram for QPSK using Convolution Coding with rate (1/2). Fig. 7 shows the Bit error rate vs signal to noise ratio for 16-QAM using Convolution Coding with rate (1/2).

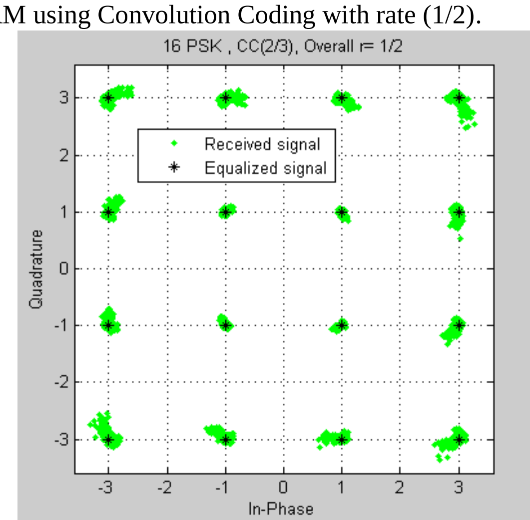

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Fig. 5. Constellation diagram for 16-PSK using Convolutional Coding with rate (1/2)

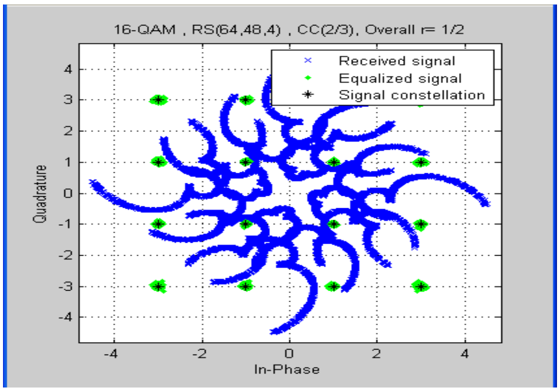

Fig. 6. Constellation diagram for 16-QAM using Convolutional Coding with rate (1/2)

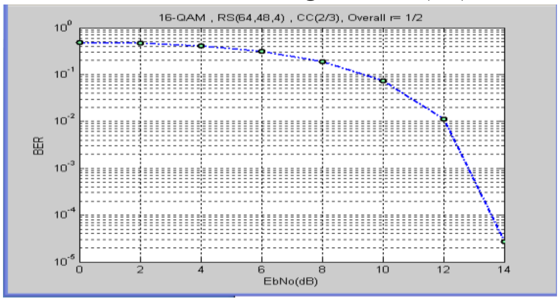

Fig. 7. Bit error rate vs. signal to noise ratio for 16-QAM using Convolutional coding with rate (1/2)

V. CONCLUSIONS

In this paper, Convolutional codes are used for the performance analysis of OFDM system. The simulation results include the performance analysis based on bit error rate (BER) versus bit energy to noise rate (Eb/No) plots with different modulation scheme such as 16-PSK and 16-QAM. OFDM technology promises to be a key technique for achieving the high data capacity and efficiency requirements for wireless communication systems. In mobile communication applications higher capacity and data rates is the basic requirement for the reliable communication Forward error correction coding. Combination of RS & Convolution coding (CC) and modulation technique is applied to improve the BER of a OFDM system.

REFERENCES

[1] L. Nuaymi, “WiMAX: Technology for Broadband Wireless Access,” John Wiley & Sons, 2007.

[2] IEEE 802.16. Worldwide Interoperability for Microwave Access. www.wimaxforum.org.

[3] WiMAX Forum, “Mobile WiMAX - Part I: A Technical Overview and Performance Evaluation,” White paper, August 2006.

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

[5] WiMAX Forum, “Mobile WiMAX - Part I: A Technical Overview and Performance Evaluation,” white paper, August 2006.

[6] A. Svensson, A. Ahlen, A. Brunstrom, T. Ottosson, and M. Sternad, “An OFDM based system proposal for 4G downlinks,” Proceeding MC-SS 2003, Oberp faffen hofen, Germany, pp. 15–22, September 2003

[7] K. Fazel and S. Kaiser, Multi-Carrier and Spread Spectrum System, 2nd edition, New York: John Wiley and Sons Ltd, 2003.

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

[9] Daniel J., Costello, JR., "Error Control Coding, Fundamentals and Applications", Prentice Hall, Inc. Englewood Cliffs, New Jersey, 1983.

[10] Proakis, J. G., "Digital Communications", 3rd ed., New York, McGraw-Hill, 1995.

[11] Vineet Sharma, Anuraj Shrivastav, Anjana Jain, Alok Panday, “BER performance of OFDM-BPSK,-QPSK,-QAM over AWGN channel using forward Error correcting code”, International Journal of Engineering Research and Applications (IJERA) , Vol. 2, Issue 3, pp.1619-1624, May-Jun 2012.

[12] Vivek K. Dwivedi, Abhinav Gupta, Richansh Kumar and G. Singh, ―Performance Analysis of Co ded OFDM System Using Various Co ding Schemes‖ Progress In Electromagnetics Research Symposium Proceedings, Moscow, Russia, August 18-21, 2009.